HERMOPHILOS: A Web-Based Information System for the Workflow Management and Delivery of Accessible eTextbooks

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Abstract. In this work we present the functional specifications, architecture and implementation of the HERMOPHILOS web-based system developed to auto-mate and accelerate the accessible eTextbooks' production, workflow management, and delivery in an a higher education environment. We describe the redesign of the relative manual procedures and we show how HERMOPHILOS makes things easier and faster for the print-disabled students, as well as for the personnel involved. The web services of HERMOPHILOS include user sign up, user authentication, user rights management, students' accessible textbooks re-quests, digital textbook requests to publishers, requests' progress monitoring, original digital textbook copy submission, scanning, OCR, version and archive management, copyright protection, distribution, and digital content usage statistics. Implementation specifications included support for all browsers, operating systems, and mobile devices, accessible user interfaces (WCAG 2.0 AA), and advanced encryption and security policies. The HERMOPHILOS system sup-ports multiple formats for eTextbooks: plain text (.txt), rich text (.rtf), accessible markup (.xml, .xhtml, and .html), large print (.doc), audio books (.mp3), DAISY 2&3 (text only or full text - full audio), Braille (.brf or .brl), MS-Word (.docx), portable document format (.pdf) and LaTex (.tex). Paperwork was dramatically reduced, and the need for students' visits to the accessibility office was eliminated. The results show that, compared to the traditional procedure, the HERMOPHILOS workflow management system reduced the overall production and delivery time by 47 %.

Keywords: Accessibility · eTextbook · Accessible books

1 Introduction

Accessible digital textbooks production and distribution is one of the core services that the Accessibility Unit[1] of the University of Athens has undertaken to benefit students with print-disabilities [1]. This service supplies accessible eTextbooks mainly to students who are blind or with low vision, those with upper limbs motion disability resulting in inability to manually handle printed books, and students with dyslexia.

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[1] University of Athens Accessibility Unit - http://access.uoa.gr/.

Although the Unit's experts and personnel lived up to the increasing requests for new accessible eTextbooks for some years, the man-hours needed to meet the overwhelming production requirements have surpassed their potential. A new web-based Information Technology (IT) system has been recently designed and developed in order to automate and accelerate the accessible eTextbooks' production, workflow management, and delivery. In this work we present the functional specifications, architecture and implementation of this new system entitled HERMOPHILOS[2] and report on the qualitative and quantitative improvements that it offered.

First, we describe the traditional procedure of accessible eTextbook request, production, and delivery by all stakeholders, namely the disabled students, the Accessibility Unit's personnel, and the textbook publishers. In the next section, we present the state of the art in the development of accessible eTextbooks in higher education. Then, we will present the new IT system that aims to automate and accelerate the procedure, with its two subsystems, the "Users and Requests Management Subsystem", and the "Digital Content Management Subsystem. Moreover, in the same section, we describe the services that HERMOPHILOS provides. In the next section, we will describe the accessible formats that HERMOPHILOS supports. We will conclude with the results section, showing how the new web-based information system for the workflow management and delivery of accessible eTextbooks improved the efficiency of the traditional eTextbook services provided by the Accessibility Unit.

2   State of the Art

Nowadays, there is a wide range of methodologies for the development of accessible eTextbooks in higher education. Some of them are based on user-centric approaches. These methodologies do not just highlight the individual stents' needs with regards to skills and abilities, but also take into account localization issues in terms of language and cultural differences [2]. On the other hand, the provision of educational material in alternate formats for students with print-based disabilities is challenging and often time-consuming, expensive, and requires special knowledge and training of staff [3].

Legislation, universal guidelines [4] and universal standards [5] play an important role in providing accessible learning material provision (in either traditional or e-learning settings) within a higher education institution. University libraries or accessibility units/disability services offices undertake the role for the production and delivery of accessible eTextbooks [6]. Many libraries [7] or academic accessibility units, like the Institute Integriert Studieren, Johannes Kepler University Linz[3] or the Teiresias Support Centre for Students with Special Needs, Masaryk University[4] are doing an excellent job, but standards of provision of accessible eTextbooks vary from place to place even in

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[2] Digital Services of Accessible Academic Textbooks for Students with Disabilities, http://ermofilos.uoa.gr/.

