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Multimedia, Computer Graphics and Broadcasting

First International Conference, MulGraB 2009
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Foreword

As future generation information technology (FGIT) becomes specialized and fragmented, it is easy to lose sight that many topics in FGIT have common threads and, because of this, advances in one discipline may be transmitted to others. Presentation of recent results obtained in different disciplines encourages this interchange for the advancement of FGIT as a whole. Of particular interest are hybrid solutions that combine ideas taken from multiple disciplines in order to achieve something more significant than the sum of the individual parts. Through such hybrid philosophy, a new principle can be discovered, which has the propensity to propagate throughout multifaceted disciplines.

FGIT 2009 was the first mega-conference that attempted to follow the above idea of hybridization in FGIT in a form of multiple events related to particular disciplines of IT, conducted by separate scientific committees, but coordinated in order to expose the most important contributions. It included the following international conferences: Advanced Software Engineering and Its Applications (ASEA), Bio-Science and Bio-Technology (BSBT), Control and Automation (CA), Database Theory and Application (DTA), Disaster Recovery and Business Continuity (DRBC; published independently), Future Generation Communication and Networking (FGCN) that was combined with Advanced Communication and Networking (ACN), Grid and Distributed Computing (GDC), Multimedia, Computer Graphics and Broadcasting (MulGraB), Security Technology (SecTech), Signal Processing, Image Processing and Pattern Recognition (SIP), and u- and e-Service, Science and Technology (UNESST).

We acknowledge the great effort of all the Chairs and the members of advisory boards and Program Committees of the above-listed events, who selected 28% of over 1,050 submissions, following a rigorous peer-review process. Special thanks go to the following organizations supporting FGIT 2009: ECSIS, Korean Institute of Information Technology, Australian Computer Society, SERSC, Springer LNCS/CCIS, COEIA, ICC Jeju, ISEP/IPP, GECAD, PoDIT, Business Community Partnership, Brno University of Technology, KISA, K-NBTC and National Taipei University of Education.

We are very grateful to the following speakers who accepted our invitation and helped to meet the objectives of FGIT 2009: Ruay-Shiung Chang (National Dong Hwa University, Taiwan), Jack Dongarra (University of Tennessee, USA), Xiaohua (Tony) Hu (Drexel University, USA), Irwin King (Chinese University of Hong Kong, Hong Kong), Carlos Ramos (Polytechnic of Porto, Portugal), Timothy K. Shih (Asia University, Taiwan), Peter M.A. Sloot (University of Amsterdam, The Netherlands), Kyu-Young Whang (KAIST, South Korea), and Stephen S. Yau (Arizona State University, USA).

We would also like to thank Rosslin John Robles, Maricel O. Balitanas, Farkhod Alisherov Alisherovish, and Feruza Sattarova Yusfovna – graduate students of Hannam University who helped in editing the FGIT 2009 material with a great passion.

October 2009

Young-hoon Lee
Tai-hoon Kim
Wai-chi Fang
Dominik Ślęzak

Preface

We would like to welcome you to the proceedings of the 2009 International Conference on Multimedia, Computer Graphics and Broadcasting (MulGraB 2009), which was organized as part of the 2009 International Mega-Conference on Future Generation Information Technology (FGIT 2009), held during December 10–12, 2009, at the International Convention Center Jeju, Jeju Island, South Korea.

MulGraB 2009 focused on various aspects of advances in multimedia, computer graphics and broadcasting, mathematics and information technology. It provided a chance for academic and industry professionals to discuss recent progress in the related areas. We expect that the conference and its publications will be a trigger for further related research and technology improvements in this important subject.

We would like to acknowledge the great effort of all the Chairs and members of the Program Committee. Out of around 40 submissions to MulGraB 2009, we accepted 11 papers to be included in the proceedings and presented during the conference. This gives an acceptance ratio firmly below 30%. One of the papers accepted for MulGraB 2009 was published in the special FGIT 2009 volume, LNCS 5899, by Springer. The remaining 10 accepted papers can be found in this CCIS volume.

We would like to express our gratitude to all of the authors of submitted papers and to all of the attendees, for their contributions and participation. We believe in the need for continuing this undertaking in the future.

Once more, we would like to thank all the organizations and individuals who supported FGIT 2009 as a whole and, in particular, helped in the success of MulGraB 2009.

October 2009

Dominik Ślęzak
William I. Grosky
Niki Pissinou
Timothy K. Shih
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A CAD System for Evaluating Footwear Fit

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Abstract. With the great growth in footwear demand, the footwear manufacturing industry, for achieving commercial success, must be able to provide the footwear that fulfills consumer's requirement better than it's competitors. Accurate fitting for shoes is an important factor in comfort and functionality. Footwear fitter measurement have been using manual measurement for a long time, but the development of 3D acquisition devices and the advent of powerful 3D visualization and modeling techniques, automatically analyzing, searching and interpretation of the models have now made automatic determination of different foot dimensions feasible. In this paper, we proposed an approach for finding footwear fit within the shoe last data base. We first properly aligned the 3D models using "Weighted" Principle Component Analysis (WPCA). After solving the alignment problem we used an efficient algorithm for cutting the 3D model in order to find the footwear fit from shoe last data base.

Keywords: 3D acquisition, Alignment, "Weighted" Principle Components Analysis.

1 Introduction

Footwear fit is one of the most important consumer considerations when purchasing shoes. Properly constructed footwear may provide the right pressure and force at the different locations on the foot surface, and this may result in improved comfort, fit and foot health. The design of new shoes starts with the design of the new shoe last. A shoe last is a wooden or metal model of human foot on which shoes are shaped. Traditional foot measurement techniques took a lot of time and custom-tailored shoe making has to make a great deal of work for each specific consumer, i.e. specific consumer's foot and shoe last must be manually manufactured with shoe maker's experience.

Customer's focus can influence today's business. Mass customization starts with understanding individual customer's requirements and it finishes with fulfillment process of satisfying the target customer with near mass production efficiency. The issue of good shoe fit was posed as early as 1500 B.C. in " Ebers Papyrus", which describes a wide range of illnesses from poor footwear. Well designed of shoe last, which represent the approximate shape of the human foot, is very important in the

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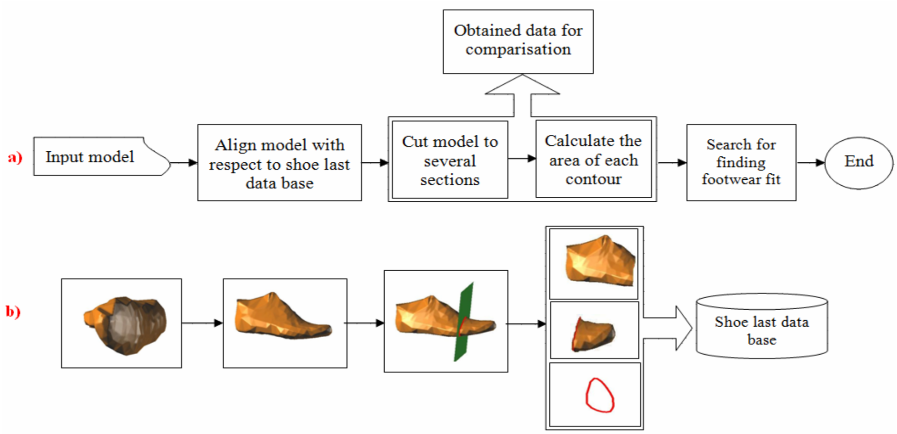

Fig. 1. a, b. Algorithm flowchart and its illustration. a) The flowchart. b) The illustration of flowchart.

whole shoemaking process. Traditionally, foot dimensions are measured using the device such as the Ritz Stick device [1], the Brannock device [2], the Scholl device [3], calliper and tape are used for measurement of foot dimensions. Foot measuring always takes a lot of time.

Unlike any other consumer product, personalized footwear or the matching of footwear to feet is not easy if delivery of comfortable shoe is to be the ultimate goal, even though footwear related discomfort is predominantly caused by localized pressure induced by a shoe that has a design unsuitable for the particular foot shape.

There are already some approaches in literature [4], [5] and [6]. The typical suggestion coming from literature is selecting a shoe last from a shoe last data base or deforming it into one that fits the scanned foot data. For instance, Li and Jneja [4], obtained the new shoe last by generating smooth surface between two given disjoined surfaces of the front and rear parts of the shoe last. This method is helpful for companies which already maintain library of shoe last rear parts. However, this method is not very accurate because the consumer's foot may change from time to time. Authors in [7], used colour-code mismatch between human foot and shoe last quantify footwear fit to predict the fit related comfort.

Nowadays, the combination of 3D scanning system with mathematical technique makes it possible, to produce shoe last automatically based on consumer’s foot shape.A meaningful way to evaluate footwear compatibility would be to determine the dimensional difference between the foot and shoe. The approach proposed in this paper is meant to automatically align 3D models and cutting 3D model to several sections. Then the area of each section (available contours) is calculated and compared with the area of equal sections in shoe last data base. So that best fit can be obtained relatively automatically and quickly. Figure 1 shows the flowchart of our proposed process presented in this paper.

This paper is structured as flows: Section 2 presents alignment of 3D model, while in Section 3 we present an efficient algorithm for cutting the 3D model. Finally, the conclusion remarks are gathered in section 4.

2 Alignment of 3D Model

Point-clouds resulting from 3D scanning are given in an arbitrary position and orientation in 3D space. Pose estimation of a 3D-mesh model, based on the Extended Gaussian Images (EGIs) [8], is one of the first approaches reported in the literature. An EGI defines a function on a unit sphere, by using normal vectors of faces of the mesh. The method is sensitive to polygon tessellations of a 3D-shape, noise, and face orientation. Minovic et al. [9] introduce a method based on the computation of symmetries of a principle octree aligned with the principle axes.

Principle Component Analysis (PCA) is a common method extensively used in analysis, compression, neutral computing and recognition of objects because of its simplicity and ability for dimensionality reduction [10], [11]. The purpose of the principle component analysis applied to 3D model is to make the resulting shape feature vector independent to translation and rotation as much as possible. Comparing two models requires finding the rotation at which the models are optimally aligned.

We may apply PCA to sets of 3D point-clouds, but different sizes of triangle meshes cannot be considered. In order to account for different sizes of triangle Paquet et al. [12] established weights associated to center of gravity of triangles and Vranic et al. [13] used weighting factors associated to vertices. These two methods showed improvements if compared to the classical PCA. The "weighted" PCA analyses were designed to approximate the PCA of the whole point set of the model.

All the models should be aligned at equal position, in order to have equivalent cross sections from center of mass of each model towards the heel and toe. To achieve the alignment we described the main steps and details of "weighted" PCA in the next subsection. First, we applied Step 1 through Step 3 for the first model in shoe last data base (See Figure 2). Then, for alignment of another models with the first model we applied Steps 1, 2, 4, 5. (See Figure 3).

Let $T=\{t_1, \ldots, t_n\}$ ($t_i \subset R_3$) be a set "triangle mesh", $V=\{v_1, \ldots, v_n\}$ ($v_i= (x_i, y_i, z_i) \in R_3$) be a set of "vertices" associated to triangle mesh and c be the "center of gravity" of the model.

Step 1. Translate center of gravity to the origin and create a new list of vertices, I , such that:

$$c = \sum_{i=0}^{n} \frac{v_i}{n} \quad (1)$$

$$I=\{v_1-c, \ldots, v_n-c\} \quad (2)$$

Step 2. Let A be the total sum of the areas of all triangles in the mesh, let A_k be the area of triangle k within the mesh, let ct_i be "center of gravity of each triangle " and ct

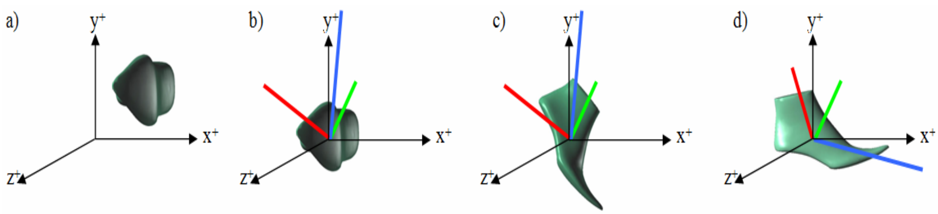

Fig. 2. a) Input 3D smooth triangle. b) Translated center of gravity to the origin. The red, green and blue lines are eigenvectors. c) Rotated 3D model with it's eigenvectors. d) Target model.

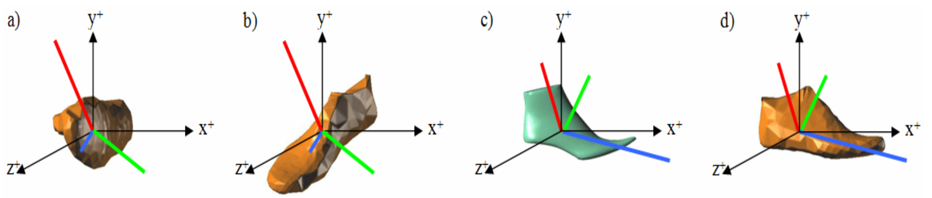

Fig. 3. a) Translated center of gravity to the origin. b) Rotated 3D foot model. d) The alignment of 3D foot in b with shoe last in c.

the total sum of "center of gravity" of all of triangles in mesh. The covariance matrix (3*3) is determined by:

$$ct = \sum_{i=0}^{n} \frac{ct_i}{n} (ct = (x_i, y_i, z_i \in R_3)) \tag{3}$$

$$CM = \begin{bmatrix} \mathrm{cov}_{xx} & \mathrm{cov}_{xy} & \mathrm{cov}_{xz} \\ \mathrm{cov}_{yx} & \mathrm{cov}_{yy} & \mathrm{cov}_{yz} \\ \mathrm{cov}_{zx} & \mathrm{cov}_{zy} & \mathrm{cov}_{zz} \end{bmatrix} \tag{4}$$

$$\mathrm{cov}_{xx} = \sum_{i=0}^{n} \frac{A_i (ct_i x - ctx)(ct_i x - ctx)}{A} \tag{5}$$

Covariance matrix CM is a symmetrical real matrix, therefore its eigenvectors are positive real numbers and orthogonal. We sort eigenvalues in decreasing order to find the corresponding eigenvectors and to scale them in Euclidean unit lengths.

The rotational matrix R is constructed with eigenvectors in rows. We apply this matrix to all of the vertices of a triangle and we form a new vertex sets called:

$$I' = \{R \times I_1, \ldots, R \times I_n\} \tag{6}$$

Step 3. Rotate first shoe last with its eigenvectors in Figure 2.c up to a position where the foot shape becomes parallel with x-y space, see Figure 2.d. Record the new position of these 3 eigenvectors in the file as the origin matrix, O_{em}.

$$O_{em} = \begin{bmatrix} OrgionEig_1 x & OrgionEig_2 x & OrgionEig_3 x \\ OrgionEig_1 y & OrgionEig_2 y & OrgionEig_3 y \\ OrgionEig_1 z & OrgionEig_2 z & OrgionEig_3 z \end{bmatrix} \tag{7}$$

Step 4. Let matrix N_{em} be transpose of a matrix R and O_{em} be the origin matrix that is recorded in step 3. The alignment is accomplished by constructing a rotation matrix R' through the following formula:

$$R' = O_{em} \times N_{em} \tag{8}$$

Step 5. Get the matrix R' calculated in Step 4 and apply it to all I′. New point sets I'' are calculated .see Figure 3.

$$I' = \{ R' \times I_1', \ldots, R' \times I_n' \} \tag{9}$$

3 Cutting 3D Model into Several Sections

The similarity search algorithm is based on the cutting foot triangle mesh into several sections towards the heel and the toe. Then the area of each section (available contour) is calculated and compared with the area of equal sections in shoe last data base

Let M be the mesh structure of the model. A triangular mesh is defined as a set of vertices and a set of edges and triangles that join these vertices. The two triangles which share a common edge are called adjacent triangles. The model consists of three list V, E, T as follows:

Triangle list consists of 3 edges, edges list consists of 2 vertices and adjacent triangles and Vertex list consists of coordinates in 3D ($v_i = (x_i, y_i, z_i) \in R_3$). Fig.4.a is illustrated these basic concepts.

3.1 Search for Similarity Estimation

The algorithm has the following steps summarized in Figure 4.b. First, find the intersection of the cutting plane with the edge of a triangle and create new vertex. Then, choose the edge with the endpoints on the opposite sides of the intersection point and build edge between the intersection point and the opposite vertices of the current edge's triangles. Next, build new triangles between the new edges. Finally, Update the triangles and vertices of the current edge and add new triangles and the edges to the list.

The output of our algorithm is a set of vertices and edges related to each contour . Let $Vc = \{v_1, \ldots, v_n\}$ ($v_i = (x_i, y_i, z_i) \in R_3$) be a set of "vertices" and $E_c = \{e_1, \ldots, e_n\}$ the set of "edges" associated to the contours. The area of each contour can be calculated by finding center of contour (c_{oc}) and dividing the vertices of contour's edge and center of contour in triangles. Let A_i be the area of each associated triangle in the contour and N be the number of triangles that associated with the edges and center of gravity of contour. The area of each contour can be calculated as follow:

$$c_{oc} = \sum_{i=0}^{n} \frac{Vc_i}{n} (c_{oc} = (x_i, y_i, z_i \in R_3)) \tag{10}$$

$$A = \sum_{i=0}^{N} A_i \tag{11}$$

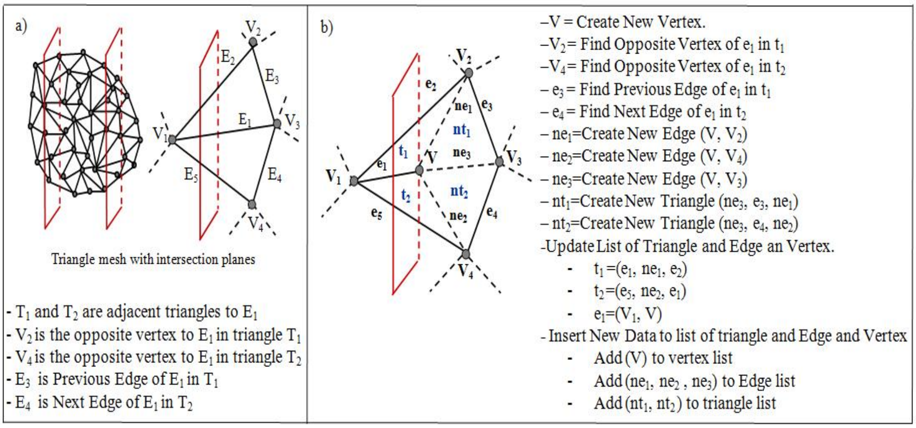

Fig. 4. a) Basic concepts related to algorithm. b) Steps for cutting shape to several.

4 Conclusion

In this paper, an approach for computerize footwear fit is proposed. It deals with the alignment of foot with shoe last data base and an efficient and precise algorithm for cutting the model to several sections to find the footwear fit within a shoe last data base. This approach should clearly help to improve the user's comfort and it could be the starting point for mass customization approach in footwear design. As a future work and development, the specific sections of the foot will be compared to corresponding sections of shoe last data base, so that new shoe lasts will be designed in such a way that they fit costumer's feet completely.

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A New Method of Viewing Attachment Document of eMail on Various Mobile Devices

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Abstract. As the computing power of the mobile devices is improving rapidly, many kinds of web services are also available in mobile devices just as Email service. Mobile Mail Service began early, but this service is mostly limited in some specified mobile devices such as Smart Phone. That is a limitation that users have to purchase specified phone to be benefited from Mobile Mail Service. In this paper, it uses DIDL (digital item declaration language) markup type defined in MPEG-21 and MobileGate Server, and solved this problem. DIDL could be converted to other markup types which are displayed by mobile devices. By transforming PC Web Mail contents including attachment document to DIDL markup through MobileGate Server, the Mobile Mail Service could be available for all kinds of mobile devices.

Keywords: Mobile Mail, DIDL markup, MobileGate Server, PC Web Mail.

1 Introduction

As the Mobile Email Service has started early, user could check original PC Web Mail contents with mobile device including attachment. Attachment document is the widely used contents in Email Service such as MS Office, PowerPoint, Excel, PDF and so on. These documents could not be viewed through mobile devices directly. Devices have to be installed with special software to view document, and then user downloads the attachment document in devices and views them through installed software. This is a limited and inconvenient way of Mail Service in mobile device. Users have to purchase specified mobile device which could install specified software for using the service. [3]

In WAP(wireless application protocol) based Mobile Mail Service, users do not have to install software. But there is still existing problem for any mobile device. The supporting markup types of mobile devices are different. There are some kinds of markup types being used in mobile devices, they are WML(wireless markeup language), XHTML(extensible hypertext markup language), MHTML(mobile hypertext markup language), HDML(handheld devices markup language) and so on. There is no special markup type could support all kinds of mobile devices, and no markup type could available for viewing attachment document with any mobile

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device. In this paper, it solved this problem by using DIDL(digital item declaration language) markup type and MobileGate Mobile Web Server. DIDL is kind of markup type which could be converted to other markup types, and MobileGate does this job, converting DIDL to other markup types corresponding accessing mobile device.[5]

In this paper, it described new kind means of service of viewing attachment document of Email. It converts attachment document to image first, then, generates DIDL with converted image. Since the converted image is big to view with small mobile device, it needs to be divided suitable for device's browser. And it services generated DIDL through MobileGate, users could view the attachment document in full browsing with small device screen.

2 Structure of Attachment Document Service

As mentioned above, it used a DIDL markup type and MobileGate for attachment document service. DIDL is a standard markup Language which was defined in MPEG-21, it has XML formation and Mobile Web Page could be generated in DIDL format. Generated DIDL Mobile Web Page is serviced to mobile devices through the smart server MobileGate, once a mobile device accesses the DIDL Mobile Web Page, the MobileGate checks the type of browser of accessing mobile device first, and then converts the DIDL Mobile Web Page to corresponding markup type page.

Figure 1 shows the structure of flow of new service viewing attachment document with mobile device. It is a WAP based service using DIDL markup type and servicing through MobileGate to any mobile device. As shown in Figure 1, the attachment document has three main steps to be serviced to mobile device finally. The first step is

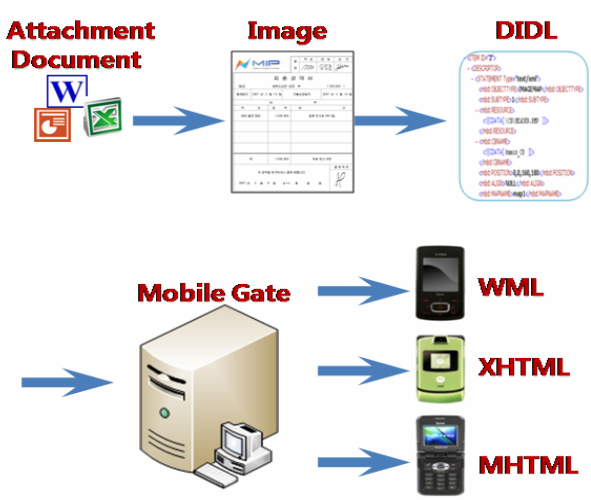

Fig. 1. The structure of service flow

converting attachment to image. This is a middle processing of attachment document to be transformed to Mobile Web Page. Since the original attachment document file could not be used for generating DIDL page. After File-to-Image process, the next step is generating DIDL page with converted image, since DIDL markup type is in XML format, DIDL page could be composed of image object. The final step is converting DIDL page to other markup type corresponding accessing mobile device. If the mobile device supporting WML, the MobileGate converts DIDL page to WML markup type and services the converted WML page to that mobile device. Other mobile devices are also serviced in the same way. Therefore, any mobile devices could access the DIDL page through MobileGate. This whole service also has meaning of transforming attachment document to Mobile Web Page through middle format image. And the method of transforming document to DIDL enables uses view attachment document with any mobile device. It is a new kind of method supporting attachment document in Mobile Email Service.

3 Method of Dividing Attachment Document

Since there is remarkable contrast between size of document and size of browser embedded in mobile device, it needs to do previous work on document. The first step is converting attachment document to image, image is the middle format for converting document to Mobile Web page, and next step is generating DIDL with converted image, finally, the generated DIDL is serviced through MobileGate and attachment document could be viewed with mobile device.

3.1 Converting Attachment Document to Image

There are various documents can be attached in Email, and these documents could not be used for generating DIDL directly. First it must convert these documents to image, and the converted image could be used for generating DIDL. For example, attached MS word document could not be converted to Mobile Web Page or be used for generating Mobile Web Page, it needs be converted the other file type which could be one component of Mobile Web Page. And image is the best type to be the middle format between original document file and DIDL.

DIDL page is composed of many kinds of objects. They are text, image, input box, combo box, button, etc. These objects compose the DIDL page as items of page, and one DIDL page could contains many objects. In this paper, it only needs one image object to compose DIDL page. In other words, DIDL page contains the converted image to be serviced for mobile device.

3.2 Dividing Image Suitable for Mobile Device

The size of normal document is far bigger than any mobile device, that the original image from attachment document could not be viewed at one look with mobile device. To check every corner of DIDL page contains large image, it needs to be navigated using scroll bar. But most of mobile devices only support vertical scroll bar for Mobile Web Page. User can navigate up and down, but can’t navigate right and left. If it reduces the whole image size suitable for browser, it can't read the content clearly in image.

User would need to view two kinds of service of viewing attachment document with mobile. The first is user would need to view whole structure of document in one look. The other service is user need to read content of document clearly. To be capable of these two services, in this pager, it reduces the size of big image size and servers that for viewing full image of document first. And then, for viewing detail content of document, it divides big image into several blocks which should be clear enough for reading. User could read any corner of document by handling vertical scroll bar of mobile device.

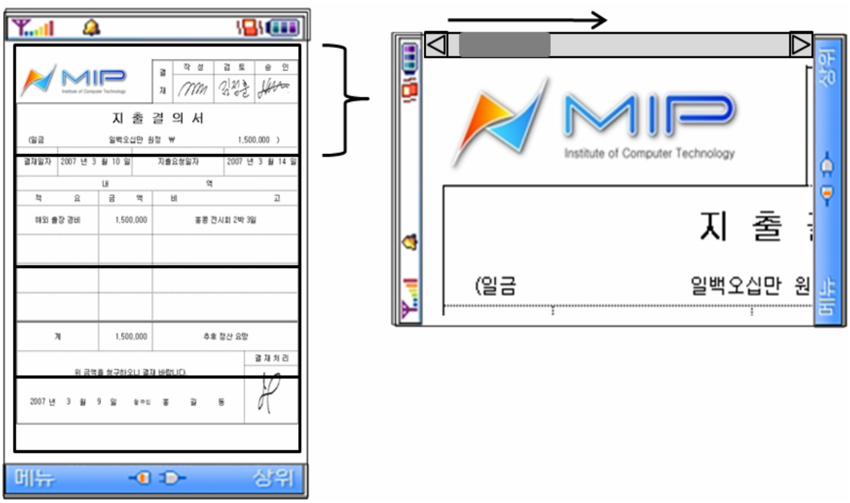

Fig. 2. Dividing image into blocks

Figure 2 shows the method of dividing image converted from attachment document. It divides one image to several blocks, and one block image could be viewed completely in browser by navigating with vertical scroll bar.

4 Generating DIDL from Attachment Document

Once the attachment document was converted to image and divided into blocks, it is ready for generating DIDL page with them. The generated DIDL page could be viewed with any mobile device through MobileGate.

4.1 Structure of DIDL

DIDL is kind of markup type which is another XML-packaging specification containing objects composing DIDL page. DIDL page starts from tag <CONTAINER> and ends at tag </CONTAINER>, these tags represent start and end of whole page. Tag <CONTAINER> contains tag <ITEM> which ends at tag

</ITEM>. <ITEM> represents all kinds of objects which compose DIDL page such as text, image, input box, combo box, button, etc. <ITEM></ITEM> contains object's properties as object type, subtype, position, align and so on.

4.2 Generating DIDL

In this paper, it composes two DIDL pages with divided image blocks, these block could be the items of DIDL by IMAGE object type. One page is a full viewing of whole page which is composed of several blocks. The other page is detail viewing page which is composed of one block.

Table 1 shows the structure of generated first DIDL page which contains several images. In script, every image is one item, and it has item ID which is unique. Item has its object properties in DIDL page. The first image item gets ID "1". And there are several properties, since it uses image object, the property of OBJECTTYPE is IMAGE. POSITION represents position of object at DIDL page and size of image when displays in browser. RESOURCE represents the location of the image stored, it is the path of image would display in browser. The next image block is the next object in DIDL page. It get item ID 2, and also has its own properties about OBJECTTYPE, POSITION, RESOURCE, etc. The other DIDL page also has the same structure which only contains one image object. Since it is detail viewing page, the POSITION property has relatively big image size which enable image to be displayed clearly in browser.

The generated DIDL pages are displayed like this: user views the full viewing of image from attachment document, but displayed image is a relatively reduced image, user can't read the content in it. User selects one part of image in block and displays it in the other DIDL page. It is detail viewing page which user can read the content clearly. User could check any part of attachment document in this way.

Table 1. The structure of generated DIDL page

```
<CONTAINER ID="Page">
  <DESCRIPTOR>
  </DESCRIPTOR>
   <ITEM ID="1">
        <DESCRIPTOR>
         <STATEMENT Type="text/xml">
               <mbd:OBJECTTYPE>IMAGE</mbd:OBJECTTYPE>
            <mbd:SUBTYPE>NULL</mbd:SUBTYPE>
               <mbd:POSITION>0,0,240,150</mbd:POSITION>
            <mbd:Z-INDEX>0</mbd:Z-INDEX>
            <mbd:ALIGN>NULL</mbd:ALIGN>
               <mbd:RESOURCE>./img_block01.jpg</mbd:RESOURCE>
         </STATEMENT>
         </DESCRIPTOR>
        </ITEM>
 <ITEM ID="2">
    … … …
         <mbd:OBJECTTYPE>IMAGE</mbd:OBJECTTYPE>
         <mbd:RESOURCE>./img_block02.jpg</mbd:RESOURCE>
… … …
  </ITEM>
  … … …
</CONTAINER>
```

5 Experiment

The experiment with different attachment document was performed like this, environment of server installing MobileGate and serving DIDL Mobile Web Page can be outlined as showed in Table 2, The MobileGate works with IIS Web Server.

Table 3 shows the mobile devices supporting different markup type and attachment documents used in experiment. The first device is SPH-V9850, it embeds LION browser which supports WML markup type. The second device is SPH-W2400, it embeds KUN browser which supports XHTML markup type. The third device is LG-KP4400, it embeds KUN browser which supports MHTML markup type.

Table 2. The environment of server

OS	Microsoft Windows 2003 Professional Edition
CPU	Intel Pentium IV 3 GHz
Memory	2G byte
Web Server	IIS 6.0

Table 3. The test mobile devices

Device	markup	Attachment
SPH-V9850	WML2.0	MS Word &PPT
SPH-W2400	XHTML	MS Word &PPT
LG-KP4400	MHTML	MS Word &PPT

The attachment document was converted to image by File-to-Image module first, and then it divides the image into blocks suitable for device's browser. The next step is generating DIDL page with divided images. There are two DIDL pages as shown in Figure 3 and Figure 4. The first one is full viewing page and the other is detail viewing page. When user accesses the DIDL page with mobile devices showed in Table 3, MobileGate converts DIDL to WML, XHTML or MHTML corresponding to accessing device's browser, and then services that to mobile device. The displayed screen of mobile device is shown in Figure 3 and Figure 4. First user views full attachment document, selects one block which user intends to read detailed content. The next screen shows the detailed viewing of block image, user navigates with vertical scroll bar on screen reading contents. As shown in Figure 3 and Figure 4, the method of diving image is a little different according to document type. In Figure 3, it displays MS Word document on device screen. It divided image from one document page into several image blocks, for one page of MS Word document could not be viewed clearly in one look. In Figure 4, it displays MS PowerPoint document on device screen.Since one slide of PowerPoint file could be showed clearly in screen, it divided the image from PowerPoint document into block images in slide unit, every slide is one block image and user could read content contained in document.

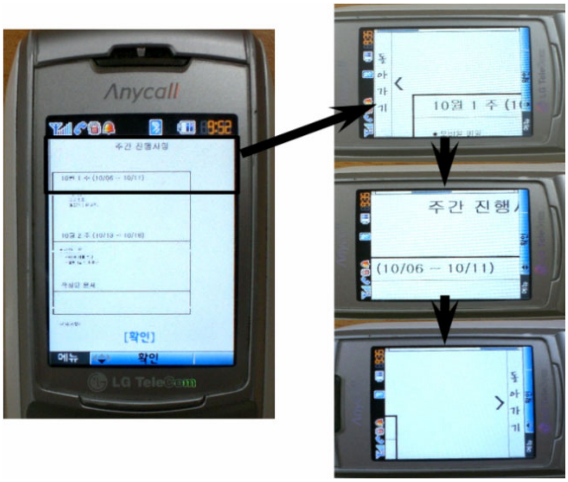

Fig. 3. Displayed result of MS Word attachment document

Fig. 4. Displayed result of MS PowerPoint attachment document

In experiment, it tested three different mobile devices supporting different markup types shown in [Table3]. MobileGate successfully converted DIDL to corresponding markup types and made them displayed in devices as shown in Figure 3 and Figure 4. There would be more mobile devices using this service in Mobile Email Service, MobileGate converts DIDL to their supporting markup type in real time, users could view the attachment document with any mobile device through DIDL and MobileGate. The purpose of displays attachment document of Email with no installing and for any mobile device is accomplished through DIDL markup type and MobileGate Mobile Web Server in this paper.

6 Conclusion

Viewing attachment document of Email with mobile device is a hot issue in Mobile Email Service. Many services display attachment document by installing special software to open and view them. It is a problem that user has to purchase the limited mobile device and install software in device to use service. WAP based Mobile Email Service could solve this problem by displaying document with Mobile Web Page. However, there is another difficulty existing in WAP based system, that mobile devices support different markup type of Mobile Web Page. This paper solved this problem by DIDL(digital item declaration language) markup type and MobileGage, it converts attachment document to image first, and then generates DIDL with that image and serves through MobileGage. MobileGate converts genterated DIDL to other markup types corresponding to accessing mobile devices. In this service, it needs a powerful File-to-Image module which could convert all kinds of attachment document to image, currently, the service is only limited in MS Office document in this paper, it needs to be upgraded in the future work. And there would be more new mobile devices to be used in the future, it needs to continuously upgrade converting function of MobileGate converting DIDL markup type to any markup type, therefore, any mobile device could view more attachment documents through this service.

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18. http://www.nttdocomo.co.jp/english/ps/imode/

Parallel Mass Transfer Simulation of Nanoparticles Using Nonblocking Communications*

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Abstract. This paper presents experiences and results obtained in optimizing parallelization of the mass transfer simulation in the High Gradient Magnetic Separation (HGMS) of nanoparticles using nonblocking communication techniques in the point-to-point and collective model. We study the dynamics of mass transfer statistically in terms of particle volume concentration and the continuity equation, which is solved numerically by using the finite-difference method to compute concentration distribution in the simulation domain at a given time. In the parallel simulation, total concentration data in the simulation domain are divided row-wise and distributed equally to a group of processes. We propose two parallel algorithms based on the row-wise partitioning: algorithms with nonblocking send/receive and nonblocking scatter/gather using the NBC library. We compare the performance of both versions by measuring their parallel speedup and efficiency. We also investigate the communication overhead in both versions. Our results show that the nonblocking collective communication can improve the performance of the simulation when the number of processes is large.

Keywords: Message Passing Interface; Parallel Simulation; Nonblocking collective operations; Scatter and Gather; Communication optimization; High Gradient Magnetic Separation (HGMS).

1 Introduction

High Gradient Magnetic Separation (HGMS) is a powerful method for the removal of weakly magnetic particles from fluids [1]. In this method, high gradient of magnetic field and magnetic energy density are produced in the separation process to maximize the magnetic force that acts on the magnetic particles. HGMS has been applied in many fields including mineral beneficiation [2], blood separation in biochemistry, waste water treatment, and food industry [3-5]. HGMS can be also used in other research and industrial areas that rely on the separation of colloidal particles. The mass transfer process is studied via statistical approach. Sequential simulation of

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diffusive capture of weakly magnetic nanoparticles in HGMS had been developed and reported in [6].

To investigate the process of mass transfer in a particular situation, the governing equations describing the process dynamics are solved to obtain the distribution behavior of target particles in the considered regions. Equations of a mass transfer process frequently occur as non-linear partial differential equations of second or higher order which are hard to be solved analytically, hence numerical methods are used. The finite-difference method is a standard approach for that: The distribution configuration of the particles is computed numerically at many discrete points in the considered regions. The increase the number of discrete points, the higher is the accuracy of the results the more time is needed to accomplish the computation. Parallelization is necessary to improve the accuracy of the results and reduce the computing time.

This paper proposes two parallel algorithms for the parallelization of HGMS. Both algorithms use nonblocking communications. The first algorithm using point-to-point model with MPI_Isend/Irecv in a ring communication. The second algorithm uses the nonblocking collectives Igather/Iscatter from libNBC [8]. We compare the efficiency of both communication styles. We found that the first algorithm has a small overhead compared to the second one in our experiments. However, the communication cost of the ring communications increases as the number of processes increases while the communication time in the collective style remains quiet constant. Thus, when computing using more number of processes, the nonblocking collective approach can perform well.

2 Backgrounds

Our case study is the mass transfer process of weakly-magnetic nanoparticles during magnetic separation. As a particular application we study the separation of such particles from static water by a magnetic method. The system consists of static water with an assembly of monotype weakly-magnetic nanoparticles as a suspension and a capture center modeled as a long ferromagnetic cylindrical wire of radius . All compositions of the system are considered as linear isotropic homogeneous magnetic media. A uniform magnetic field is applied perpendicular to the wireṣ axis. We define the particle volume concentration, denoted by c, as the fraction of particle volume contained in an infinitesimal volume element of the system. According to the geometry of the capture center and the symmetry of the problem, the normalized polar coordinates are used[7]. The distance is the radial distance from the wireṣ axis in the unit of wire radius, is the angle defined in a plane perpendicular to the wireṣ axis. The mass transfer process is studied in normalized time domain which is defined based on real time, particle diffusion coefficient and wire radius. The governing equation of our case study, derived by Davies and Gerber [7], can be expressed as

$$\frac{\partial c}{\partial \tau} = \frac{\partial^2 c}{\partial r_a^2} + \frac{1}{r_a}\frac{\partial c}{\partial r_a} + \frac{1}{r_a^2}\frac{\partial^2 c}{\partial \theta^2} - \frac{G_r c}{r_a} - G_r \frac{\partial c}{\partial r_a} - c\frac{\partial G_r}{\partial r_a} - \frac{G_\theta}{r_a}\frac{\partial c}{\partial \theta} - \frac{c}{r_a}\frac{\partial G_\theta}{\partial \theta} \tag{1}$$

and

$$\left(\frac{\partial c}{\partial \tau}\right)_I = \frac{1}{(r_a)_I^2}\left(\frac{\partial^2 c}{\partial \theta^2}\right)_I - \left(\frac{G_\theta}{r_a}\frac{\partial c}{\partial \theta}\right)_I - \left(\frac{c}{r_a}\frac{\partial G_\theta}{\partial \theta}\right)_I + \frac{(G_r c)_{I+1}}{\delta r_a} - \frac{1}{\delta r_a}\left(\frac{\partial c}{\partial r_a}\right)_{I+1} \tag{2}$$

where functions G_r, G_θ and factor G_0 depend on the magnetic properties of the wire, the fluid, the particle, the strength of applied magnetic field and the position in the region. The equation (1) is used for ordinary discrete points whereas equation (2) is used for special discrete points that are adjacent to the wire surface or other impervious surfaces. The governing equations are solved numerically as an initial and boundary value problem, by using the finite-difference method.

Firstly, a uniform mesh is constructed in an annular region around the wire. The outer boundary of the region locate at $r_{a,L} = 10$. Then the particle volume concentration at ordinary discrete points $(r_{a,i}, \theta_j)$ and special discrete points $(r_{a,I}, \theta_j)$ at a given normalized time τ_n are discretized and computed numerically. It is seen that the new value of particle concentration at any discrete points depends on the old values of particle concentration at adjacent discrete points.

3 Nonblocking Point-to-Point Communication Algorithm

In the process of mass transfer simulation, old and new concentration data at every discrete point are stored in two identical two-dimensional arrays. In the parallel simulation based on the distributed memory model, all data are decomposed into equal parts, by using a row-wise partitioning scheme and distributed to a group of processes. Consequently, each process holds its array. First, the old data at a given point and the old data of necessary adjacent points are read. Second, the new value of particle concentration is computed. Let the maximum column and row index of the subarray occupied by a process be $i_{\max}$ and $j_{\max}$ respectively, and let I be the column index that contains data at a given special discrete point. The iterative computation in every row of the subarray can be described in general as follows:

1. Search and specify the column index "I" corresponding to the special discrete point.
2. Assign the initial concentration in column $i_{\max}$
3. Iteratively compute the new concentration, starting from column $i_{\max}-1$ down to column $I+1$.
4. Compute the new concentration, at column of index *i*.

Finally, the new data replaces the old data. The simulation continues until the final value of normalized time is reached. Due to the data dependency, the computation in the first and last rows of the array of each process requires the data in the arrays of the two adjacent processes. On the other hand, each process has responsibility to send its data in the first and last row of its subarray to its two adjacent processes. Also, data exchange between the process 0 and the process (N-1) is necessary. An individual process communicates to its neighbors in a ring pattern. Each process uses row arrays called *Sent_bottom* and *Receive_bottom* to exchange data with the lower rank process and uses row arrays *Sent_top* and *Receive_top* to exchange data with the higher rank process.

In this approach, the communication between adjacent processes are performed via non-blocking *MPI_Isend* and *MPI_Wait* communication procedures for process 0 and *MPI_Wait* . and *MPI_Isend* for the remainders. Steps of the parallel algorithm are rearranged using nonblocking communications as follows:

Step 1: Start first ring communication using *MPI_Isend* and *MPI_Irecv.*
Step 2: Start second ring communication using *MPI_Isend* and *MPI_Wait* nonblocking communication procedures.
Step 3: Perform iterative computing of new concentration in all rows of index $1 \le j \le j_{\max} - 1$
Step 4: Perform MPI_Wait operation to ensure the available of data necessary for iterative computing in the row $j = 0$.
Step 5: Perform iterative computing of new concentration in the row $j = 0$.
Step 6: Perform MPI_Wait operation to ensure the available of data necessary for iterative computing in the row
Step 7: Perform iterative computing of new concentration in the row index $j = j_{\max}$.

Then Steps 1-5 are repeated until convergence is achieved.

The idea of using non-blocking communication is to overlap communication with computation. In the original algorithm, once the data is needed, the communication is required. In this algorithm, the communication in Step 1 in the previous algorithm is moved to Step 3 to hide the communication latency. The nonblocking communication is done first and then computations start. When data is required, MPI_Wait() is performed to ensure that the needed data arrived. The computation of rows $1 \le j \le j_{\max} - 1$ is used to overlap with the communication. Here, it can be observed that the overlapped computation depends directly on the size of domain for each process.

4 Nonblocking Collective Algorithm

The test of communication algorithms of both blocking ring and blocking scatter/gather in our recent work indicated that communication algorithm using scatter/gather provides a better efficiency than the blocking ring approach. Therefore, we hypothesize that the non-blocking scatter/gather would also be better than non-blocking ring as well. We then implement our new communication algorithm using non-blocking collective using libNBC.

To compare with the ring communication algorithm, the algorithm is devised in the same manner. Using the collective style, the root process, 0, collects the necessary updated data at the end of each iteration using gather and distribute the updated rows to each relevant process using scatter. We use the *buffers Scatter_top, Scatter_bottom*, to hold data scattered from the root for each process. Also, the buffer *Gather_top, Gather_bottom*, are used by the root to hold data gathered from the others. After the root gathers all updated rows from other processes, it needs to update and rearrange the concentration data before scattering in the next round. We also include the computation in the root process as well. The iterative process is changed as follows:

Step 1: Root process, p=0, scatters the arranged data in its *scatter_bottom* and *scatter_top* buffers to *receive_top* and *receive_bottom* buffers of every process, respectively using NBC_Iscatter().

Step 2: Root process, rank $p = 0$, gathers data in the *sent_bottom* and *sent_top* buffers of each process into its *gather_bottom* and *gather_top* buffer respectively using NBC_Igather().

Step 3: All processes, including the root, perform iterative computation, from the first row+1 to the last row -1 of its subarray,

Step 4: All processes performs NBC_Wait() for *receive_top* and *receive_bottom* respectively. Then they computes the first row and the last rows accordingly.

Step 5: All processes copy data in the new concentration subarray into the old concentration subarray.

Step 6: All processes put data in the first and last row into its *sent_bottom* and *sent_top* buffers, respectively.

Step 7: Root process performs NBC_Wait() for *gather_bottom, gather_top.*

Step 8: Root rearranges data in its *gather_bottom* and *gather_top* buffers and then put the arranged data in the *scatter_bottom* and *scatter_top* buffers, respectively. The pattern of rearrangement is as follows.

From the algorithm, it is seen that Step 1 and Step 2 performs the nonblocking communications using NBC scatter/gather. The overlapped computations are in step 3. The number of rows implies the amount of overlapped computation. In our case, if the number processes are large the number of rows are reduced, the communications are overlapped less.

5 Experimental Results

We perform the experiments on a 32 nodes, totally 64 cores Linux cluster, with a Gigabit Ethernet interconnection at Louisiana Technology University, USA. In the cluster, each core is Intel Xeon 2.8GHz with 512 MB RAM. The cluster runs LAM-MPI 7.1 and on Gigabit Ethernet network.

The speedup of parallel simulation is defined as $S_p = t_1 / t_p$, where t_1 is the average sequential simulation time and t_p is the average parallel simulation time on p processes. The parallel efficiency is computed by $E_p = S_p / p$.

Table 1. Speedup and Efficiency results

#of Processes	NBC Ring speedup	NBC Collective speedup	NBC Ring speedup	NBC Collective speedup
4	4.091502	4.312826	1.02287556	1.07820639
6	5.985637	6.235232	0.99760621	1.03920526
8	7.950379	8.183956	0.99379741	1.02299452
10	8.753601	9.445269	0.87536013	0.94452691
12	11.63329	11.404066	0.9694407	0.95033881
16	14.89231	14.111646	0.93076926	0.88197789
20	17.87601	16.600328	0.89380027	0.83001640

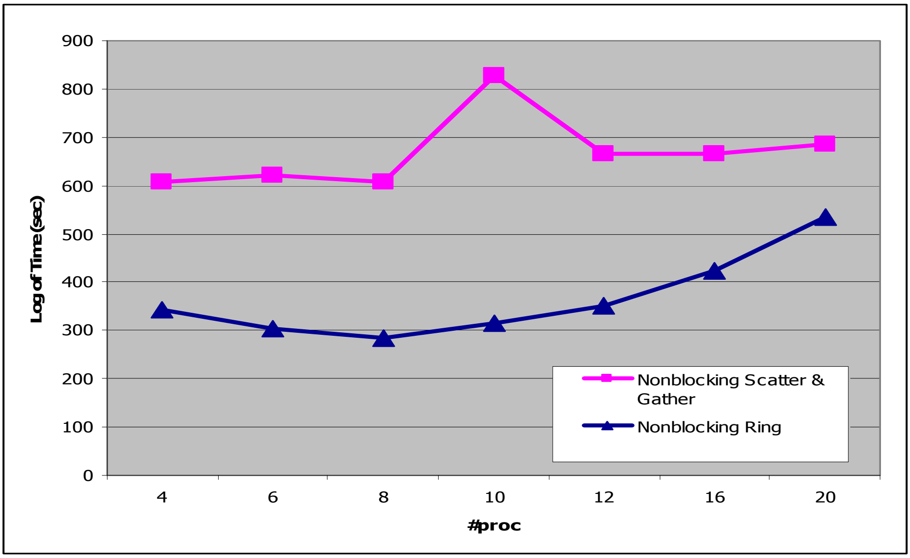

Fig. 1. Communication time comparison graph

Table 1 shows data of speedup and efficiency of nonblocking ring and nonblocking collective algorithms, respectively, for various number of processes cases. From the data, it is surprising that the nonblocking collective algorithm performs about the same as the nonblocking ring approach and worse in some case, unlike in the original collective algorithm which performs better than the traditional ring approach.