[3] Institute Integriert Studieren, Johannes Kepler University Linz, http://www.jku.at/iis/.

[4] Teiresias Support Centre for Students with Special Needs, Masaryk University, https://www.teiresias.muni.cz/.

the same country. eTextbooks in academic libraries often require new workflows from inquire to access [8].

Related research and development projects which address the challenges faced in providing access to the scientific and technical literature [9] or service solutions [3] are of special interest. Finally, copyright protection of eTextbooks in connection with the disability rights is another challenging issue [10] that varies across countries.

3   The Traditional Procedure

The traditional service followed by the Accessibility Unit of the University of Athens, before HERMOPHILOS was introduced, comprised the following steps:

1. A student who had a disability was registered in the Accessibility Unit's records after filling a form, stating his or her needs, and especially pointing out his or her print-disability.
2. The student applied for accessible textbooks each semester.
3. The Accessibility Unit contacted the publishers and asked for the requested books that are normally distributed in printed format, to be delivered in digital format, as dictated by law. At this point the main difficulties occurred due to the facts that many books were too old and not available in digital format, or that the publishing software that was used to create the digital format did not take into account that Greek font encoding would probably be read by a screen reader; so the printed output would be perfect but the lack of correct encoding would render this document unusable to assistive technology (AT).
4. The processing of the document followed. This step varied according to the nature of the digital document sent by the publisher (if any). In the worst, but the very likely scenario of having just the printed book to work with, the processing involved: scanning; optical character recognition; error correction; image description; math and science transcription; tactile figures creation; accessible document assembly.
5. For copyright protection, the document was password-locked for each student individually. Furthermore, the student signed a legal document that made very clear this digital material was not for sharing. The publisher received a copy of this signed statement, clarifying that the student would use the digital book only for his or her own needs and not distribute it to anyone else.
6. For copyright protection, the document was password-locked for each student individually. Furthermore, the student signed a legal document that made very clear this digital material was not for sharing. The publisher also received a copy of this signed statement clarifying that h or she would use the digital book only for his or her own needs and not distribute it to anyone else.
7. The next step of the procedure was the delivery of the accessible digital textbook to the student. This required the student to come to the Accessibility Unit premises in order to receive the material in a CD and sign all the paperwork. This was also a way to make sure that the same person who applied will receive the book, and no copyright-protected content would leak. Such a possibility would jeopardize the cooperation with the publishers.