From the table, we discovered that speedup of the algorithm is always higher than nonblocking ring algorithm when the number of processes is low (less than 12) but when the processes become higher (greater than 12) nonblocking collective performance will become lower than ring algorithm. This is because incurring overheads of libNBC is more than that of the original MPI and when the overlapping computation is less as the number of processes grows (see the cases for 12 or more processes), the overheads cannot be hidden totally.

We further inspect the communication overheads of the libNBC approach as in Figure 1. The communication time shown here is the total communication time for all NBC_Iscatter, NBC_Igather, and NBC_wait for the collective case and is the total time for all MPI_Isend, MPI_Irecv, MPI_Wait for the nonblocking ring case. Figure 1 plots the comparison of overall times between two schemes. It is seen that the libNBC approach produces more overheads for each case. However, it is noticed that the overheads grow very slowly when the number of processes increases. On the contrary, the overheads grow faster for the nonblocking ring case. The difference of communication overheads between the two approaches are reduced as the number of processes increases. Also, in Figure 2, we analyze the time spent for each libNBC call. It is seen that the time spent most are on wait3, wait1, wait2, and wait4 calls accordingly. For wait3 call, it is the NBC_Wait for the first NBC_Igather. For wait1 call, it is the average waiting time for first NBC_Iscatter for all processes, and for wait2 call, as well as wait4 call, they are the average waiting time for the second NBC_Igather, NBC_Iscatter respectively. We can see that for wait4 call, it is the time that the root process requires to gather all updated top rows from other processes. For wait1 call, every process waits for the root to scatter the updated top rows in the new iteration.

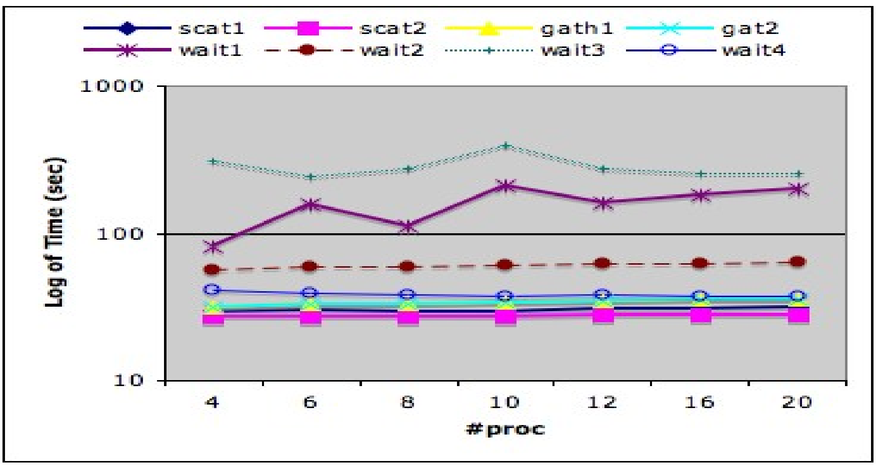

Fig. 2. Details communication time of the nonblocking collective case

6 Conclusion

We propose the two nonblocking parallel algorithms for High Gradient Magnetic Separation (HGMS) of nanoparticles. In both scheme, we distribute the domain of computation equally by row-wise. The first algorithm is based on MPI_Isend/Irecev ring style communication where the second algorithm is based on NBC_Iscatter/ Igather collective style communication. The results show that in the tested environment, the nonblocking ring algorithm performs better. This is because the overhead incurred by the nonblocking MPI calls are less for all the test cases and can be hidden totally in the overlapped computation. For the nonblocking collective algorithm using libNBC, it has more communication overheads and needs more overlapped computation time to hide them.

We found that communication time of the nonblocking collective algorithm is always lower than nonblocking ring algorithm when the number of processes is small. When the number of processes becomes larger higher, the communication time of the collective style only slightly increases while the communication time of the nonblocking ring increase at a faster rate. We predict that if we increase more number of processes and the work size, the collective communication style will perform better than the nonblocking ring approach. This exploration of communication style and domain partitioning will be investigated in the next paper.

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Efficient Index for Handwritten Text

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Abstract. This paper deals with one of the new emerging multimedia data types, namely, handwritten cursive text. The paper presents two indexing methods for searching a collection of cursive handwriting. The first index, word-level index, treats word as pictogram and uses global features for retrieval. The word-level index is suitable for large collection of cursive text. While the second one, called stroke-level index, treats the word as a set of strokes. The stroke-level index is more accurate, but more costly than the word level index. Each word (or stroke) can be described with a set of features and, thus, can be stored as points in the feature space. The Karhunen-Loeve transform is then used to minimize the number of features used (data dimensionality) and thus the index size. Feature vectors are stored in an R-tree. We implemented both indexes and carried many simulation experiments to measure the effectiveness and the cost of the search algorithm. The proposed indexes achieve substantial saving in the search time over the sequential search. Moreover, the proposed indexes improve the matching rate up to 46% over the sequential search.

1 Introduction

The handling of handwritten text has recently increased in importance, especially with the widespread of personal digital assistants (PDA) and tablet computers. This allows the user to store data in the form of handwritten notes and formulate queries based on handwritten samples. For example, searching a large database which contains one or more handwritten fields (e.g., verifying signature of the bank accounts.)

One way to handle the handwritten text is to translate it first into ASCII-equivalent characters using pattern recognition techniques and then to store it as ASCII text. Similarly, the search algorithm translates the query string into a sequence of ASCII characters and then performs a traditional search through the database. Thus, the recognition phase is an intermediate step between the input device (pen and tablet) and the storage device. But this is not practical because of the latency delay introduced by the recognition step. Moreover, accuracy of the recognition of cursive writing is low and thus will result in high error rate. It is difficult even to identify letter boundaries in the cursive string. Moreover, by translating the handwritten string into a sequence of predefined symbols (alphabet), we lose much information, such as the particular shape of the letter "allograph", the writing style, etc. Another disadvantage to this method is that the recognition phase renders the system sensitive to the underlying language.

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A more natural way to handle the handwritten text is to treat it as a first-class data type. The handwritten string is treated as a pictographic pattern without an attempt to understand it. During the search process, the query string is compared to database strings using an appropriate distance function. This gives the user more expressive power; he can use non-ASCII symbols, drawings, equations, other languages, etc. Searching in handwritten cursive text is a challenging problem. A word written by two different people cannot look exactly the same. Moreover, a person cannot recreate perfectly even his own previously drawn word. Hence, exact match query will not be appropriate and similarity (or approximate string matching) would be more suitable in this case. The search algorithm should look for all strings which are "similar" to the query string. One additional requirement for pen-based and/or personal digital assistant environment is the need to support online retrieval and fast response time.

In this paper we address the problem of searching for a given cursive string in a database of handwritten text. The rest of the paper is organized as follow. Section 2 describes the proposed word-level index while section 3 presents the proposed stroke-level index. Prior works related to cursive handwriting is briefly described in section 4. In Section 5 we show experiments for measuring the response time and the matching rate of the proposed indexes. Section 6 gives our conclusions and future work.

2 The Proposed Word-Level Index

In this section we propose a two-step indexing schema to index a large repository of handwritten cursive text. The proposed index treats each word as a pictogram (or an image) and it consists of two steps, the filtering step and the refinement step. In the first step we use a coarse index that filters out most of the unwanted pictograms and produces a set of pictograms called the *candidate* set. The second step uses a sequential algorithm that operates on the candidate set to find the best k matches to the query word which are reported as the final answer.

The filtering step uses global features to characterize the different pictograms (words). A set of features $f_1, f_2, \ldots, f_x$ (described in Section 1.1) are calculated for each pictogram in the database as well as for the queries. Thus, each pictogram can be represented as a multidimensional point in x-dimensional space. A good set of features maps two instances of the same pictogram to points that are close in the multidimensional space. At the same time, two different pictograms should be positioned as far apart as possible.

These points are organized in a multidimensional index. We choose the R-tree because of its ability to prune the search space at early levels of the tree structure and because of the guarantee of good space utilization.

Edit distance: is a distance function that quantifies the similarity between two text strings. The edit distance used in [LT94] aligns the two strings and transforms one string into the other using the following operations:

- deletion of a symbol.
- insertion of a symbol.
- substitution of a symbol by another one.
- splitting of a symbol into two.
- merging two symbols into one.

Each of these operations has a predefined cost associated with it. The weighted cost of the transformation is used as a distance between the two strings. We call this distance metric ED.

Inflection distance: we define the inflection distance in the same way the edit distance is defined. Ink can also be represented by a sequence of codewords that represent the inflection points of the pictogram. An inflection point marks the change of direction in the pictogram, e.g., going from an upwards direction to a downwards direction, or from a leftward direction to a rightward one. We define eight inflection symbols. Using the inflection representation, we can also compute an edit distance between two pictograms. For this, we assume that only insertions and deletions are allowed and that each operation (insertion or deletion) has an associated cost of 1. We call this *inflection distance* (ID).

To find the pictograms that are similar to a given query pictogram, we map the query to a point in the x-dimensional space, by extracting x global features. Then, we perform a similarity search. The candidate set is formed by the multidimensional points (i.e., pictograms) returned by the query. In the refinement step, we apply a sequential algorithm to the candidate set to find the best k matches to the query word. We use a combination of the two metrics ID and ED. Our experiments show that the cost of the ID comparison is about 5 times less than the cost of ED comparison. Thus, we use the ID as a second stage filter in the retrieval process. The procedure is as follows. First, we perform pair wise comparison (sequential search) of the query against each of the retrieved pictograms by using ID. This results in a ranked set S of pictograms. Then, we take the best m (in the experiments we set m = 20%) elements of S and use the metric ED+ID to perform another round of sequential comparison. We call this procedure EID. Increasing m improves the retrieval rate but it increases the total response time. The value of m can be determined experimentally. After that, the best k matches are presented to the user.

Two instances of the same word will have two different values v_i, v'_i for feature f_i. To accommodate for this variability, the length l_i of the query hyper-rectangle along feature (axis) f_i should satisfy:

$$l_i \geq v_i - v'_i$$

2.1 Global Features

The eight global features are used in our indexing scheme are: number of strokes, number of points, number of vertical inversions, total-change-MBR-height, avg-weighted-MBR-area, number of thin strokes, X-centroid, Y–centroid.

This word-level index is suitable for searching large number of cursive handwriting. In Section 5, we perform simulation experiments to measure the effectiveness of the proposed index in filtering unwanted pictograms and identifying the most similar word.

3 The Proposed Stroke-Based Index

In this section, we propose an index that is suitable for small database of cursive handwriting. Unlike the word-level index, the index compares text at the stroke level rather than word level. Thus, this index is more costly than the word level index but it is more accurate in identifying the query work. The stroke-based index allows fast retrieval of similar strings and can handle insertion, deletion, m-n substitution errors and substring matching. This index is dynamic in the sense that insertion and deletion operations can be intermixed in real time with the search operations. Given a search query string, the answer would be a set of the strings or substrings that look like the query string.

3.1 The Basic Idea

We model the cursive string as a sequence of strokes. Each stroke is described by a set of features and thus can be represented by a point in the multidimensional feature space. We propose to store these points in a multi-dimensional index, and more specifically, the R-tree because of its ability to prune the search space at early levels of the tree structure and because of the guarantee of good space utilization. A cursive string is read from the tablet as a sequence of points in real time. Each point is represented by the tuple (x, y, t) where x, y are the coordinates of the point in two-dimensional space and t is the time at which the point is printed. These points are grouped into strokes. A stroke ends and a new one starts at each local minimum in the x-y coordinates. This method is known as local minima segmentation.

We describe each stroke with a set of 11 features. The features, which have been described in [15], describe the geometric properties of the stroke, e.g., the length of the stroke, the total angle traversed, and the angle and length of the bounding box diagonal. The features are selected so that strokes that look alike tend to have similar vector values according to some distance functions. Due to the variability in handwriting, the feature vectors that correspond to different instances of one stroke tend to vary slightly. Vectors that represent different instances of the same stroke form a cluster in the feature space. Thus, strokes that look similar will have their representative clusters close to each other or even overlapping in the multi-dimensional space.

Given a string *S*, the stroke segmentation program decomposes *S* into a sequence of *t* stokes S_i, 1 > i < t. Each stroke S_i is represented as a point in an 11-dimensional space formed by the features $f_1, f2, \ldots, f_{11}$. The string *S* is represented by *t* points in the space. These multi-dimensional points (=strokes) are stored in an R-tree index. Each R-tree node occupies one disk page. Non-leaf nodes, which are small in number, are kept in main memory, while leaf nodes are stored on the disk. A set of points that are close to each other will be stored in the same leaf node (level 0 in the tree). Each entry in the leaf node in the form of (word-id, P) contains the coordinates of a point P (=stroke) and a word-id for the pictographic description of the string that contains (owns) this stroke (see Figure 1). Non-leaf nodes in level *i*, where *i* > 0, have entries of the form (ptr, R) where ptr points to a child node and R is the Minimum Bounding Rectangle (MBR) that encloses all the entries in the child node.

3.2 Similarity Search Queries

To search for a string Q, we treat the query string in a manner similar to that described in the previous section. The set of strokes $q_1, q_2, \ldots, q_x$: are extracted from Q. Since it is impossible to write the same word twice identically, we need similarity queries. For each stroke q_i, a range query in the form of a hyper-rectangle is formed in the 11-dimensional space. The center of the hyper-rectangle is the query point, and the length along each axis is a ratio (2 x p) of the standard deviation of the data along that axis.

The output of each query would be a set of word-ids for those words which contain a stroke similar to the query stroke. We call this set the candidate set C. We then apply a simple voting algorithm as follows. Each word-id takes a score that indicates how many times it has appeared as an answer for the queries q_i, $1 < i < x$. The set of word-ids that have the highest scores are reported as the answer. Note that we did not use any expensive operations, nor did we access any of the pictographic representation of the strings from the database.

Algorithm Search (**node** Root, **string** Q):
S1. *Preprocessing*:
    Use Q to build the set of strokes q_i, q_2, … , q_x.
    Extract the set of features for each q_i, $1 < i < x$.
S2. *Search the index*:
    For each stroke q_i, perform a range query.
    Form the candidate sets.
53. *Voting algorithm*:
    Words with the highest score are the answer.

3.3 Feature Space Dimensionality

Our goal here is to reduce the number of features needed to describe the stroke by transforming the data points into another space with smaller dimensions. This problem is known as dimensionality reduction. Until now, we used 11 highly correlated features to describe each stroke. We use the *Karhunen-Loève* transform [5], also known as *Hotelling* transform or *Principal Component Analysis*) to reduce the dimensionality of the feature space. The transform maps a set of vectors to a new space with an orthogonal uncorrelated axis. The *Karhunen-Loève* transform consigns most of the discrimination power to the first few axes. Hopefully, using only k axes, k < 11, we lose little information while reducing the index size significantly.

The axes of the new feature space are the Eigen vectors of the auto correlation (covariance) matrix for the set of data points. The *Karhunen-Loève* transform sorts the eigenvectors in decreasing order according to the eigen values and approximates each data vector with its projections on the first k eigenvectors, $k < 11$.

We collect a small sample from the writer in advance and apply the *Karhunen-Loève* transform to calculate the vector transformation matrix. All strokes (vectors) are mapped to the new space and then inserted in the index.

3.4 Reducing the Candidate Set Size

Two strings are similar if they have similar strokes in the same order. The output of the search query gives a set of strings which has strokes similar to the query stroke but they do not necessarily occur in the same location. The candidate set is thus large because it contains many false candidates. Moreover, the voting algorithm does not take into consideration the location of the stroke.

To make use of the stroke location and to reduce the size of the candidate set, we store the location of the stroke inside the string as one more dimension in the feature space. Each stroke is then represented by k features f_1, $f2$, ... , f_k and by its location stk_{loc} inside the string in (k + 1) dimensional space.

Two instances of the same string will not, in general, have equal numbers of strokes. The difference, however, is expected to be small. Thus, the answer to the range query that corresponds to stroke q_i should include strings that have similar strokes not only in the position i but also in a window of length w around i. We found experimentally that $w = 3$ gives the best results (thus covering stroke numbers $i - 1$, i, and $i + 1$).

In substring matching, however, we want to allow the query string to start at any position inside the database string. In this case, a partial match query rather than a range is used. In a partial match query, the extent of the query rectangle is specified for all axes f_1, $f2$, ... , f_k as before. For the stroke location stk_{loc} axis, the extent is left open $(-\infty, +\infty)$ to allow the query string to start at any position inside the database string. Otherwise, the algorithm is similar to that for similarity query.

4 Prior Work

There are many researches on modeling, retrieval, and annotation of cursive handwriting. However, there are not many works on indexing cursive handwritten text. Research included handling different languages like Arabic [17], Chinese [12], and Indian languages [2] and on-line handwriting [8].

[16] proposed a technique that is based on an additive fusion resulted after a novel combination of two different modes of word image normalization and robust hybrid feature extraction. They employ two types of features in a hybrid fashion. The first one, divides the word image into a set of zones and calculates the density of the character pixels in each zone. In the second type of features, they calculate the area that is formed from the projections of the upper and lower profile of the word.

[11] proposed a method for generating a large database of cursive handwriting. Synthesized data are used to enlarge the training set. He proposed method learns the shape deformation characteristics of handwriting from real samples; then used for handwriting synthesis.

[4] also proposed a method to synthesize cursive handwriting of the user's personal handwriting style, by combining shape and physical models together. In the training process, some sample paragraphs written by the user are collected and these cursive handwriting samples are segmented into individual characters by using a two-level writer-independent segmentation algorithm. Samples for each letter are then aligned and trained using shape models.

[7] word-spotting system operates on a database containing a number of handwritten pages. The method used for word matching is based on a string matching technique, called dynamic time warping. Dynamic Time Warping (DTW). The following three features are computed at each sample point in the word, resulting in a sequence of feature vectors: The height (y) of the sample point: This is the distance of the sample point from the base of the word; the stroke direction; and the curvature of the stroke at point p. The word to be compared is first scaled so that it is of the same size

(height) as the keyword, and translated so that both the words have the same centroid. The DTW technique then aligns the feature vector sequence from a database word to that of the keyword using a dynamic programming-based algorithm. The algorithm computes a distance score for matching points by finding the Euclidean distance between corresponding feature vectors and penalizes missing or spurious points in the word being tested.

5 Experimental Results

This section presents experimental results that show the effectiveness of our proposed indexes. The two proposed methods are implemented in C. Our database consists of 8,000 handwritten cursive words produced by one writer. The same writer then recreated 100 words to be used as queries. Since our data is static (no insertion nor deletion) we used the Hilbert packed R-tree [9] because of its high space utilization. For dynamic data, other R-tree variants that allow insertions and deletions can be used (such as R*tree [1], and the Hilbert R-tree [10].

5.1 Evaluation of the Global Features

In this section we evaluate how good the set of global features, listed in Section 1.1, are in pruning the search space and retrieving the most similar set of words. We store the leaf nodes (which account for the large portion of the R-tree) on the disk and keep the non-leaf nodes in main memory (non-leaf nodes occupy about 50 K-bytes for 8000 words.) Figure 1 shows the percentage of the database that is filtered out by the R-tree as a function of the database size. Notice that the pruning capability is increasing with increasing the database size. The reason for this is that the query size is constant regardless of the database size (recall that the query size is defined by the characteristics of the user handwriting.)

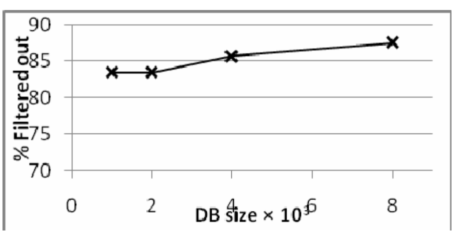

Fig. 1. The percentage of the database filtered out by the R-tree

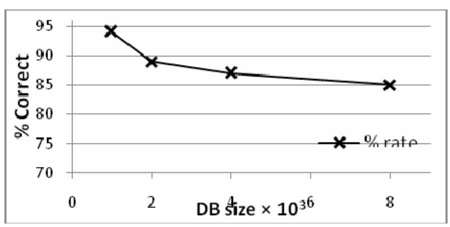

Fig. 2. The retrieval rate of the R-tree only

To see how good the global features are in describing the cursive handwriting, we show in Figure 2 the percentage of cases in which the correct answer to queries are in the candidate sets (R-tree retrieval rate). The graph show high retrieval rate 86% - 95%. As expected, the retrieval rate decreases with the size of the database.

5.2 Comparison between the Proposed Index and the Sequential Scan

In this section we compare the proposed schema (R-tree + EID) with ED and EID sequential searches.

Figure 3 shows the total search time per query for various database sizes. The above R-tree package stored the tree in main-memory; thus, we had to simulate each disk access with a 15 msec delay. For our method (marked as "R-tree+EID"), it shows the time per query after searching the R-tree and screening the resulting subset of pictograms with EID. We compared our method with the ED sequential algorithm. The figure also shows the time it takes to perform sequential search over the entire database using our EID sequential algorithm. Our method "Rtree+ EID" outperforms ED sequential search in the entire range of database sizes. For 8,000 pictograms the ratio of search times is 12:1. We included in the graph the performance of our sequential EID (no Rtree) which also outperform ED. Note that, for small databases 1000 or less, EID is little faster than "Rtree + EID". This is because of the overhead of the R-tree (the relative cost of node access increases with decreasing the database size). As expected the sequential search times grow linearly with the size of the database, while for our method "R-tree+EID" the search times grow sub-linearly in the entire range. Figure 4 and Figure 5 plot the matching rates obtained when showing the best k = 3 and k = 5 pictograms respectively. As we can see, the matching rates for the index outperform those of sequential search.

Figure 6 and Figure 7 explain the sub-linear behavior of our method. Figure 6 shows the percentage of pictograms returned by querying the R-tree. As we can see, the relative size of the subset obtained by searching the tree decreases with increasing

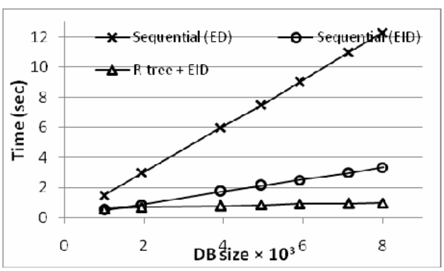

Fig. 3. Total search time

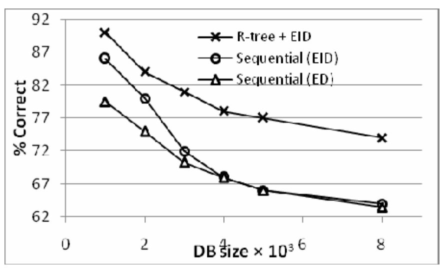

Fig. 4. Matching rate (top 5)

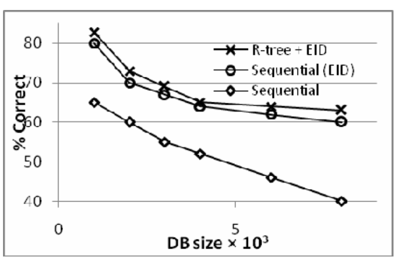

Fig. 5. Matching rate (top 3)

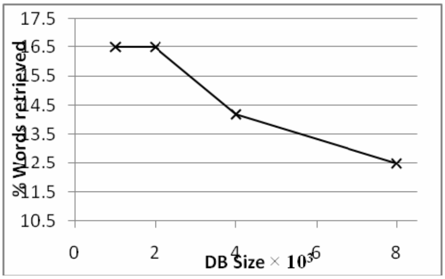

Fig. 6. Percentage of pictograms retrieved

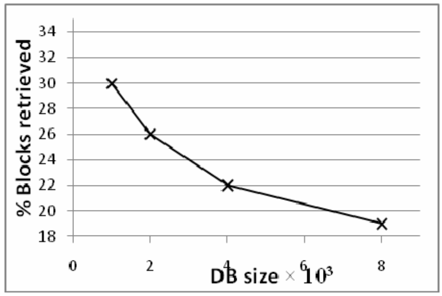

Fig. 7. Percentage of blocks retrieved

the size of the database. Figure 7 shows the percentage of blocks retrieved by the tree search as a function of the database size. Again, since the relative size of the retrieved subset decreases, so does the percentage of blocks brought to memory.

5.3 Evaluation of the Stroke-Based Index

We implemented the proposed stroke-based index and the VUE algorithm [14]. We carried several experiments to evaluate the performance of our proposed index and compare it with the VUE algorithm. Due to the space limitation, we do not show all the results. We asked one writer to produce 200 handwritten cursive words. The same writer then recreated 74 words to be used as search strings. In all the experiments, the stroke location was stored as additional feature as explained in Section 3.5. For the experiments shown here, the value w was set at 3 and the value of s was set at 1 (each stroke was stored as a separate point.) Since the data used in the experiments were static, we used the Hilbert-packed R-trees [9] as an underlying multi-dimensional index. For data that has dynamic nature (where data can be inserted or deleted at any time), the R-tree [6], Hilbert R-tree [10] or the R*-tree [1] can be used. Node size was fixed at one KByte.

The segmentation algorithm cuts the stroke once it encounters a local minimum. During our experiments, we noticed that some of the resulting strokes are tiny and do not contribute to the final image of the string, and thus considered noise. These tiny strokes can be produced simply by pressing or raising the pen. These strokes not only increase the size of the database but might also adversely affect the retrieval performance. We filtered out such strokes from both the database and the query strings. We only included strokes whose MBR diagonal is larger than 15 points (where the point is the unit distance in the tablet device.)

Figure 8 compares the search time of our proposed index with the search time of the VUE algorithm for different database sizes. As expected the VUE algorithm time increases linearly with the database size. Our proposed index achieves substantial saving in response time over the VUE. Note that the VUE algorithm is faster than the index for small database (less than 15 words) because of the constant overhead of the R-tree. The saving in time, when using the index, increases with the database size.

We also compared the matching rate of the proposed index and the VUE algorithm. Figure 9 shows the number of times the correct answer (matching rate) is

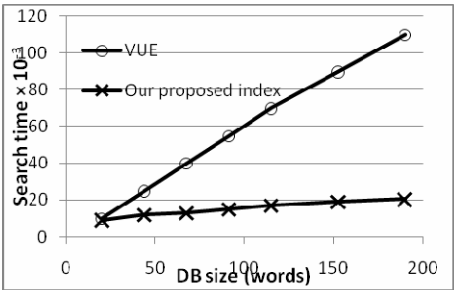

Fig. 8. Response time of our proposed index versus the VUE algorithm

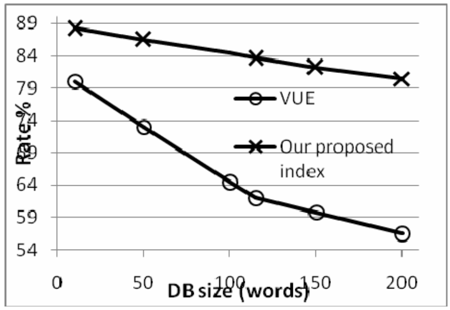

Fig. 9. Matching rate of our proposed index versus VUE algorithm

Table 1. Matching rates for index that uses all 11 features vs, index that uses 6 features only

Voting algo, rank	Matching rate	
	11 features	6 features
first	80	73
top 2	85	82.5
top 3	89	84

ranked among top two for different database sizes. We also carried experiments that show the matching rate when the answer is ranked the first (received highest score) and among the top 5 for different database sizes (not shown for space limitation). The common observation is that the matching rate of our proposed index is consistently higher than that of the VUE algorithm. The improvement in the matching rate is up to 46%.

To evaluate the index when it uses the reduced feature space (as discussed in Section 3.3.), we carried out two sets of experiments, one using the full set of features (= 11). In the second set of experiments we applied the *Karhunen-Loève* transform to a sample of 30 words to calculate the transformation matrix, and then all words in the database were mapped to the new six-dimensional space. The queries were also mapped using the same transformation matrix before searching the tree. Our experiments measured matching rate. We count the number of search words that were ranked first (received the highest score), among top two, and among top three by the voting algorithm. As we see in Table 1, the matching rate is about 84% when reporting strings with the highest three scores. As expected, the matching rate decreased as we used a smaller number of dimensions. The good news is that, although we cut the space required to store a stroke to nearly half, we nevertheless achieved about 93% of the matching power of the index that used all 11 features.

6 Conclusions

We have introduced two new methods for indexing cursive handwriting. The first index works at the word-level and suitable for large database of cursive handwritten text. While the second index, which works at the stroke level is more accurate but it is also more costly.

The word-level index uses a set of global "word" features that provides an effective way of reducing searching cost. The experimental results showed that the proposed index, which is using R-trees followed by EID clearly outperforms the ED and EID searches. The space overhead incurred by the R-tree is low. The sequential algorithm EID outperforms ED. Another important contribution is the identification of a small set of global features (eight features) that can be used to characterize cursive handwriting.

In the second index, each string is divided into a set of strokes; each stroke is described with a feature vector. Subsequently, the feature vectors can be stored in any multi-dimensional access method, such as the R-tree. A similarity search can be performed by executing a few range queries and by then applying a simple voting algorithm to the output to select the most similar strings. The stroke-level index is resilient to the errors resulting from segmentation errors, such as insertion, stroke deletion, or m-n substitution. Our experiments showed that the extra effort we spent in mapping the data to lower dimensionality space pays off. The stroke-level index achieves substantial saving in search time over the VUE algorithm and improves the matching rate up to 46% over the VUE algorithm. With a sacrifice of less than 10% of the matching accuracy we saved almost half of the space required to represent a stroke.

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SVM-Based Classification of Moving Objects

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Abstract. In this paper, we propose a single SVM-based algorithm to classify moving objects inside videos and hence extract semantics features for further multimedia processing and content analysis. While standard SVM is a binary classifier and complicated procedures are often required to turn it into a multi-classifier, we introduce a new technique to map the output of a standard SVM directly into posterior probabilities of the moving objects via Sigmoid function. We further add a post-filtering framework to improve its performances of moving object classification by using a weighted mean filter to smooth the classification results. Extensive experiments are carried out and their results demonstrate that the proposed SVM-based algorithm can effectively classify a range of moving objects.

Keywords: SVM(support vector machine); moving object classification and video processing; weighted mean filter.

1 Introduction

There are many different approaches, which have been proposed to automatically classify objects in images and videos. Most existing research on moving object classification requires pre-definition of the moving objects, such as walking human object, running vehicles etc. [1]-[6]. Wender et. al[1] introduced an object classification system for vehicle's monitoring applications, which is applied with a laser scanner. However, common cameras are widely used rather than laser scanners in social life, therefore, the algorithm reported in [1] can only be used for very limited occasions, and the cost of installation is high. In [2][3], some new features were proposed for object classification, such as Bag of Words and SIFT features, which have been popular for large-scale object classification in still images. In general, these methods are not suitable for classifying moving objects in low resolution surveillance videos. In references [4]-[6], several algorithms have been reported for object classification, which apply specialized detectors at each frame to detect object instead of segmenting the object. These methods may not sufficiently consider the temporal correlation among neighboring frames and the detected object regions usually lack shape information, making it difficult for their classification.

Essentially, moving object classification is a multi-class problem, which requires multi-class machine learning techniques to learn from training samples before objects can be classified. Typical examples of such learning machines include neural networks, K nearest neighbours and SVM (support vector machine) [7]-[9]. In the community of

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multimedia and signal processing, recent trend of combining artificial intelligence with video processing indicates that SVM is one of the most popular machine learning tools for video content analysis and processing [7].

In this paper, we describe a multi-class SVM based object classification algorithm towards semantics extraction for multimedia content processing and analysis, in which our contribution can be highlighted as: (i) mapping of SVM output into multiple posterior probability domain for object classification; and (ii) introduction of weighted mean-based filtering for post-processing to improve the classification performances. The rest of the paper is organized into three sections. While section 2 describes the proposed algorithm, Section 3 reports our experimental results and Section 4 provides concluding remarks.

2 Proposed Algorithm Design

Correspondingly, we introduce a new multi-class SVM algorithm, where the output of SVM is mapped into a posterior probability domain for the classified objects via Sigmoid function and post-filtering approaches. By selecting the maximum value of the posterior probability, optimal performances can be achieved in classifying all the moving objects.

For the conciseness and coherence of description, M classes are pre-defined as $C=\{c_1,c_2,\ldots,c_M\}$. To represent each object, we construct L features, which can also be arranged as an input feature vector: $\boldsymbol{X}=(x_1,x_2,\ldots,x_L)$, where x_i is the ith feature extracted to describe the moving object. The proposed SVM-based algorithm consists of three operation phases, which include: (i) segmentation of moving objects; (ii) extraction of multiple features; and (iii) design of classification rules.

To convert the input video into a moving object sequence, we have a range of existing algorithms to select, where detection of changes is exploited to segment those moving objects and background information is removed to pave the way for feature extraction around the moving objects [10][11]. As our work is primarily focused on object classification, we simply adopted the existing segmentation techniques reported in [10] to expose the moving objects. The exposed moving objects are then further processed to produce binary mask sequences, from which corresponding ROI (region of interests) can be generated for feature extraction. For the convenience of evaluating the proposed algorithm without incurring complicated procedures and high computing costs, we selected three features to be extracted for describing the moving objects, which include contour, statistics of intensity and texture. Details of individual feature extraction are given below.

Contour and shape of the object is widely reported to be important features for describing moving objects [12]-[16], which presented significant discriminating power in characterizing different objects. In our proposed algorithm, we combine various features extracted from the contour of moving objects to ensure that the best possible performances could be achieved in object classification. These features include: (i) ρ: ratio of height to width inside the boundary rectangle; (ii) $\rho_{1/3}$ and $\rho_{2/3}$: ratio of height to width when its height is one third and two thirds of the object; (iii) φ: ratio of squared circumference to the object area; (iv) δ: ratio of areas between the object and its bounding rectangle; (v) α : the rotation angle of the minimum bounding ellipse of the moving object; (vi) γ: the eccentricity of the minimum bounding ellipse of the moving object. Their definitions are given as follows.

$$\rho = \frac{h_o}{w_o} \tag{1}$$

Where h_o and w_o are the height and width of object respectively.

$$\rho_{1/3} = \frac{h_o}{w_{o1/3}}, \tag{2}$$

$$\rho_{2/3} = \frac{h_o}{w_{o2/3}} \tag{3}$$

Where $w_{o1/3}$ and $w_{o2/3}$ are the width of the object when its height are one third and two thirds respectively.

$$\varphi = \frac{\tau_o^{\ 2}}{\eta_o} \tag{4}$$

Where τ_o stands for the circumference of the object, and η_o the object area.

$$\delta = \frac{\eta_o}{\eta_r} \tag{5}$$

Where η_r is the area of the bounding rectangle.

Statistics of intensity simply contains the mean and variance of all the pixels inside the moving objects, which can be defined as:

$$\mu = \frac{1}{N}\sum_{i=1}^{N} I_i^O \tag{6}$$

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}\left(I_i^o - \mu\right)^2 \tag{7}$$

Where I_i^o stands for the intensity of the *i*th pixel inside the object and *N* the total number of the internal pixels.

The texture feature is adopted from the one reported in [17], which can be organized into a feature vector of 140 elements to represent each object. This procedure is detailed in [17].

To ensure the comparability of all the extracted features, we pre-process all the features by the following normalization process:

$$x_i{}' = \left(x_i - x_{i\ \min}\right) \big/ \left(x_{i\ \max} - x_{i\ \min}\right) \tag{8}$$

Where x'_i is the normalized feature x_i, and $x_{i,\min}$ and $x_{i,\max}$ are the minimum and the maximum values of the extracted feature, respectively.

As SVM is essentially a binary classifier, we adopt the modeling technique reported by Platt [18] to train the SVM with known data set and exploit Sigmoid function to map its outputs into posterior probability $P(c_j=1|\boldsymbol{X})$. Such mapping is described as follows:

$$P(y=1\,|\,f) = 1\big/\left(1+\exp(Af+B)\right) \tag{9}$$

Where f is the output of SVM, $P(y=1|f)$ is the probability of correct classification under the condition of f, and A, B are the controlling parameters, which need to be determined by solving the following problem of maximum likelihood:

$$F(z) = \min_{Z=(A,B)} \left(-\sum_{i=1}^{l} (t_i \log(p_i) + (1-t_i)\log(1-p_i))\right) \tag{10}$$

where, $p_i = 1/\exp(Afi + B)$, $f_i = f(x_i)$, and t_i are determined via:

$$t_i = \begin{cases} (N_+ + 1)/(N_+ + 2) & \text{if } y_i = 1 \\ 1/(N_- + 2) & \text{if } y_i = -1 \end{cases} \tag{11}$$

and N_+, N_- are the number of positive and negative samples inside the training set.

Given M classes $\{c_1, c_2, \ldots c_j \ldots c_M\}$, the above mapping is exploited to construct a classifier d_j for each c_j and assign the output $P(c_j = 1|\boldsymbol{X})$ as the probability of classifying the input sample into c_j. Therefore, The class of the input sample $\boldsymbol{X}$ can be determined as the one to make the output probability maximum, i.e.

$$\hat{c} = \arg\max_{c_j} P(c_j = 1 | X) \tag{12}$$

In summary, the proposed algorithm constructs M SVMs and map their outputs into a posterior probability space to complete the M-class classification for input samples. Our experiments suggest that the proposed SVM multi-classification performs better than those with fusion module such as voting [19] and pair-wise coupling [20] when tested on the same dataset.

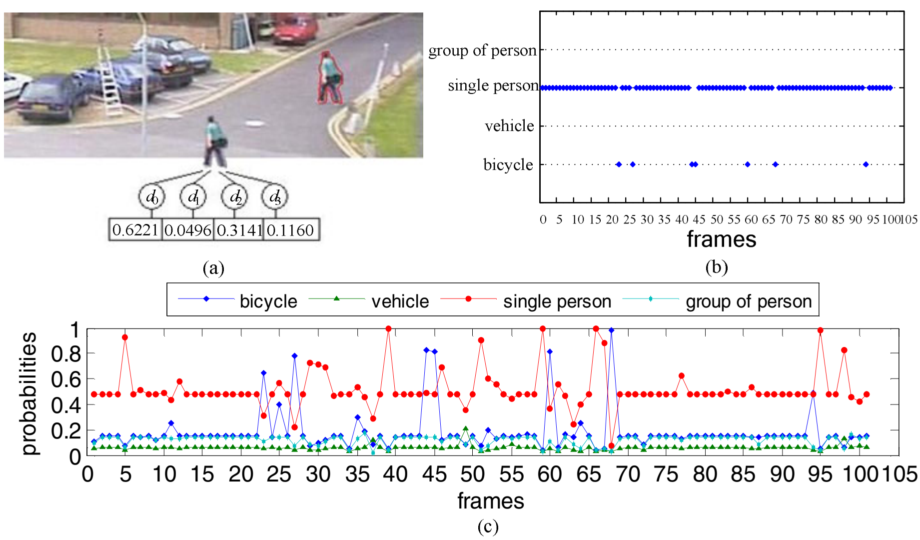

Fig. 1. Experimental results:(a) posterior probabilities for the object of single person generated in the 23rd frame of the video PETS2001; (b)The classification results of the single person across all frames in the video. (c)The posterior probability outputs of single person across all frames inside the video.

During the mapping procedure, it is observed that correct classification is dependent upon the accuracy of moving object segmentation and feature extraction. Yet such segmentation and extraction is largely affected by noises and limitation of segmentation techniques. As shown in Figure-1, the mapped posterior probabilities in the 23rd frame of the video, PETS2001, are 0.6221, 0.0469, 0.3141 and 0.1160 for bicycle, vehicle, single person, and group of people, respectively. According to (12), the input moving object, single person, will be wrongly classified as bicycle.

The part (c) in Figure-1 illustrates the posterior probability distribution over all the frames. By comparing with the part (b), it can be seen that classification for most frames are actually correct and such trend remains true even for those frames that are neighbours of the wrongly classified frames. To this end, we are encouraged to propose a weighted mean filtering as the post-processing to smooth the classification results and improve the performances of the proposed SVM-based classifier.

Essentially, all the posterior probabilities for the sequence of video frames can be regarded as a time series. As the moving object presents significant correlation within neighboring frames, there exists large extent of stability among the posterior probability values within this neighbourhood, and hence the wrong classification shown in Figure-1 can be regarded as caused by the noise of the high frequency components within the input time series. By applying the principle of low-pass filtering, such wrong classification could be eliminated and thus the classification performances could be further improved. Figure-2 illustrates the structure of our proposed weighted mean filter.

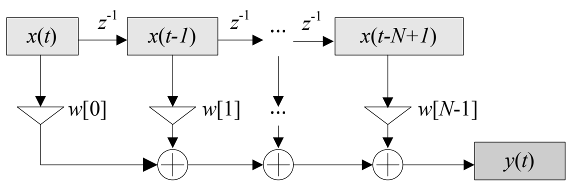

Fig. 2. Illustration of the proposed weighted mean filter

In Figure-2, $x(t)$ represents the value of input sample at the time t, z^{-1} is the delaying unit, $w[k]$ are the parameters of the filter corresponding to sampling at t-k, N represents the length of filter, and $y(t)$ is the output value of the filter at the time t. Hence, the proposed filter [21] in the time domain can be described as:

$$\hat{P}(c_j = 1 \mid X_{t-k}) = \sum_{k=0}^{N-1} \left[w[k] \left(P(c_j = 1 \mid X_{t-k}) \right) \right] \qquad (13)$$

Where $\hat{P}(c_j{=}1|X_t)$ is the probability of $x_t \in C_j$, following the filtering of the input classification by SVM in the t[th] frame.

To determine the filter coefficients, we apply the following two principles: (i) the nearer the observation to the t[th] frame, the larger its influence upon the probability estimation of the t[th] frame; (ii) all coefficients must satisfy normalization process, i.e. $\sum w[k]=1$, and $0 \le w[k] \le 1$. Under the principles, our extensive experiments indicate that the following weighting produces good filtering performances:

Let k be the distance between the t[th] frame and the t-k[th] frame, we define a descending function $F(k)$, $k \in [0, N-1]$, as follows:

$$F(k)=(N-k)^2 \tag{14}$$

Therefore, the filter coefficients can be determined by:

$$w[k]=\frac{F(k)}{\sum_{i=0}^{N-1} F(i)} \tag{15}$$

In general, larger value of N enables the filter to consider more neighbouring values for producing its output, the result of which is that the output becomes more smooth, and hence more storage space would be needed in order to buffer all the relevant values before the moving objects inside the N video frames can be classified. Further, experiments suggest that different moving object classification requires different length N. Figure-4 illustrates the relationship between the length of filter N and the type of moving object, in which the vertical axis represents the performance of the filter, i.e. the normalized ECR (error correcting rate):

$$ECR=(AR'-AR)/AR \tag{16}$$

Where AR is the accuracy rate of classification before the filter, and AR' is the accuracy rate of classification after the filter.

The results in Figure-3 indicate that, when N>20, the classification results after filtering tends to be stabilized, and therefore, we select N=20 for the proposed algorithm and all evaluation experiments in the rest of this paper.

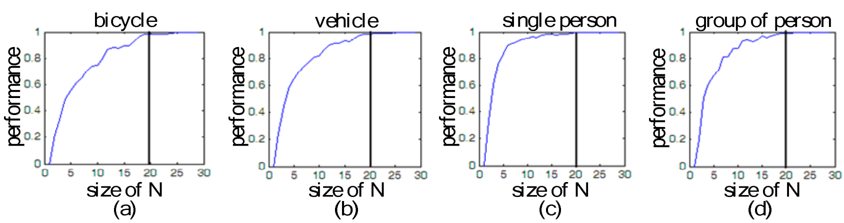

Fig. 3. Illustration of the dependency between the length of filter and the results of classification, where (a)bicycle (b)vehicle (c) single person and (d) group of people

Due to the fact that multiple moving objects could appear in the same frame, it is required to have object tracking module to characterize the relationship among all the moving objects in order to achieve sustainable classification results. As object tracking is a well researched area and many good tracking algorithms have already been reported in the literature [16][17], we select the algorithm reported in [17] as the multiple-object tracking method.

3 Experimental Results

To evaluate the proposed algorithm, we developed its software implementation in C++ and run extensive experiments for a set of surveillance videos, which are publicly available in the Internet [18]. According to the content nature of all the videos, we identified four types of moving objects, which are ‘single person’, ‘group of people’, ‘bicycle’ and ‘vehicle’.

As the PETS2001 video set contains 14 video clips, we used 4 video clips for training and the rest for testing. The size of all the video frames are 768x576. Figure 4 illustrate the classification results for the moving object ‘group of people’, where part-(a) illustrates the value of posterior probabilities generated by the mapping of SVM output without the filtering, part (b) the results of its classification without the filtering, part (c) the smoothed values of posterior probabilities after the filtering,

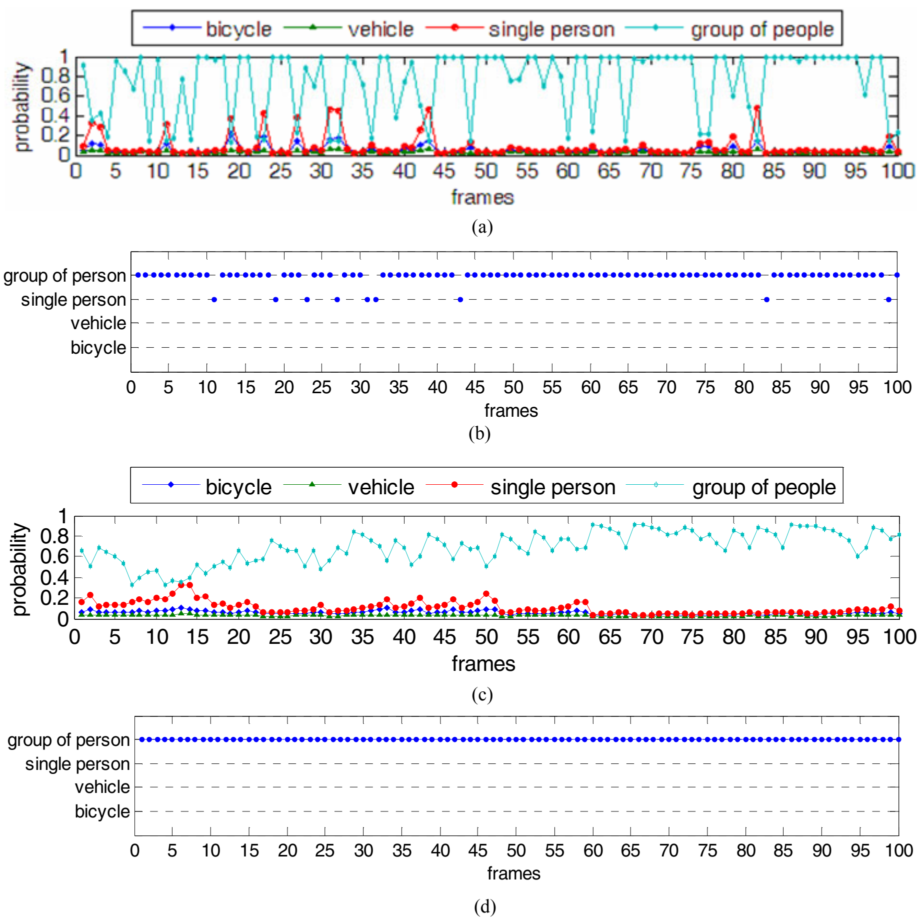

Fig. 4. Classification results for the moving object ‘group of people’

part (d) the final results of classification. Via comparison between part (b) and part (d), it can be seen that the introduction of the weighted mean filtering has improved the classification performances.