8. Finally, the publisher should be notified about the book delivery and receive the signed forms.

4 The HERMOPHILOS System

Many of the aforementioned steps should be made online and new hardware and software was needed, and this was the aim of the new IT system. It includes a server with a high-speed network and internet connection to host all information, online content, website, services, and software. Additionally, a large page color laser printer, a Braille embosser, a tactile graphics printer, a book cutter, a large page scanner, and format conversion software help to enrich the offered accessible media and formats, and speed tasks up. HERMOPHILOS gave the opportunity to redesign some of the procedures and rethink of ways to make things easier and faster for students as well as for the Accessibility Unit personnel. Procedures and actions were rendered as Web Services which will be summarized, along with the issues that they address. For organizational reasons, the system was partitioned into two subsystems. Figures 1 and 2 illustrate the environment and architecture of the new system.
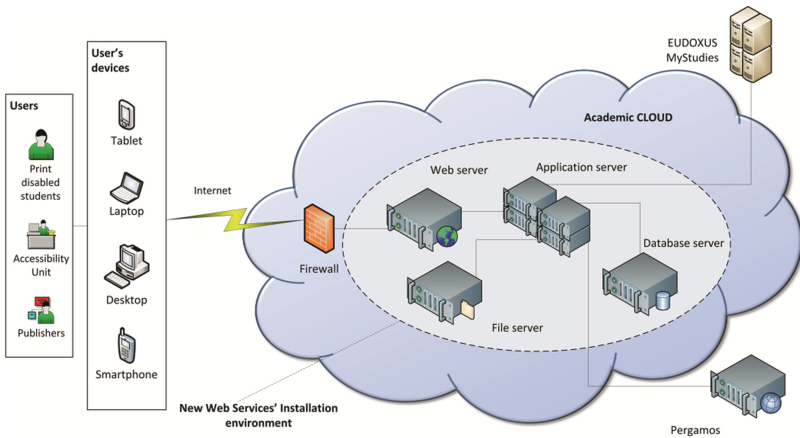
Fig. 1. Web services deployment and operation environment of ERMOPHILOS
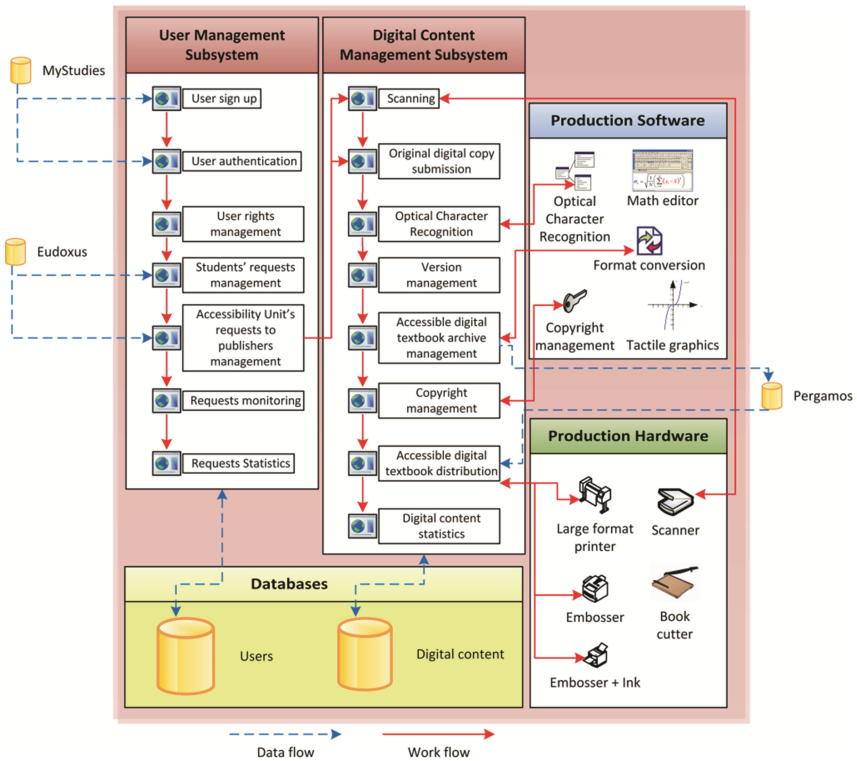
Fig. 2. HERMOPHILOS' functional architecture, workflow, and dataflow

4.1 Users and Requests Management Subsystem

The first subsystem of HERMOPHILOS comprises the following Internet services:

– User sign up service: Three main user groups are using the web services, namely students, publishers, and the Accessibility Unit personnel. Students can use the same credentials they use for all other online University services like MyStudies (the secretariats' system where students declare the courses they will take) and Eudoxus (where students register their preferred books for each course).
– User authentication service: Only the print disabled students are entitled to the accessible digital textbooks and the web services, so this service ensures that only accredited students, personnel, and publishers will access the system.
– User rights management service: A general administrator (a member of the Accessibility Unit staff) manages all user rights for all three user groups.
– Students' accessible textbooks request service: All new requests are made online now, and no physical presence of the student at the Accessibility Unit's office is required.

– Digital textbook requests to publishers' service: A secure system for electronically sending new requests for textbooks to the publishers now automates and speeds up this procedure.
– Requests' progress monitoring service: Both students' requests to Accessibility Unit and the Unit's applications to the publishers are monitored and displayed online.
– Requests' statistics service: All stages of the procedure are logged and executive reports are offered in real time.