Table-1 lists all the experimental results for the video set PETS2001, where the performances of all the compared algorithms are measured by the correct classification rate. To benchmark the proposed algorithm, we compare the proposed algorithm with two other relevant versions to ensure their comparability, which are SVM plus voting for post-processing and the proposed SVM without post-processing. From all the results in Table 1, it can be seen that the proposed SVM with filtering outperforms the other two versions in terms of the correct classification rate. Note the number of classified moving objects is dependent on the content of the training and testing video set. In PETS2001, there are only four moving objects, which are listed in Table-1. For other videos, the number and type of the moving objects may vary and hence the proposed algorithm needs to be re-trained.

Table 1. Experimental results in terms of correct classification rate

	SVM+voting method	presented method	
		probability SVM	probability SVM+filtering
bicycle	75.2%	84.9%	90.5%
vehicle	83.3%	89.5%	96.7%
single person	86.3%	91.3%	98.8%
group of person	85.6%	92.4%	97.3%
Total-average	83.9%	90.3%	97.2%

4 Conclusions

In this paper, we described a SVM-based classification algorithm to automatically process input videos and identify moving objects. To overcome the binary nature of SVM, we introduced a post-processing method to map the SVM output into a posterior probability space and thus enable SVM to produce multi-classification results. To improve its performances, we further proposed a weighted mean filtering as a final post-processing to smooth the posterior probability among neighbouring frames and exploit the correlation property within a neighbourhood of the input videos. As a result, such filtering is capable of removing the negative effect of noises and correct those random wrong classifications to make the proposed algorithm more robust. Experimental results support that the proposed algorithm achieves excellent classification results for the video set PETS2001, which is publicly available in the Internet and make it convenient for comparative evaluations with any further research.

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Memory Management of Multimedia Services in Smart Homes

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Abstract. Nowadays there is a wide spectrum of applications that run in smart home environments. Consequently, home gateway, which is a central component in the smart home, must manage many applications despite limited memory resources. OSGi is a middleware standard for home gateways. OSGi models services as dependent components. Moreover, these applications might differ in their importance. Services collaborate and complement each other to achieve the required results. This paper addresses the following problem: given a home gateway that hosts several applications with different priorities and arbitrary dependencies among them. When the gateway runs out of memory, which application or service will be stopped or kicked out of memory to start a new service. Note that stopping a given service means that all the services that depend on it will be stopped too. Because of the service dependencies, traditional memory management techniques, in the operating system literatures might not be efficient. Our goal is to stop the least important and the least number of services. The paper presents a novel algorithm for home gateway memory management. The proposed algorithm takes into consideration the priority of the application and dependencies between different services, in addition to the amount of memory occupied by each service. We implement the proposed algorithm and performed many experiments to evaluate its performance and execution time. The proposed algorithm is implemented as a part of the OSGi framework (Open Service Gateway initiative). We used best fit and worst fit as yardstick to show the effectiveness of the proposed algorithm.

1 Introduction

Broadband connections like Fiber to Home allowed the Internet to be used not only for connecting computers, laptops, and PDAs but also for home appliances like TV, refrigerators, washers [20]. Remote diagnosis and remote configuration of home appliances are some of the most attractive applications. In the entertainment field there are several interesting applications, for example, users can download movies on demand and an Electronic Programming Guide (EPG). Power companies are also keeping an eye on home networking because it will allow them to provide value-added services such as energy management, telemetric (remote measurement), and better power balance that reduces the likelihood of blackout. Consumer electronics companies started to design Internet-enabled products. Merloni Elettrodomestici, an

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Italy-based company announced their Internet washer Margherita2000 that can be connected to the Internet through which it can be configured, operated, or even diagnosed for malfunctions. LG presented the GR-D267DTU Internet Refrigerator which contains a server which controls the communication to the other three appliances; it also has full internet capabilities. Matsushita Electric showed during a recent Consumer Electronic exhibition showed an Internet-enabled microwave, which can download cooking recipes and heating instructions from the Internet.

There are several initiatives to define the specification for network protocols and API suitable for home applications, like UPnP [11], Jini [9] [10] , to name a few. It is expected that multiple home network protocols will coexist in the home and interoperate through the home gateway. The gateway acts also as a single point of connection between the home and outside world. OSGi [14] [15] (Open service Gateway initiative) is a consortium of companies that are working to define common specifications for the home gateway. According to OSGi model, the gateway can host services to control and operate home appliances. In the OSGi model, services are implemented in software bundles (or modules) that can be downloaded from the Internet and executed in the gateway [6]. For example, HTTP service is implemented in a bundle while security application would be implemented in another bundle. Bundles communicate and collaborate with each other through OSGi middleware and thus, bundles depend on each other. For example, a home security bundle uses an HTTP bundle to provide external connectivity [5].

The price of the gateway is a main concern. Consumer might not be willing to pay for an extra box (home gateway). Also adding gateway functionality to an existing appliance, e.g., TV or STB will increase the appliance prices and shrink an already slim profit margin in this market. There is no consensus among consumer electronic industry on whether the gateway will be a separate box or it will be integrated in home appliances like DTV or STB (Set-Top-Box), or whether the gateway functionality will be centralized in one device or distributed among several appliances. However, the gateway will be, in general, limited in computational resources, especially main memory and CPU. Home gateway main memory will be used by various service bundles and home applications.

This paper discusses the memory management in gateways and how to prioritize the use of memory to maximize the number of services running simultaneously in the home gateway. The paper proposes new models for efficient management of service bundles. Memory management has been studied extensively in operating system field [13]. Memory management for software bundles executed in home gateways differs from traditional memory management techniques in the following aspects:

Traditional memory management techniques, in general, assume that memory pages are independent while bundles may depend on each other as explained in section 2.

Many of the commercial gateways do not come with disks, which makes the cost of stopping applications or services relatively high; restarting a service might require downloading the service bundle from the Internet.

Some home applications are real-time, thus, kicking a bundle from the memory may result in aborting the application or the service, while in traditional memory management model, kicking a page from the memory costs one disk I/O.

In general terminating a service might result in aborting one or more applications. However, in some applications it is possible to kick one service in the application and keep the application running. For example, Audio-on-demand might still work without the equalizer service. However, if the application considers the terminated service critical to its operation, it might terminate all other services in the tree as well. In this paper, although the proposed model and models works for the two cases mentioned above we assume that terminating a node or a sub-tree would terminate the whole application. In the following discussions, the terms application, service, and bundle are used interchangeably.

Thus the main contributions of the paper are:

Identifying difference between memory management in home gateway and traditional memory management problem in general computing environment (addressed in operating system literatures).

Introducing a novel algorithm for managing bundles (or services) in home gateway. The proposed algorithm takes into consideration the priority of the application, the dependencies between applications, and the memory requirements for each application.

The rest of the paper is organized as follow; the next section describes prior works and the service model proposed by Open Service Gateway (OSGi). Section 3 presents a formal definition of the problem and an application scenario that helps describing the problem under consideration. In section 4 we describe the proposed service replacement algorithms. Experimental results are presented in section 5. Finally, conclusions and future works are outlined in section 6.

2 Prior Work

Traditional computer applications addressed the memory management problem extensively in the past. However, the service model is different than that of the home applications. The most efficient traditional memory management algorithms are best-fit, worst-fit. In the experiment section, we compared them with our proposed algorithms in section 3. One of the main differences between memory management for smart home applications and general computer applications memory management in that the first one takes into account the priority of the application and subservices and the dependencies among the different services or bundles. In [24] we addressed smart home applications but all of the same priority or importance. To the best knowledge of the authors there is no study related to the memory management in the context of smart home applications. Vidal et.al. [19] addressed QoS in home gateway, they proposed a flexible architecture for managing bandwidth inside the home; however they have not addressed memory management in home gateways. [8] proposed an architecture based on OSGi for wireless sensor network where data is processed in distributed fashion. They showed how to execute simple database queries like selection and join in a distributed fashion. [17] addresses protocol heterogeneity, interface fragmentation when connection several devices to OSGi-based gateway at home. The paper describes different scenarios and challenges for providing pervasive services in home applications.

2.1 Application Dependency Model

OSGi is a middleware that provides a service-oriented, component-based environment for developers. The OSGi technology provides the standardized primitives that allow applications to be constructed from small, reusable and collaborative components. These components can be composed into an application and deployed. The core component of the OSGi specifications is the OSGi framework that provides a standardized environment to applications (called bundles), and is divided into four layers: Execution Environment, Modules, Life Cycle management, and Service Registry. The Execution Environment is the specification of the Java environment. Java2 profiles and configurations, like J2SE, CDC, CLDC, MIDP etc., are all valid execution environments. The OSGi platform has also standardized an execution environment based on Foundation Profile and a smaller variation that specifies the minimum requirements on an execution environment to be useful for OSGi bundles. The Module layer defines the class loading policies and adds private classes for a module as well as controlled linking between modules. The Life Cycle layer adds bundles that can be dynamically installed, started, stopped, updated and uninstalled. Bundles rely on the module layer for class loading but add an API to manage the modules in run time. The life cycle layer introduces dynamics that are normally not part of an application. The Service Registry provides a cooperation model for bundles that takes the dynamics into account. Moreover, the Service Registry layer provides a comprehensive model to share objects between bundles. A number of events are defined to handle the coming and going of services. Services are just Java objects that can represent anything. Many services are server-like objects, like an HTTP server, while other services represent an object in the real world, for example a Bluetooth phone that is nearby.

OSGi is a framework and specifications for services that can be deployed and managed over wired home network [4] [5] and wireless networks [4]. The OSGi framework is completely based on Java technology. In fact, the specification itself is just a collection of standardized Java APIs plus manifest data. The use of Java technology has several important advantages. First, Java runtimes are available on almost all OS platforms, allowing the OSGi framework and services to be deployed to a large variety of devices across many different manufacturers. Java also offers superb support for secure mobile code provisioning, which allow developers to package and digitally sign a Java applications and send them over the network for remote execution. If the execution host cannot verify the digital signature or determines that the application does not have sufficient permission, it could reject the application or put it in a sandbox with limited access to local resources. Furthermore, Java has an extensive set of network libraries. It supports not only HTTP and TCP/IP networking, but also advanced peer-to-peer protocols such as Jini, JXTA and BlueTooth.

Services are implemented as plug-ins modules called bundles. These bundles can be downloaded from the application service providers through the Internet. Examples for services that are used for application development are Java development tools, J2EE monitor, crypto services, bundles that provide access to various relational database management systems (e.g., DB2, Oracle, etc.), HTML creation, SQL, Apache, Internet browser, XML plug-ins, communication with Windows CE, etc. Other system administration bundles like core boot, web application engine, event handling, OSGi monitor, file system services, etc. Bundles for various Internet and network protocols, like, HTTP service, Web services, SMS, TCP/IP, Bluetooth, X10, Jini, UPnP, , etc. There are many bundles that are already implemented by OSGi partners [15].

Our proposed algorithms are implemented as a part of the framework. The gateway can download the corresponding bundles (that correspond to specific services) when it becomes necessary. In order to share its services with other, bundles register any number of services to the *framework*. A bundle may import services provided by other bundles.

3 Problem Definition

The gateway might need to free memory space to accommodate new services that are triggered by connecting a new device to the network or upon explicit local or remote requests. Although the amount of memory required to execute a service might change with time, the application service provider (or the author who provides the bundle) can give approximate statistical estimates of the amount of memory required to execute the services such as average, median, or maximum. Moreover, extra memory space might be requested by any one of the service instances (inside the residential gateway) to continue its service. If such memory is not available, the gateway picks a victim service instance (or instances) to terminate to allow the new application to start. Given that many of the smart home applications are real-time in nature, thus, the gateway tends to terminate the victim service rather than suspending it.

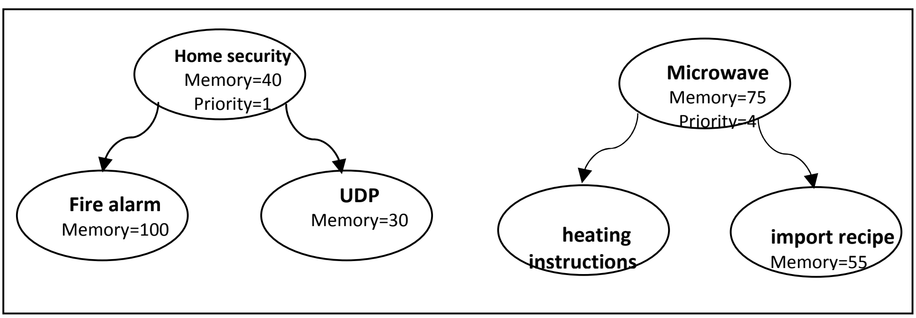

Fig. 1. A gateway that hosts two applications: Home security and Microwave

The following is a typical example that explains the problem in hand. Suppose that there are two applications that are already running in the gateway namely, home security and microwave applications. One application is the home security which uses fire alarm and UDP as a dependent services; it has a priority level 1 (highest priority). The second application is the microwave service, which has a priority level 4 and it uses two subservices: heating instructions and import recipe. The details of the memory requirement for each application and service are shown in Figure 1. Now we would like to start the refrigerator application, which requires a total of 90 memory units. The priority level of the refrigerator application is 3, which means it is more important than the microwave application but it is less important than the home security. The fire alarm service (which is a part of the home security application) has the required memory but it will not be kicked out, because it has the highest priority. Instead it can replace the Microwave application because it has the least priority level. Notice that the required space can be fulfilled by terminating several services. The challenge is to select those services to kick out from the memory gateway such that the services will be with least priority and the number of applications/services affected is minimal.

3.1 Formal Definition of the Problem

More formally, our problem can be described as follows. Let $G=\{g_1,g_2,\ldots,g_j\}$ present the set of graphs (applications), and let $S=\{s_1,s_2,\ldots,s_i\}$ be the set of service instances currently resident in each graph in the main memory. Service instance s_i occupies $M(s_i)$ memory, and each s_i may have other services depending on it. $T(s_i)$ is the set of services that depend on s_i , and the memory occupied by s_i and its dependants is denoted as $M(T(s_i))$. The services in the memory gateway have three levels of priorities High, Medium and Low (*H*, *M* and *L*).

Given that a new service instance s_i , with memory requirement $M(s_i)$ has to be created, it might be required to remove some of the currently existing instances in order to free room for the new instance. Assume that the extra required memory for this operation is M_t units, that is $M_t=M(s) - M_f$, where M_f is the current amount of available memory. Here we assume that, when a service instance is terminated, all instances depending on it will be terminated and removed as well. Our goal is to reduce the quality of removed (stopped) services. More precisely, it is desired to find a service with least priority, whose ejection, together with all its dependents, will make available a total memory of at least M_t units.

In this paper we discuss two approaches to achieve our goal in preserving the quality of services in the memory gateway and present two algorithms The *Relative Weights* (*RW*), and the *Strict Priority* (*SP*) algorithms.

3.2 Naive Solutions

One way to solve this problem is to adapt one of the know solution for memory replacement from the Operating System literatures.

The traditional memory management techniques, like *Best Fit* and *Worst Fit* make selection based on the amount of memory used and ignore the dependencies. We modify these techniques to take into consideration the total accumulative memory of each service (bundle) resulting from stopping one or more service(s). The purpose of presenting traditional memory management algorithms is to use them as yardstick to give an idea about the performance improvement achieved by the proposed algorithms. We consider the following two algorithms:

Best Fit: choose the service $s \in S$ with the smallest total memory that is $\geq M_t$:

$$s \leftarrow \operatorname{argmin}\{M(T(s)) : s \in S, M(T(s)) \geq M_t\} .$$

Worst Fit: choose the service $s \in S$ with the largest total memory:

$$s \leftarrow \operatorname{argmax}\{M(T(s)) : s \in S\} .$$

4 Proposed Service Management Algorithms

The algorithm mainly visits all the nodes in sequential manner. Note that the node *X* can be either a root of a tree (an application), a leaf node, or a non-leaf that acts as a root of a sub-tree. Recall, leaf and non-leaf nodes represent services that belong to that application. If *X* is the root node then the gateway will stop the corresponding application. But if *X* is non-leaf node, then deleting *X* delete the sub-tree under *X*. This will result in stopping some features of the application. In many cases applications can continue to run at reduced functionality. For example, stopping the "Equalizer" service in an Audio-on-Demand application would not stop the audio delivery and the Audio-on-Demand service can still continue working without the "Equalizer" service. In our experiments, without loss of generality, we assume that stopping a service will stop all dependent services in its sub-tree but will not stop the hosting application. We implemented two flavors of the service management algorithm depending on how the priority is handled.

4.1 RW Replacement Algorithm

Some of the real life scenarios represent priority by weight values that reflect the importance of the application. Relative Weight (*RW*) algorithm treats priorities as weights. Large weight values are assigned to high priority services and small weight values are assigned to low priority services. In this algorithm, $W(s_i)$ is assigned to each root node to the priority level that the corresponding application. Subservices, which are represented by leaf and non-leaf nodes, inherit the priority from their parents.

$W(T(s_i))$ is the total weight for the service with its dependants. $W(T(s_i))$ is calculated by adding up the weights of the node s_i and all the nodes in its sub-tree. The terminated service (victim) will be the one with the least weight and of course its

RW Algorithm

```
for each g_j in set G      // graphs loop
  for every s_i in graph g_j     //services loop
        if (M(T(s_i))>M_t )
            //s has enough  memory
                if(W(T(victim))  > W(T(s_i))  )
                    victim= s_i;      // total  weights for s_i < victim
                end if
            end if
   end for // services loop
 end for // graphs loop
if (victim!=NULL)
   delete(victim);        // delete  victim service
else
   return  "no solution found"
end if
```

Fig. 2. RW replacement algorithm

termination frees enough space for the new coming application. The algorithm in Figure 2 checks if the service has the required memory for the new coming service, then we check for the service with least weight. So the *RW* algorithm traverses all the services available in the gateway and checks if the service has the required memory. If the service does have the required memory the algorithm checks if its weight is less than that of the victim; if this is true, the victim is updated. Note that the *RW* model may not find a service with enough memory space; in this case, the new service cannot start.

4.2 Strict Priority Model (*SP*)

The other way to treat applications with different priority is to give an unprecedented attention to high priority applications before serving applications with lower priorities. We refer to this algorithm as the *Strict Priority* algorithm. The difference between the strict treatment and the relative weight treatment of the priority appears when there is a need to delete more than one low priority service, say *c* low priority services. If the total weight of the *c* low priority services is larger than the weight of a high priority service, then the *Relative Weight* algorithm will remove the high priority service. While the *Strict Priority* algorithm will remove the *c* low priority services regardless of the value of *c*.

Strict Priority model assumes that the priority is a property of the application; all services and subservices inherit their priorities from their parent applications. The model assumes that there are *k* different priority levels assigned values from 1 to *k,* where 1 refers to the highest priority and *k* refers to the lowest priority.

To minimize the number of services terminated, we select to terminate the node with minimum number of dependents. To account for the number of dependent services (that will be terminated by kicking the sub-tree root) we use the $Ratio(s_i)$ formula:

$$\boldsymbol{Ratio(s_i)} = \frac{\boldsymbol{M(T(s_i))}}{\boldsymbol{|T(s_i)|}} \quad . \tag{1}$$

The terminated service (victim) will be the one with least priority and has low *Ratio value.* The *SP* algorithm performs one pass through the services in the memory gateway. Since the new service cannot kick out a service of higher priority, the *SP* algorithm simply considers services of equal or less priority than the new services. So the *SP* algorithm traverses all services in the gateway to select the candidate victim. The algorithm will check if the priority of s_i is less than the priority candidate victim. If true, s_i is added to the candidate victim list. Among all candidate victims with the same priority, the algorithm chooses the one with the least *Ratio*. This process is repeated until all services are processed.

5 Performance Evaluation

We carried extensive empirical studies to evaluate the proposed algorithms. We compared the performance of the proposed algorithms in terms of the number and priority of the removed services. We also measured the algorithm execution time. The sizes of the services are assumed to be uniformly distributed. First we describe how the experimental data is generated, and then we present our results.

5.1 Experiment Setup

Initially, services are generated with random sizes and loaded into gateway memory, until the memory becomes almost full; in our experiments we filled the gateway with 100 services. Each service can be dependent on a number of randomly selected services with probability varying from 0 to 1. Service sizes are selected randomly in the range from 1MB to 5MB according to a uniform distribution. Services have three levels of priorities High, Medium and Low (*H*, *M* and *L*).

The memory requirements for the new services are selected randomly. The expected output of the simulation is to find out which service(s) should be kicked out to make room for the incoming services. To measure the quality of the deleted services we calculate the total weight of the stopped services using equation (3). *V* is the set of stopped services. W_v denotes the total weight of all services that are stopped to start the new service.

$$Wv = \sum_{s \varepsilon V} W(s) \ . \quad (2)$$

We conducted experiments to compare the performance of the traditional algorithms, namely, Best-fit and Worst-fit with the proposed algorithms *RW* and *SP*. Each experiment is repeated 100 times and the average of the results is calculated.

5.2 Experimental Results for *RW*

In this experiment we compared the *RW* algorithm with the well-known best fit and worst fit algorithms in terms of the quality of victim services, as the size of the new coming bundle increases from 1 MB to 10MB. To measure the quality of the deleted services we assign weights {400, 200, 1} according to the priority these services obtain (High, Medium and Low) respectively. The performance of the service management algorithms is evaluated by measuring the total weight of the stopped services as a function of the size of the new coming service. Figure 3 shows the total weight of the stopped services in the Y-axis and the size of the new services in the X-axis. The total weight of the stopped services is increasing as the size of the new coming service increases because of the need to terminate more services. The results show that the *RW* outperforms the traditional algorithms in preserving the services with high priority. The performance gain increases with increasing the size of the new service.

Table 1 compares the execution time of the *RW* algorithm with the execution time of the best fit and worst fit algorithms as a function of the number of services that exists in the gateway. The size of the new coming service is fixed to 5 MB. The costs of the three algorithms increase with increasing the number of services in the gateway because of the sequential nature of the algorithms. The results show that the cost of the *RW* algorithm is higher than (but close to) the best fit and worst fit algorithm. The difference in the execution time is always less than 6% and it significantly decreases

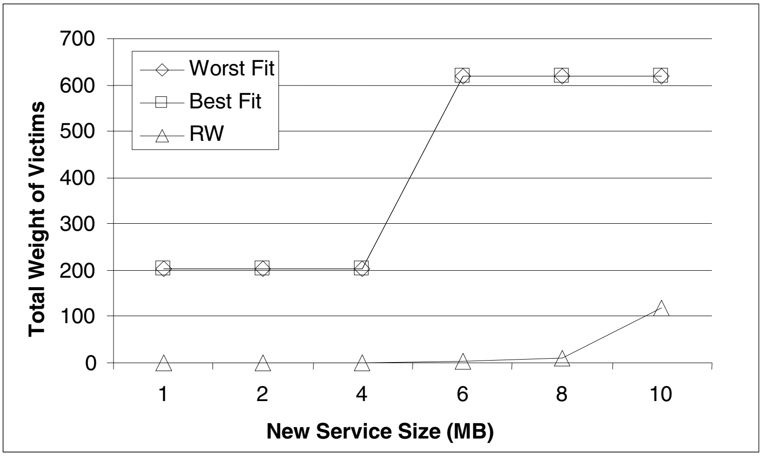

Fig. 3. Quality performance of algorithms while increasing the new service size

Table 1. Comparing the execution time of the RW with best and worst fit

No. of existing services	Worst Fit(μs)	Best Fit(μs)	*RW*(μs)
100	18	18	19
200	35	35	36
300	51	51	53
400	68	68	69
500	85	85	86

as the number of services in the gateway increases. This makes the proposed algorithms suitable for practical applications.

5.3 Experimental Results for *SP*

In this experiment we compared the *SP* algorithm with the traditional algorithms, best fit and worst fit, in terms of the quality of victim services, as the size of the new coming service increases from 1 MB to 10MB. We used a weight vector {400, 200, 1} to represent the priority vector (High, Medium and Low) respectively.

Figure 4 shows the total weight of the stopped services in the Y-axis and the size of the new services in the X-axis. The total weight of the stopped services is increasing as the size of the new coming service increases because of the need to terminate more services. In Figure 4 we can see that the *SP* algorithm outperforms the best fit and worst fit algorithms. The total weight of the stopped services for the *SP* algorithm is always less than that of the best and worst fit algorithms.

By comparing Figure 3 and Figure 4, one can realize that SP algorithm performance, in terms of the total weight of the stopped services, is better than the performance of the *RW* algorithm. This can be explained as follow. The SP algorithm protects

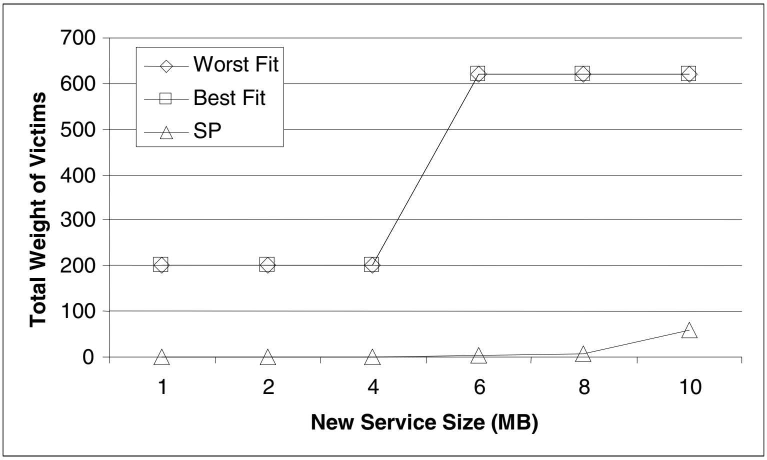

Fig. 4. Quality performance of algorithms while increasing the new service size

Table 2. Execution time for all three algorithms

No. of existing services	Worst Fit(μs)	Best Fit(μs)	*SP*(μs)
100	18	18	24
200	35	35	46
300	51	51	69
400	68	68	95
500	85	85	116

high priority services as long as there are lower priority services in the gateway. So, in some cases the service management algorithm is obliged to stop a large number of low priority services to avoid stopping a high priority services. If the total weight of the low priority services is higher than the weight of the high priority service, the *SP* performance will be less than the *RW* performance.

Table 2 shows the cost of the *SP* algorithm in terms of execution time and compare it with the execution time of the best fit and worst fit algorithms as the number of services in the gateway changes. The size of the new coming service is fixed to 5 MB. The execution time of the SP algorithm is larger than the execution time of the traditional algorithms (as well as the *RW* algorithm).

6 Conclusions

We have considered the problem of managing applications and services in home gateways with limited amount of main memory. One of the main differences between our problem and the traditional memory management is the priority of the applications and the dependencies among different services.

The paper proposed two algorithms; the first one is the *Relative Weights* (*RW*) algorithm that uses weight vector to represent the priority between applications. Furthermore subservices inherit the priority of the parent application. The second one is the *Strict Priority* algorithm (*SP*), which assumes that high priority service is more important than any number of low priority services. We compared the proposed algorithms with the traditional memory management algorithms like best fit and worst fit. Simulation results indicate that *RW* and *SP* are much better than best fit and worst fit in terms of the total number of services kicked out and their priorities. At the same time, the proposed algorithms execution time is comparable to the execution time of the best fit and worst fit. In the future, we will try to find an optimal solution for the memory management problem.

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Stochastic Capturing Moving Intrusions by Mobile Sensors

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Abstract. In our previous work [1], we studied Intrusion/Detection Model 1 (IDM-1), in which intrusion events occur /arrive randomly at the points of the region of interest and then fade way after a random time. In this paper, we built a stochastic model analyzing the detection quality achieved by a single sensor moving along a certain track, based on velocity and mobility pattern. We consider the modes of intrusion events defined as follows: intruders occur/arrive at random points at the edge of the field of interest, and move directly to the center of the field of interest at a constant/maximum speed. We called this model as IDM-2. In order to compare the results, two detection scenarios are studied: the robot detection scenario and the radar detection scenario. In the robot detection scenario, a robot is set to move periodically along a certain route at a constant speed. In the radar detection scenario, radar is rotated at a constant speed in a clockwise/anti-clockwise direction. An intrusion is said to be captured if it is sensed by the moving robot or radar before it arrives at the center of the field of interest. For both scenarios, we derive general expression for intrusion loss probability and the expected time that it takes the robot or radar to make the first capture of the intruders.

Keywords: Sensor Networks, Mobile Sensors, robots, Intrusions.

1 Introduction

Recent advances in robotics and low power embedded systems have made dynamic detection [3, 4, 5, 6] an available choice for sensing applications. Due to their mobility, a small number of moving robots may be deployed to cover a large sensing field [7]. A properly designed routine of the moving robots makes the networking connection more reliable because the robots are capable of exchanging information with each other whenever one is within communication range of any of the others.

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However it is important to notice that the instantaneous areas covered by a moving robot and a stationery detection device of the same type are the same. Without properly designing the moving track, the moving robots may not have better detection quality than the stationary detection devices, especially when the sensing field is highly dynamic (either spatially or temporally) in nature.

In [2], the authors derived results for how the quality of coverage in mobile sensor networks is affected by the number of mobile sensors, their velocity, velocity pattern, and event dynamics. They analyzed the case where the PoI's (point of interest) are located on a simple closed curve and the sensors move along the curve. Their model is based on the assumption that the intrusions occur at one or more fixed points of the region that the sensors detect and that the intrusions do not occur randomly on the points of the region of interest.

In [1], we studied Intrusion/Detection Model 1 (IDM-1), in which intrusion events occur /arrive randomly at the points of the region of interest and then fade way after a random time. We investigated and drew conclusions on how the quality of the first intrusion capture in the moving robot detection scenario, as well as in the radar detection scenario, depends on parameters such as robot moving speed and event dynamics in both scenarios. Analysis and derivation of the first capture were also presented.

In this paper, we will study Intrusion/Detection Model 2 (IDM-2), in which intrusion events arrive at random points at the edge of the field of interest and move directly to the center of the field of interest at a constant (or the maximum) speed. There are many examples of applications in IDM-2 in the real world. For instance, thieves may arrive at the periphery of a house and try to get in the center of the house where there is jewelry as quickly as possible. We analyze how the quality of the first intrusion capture in moving robot detection scenario, as well as in the radar detection scenario, depends on parameters such as robot moving speed, event dynamics, and the speed of the intruder in both scenarios. We draw our conclusions for the problem above and for the first capture problem.

The rest of this paper is organized as follows. Section 2 presents problem definition including model, problems to be solved, and assumptions. Section 3 provides analysis of first capture of intrusions. Finally, we conclude our paper in Section 4.

2 IDM-2: Problem Definition

In this section, we define an intrusion/detection model, explain the problems to be solved, and give assumptions.

2.1 Intrusion/Detection Model 2 (IDM-2)

In this paper, we considered the following intrusion mode, called Intrusion/Detection Model 2 (IDM-2). The detection region studied here is a circle with radius R, shown in Fig. 1. An intrusion is a target/intruder that appears /occurs along the perimeter of the circle (i.e., the edge of the sensing field), and moves straightly towards the center

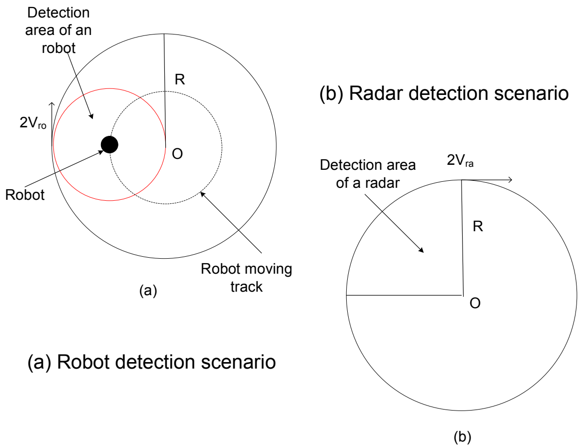

Fig. 1. Robot and radar detection scenarios

of the circle. An intrusion/intruder is considered to be detected if the target/intruder appears within the sensing range of a moving sensor (robot) or radar on its way to the center. The intruder is immediately captured by the robot or radar as soon as it is detected. If the intruder is captured, it will stop moving. Once the intruder arrives at the center, we regard it to be missed or not captured. Detection qualities for this intrusion mode are derived based on two different detection scenarios, the radar detection scenario and the robot detection scenario, respectively.

The robot detection scenario is shown in Fig. 1a. The robot is moving clockwise or anti-clockwise along the dotted circle at a constant speed V_{ro}. At any time, the robot has a detection range of a circle with radius R/2, which can cover a quarter of the detecting region. In such a model, a single robot would have the ability to cover the whole circle field of interest in one time period.

The radar detection scenario is shown in Fig. 1b. It is very common in surveillance applications. At any given time, the radar has a detection range of a sector, which can cover a quarter of the detecting region. The radar will rotate in a clockwise/anti-clockwise direction, and the speed at the middle point of the radius is V_{ra}, which is also considered to be the speed of the radar . The whole detect region can be covered by the radar in one time period.

In the IDM-2, we assume that an intruder moves towards the center at its maximum speed. By intuition, once the intruder starts its intrusion, it always desires to reach the center as soon as possible. Therefore, the movement of the intruder can be considered to be a constant speed movement, where the speed is the maximum speed of the intruder, denoted as V_{in}.

2.2 Problems to Be Solved

We will address the following issues:

- *Problem 1*: What is the probability that an intruder is lost by a single moving sensor with a constant speed in the robot detection scenario?
- *Problem 2*: What is the probability that an intruder is lost by a single moving sensor with a constant speed in the radar detection scenario?
- *Problem 3*: If an intruder is captured by the robot, what is the expect time that the robot spends to capture it from the time when it occurs?
- *Problem 4*: If an intruder is captured by the robot, what is the expect time that the radar spends to capture it from the time when it occurs?

Note that an event that an intrusion is lost is critical, especially in some critical applications where even one intrusion would destroy the system.

2.3 Assumptions

We assume that an intrusion is a target/intruder moving from the edge of the sensing field straight towards the center. Let X_i denote the length of the time interval between the times when the *i*-th and *(i+1)*-th adjacent intruders appear. We assume X_i to be a stochastic variable that has an exponential probability distribution with a mean $1/\lambda_i$. Therefore, intruders appear at the edge of the sensing field one by one. In our math model, we further assume $\lambda_i = \lambda$ for any i .

Since what we are concerned with is the intrusion capture quality, we assume that no intrusion happens before the robot or radar starts to move to detect intrusions, and let zero to be the time when the robot begins to move to detect intrusions.

Let O(R) denote as the circular area with radius *R* that the robot or the radar will detect intrusions. Let O denote the center of the round region O(R). Any intrusion can appear randomly at any point on the perimeter of O(R). The point where the intrusion appears is a variable, which is subject to a uniform probability distribution along the perimeter. Without losing generality, we suppose that both the robot and the radar move a clockwise direction. If A and B are two points on the edge of O(R), an angle <AOB> represents the angle of line AO to line OB in a clockwise direction, and its value can vary from o to 2π .

3 IDM-2 Analysis of Capture of Intrusions

We consider only the capture of the first intrusion, called first capture. Let T denote the time that the first intruder/intrusion occurs. Let $\Pr_o[loss]$ and $\Pr_a[loss]$ denote the probabilities that the robot and the radar, respectively, misses (or does not capture) the first intruder. Let $\Pr_o[loss \mid T = t_0]$ and $\Pr_a[loss \mid T = t_0]$ denote the conditional probabilities that the robot and the radar, respectively, misses the first intruder under the condition that $T = t_0$.

3.1 Robot Detection Scenario

Let $\bar{r} \approx 4.6033$ .Then we can obtain that

$$
\Pr_o[loss] = \Pr_o[loss \mid T = t_0]
= \begin{cases}
1-\dfrac{\theta}{2\pi}=1-\dfrac{\pi}{2\pi}=\dfrac{1}{2} & \text{if } \dfrac{2V_{ro}}{V_{in}} \le 1 \\[2ex]
1-\dfrac{\theta}{2\pi}=1-\dfrac{\dfrac{\pi}{2}+\arcsin(\dfrac{V_{in}}{2V_{ro}})+\dfrac{\sqrt{1-(\dfrac{V_{in}}{2V_{ro}})^2}}{\dfrac{V_{in}}{2V_{ro}}}}{2\pi} & \\[2ex]
=\dfrac{3}{4}-\dfrac{\arcsin(\dfrac{V_{in}}{2V_{ro}})+\dfrac{\sqrt{1-(\dfrac{V_{in}}{2V_{ro}})^2}}{\dfrac{V_{in}}{2V_{ro}}}}{2\pi} & \text{if } 1<\dfrac{2V_{ro}}{V_{in}} \le \bar{r} \\[2ex]
0 & \text{if } \dfrac{2V_{ro}}{V_{in}} > \bar{r}
\end{cases}
$$

Therefore, Problem 1 is solved. To examine the expected time that the robot takes to capture the first intrusion under the condition that it can be captured, we first introduce a stochastic variable T_{ro}, which represents the time the robot takes to capture the first intrusion.

$$E(T_{ro} \mid I[\text{the first intruder is captured}]=1)$$

$$=\frac{E(T_{ro}I[\text{the first intruder is captured}] \mid T=t_0)}{1-\Pr_o[loss]}$$

$$=\begin{cases} 4\int_0^{\frac{R}{V_{in}}} t\frac{1}{2\pi}\left(\frac{V_{in}}{R\sqrt{\frac{2V_{in}}{R}t-(\frac{V_{in}}{R}t)^2}}\right)dt & \text{, if } \frac{2V_{ro}}{V_{in}}\le 1 \\ \dfrac{\int_0^{\frac{1-\sqrt{1-(\frac{V_{in}}{2V_{ro}})^2}}{\frac{V_{in}}{R}}} t\frac{1}{2\pi}\left(\frac{V_{in}}{R\sqrt{\frac{2V_{in}}{R}t-(\frac{V_{in}}{R}t)^2}}-\frac{2V_{ro}}{R}\right)dt + \int_0^{\frac{R}{V_{in}}} t\frac{1}{2\pi}\left(\frac{2V_{ro}}{R}+\frac{V_{in}}{R\sqrt{\frac{2V_{in}}{R}t-(\frac{V_{in}}{R}t)^2}}\right)dt}{\frac{3}{4}-\dfrac{\arcsin(\frac{V_{in}}{2V_{ro}})+\dfrac{\sqrt{1-(\frac{V_{in}}{2V_{ro}})^2}}{\frac{V_{in}}{2V_{ro}}}}{2\pi}} & \text{, if } 1<\frac{2V_{ro}}{V_{in}}\le \bar{r} \\ \int_0^{\frac{1-\sqrt{1-(\frac{V_{in}}{2V_{ro}})^2}}{\frac{V_{in}}{R}}} t\frac{1}{2\pi}\left(\frac{V_{in}}{R\sqrt{\frac{2V_{in}}{R}t-(\frac{V_{in}}{R}t)^2}}-\frac{2V_{ro}}{R}\right)dt + \int_0^{\overline{T_{ro}}} t\frac{1}{2\pi}\left(\frac{2V_{ro}}{R}+\frac{V_{in}}{R\sqrt{\frac{2V_{in}}{R}t-(\frac{V_{in}}{R}t)^2}}\right)dt & \text{if } \frac{2V_{ro}}{V_{in}}>\bar{r} \end{cases}$$

Therefore, Problem 3 is solved.

3.2 The Radar Detection Scenario

We know that if $V_{ra}/V_{in} \ge 3\pi/4$, the first intruder is surely captured, namely,

$$\Pr_a[loss]=\Pr_a[loss \mid t_0]=0;$$

if $\frac{V_{ra}}{V_{in}}<\frac{3\pi}{4}$,

$$\Pr a[loss] = \Pr a[loss \mid t_0] = \int_{\frac{2V_{ra}}{V_{in}}}^{\frac{3\pi}{2}} \frac{1}{2\pi} d\theta = \frac{\frac{3\pi}{2} - \frac{2V_{ra}}{V_{in}}}{2\pi} = \frac{3}{4} - \frac{\frac{V_{ra}}{V_{in}}}{\pi}.$$

Therefore, Problem 2 is solved. Let T_{ra} represent the time the radar talks to capture the first intrusion.

$$E(T_{ra} \mid I[\text{the first intruder is captured}])$$
$$= \frac{E(T_{ra} I[\text{the first intruder is captured}] \mid T = t_0)}{1 - \Pr a[loss]}$$
$$= \begin{cases} \dfrac{R \frac{V_{ra}}{V_{in}^2}}{\frac{\pi}{2} + \frac{2V_{ra}}{V_{in}}} & \text{if } \dfrac{V_{ra}}{V_{in}} < \dfrac{3\pi}{4} \\ \dfrac{9\pi R}{32 V_{ra}} & \text{if } \dfrac{V_{ra}}{V_{in}} \geq \dfrac{3\pi}{4} \end{cases}$$

Therefore, problem 4 is solved. Therefore, all of the proposed problems have been solved.

4 Conclusion

In this paper, under an intrusion mode, called IDM-2, we analyze intrusion capture performance under two different detection scenarios: the robot and radar detection scenarios. Intrusion loss probabilities for both detection scenarios are considered. We derive first capture probabilities and capture time durations under both the robot and the radar detection scenarios. For both detection scenarios, we consider the expected time (capture time) that the moving sensor or radar takes to capture the intruder from the time it occurs, in the case that the moving sensor or radar captures it. Our results (omitted due to limited space) show that the robot performs better than the radar in terms of the probability of capturing an intruder, and that the radar performs better than the robot in terms of capture time.

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Effects of Action Video Game on Attention Distribution: A Cognitive Study*

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Abstract. Based on the previous researches, Flanker compatibility effect paradigm was applied to explore the degree where people process the visual information presented on to-be-ignored locations. In present study, this paradigm was used to investigate attention distribution of Video Game Players (VGPs) and Non Video Game Players (NVGPs). The results suggested, under low perceptual load, VGPs tried to focus their attention on the task at-hand whereas the NVGPs tried to explore the adjacent locations with the left-over resources from the research task; however, under high perceptual load, the players would process the visual information at the adjacent locations of the target with the left-over resources, because they had comparatively greater attention capability, whereas the non-players focused their attention on the target locations to finish the search task. To conclude, the present study suggested that action video game play could not only enhance the attention capacity but also cause a different way of attention distribution in different perceptual load situations.

Keywords: Action Video Game; Focused Attention; Perceptual Load; Attention Distribution.

1 Introduction

Traditional attention theory suggested a limited capacity of attention resource, meaning that, at a given time unit, people were just able to pay attention to a limited subset rather than all information in the visual field. Therefore, one of the most important functions of our visual system was to search for and select the relevant information for the task at hand and at the same time to ignore the interference from the irrelevant stimuli (e.g., Castel, Pratt & Drummond, 2005; Lavie, 2005). For example, when driving on the road, drivers must focus on the road ahead instead of being attracted by the kite in the sky. However, a boy at the roadside that should be considered as "irrelevant" information will turn into relevant information by running across the road to chase a ball. Therefore, how do people allocate their attention to help them to effectively select useful information from the visual field which contains a huge amount of distracting stimuli?

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1.1 Effect of Video Games on Attention Processing

In the experiments conducted by Eriksen and Hoffman (1973, 1974), some letters were randomly presented around the fixation point one by one, and participants were required to discriminate the target letter from the others. They found that the participants could react 30-40 ms faster when the target letter was presented at the cued location. This result was also proved by Hoffman (1975) in his study. However, some researchers thought that this progress was not concerned with visual search and selection because the letters were presented one by one. Some other studies (e.g. Eriksen & Collins, 1969; Jonides, 1980; Posner, Snyder, & Davidson, 1980; Yantis & Johnston, 1990; Johnson & Yantis, 1995) required participants to search for and select targets from some other to-be-ignored stimuli, and the results indicated that people could also perform better when targets presented at the cued locations. Jonides (1980, 1983) explained this with attention resource theory. He thought that participants, when searching for targets, allocated their attention resource to different locations in the visual field. To promote their searching efficiency, they allocated a greater proportion of their attention resource on the cued location whereas a smaller part at the uncued locations. Therefore, they could process the information presented at the cued locations faster than that at the uncued locations. Some other researchers (e.g. Johnson & Yantis, 1995; Muller, 2003) found similar results and pointed out that cues could influence attention's allocation; that is, more attention resource would be distributed at the cued locations where the visual information could be processed faster, whereas less resource at other locations.

Researchers (e.g., Eriksen & Yeh, 1985; Yantis & Johnston, 1990) also found that participants performed better at cued locations (the cue was 100% valid) in a visual search task, and that at the uncued locations which were also called the to-be-ignored locations, the interference from the distracting stimuli decreased significantly. Therefore, they thought that under conditions where the cue was 100% valid, most attention resource of the participants would distribute at the cued locations and little (or even none) at the to-be-ignored locations, which was also the reason why there was no distractor interference.

Many researchers had noted the effects of video-game playing on various aspects of cognition including visual attention (e.g. Castel, Pratt, & Drummond, 2005; Dorval & Pepin, 1986; Gopher, Weil, & Bareket, 1994; Green & Bavelier, 2003; Green & Bavelier, 2006a; Green & Bavelier, 2006b; Greenfield, DeWinstanley, Kilpatrick, & Kaye, 1994; Li & Atkins, 2004; McClurg & Chaille, 1987; Yuji, 1996). In 2003, Green and Bavelier, using the Flanker compatibility effect which was a standard experimental paradigm in attention studies, measured the attention resource of both action video-game (we would explain action video game in the following part) players (VGPs) and non-video-game players (NVGPs) (Green & Bavelier, 2003). In their experiment, subjects were required to finish a target task (searching through the display to determine whether a square or diamond was presented) while ignoring the to-be-ignored distractors (other shapes such as triangle). When the target task was made very difficult by increasing the number of to-be-ignored distractors, NVGPs had to devote all their available attention resource to the target task and had no left-over resource to deal with the distractors. However, at the same difficulty level, VGPs, successfully finished the target task, and still had left-over resource to process the distractors. The results indicated that VGPs rather than NVGPs had an enhanced attention capacity and were able to process more visual information at a given time period.