4.2   Digital Content Management Subsystem

The second subsystem provides the following Internet services:

– Scanning service: A new high-resolution scanner with a page feeder came with the IT system, and the scanning and storing process can be managed remotely.
– Original digital textbook copy submission service: This service is for the publishers that no longer have to send large files on CDs and normal post just to have an official receipt on paper proving that they fulfilled a request.
– Optical Character Recognition service: OCR now runs on the high-speed server using several processors accelerating the process.
– Version management service: Many volunteers and the Accessibility Unit's staff contribute to OCR correction, document formatting, image description, math and science transcription, tactile graphics preparation, etc. All these produce a huge amount of data and numerous versions of intermediate documents managed online by administrators.
– Accessible formats archive management service: HERMOPHILOS supports the creation of multiple accessible formats: plain text (.txt), rich text (.rtf), accessible markup (.xml, .xhtml, and .html), large print (.doc), audio books (.mp3), DAISY 2&3 (text only or full text-full audio), Braille (.brf or .brl), MS-Word (.docx), portable document format (.pdf) and LaTex (.tex). The required storing capacity is offered by the repository Pergamos provided by the central University digital library system.
– Copyright management service: Digital IDs, electronic signatures, and water-marks are produced and managed centrally, offering a high degree of security and confidence to all stakeholders.
– Accessible digital textbooks distribution service: As soon as the preferred accessible format is ready the student is informed that he or she can immediately download it.
– Digital content usage statistics service: File transfer reports and upload/download statistics are offered by HERMOPHILOS for all stages of preparation and distribution of the digital content.

4.3   Implementation Specifications

The Web Services' deployment and operation environment of HERMOPHILOS is described and illustrated along with its functional architecture, workflow, and dataflow in Figs. 1 and 2. HERMOPHILOS was implemented complying with a set of basic specifications:

- All popular web browsers are supported by HERMOPHILOS (e.g., Internet Explorer, Mozilla Firefox, Google Chrome, Safari, etc.). The latest versions of these web browsers deliver the web interface correctly independently of the platform (i.e., Microsoft Windows, Linux based operating systems, Mac OS X, etc.).
- Web browsers built in portable devices (smartphones, tablets, etc.), and the corresponding operating systems are supported without any information loss for the end user.
- The web interface complies with WAI's WCAG 2.0, and achieves AA level certification. User profiles that specify the interaction with the system and the content presentation style are supported.
- Encryption and security policy is applied during data manipulation, especially when data is routed through the Internet, as well as on the data centers.

5   Results

After statistical analysis, we show that with the traditional manual procedure a student would wait for 45 days in average from request to delivery. This period was reduced to 21 days with the HERMOPHILOS workflow management and delivery system. Various aspects of the new system contributed to this result; for example, the Version Management Web Service made the assignment of editing and correction tasks to multiple editors who work in parallel, easy and manageable, reducing the textbook processing time by 40 %. The new web services such as Sign up, Request submission and monitoring, Authentication, Textbook Submission and Delivery dramatically reduced paperwork, as well as eliminated the need for students' visits to the Accessibility Unit's office. Making all those procedures online reduced movement and communications time overhead by 60 %. The production hardware accelerated book cutting, scanning, OCR, storing, and embossing/printing tasks by 75 % overall.

6   Conclusion

We presented the functional specifications, architecture and implementation of the HERMOPHILOS web-based system developed to automate and accelerate the accessible eTextbooks' production, workflow management, and delivery in a university environment. It includes: (a) the Users and Requests Management Subsystem (targeting the disabled students, publishers of textbooks, and the Accessibility Unit personnel) and (b) the Digital Content Management Subsystem. The HERMOPHILOS system supports the following formats for eTextbooks: plain text (.txt), rich text (.rtf), accessible markup (.xml, .xhtml, and .html), large print (.doc), audio books (.mp3), DAISY 2&3 (text only or full text - full audio), Braille (.brf or .brl), MS-Word (.docx), portable document format (.pdf) and LaTex (.tex). With the traditional procedure, a student would wait for 45 days in average from request to delivery of a new accessible eTextbook. This period was reduced to 21 days with the HERMOPHILOS workflow management and delivery system.

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