In addition to possessing greater attention capacity, VGPs could allocate or distribute their attention more efficiently. Research by Greenfield and colleagues (1994) measured experts and novice VGPs' capacity of distributing attention and the results indicated that experts could allocate their attention more efficiently than novices (experts could detect the presentation of the target at locations where targets were presented at a very low probability with no increment of reaction time compared with at locations where targets were presented at 50% probability; while novices showed reaction time increment). Furthermore, studies by Green and Bavelier (2006b) and Castel and Pratt and Drummond (2005) suggested that, with greater attention capacity, action-video-game players, were able to distribute their attention more efficiently, search and select targets from distracting stimuli more efficiently.

1.2 Hypothesis of Present Study

Therefore, based on these experiments discussed above, it could be suggested that video game playing could play an important role in enhancing attention resource and its allocation efficiency or visual search efficiency. Besides that, spatial cue, spatial position and perceptual load could affect attention distribution, and training could influence attention capacity, which improves searching efficiency. Moreover, action video game would affect spatial attention processing, perceptual processing and attention allocation.

In some video games (e.g., Counter-Strike, CS), the targets appear at fixed locations (for example, the bomb or the hostage) and the players are required to finish their task at these fixed locations. However, in most such games, "enemies" may pop up anywhere at any time and the penalty for failing to detect their appearance is great (death, for example). As discussed above, people always allocate most of their attention resource at the cued locations and little at the to-be-ignored locations; and therefore we propose a hypothesis that video game experience may influence the spatial distribution of players' attention resource. We will explore different methods of allocating attention between VGPs and NVGPs under different perceptual load, and how the players allocate their left-over attention resource under different perceptual load.

2 Method

2.1 Participants

18 participants with normal or corrected vision, aged between 19 and 25, were placed into one of two groups, VGPs or NVGPs. All 9 VGPs were Counter-Strike (CS) players with a minimum of 2 hours of CS play per day and 6 days a week at least in the past 6 months. None of the 9 NVGPs had little action video-game experience in the past.

2.2 Apparatus

All the tasks were completed on 19 inch CRT computers with resolution of 600X800 and refreshing rate of 85Hz.

2.3 Design and Procedures

Studies by Lavie and his colleagues (Lavie et al., 2004; Lavie, 2005) indicated that the left-over attention resource of the participants from the task was not simply turned off. Instead it was distributed at the adjacent locations. In present experiment, we used a cue with validity of 70% and therefore the participants, with their attention resource directed to the pre-cued locations, had to search for the target shape from four possible locations in each trial. The Flanker compatibility effect was also used in this experiment.

All stimuli were identical to those used in Green & Bavelier (2006b). There were three categories including targets, fillers and distractors (see Figure 1). The target set consisted of a square and a diamond. The filler set included a house-like pentagon, an upside-down pentagon, a sideways trapezoid, a triangle pointing up and one pointing down. Both the target and filler stimuli subtended an average of 0.6° vertically and 0.4° horizontally. The distractor set consisted of a square, a diamond and an ellipse which were presented peripherally (4.2°to the right or left of fixation). According to cortical magnification factor (Rovamo & Virsu, 1979; Green & Bavelier, 2006a), the distractors subtended 0.9°vertically and 0.5°horizontally.

In the experiment, eight circular frames were presented around the fixation point at a distance of 2.1°. The center of each circular frame was 2.1°away from that of adjacent one. Both the target and filler shapes were presented inside these circular frames, whereas the distractors were presented outside of the circular frames. In each trial, one member of the target set always appeared in one of the four circular frames up, down, to the right or to the left of the fixation point; and also one member of the distractor set always appeared outside the ring of the circular frames, either near the target or to the opposite side of the target. No filler was presented when perceptual load was low and seven fillers were presented inside the other seven circular frames when perceptual load was high.

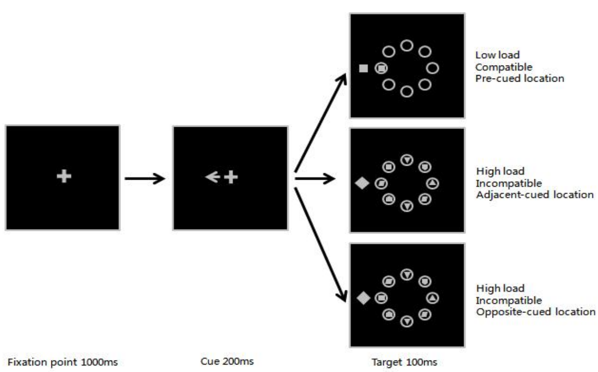

Fig. 1. Sample stimuli and trial experiment procedure

The participants were first given a block of practice of 48 trials and then would start the test until they finished the practice with an accuracy of at least 85%. The test was divided into six blocks, and following each block of 240 trials, participants were given a resting screen telling them to have a rest for at least one minute. Participants were paid for the participation of the experiment which was about 50 minutes.

3 Results

3.1 Analysis of Accuracy

We put the accurate data into a 2x2x2x3 repeated measure analysis of variance with VGP (VGPs vs. NVGPs), perceptual load (low vs. high), distractor compatibility (compatible vs. incompatible) and target location (pre-cued location, adjacent-cued location, and opposite-cued location) as factors. Main effects of distractor compatibility (compatible: 88.7%±0.7; incompatible: 81.7%±1.5), $F(1,16)=40.62$, $p<0.001$, demonstrating the influence of the distractors on the performance of the participants, and target location (pre-cued location : 89.3%±1.3; adjacent-cued location : 80.0%±1.4; opposite-cued location: 86.3%±0.7), $F(2,32)=47.08$, $p<0.001$, suggesting a better performance at the pre-cued locations, were found. Also, the lack of interaction between VGP and any other factors suggested that different level of factors caused the same task difficulty change for the VGPs and NVGPs.

3.2 Analysis of Reaction Time

For the RT analysis, the incorrect trials and the trials with RT longer than 1800 ms or shorter than 200ms were excluded (VGPs: 14.3%±0.06; NVGPs: 15.1%±0.07). Then the filtered data were analyzed in a 2 x 2 x 2 x 3 analysis of variance (ANOVA) with video-game experience (VGP vs. NVGP), perceptual load (low vs. high), distractor compatibility (compatible vs. incompatible) and target location (pre-cued location, adjacent-cued location, and opposite-cued location) as factors. See the results in table 1.

Table 1. Mean Reaction Time in All Levels of 2 x 2 x 2 x 3 Design

	Pre-cued Location				Adjacent-cued Location				Opposite-cued Location			
	Low Load		High Load		Low Load		High Load		Low Load		High Load	
	Com.	Incom.	Com.	Incom.	Com.	Incom	Com.	Incom	Com.	Incom	Com.	Incom
VGPs	545	550	610	618	614	621	938	953	592	604	842	843
NVGPs	517	527	593	583	591	607	851	850	566	586	742	738

Notes: Com. = compatible; Incom. = incompatible.

The analysis revealed main effects of perceptual load (low load: 554ms±56; high load: 661ms±76), $F(1, 16)=114.62$, $p<0.001$, with a shorter RT under low perceptual load than under high perceptual load, indicating that the task difficulty increased with perceptual load increasing, distractor compatibility (compatible: 602ms±63; incompatible: 607ms±63), $F(1,16)=6.41$, $p=0.02$, demonstrating the effect of distractor compatibility on RT, and target location (pre-cued location: 568ms±60; adjacent-cued location: 723ms±90; opposite-cued location: 678ms±69), F(2,32)=83.27, p<0.001. Further analysis revealed that participants responded faster at pre-cued locations than at adjacent-cued or opposite-cued locations, and faster at opposite-cued locations than at adjacent-cued locations. The interaction between perceptual load and target location, F(2,32)=36.73, p<0.001, was found, suggesting a biggest decrement of RT at adjacent-cued locations and a smallest decrement at pre-cued locations with the increment of perceptual load. The interaction between VGP, perceptual load and distractor compatibility reached significant level, F(1,16)=6.65, p=0.02, indicating the VGPs were still processing the distractor under high load, whereas the NVGPs were not.

The main effect of VGP/NVGP group was not significant (VGPs: 622±76; NVGPs: 588±44), F(2,32)=2.1, p=0.17, suggesting that the difference on the compatibility effect between VGPs and NVGPs was not caused by their reaction time.

3.3 Distractor Compatibility Effect under High and Low Perceptual Load

The results suggested that the cue with a validity of 70% could effectively help the participants focus their attention at the pre-cued locations. Therefore, to better explore the spatial distribution of attention resource, we analyzed the Mean difference RT compatible and incompatible conditions and a 2x2 repeated analysis of variance was done to study the size of the distractor compatibility effect with VGP (VGPs vs. NVGPs) and perceptual load (low vs. high) as factors.

Main effect of perceptual load (low load: 5.31ms±1.95; high load: -1.65ms±1.44), F(1,16)=10.39, p=0.005, was found, with a bigger size of compatibility effect under low percptual load than under high load, indicating that more attention resource was left over under low load than under high load. The main effect of VGP was not significant (VGPs: 3.69ms±1.90; NVGPs: -0.02±1.89), F(1,16)=0.91, p=0.19, but VGP interacted significantly with perceptual load, F(1,16)=33.46, p<0.001, demonstrating a larger decrement on the size of the distractor compatibility effect for NVGPs than VGPs with the perceptual load increasing. We further noted that VGPs showed a

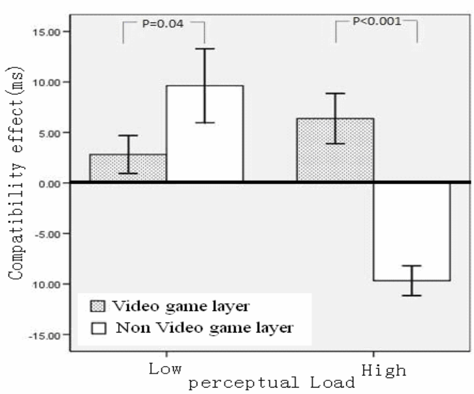

Fig. 2. Compatibility effect under high and low perceptual load

bigger size of distractor compatibility effect under high perceptual load, $F(1,16)=31.01$, $p<0.001$, whereas a smaller one under low load, $F(1,16)=4.74$, $p=0.045$, than NVGPs. See the results in figure 2.

4 Discussion

In present experiment, we used the cue with a validity of 70% which could also effectively help the participants to focus their attention on the pre-cued locations, and therefore one of the two target shapes was presented at three kinds of possible locations – pre-cued locations, adjacent-cued locations and opposite-cued locations. It was noted that participants performed best when targets were presented at pre-cued locations with the shortest RT. However, we also found that they performed better at opposite-cued locations than at adjacent-cued locations with higher accuracy and shorter RT. Eriksen and his colleague(Eriksen & Yeh, 1985) found the same phenomenon and they called it second-cue-location effect; that is, participants performed better at second-cue-locations (the location exactly to the opposite side of the pre-cued location) than at other locations with pre-cued location excluded. Furthermore, the interaction between perceptual load and target location also supported the second-cue-location effect that the participants showed the biggest increment on RT at adjacent-cued locations and the smallest one at pre-cued locations with the perceptual load increasing.

The present study found a trend that VGPs than NVGPs showed a smaller size of distractor compatibility effect when the task difficulty level was low and a bigger one when the task difficulty level was high. When the perceptual load was high, the VGPs showed a bigger size of distractor compatibility effect than the NVGPs, indicating that VGPs not only possessed greater attention resource capability but that they were still processing the distracted stimuli with no decrement of the target search performance. However, when the perceptual load was low, the NVGPs showed a larger size of distractor compatibility effect than the VGPs, indicating that the VGPs were trying to focus their attention on the pre-cued locations whereas the NVGPs would rather like to distribute the left-over attention resource at the adjacent locations.

The author had an interview with some of the participants on the internet and proposed a suggestion as follows. The participants of the VGP group were all CS (Counter-Strike) players with a minimum of 2 hours per day and 5 days a week at least in the past six months and the low and high perceptual load conditions in the experiment probably corresponded to the “low threat” (no enemy would pop up) and “high threat” (more than one enemies were usually expected to pop up) situations respectively. Therefore, under low perceptual load (“low threat” situation), VGPs did not need to pay attention to other locations and would prefer to focus their attention on the task at-hand with a smaller size of distractor compatibility; however, under high perceptual load (“high threat” situation), VGPs would try to focus their attention on the pre-cued locations and paid enough awareness to the adjacent locations where enemies would probably pop up, thus they showed a bigger size of distractor compatibility.

Therefore, we thought that there were some differences on the spatial distribution of attention resource between the VGPs and NVGPs. Both VGPs and NVGPs would try to focus their attention on the task at-hand. However, NVGPs would also allocate some attention to adjacent position of pre-cued position while VGPs would allocate less attention to these positions under low perceptual load. The condition was opposite when the load was high, for limited attention resource cause NVGPs to focus on target, but to VGPs, high load meant high threat, so they would pay more attention to adjacent areas to avoid enemies popping up, keeping the search task results not being affected. Compared with the pre-cued locations, the adjacent-cued locations should also be considered adjacent locations and therefore the VGPs and NVGPs should show some differences on their performance at the adjacent-cued locations. However, we did not find such difference in the analysis. For example, VGPs were expected to focus their attention on the pre-cued locations under low perceptual load and perform not so well as NVGPs at the adjacent-cued locations, but they did not show such difference. Therefore, we suggested that the adjacent-cued locations corresponding to low threatening position of the game be considered to be different from the adjacent locations corresponding to the safe position of the game by the VGPs and they still distributed some, although maybe a very small portion of attention at the adjacent-cued location under low perceptual load. And that was why they did not show any differences from the NVGPs.

In conclusion, the present study found that action video-game-play could not only enhance the attention capacity but also cause a different way of attention distribution under different perceptual load situations. Under low perceptual load, VGPs tried to focus their attention on the task at-hand whereas NVGPs tried to explore the adjacent locations with the left-over resource from the research task; however, under high perceptual load, the players would process the visual information at the adjacent locations of the target with the left-over resource, because they had a comparatively greater attention capability, whereas the non-players focused their attention on the target locations to finish the search task.

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Developing Critical L2 Digital Literacy through the Use of Computer-Based Internet-Hosted Learning Management Systems such as Moodle*

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Abstract. Second Language (L2) Digital Literacy is of emerging importance within English as a Foreign Language (EFL) in Korea, and will evolve to become regarded as the most critical component of overall L2 English Literacy. Computer-based Internet-hosted Learning Management Systems (LMS), such as the popular open-source Moodle, are rapidly being adopted worldwide for distance education, and are also being applied to blended (hybrid) education. In EFL Education, they have a special potential: by setting the LMS to force English to be used exclusively throughout a course website, the meta-language can be made the target L2 language. Of necessity, students develop the ability to use English to navigate the Internet, access and contribute to online resources, and engage in computer-mediated communication. Through such pragmatic engagement with English, students significantly develop their L2 Digital Literacy.

Keywords: Digital literacy, Second Language, SLA, L2, EFL, LMS, Korea, Moodle, Learning Management Systems, Internet navigation, meta-language.

1 Introduction

Within English as Foreign Language (EFL) pedagogy in Korea, there is growing recognition of the need to develop student ability to use English to navigate the Internet, use online resources, and engage in computer-mediated communication. I subsume these abilities into Second Language (L2) Digital Literacy [1], which I maintain will come to be considered as the most critical component of overall L2 English Literacy.

This growing importance springs from three key interrelated factors. Firstly, the emergence of English as a global language has been well documented [2], as has its predominance on the Internet and in digital media. Secondly, it is now recognized that

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the predominant use of English worldwide by non-native speakers will likely be in communication with other non-native speakers, rather than with native English speakers [3]; Graddol shows the number of people who speak English as a second language will exceed the number of native speakers [4]. Thirdly, as I have elsewhere drawn attention to [1], the exponential increase in computer-mediated communication through digital convergence means that we are fast approaching a critical threshold, whereby the majority of human communications will no longer be face-to-face, but will have become computer-mediated. These digital communication media include telephony, VOIP, SMS, Email, instant messaging, chat-rooms and online forums, computer gaming, television, video, movies, social networking sites, twittering, online music, etc.

Computer-based Internet-hosted Learning Management Systems (LMS) are rapidly being adopted for educational purposes by tertiary and other institutions. For example, the free open-source Moodle is described as the fastest growing system for providing e-Learning resources online (http://www.moodle.org.nz/), and in New Zealand, both the University of Canterbury and Massey University have recently selected Moodle as their Learning Management System. In the U.K., a recent survey has shown it to be the system of choice for 56 percent of all further-education institutions [5].

LMS are widely used for distance education, but can also be effectively used for blended or hybrid education, where they offer a complementary role to traditional classroom instruction. LMS in typical First Language (L1) educational environments can greatly enhance administrative functions, educational delivery, testing and grading. But in L2 Education they have a special potential. Of course, they could deliver L2 content and collect students' L2 task submissions, where all of the meta-language such as task instructions and site navigation could simply be in the students' L1 (and thus provide no incidental EFL component). But the languages used throughout the website and needed for site navigation can be controlled. LMS can therefore be set to force English to be used exclusively throughout the site and for student navigation.

Restricting a course website to L2 English will become popular with native English teachers in Korea; it offers a wide learning potential to students, who then engage with their target language not only in the content of tasks, assignments, forums, wikis, quizzes and exams, but also in meta-activities of creating and confirming an online account, enrolling in an online course, exploring a site, accessing multimedia content, contributing content through forum and wiki postings, and engaging in online tasks, quizzes and exams. In these pragmatic meta-activities, the meta-language is the target L2 language; by engaging with it students develop their L2 Digital Literacy, and so on graduation are better prepared to engage with the computer-based global community that, as I have elsewhere observed [6], mainly communicates digitally, and in English.

2 The Impetus to Implement an Internet-Hosted Learning Management System

2.1 The Transition from ExamView to Moodle

For five years I had been using FS Creations ExamView to create quizzes, exams, and surveys, and their online hosting service (previously at www.fscreations.com and since discontinued, see http://www.einstruction.com/) to administer these and to store and later retrieve scores. This use was supplementary to mainstream traditional educational content delivery in the classroom. During that time, I began to realize the developing importance of what I term L2 Digital Literacy [1]. I used the Internet in the classroom to present online multimedia resources like YouTube videos, and to demonstrate how to navigate and complete online homework tasks I had set. These tasks encouraged students to develop their ability to use L2 English to navigate online and to engage productively in the online community. Tasks required students to submit emails in English; establish homepages on an English-language Social Networking Site [7]; produce English-language video guides to their campus using the video cameras on their cell phones [1]; and collaborate online using Google Documents in preparing digital guides for students intending to study overseas. I also adapted the ExamView exams to survey students on their use of online resources [8, 9].

But in 2008, serious difficulties arose with the ExamView online hosting service, with unexpected downtimes that coincided with my scheduled online quizzes. I was keeping grade records online on Google Documents, and wanted a better integration with online tasks, quizzes and exams than ExamView (which is not a LMS) provided. Increasing problems with ExamView culminated in the chance discovery that their online hosting service was to be abruptly discontinued. The search for an affordable and effective solution became more pressing. I explored various options, including FormRouter and Acrobat, concluding that an integrated Learning Management System was required. Inspired in part by Sean Smith's EFL Geek 3.0 review [10], I began at the start of 2009 to implement Moodle. This required a steep learning curve before I had sufficient confidence to use it with classes. Its implementation was not without teething problems; but after a period the service settled down and became reliable.

2.2 Moving Questions from ExamView to Moodle

There were considerable difficulties in transferring questions (used in quizzes, surveys and exams) from ExamView to Moodle, which were initially overcome by laborious manual recreation. However, I have subsequently exported ExamView questions of the kinds I mainly use from Question Banks and imported them into Moodle, where they then only require minimal reformatting. True/False and Multiple Choice Questions (which have just one correct answer) can be exported from ExamView Test Generator 5.0 for the Mac from Question Banks as ExamView XML files, and then imported into Moodle (on www.ninehub.com) by selecting ExamView File format (rather than Moodle XML). Other question types can be partially imported, then modified. Multiple Response questions in ExamView (which have multiple correct answers), can first be converted within ExamView Test Generator to Multiple Choice questions (which have only one correct answer) by choosing Question: Change Type, which preserves the selection of the first correct answer only, then exported to XML and imported into Moodle as before. Within Moodle, the Multiple Choice question that is created can be set to have Multiple answers allowed, and any correct answer can then be given a non-None Grade (which automatically makes it a correct answer) of equal value (unless weighting is desired), ensuring grades sum to 100%. Matching questions can be exported and imported; sometimes the answers are imported cleanly;

other times the answers all revert to “Array”, and have to be reentered by manually retyping, or using copy-and-paste. Other ExamView questions may best be recreated anew in Moodle (depending on the type), using similar copy-and-paste of question and answer elements. Other means of export from ExamView and import into Moodle are available. These depend on the platform and version of ExamView from which one is exporting, and are described in the Moodle documentation and help forums.

3 Implementing Moodle

3.1 Task 1: Greeting and Introduction

The first experience students are likely to encounter with Moodle is the need to create an account and to enroll for a course; for this I chose Email-based self-registration. I made that activity a task, for which they receive credit. I set the first task to require the student to navigate to the site, create a personal account, enroll for a course using a course key (password) and enter a student ID in the ID number field of their Profile. They were then required to select the appropriate forum, and write and post a 100-word greeting and introduction that other class members could read.

The account creation process selected involves the student navigating to the site, filling in and submitting an initial account creation form, then validating it by responding to a confirmation email to actually activate the account (this proved a little complex for a class of lower grade students). But some of these confirmation emails from the Ninehub server were delayed by several hours. Then they stopped appearing at all, so the students concerned were caught in limbo, a situation complicated by their limited L2 English ability to figure out what was happening and to communicate their dilemma to me. I then intervened, and enrolled students myself, so that they could continue on to complete their first task, and to engage with subsequent tasks, quizzes and exams. While this second enrolment process is quite efficient for the Instructor to perform - as it can be done in class batches - it takes away from the potential pragmatic learning a student engages in by doing it for herself. Email-based self-registration on Moodle provides a good exemplar for L2 students, and encourages them to spontaneously enroll in other English-language sites that interest them.

3.2 Task 2: The Oxford Quick Placement Test

As Second Researcher for a University of New England research project, I had recently computerized the pen-and-paper version of the Oxford Quick Placement Test in ExamView [11]. I transposed this to Moodle, and assigned this as a supervised task to ensure students are less inclined to cheat. Students could view their score, but received a simple all-or-nothing grade for attempting the test. This work is discussed here [12], and the research developed in a companion paper to the present paper [13].

Setting the OQPT as an online task provides a fairly objective measure of English ability. It is simple to administer, quick, and convenient. Computerization removes the laborious necessity of manual grading, produces digital records of the results, and requires students to engage with the meta-language involved in sitting the test.

Students develop their L2 digital literacy skills, and learn how to do online tests in English. There are two versions of the test, both of which are divided into two parts; the two versions are designed to be equivalent, and though not designed for such use could be used to evaluate student L2 English ability at the start and end of a course.

A disadvantage of Moodle over ExamView is that while grading in Moodle shows which questions were answered incorrectly, the instructor can only determine which incorrect answers were chosen for one student at a time; this is limiting. Quizzes are useful as surveys, where one is interested in all responses, and rightness or wrongness is irrelevant. In contrast, in ExamView, the actual answers chosen - right or wrong - could be downloaded by class, so surveys could be conducted, and also quiz answers analyzed to determine common mistakes a class were making, which could later be brought to their attention. However, a patch for Moodle would allow a similar facility.

3.3 Task 3: Forum A: Should Korea Become Bilingual?

Students were required to first post a 200-word individual response to this question:

"Should Korea become a bilingual society, with both Korean and English as official languages?"

The process of doing this was demonstrated in class using an OHP. Prior to posting their comment, students were unable to read other student comments. After initial posting, the other comments became visible. Students could only view and respond to comments in their own class, though this could have been set so that they could view and respond to other class postings, or only view these but not respond. They were then required to post 100-word responses to two previous posts of other students, making at least three posts in all. These comments were graded, the highest grade being taken towards 5% of their total course grade. Online grading of forum posts and posting replies in Moodle is efficient, albeit complicated by unnecessary intermediary dialogue boxes, and a rather idiosyncratic structure for the instructor to navigate.

This forum generated animated discussion. The developing ability of students to navigate these forums, and engage in sustained written discussions in their non-native L2 English, was encouraging, and should furnish scaffolding and transferable L2 digital literacy skills that they can later apply. My educational philosophy is that the intention of EFL is not to entertain students, but to encourage them to develop L2 English skills that will be useful to them in later life, while encouraging their growth as whole individuals who should, with time, realize maturity and wisdom.

3.4 Quizzes

Moodle is well suited to deliver the required quizzes and Midterm and Final exams, though limitations do arise. Over several years I have built up a valuable stock of questions in ExamView format, which are maintained in Question Banks. Using these in Moodle requires significant work to transfer them, as discussed above. Secondly, conducting online quizzes or exams in class requires access to computer labs of adequate numbers of computers, and the online Internet-based hosting requires that all computers used have Internet access, the hosting site being accessed through a web browser. However the use of a LAN might provide a good strategy for obviating cheating through instant messaging or email, though it would also prevent the use of online digital resources such as search engines and online dictionaries, which I wish to encourage. In many universities, such lab facilities may be limited in availability. I am the only native English teacher in my university using computer-based tests; if this number increases significantly it is difficult to see how lab access will continue unimpeded. Thirdly, although I select settings so that the quiz or exam for each student opens in a secure window, determined students are still able to instant message or email one another during the task, despite my warnings not to and active proctoring. This dilemma is complicated by my wish to encourage them to use online English-language resources - such as online dictionaries, grammar sites, and encyclopedias; to encourage this use I make all of my quizzes and exams Open Book, and allow them to access any digital or online resource. So if a student screen shows windows that are not of the task in question, this need not imply that they are cheating. Often these sites are in Korean, though recently more students use the Google search engine in English. Without spy software that monitors all computer usage - or the problematic disabling of access to instant messaging and email sites, while allowing access to other sites - it is very difficult to ensure that students do not cheat. For similar reasons, while I strongly encourage the use of digital resources, it is difficult to determine whether texting on a cell phone during a quiz or exam is innocent - in accessing a built-in dictionary (which I encourage), or not (using SMS to communicate answers). Elsewhere I discuss the intentional use of cell phones and smart phones in the classroom [14]; as smart phone use becomes more prevalent in class, this difficulty will only increase.

The problem of cheating in online quizzes and exams is unresolved. Hopefully, most students are honorable, and respect the examiner's dictates not to communicate with one another. But some do not, and if not caught in the act (despite complaints by other students), uncertainty as to the reliability of exam results arises. Cultural differences also need to be taken into account. I have observed that in Asian cultures, information is more commonly stored in the collective mind than in the individual, and in later life such cooperative use of knowledge in the workplace is to be anticipated: in the educational environment is it always appropriate to penalize such practices?

3.5 Task 4: Forum B (Level 1A): Aboriginal Art, Culture, Music and Dance

A second forum, set as an online task for Fine Art (Painting) students, asked them to select an online video on Aboriginal art, culture, music and dance from links posted on the course webpage. After viewing it, they wrote a response relating it to their ideas about and practice of art. They then posted a reply to another student's response. Their engagement with the task was impressive for beginning level EFL students.

4 Student Experiences

It takes time and student goodwill for LCM to be implemented in classes. I had presumed that there was not yet a classroom culture of acceptance of computer-based tasks, quizzes and exams in L2 English, but difficulties dissipated after individuals successfully created an account, enrolled in a course, completed the first task, and completed their first online class quiz. I have yet to gather formal feedback from students; Moodle's evaluation surveys are too demanding for L2 sophomore students. Online class quizzes and exams now go smoothly, and there have been stimulating written contributions and debate on online forums. Students unable to attend class tasks, quizzes or exams (because of broken legs, hospitalization, or absence from Seoul) are able to do the class work at the same time from anywhere with Internet access. I simply SMS or email them the password shortly before their class quiz starts.

4.1 Task 4: Forum B (Level 2A): What Part Should Computers and Digital Resources Like the Internet Play in Teaching and Learning EFL in Korea?

A second online forum task addressed the part computers and digital resources such as the Internet should play in teaching and learning EFL in Korea. This resulted in insightful responses and interesting debate, and indicates that students are ready to accept LMS such as Moodle in the classroom. Encouragingly, they are open to LMS use in L2 English pedagogy, with some now expecting to use computers and the Internet.

5 Conclusion

The discipline involved in students using L2 English to navigate a course site, perform set tasks, and sit quizzes and exams online, significantly contributes to developing their general skill and confidence in using English online. The type of questions set, such as matching questions, may also require the application of logical skills that should transfer well to general pedagogical development, and to other online use.

Computer-based quizzes and exams have great advantages for rapid and automatic scoring and grading, but require a great deal more work prior to the task in setting up and testing. If Internet-hosted, they are critically dependent upon having a stable and reliable online hosting service. A significant advantage to online quizzes is that if the quiz parameters are set accordingly, the student can find out their score on completion, as the software conducts scoring automatically. With some ingenuity, overall grades can also be know immediately on completion of exams, providing an equation has been entered into the Grading menu, subsequent scaling of the class grades is not required, and other tasks have been completed and graded.

An effective means of developing student L2 Digital Literacy is to use LMS to force English exclusively on EFL course websites, which makes the meta-language the target L2 language. I believe that in time, L2 Digital Literacy will likely evolve to become regarded as the most critical component of overall L2 English Literacy.

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Computer-Based Internet-Hosted Assessment of L2 Literacy: Computerizing and Administering of the Oxford Quick Placement Test in ExamView and Moodle*

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Abstract. Sorting of Korean English-as-a-Foreign-Language (EFL) university students by Second Language (L2) aptitude allocates students to classes of compatible ability level, and was here used to screen candidates for interview. Paper-and-pen versions of the Oxford Quick Placement Test were adapted to computer-based testing via online hosting using FSCreations ExamView. Problems with their online hosting site led to conversion to the popular computer-based learning management system Moodle, hosted on www.ninehub.com. 317 sophomores were tested online to encourage L2 digital literacy. Strategies for effective hybrid implementation of Learning Management Systems in L2 tertiary education include computer-based Internet-hosted L2 aptitude tests. These potentially provide a convenient measure of student progress in developing L2 fluency, and offer a more objective and relevant means of teacher- and course-assessment than student evaluations, which tend to confuse entertainment value and teacher popularity with academic credibility and pedagogical effectiveness.

Keywords: Online hosted literacy assessment, Oxford Quick Placement Test, L2 digital literacy, Second Language, SLA, L2 literacy, L2 aptitude, EFL, LMS, Korea, Moodle, ExamView, computer-based evaluation.

1 Introduction

During 2008-9, I acted as Second Researcher of Gavin Austin's PhD research project, *Variability in L2 inflectional morphology: Syntactic, Phonological and Semantic Issues,* as approved by the University of New England Human Research Ethics Committee, a project involving Dr B Baker, Dr E Ellis, Prof J Siegel, Mr G Austin and myself. I interviewed Sejong University Korean EFL college students. To screen for

* This paper expands upon research previously presented to the 2009 KAMALL-APAMALL Conference on E-language Learning and Testing in a Globalized Era, organized by the Korea and Asia-Pacific Associations of Multimedia Assisted Language Learning, under the title *"Computerization and Administration of the Paper-and-Pen Version of the Oxford Quick Placement Test: Experiences of, Problems with, and Recommendations for the Computer-based Web-hosted Assessment of L2 Literacy",* and published in their proceedings.

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interview candidates of intermediate English level, I first custom computerized the paper-and-pen version of the Oxford Quick Placement Test (OQPT), a test of English language proficiency that assesses Reading, Vocabulary and Grammar, which is quick and easy to administer, and ideal for placement testing and examination screening [1]. I computerized the OQPT in ExamView, but problems with the FSCreations online hosting service led to my recreating the OQPT in Moodle using Ninehub.com hosting.

2 The Oxford Quick Placement Test

2.1 Administering of the OQPT

In Fall 2008, to generate an adequate pool of suitable students from which to recruit subjects for interview, and to gauge student English literacy level, I gave my computerized ExamView version of the OQPT test to seven classes of sophomore students, General English Zone (GEZ) and Sejong Global Articulation Program (SGAP) classes, and other Sejong students. 155 students were tested using Part 1 (Version 1); and Part 2 (Version 1) was also administered to 151 of these students. Then in Winter 2008-09, I gave paper-and-pen versions of both tests to classes of 23 and of 14 students. Finally in Spring 2009, in order to encourage student L2 digital literacy, I gave my computerized Moodle version of Part 1 of the OQPT to 162 sophomore students.

2.2 Parallel Versions and Two Parts of the Oxford Quick Placement Test

The OQPT is available in parallel versions, to help minimize the risk of cheating. Both equivalent versions comprise two different levels: Part 1 of 40 questions in 20 minutes is taken by all students; Part 2 of 20 questions in 10 minutes is bundled with Part 1 for all students, or given only to higher ability students (as determined by their performance on the lower level Part 1), or to those who quickly finish Part 1. These four tests are available in both paper-and-pen format, and as computer-based versions (CBT). CBT tests include listening tasks and are computer-adaptive: the computer presents a question and then assesses the student's response. As students progress through the test, questions are automatically adapted to their ability until a consistent level is identified [2]. Therefore, the question order varies from student to student.

3 Envisaged Advantages of Custom Computerizing the OQPT

The advantages to giving these tests using web-based Internet hosting include:

- EFL students are given a task that develops L2 Digital literacy, which I argue is a critical part of EFL pedagogy, the significance of which is not yet recognized [3];
- the task is included as part of their course, for which credit is given;
- although scores are kept, course credit is given on an all-or-nothing basis, so students gain full marks just for attempting and completing (most of) the task;

- the test is quickly and conveniently administered and precisely timed, as the tests are configured to include a built-in timer, which commences for each student on individual log-in, and on expiry prevents further answer modification;
- by incorporating class rosters, a convenient database is generated to record whether students have completed the task, and when and how long they took to do so;
- tests are automatically graded, with scores available on completion in a database;
- individual responses to individual questions are recorded in the database, enabling later analysis of responses - for example, questions that give difficulty to many students can be identified, as can typical wrong answers; and
- an informed sense can then be obtained of the level of English literacy of students at the time of taking the test, individually, by class, and overall.

4 Custom Computerization of the OQPT in ExamView

I computerized the paper-and-pen tests purely for the purposes of research. These computerized versions of the paper-and-pen tests differ significantly in structure from the CBT versions, as they are not computer-adaptive. My adaptations strictly follow the order of questions in the paper-and-pen version, where within four parts, each part becomes progressively more difficult. The question order for all students is fixed; but in my computerized versions (unlike the paper-and-pen version) answer orders (i.e. within a question) are automatically scrambled, and vary for each student attempt. To honor copyright, these customized computer versions will not be distributed.

I OCR-processed the scanned OQPT pdf, editing and correcting the text. The tests were then first computerized using FSCreations ExamView Pro version 5.0 for the Mac, utilizing Multiple Choice Questions throughout (which required some ingenuity). Signs in the first five questions of Part 1 of both versions of the test were recreated in the ExamView Pro word-processor. Minimal necessary changes to the English language instructions were needed to suit the form-based digital environment, so that for each question, instead of being instructed to mark one letter on the Answer sheet, students were required to choose one letter from the corresponding drop-down menu.

The tests were published to the online ExamView Learning and Test Center hosted by FSCreations, together with class rosters (of text files with first and last names, and student IDs). Publication involved setting passwords to each class, setting time limits on when the test would be available to take, and enabling an electronic timer that limited the duration of time for which the test would be available for each student.

4.1 Administration of the ExamView Custom Computerized OQPT and Problems with the FSCreations ExamView Online-Hosting Service

To administer the tests, information sheets in L2 English were prepared that instructed the students on where and how to access the correct test, and how to log-in, perform and submit the test. A computer lab of adequate size was booked, and tests scheduled.

Online web-based Internet hosting by FSCreations of my exams and tasks published with ExamView Pro software had, in the past, provided me with excellent and dependable service. Although five years of intensive use had resulted in few problems, this time around proved problematic. I commence by instructing the class on the procedure, and giving them the class password needed to access the online test. I then assist individual students as necessary to log-in, and clarify the means of answering questions as well as remind them of the necessity to click the Grade and Submit button on completion. As this is a Placement test, it is Closed Book, and (unlike my other online Tasks, Quizzes, Exams, and Surveys which are generally Open Book), students are not permitted to consult dictionaries or online resources. When they have finished, students are then free to leave the room. The first two scheduled exams were held without difficulty, and students adapted to their new L2 digital test environment without significant problem. But thereafter, the situation rapidly deteriorated.

At the commencement the next day of the third class test, with a class of students seated and ready to commence their task, it was discovered that the FSCreations website which hosted the exams was unavailable. I was forced to postpone the task and cancel the class. In the following period, the fourth class test was similarly affected, and the task had also to be postponed. We subsequently discovered by means of ping tests that a server in Texas - where FSCreations operates - was unavailable, although we were able to establish that other teachers in Korea could still access the test site.

This situation continued for several frustrating days, involving tests I had previously scheduled for seven sophomore classes and one SGAP class. Urgent emails to FSCreations to reestablish contact were and remain unanswered. For the remainder of tasks for the other classes, it was necessary to postpone the online tests until the server came back online, almost a week later. But the difficulties did not finish there.

4.2 More Problems with the Online-Hosting Service…

I had prepared other computer-based tasks for my classes, to utilize the web-hosting offered by the FSCreations website. I could publish these, but when I tried to log-in to them to test them, before giving these tasks to students, I discovered that I had exceeded my yearly quota of web-hosted exams. Therefore, although I had been able to publish the exams - without generating warning notices - they had not been validated, so could not be used. I sought to increase my level of subscription to enable them, but the information needed to renew or to expand a subscription was nowhere to be found on their website. Urgent emails requesting attention on this matter were ignored.

Eventually - by postponing tests as necessary as the hosting service was only intermittently available - it was possible to give the online test to all students. Student rolls were imported from classes where the test was unavailable, to those classes where it was, taking care to remain within the set numerical limits of students per test.

For those other tasks that had been validated, and which could not be postponed, including Final Exams, I had to copy hard-copy versions of the tasks, and take them to the scheduled session in the computer labs. A quick determination would be made as to whether the test site was available, and if not, these back-up paper-and-pen versions of the test were instead administered, and were later manually scored.

4.3 … and Still More Problems!

I then inadvertently discovered that their online hosting service was to be discontinued from the end of 2008. Despite being a subscriber, who paid a yearly subscription to use their hosting service, no notice of this had been received. This was disastrous news. I had built up an extensive library of question banks, tasks and exams that I had hoped to re-administer to future classes, or use as the basis for developing new tasks. Overnight, all of this pedagogical capital had, it appeared, become worthless.

It was possible to administer these tests by publishing them to a local network for use with ExamView Player, but this required the software used to design and publish the test to be of the same platform as the LAN used to administer the test. I was using ExamView Pro for the Mac, but the university LAN was Windows-based, so I would be required to repurchase the software for use on a different operating system. I was not inclined to do this, particularly because of the closing of the web-hosted service.

5 Exploration of Alternative Solutions and Migration to Moodle

I explored a variety of different options, including FormRouter and Adobe Acrobat forms, and proprietary Learning Management Systems, including Blackboard, WebCT, ANGEL, and Moodle. In part inspired by Sean Smith's book review [4], I settled on the open-source learning management system Moodle, and in Spring 2009 moved all of my classes to hybrid use of a Moodle site that was hosted on the Australian site www.ninehub.com. Quizzes, exams and OQPT placement tests from ExamView format needed conversion to a format suitable for importing into Moodle.

Difficulties in transferring questions (used in quizzes, surveys and exams) from ExamView to Moodle were in part initially overcome by lengthy manual recreation. However, I have subsequently exported ExamView questions of the kinds I mainly use from Question Banks and imported them into Moodle, where they then only require minimal reformatting. I elsewhere describe this process in greater depth [3, 5]. True/False and Multiple Choice Questions (with just one correct answer) are exported from ExamView Test Generator 5.0 for the Mac from Question Banks as ExamView XML files, and then imported into Moodle (on www.ninehub.com) by selecting ExamView File format (rather than Moodle XML). Other ExamView questions are recreated anew in Moodle (depending on the type), with similar copy-and-paste of question and answer elements. Other means of export from ExamView (or from other applications) and import into Moodle are available, and typically depend on the platform and version of ExamView (or other application) from which one is exporting; they are described in Moodle documents that include user-created help forums.

Questions 1-5 and 21-40 of Part 1 of the OQPT with a single correct answer are structured without difficulty as Moodle Multiple Choice questions. Questions 1-5 of Part 1 of the OQPT each require the recreation of a sign, which can be accomplished in the Moodle word-processor. However, questions 6-10, 11-15 and 16-20 of Part 1 of the OQPT combine five cloze multiple choice questions in each text. These multiple cloze questions can be recreated using Moodle Embedded Answers (Cloze) questions.

Using these multiple choice and multiple cloze questions proved suitable in developing an adequate custom online version of the OQPT in Moodle.

6 Administration of the Moodle Custom Computerized OQPT

In the Spring Semester 2009 I then gave Part 1 of the OQPT via Moodle to eight sophomore classes and two SGAP classes, a total of 162 students. The first experience students encounter with Moodle is the need to create an account and enroll in a course, before they can sit specific tests, and for this I used Email-based self-registration. That activity was a task, for which they receive credit (although I now prefer to create accounts and enroll students myself). This task and problems that arose including access problems to the hosting site for quizzes and tasks are described elsewhere [3, 5]. The site later stabilized and thereafter provided dependable service.

Setting the OQPT as an online task provided a fairly objective measure of English ability. It proved simple to administer, quick (20 minutes for Part 1, and 10 minutes for Part 2 for advanced students only when required), and convenient (a timer on the quiz automatically terminates it for the individual when time from login to the quiz has expired, so whenever students start, they still have the full time allocated). Computerization removed the laborious necessity of manual grading, and produced digital records of the results, while requiring students to engage with the meta-language involved in sitting the test. In the process, students develop L2 digital literacy skills, and learn how to do online tests in English. In principle, the two versions of the test could be used to evaluate general student L2 English ability at the start and at the end of a course (though the makers of the test advise that it is not designed for such use).

For the placement tests I administered in Moodle, each student could view their score on the test. I then gave students an "all-or-nothing" grade for attempting the test, so students received 5% of the final grade for submitting the test, irrespective of their score on the test or number of questions completed, or 0% for not attempting it - in part to reduce their stress levels. I later amended this by setting all answers within a specific question to be of equal value, with answers totaling 100%; students received marks for each question answered. This encouraged them to answer all questions.

A significant disadvantage of Moodle over ExamView is that while grading in Moodle shows which questions were answered incorrectly, the instructor can only determine specifically *which* incorrect answers were chosen by one student at a time. This is limiting, particularly as regards potentially using the quizzes as surveys, where one is interested in all responses. In contrast, in ExamView, the actual answers chosen, right or wrong, can be downloaded by class, so one could readily conduct surveys, or rapidly analyze quiz answers to determine the most common mistakes a class were making (e.g. confusing "boring" and "bored"), which could later be brought to the class's attention. However, a patch for Moodle should allow a similar facility.

7 Recommendations for the Computer-Based Internet-Hosted Assessment of L2 Literacy

There are substantial advantages to assessing L2 Literacy by means of computer-based internet-hosted quizzes. Including such tests helps develop student L2 digital literacy, which as I elsewhere identify, is critically needed [6, 7]. These tests can be integrated into comprehensive learning management systems such as Moodle, and administered as class tasks, with credit given. Administering such literacy tests at the start and completion of a course would provide a sense of individual and class L2 aptitude, and of the effectiveness of the course in developing such aptitude. The tests can be given quickly and efficiently, and are automatically graded, so students can, if desired, learn their score on completion, while teachers can view the scores online in an integrated grading resource, and download class scores into spreadsheets.

However, there are very real limitations to using such testing for evaluating student improvement in L2 ability. Firstly, it is absolutely critical that the online hosting service be reliable, with dependable access. Secondly, it is advisable to ensure students have some prior experience in creating an online account, logging in, and undertaking online quizzes before placement tests are set. Thirdly, the types of questions that can be set in an online environment have certain constraints, and favor set answers e.g. true/false, multiple choice and matching question types, though open-ended and even essay-type questions can also be set and fairly efficiently graded. Fourthly, it is very difficult to ensure students do not cheat. Whilst I maintain that access to online resources should generally be facilitated and consider the skills required to access them desirable to instill, it is difficult to prevent students then improperly accessing online resources when taking online quizzes, placement test and exams, where they may have been instructed not to do so. Similarly, students are adept at using instant messaging clients (as well as cell-phone SMS) to improperly communicate with one another during such tests, and to prevent this is challenging, requiring constant proctoring and distasteful threats to fail cheating students. Fifthly, institutional computer facilities are very probably limited; computer labs require sufficient computers for each student in the class, and are often set up in pairs, where it is easy for a student to view their partner's computer screen. Where many teachers and classes require these tests be done at about the same time of semester (e.g. during final exam week), the inherent clustering of demand for suitable computer labs will likely greatly exceed the supply, while at other times of the semester there will probably be little or no use of these facilities. Sixthly, an inherent limitation may be that of teacher motivation - the desire to get good results in a class, so that it appears the class has made a substantial improvement in L2 literacy, may result in the teacher unduly coaching the students for the test, which invalidates the results. Seventhly, the OQPT itself is described by its makers as not being appropriate for repeated use as a progress test, as it is not based on a particular course or syllabus [1]; there is a need to provide comparative online tests that are suitable. Eighthly, as far as I am aware, Moodle does not currently support viewing of actual results, right or wrong, by class, though I anticipate this could be redressed through a patch. Ninthly, ExamView tests can be quickly automatically formatted for and printed as paper-and-pen tests, but Moodle does not support paper-and-pen tests (although question banks can be exported in a variety of formats, and could be imported into other programs for paper-and-pen test publishing).

8 Conclusion

I describe my experiences in adapting the paper-and-pen versions of the Oxford Quick Placement Test to ExamView, and discuss difficulties experienced with that software and with online administering the custom computer-based tests that are produced on their FSCreations site. Secondly, I describe the conversion of the OQPT to Moodle format, and the online administering of the custom computer-based tests that are produced on the www.ninehub.com site. Finally, I recommend strategies for successful implementation of hybrid use of computer-based Learning Management Systems in L2 tertiary education. Reservations include the needs for providing a reliable hosting service, preventing student cheating, and avoiding teachers improperly coaching students for placement tests. Nevertheless, I suggest that computer-based Internet-hosted L2 aptitude tests have the potential to provide a convenient measure of student progress in developing L2 fluency, achieved as a consequence of the courses attended. Such tests are also likely to offer a more objective and relevant means of teacher- and course-assessment than student evaluations, which tend to confuse entertainment value and teacher popularity (which are hardly the task universities should be concerned with) with academic credibility and pedagogical effectiveness, which, in these times of global warming, pollution and economic recession, are sorely needed.

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