Developing an HCI Model: An Exploratory Study of Featuring Collaborative System Design

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Abstract. In a networked collaborative virtual environment (NCVE), people work together as a group and share the similar user interface (UI) design. Therefore, it is crucial to have a good UI so that activities can be performed quickly and effectively. The human computer interaction (HCI) discipline and principles can be a solution to poorly designed human-machine interfaces. Nowadays, studies of human and machine interaction is an attempt to allow task to be performed easily, friendly and fast since many activities are running concomitantly in collaborative environment. Thus, this paper presents an exploratory study of featuring collaborative system design. We highlight various collaborative features that follow the common HCI rules. The study serves as an effort towards developing a new HCI model that can be applied to any collaborative applications.

Keywords: Human computer interaction, user interface, networked collaborative virtual environment, collaborative features.

1 Introduction

Currently, it is amazing that a collaborative application is developed to allow users to collaborate with each other and bring people together for one reason or another: to socialize, to work together, to innovate, to cooperate and contribute to the production of something [1]. More concretely, in a collaborative environment, people are communicating with each other from different physical locations to share the same resources using the same interface such as online gaming, emailing, video conferencing, chatting and the like [2]. Furthermore, real-time information features offer faster decision making to accomplish users' objectives. An effectiveness and correctness of the information that communicated between users are the key elements to improve any decision making process [3].

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A task with an easy and fast performance (less number of clicks) can make collaborative system interfaces more effective and user friendly. Therefore, the best collaborative features should be integrated with HCI rules and principles in order to build interface design in networked collaborative virtual environment (NCVE). HCI models and User Interface (UI) guidelines are tools to help in UI designation in terms of usability [2]. They give great impact on high usability to make the UI easier to use and train people for using it. So, our aim is to reveal the collaborative features that follow the HCI rules and principles in order to increase the user's satisfaction.

The remainder of this paper is organised as follows: Section 2 discusses on the related works of HCI and collaborative applications, while the exploratory study of collaborative interface features is performed in Section 3. Then, Section 4 describes the new features for collaborative interface and followed by the conclusion in Section 5.

2 Related Works

2.1 Human Computer Interaction

Human computer interaction (HCI) is clearly focused on a study of interaction between humans and computers rather than just design of the interface. Therefore, the supporting knowledge on the human side such as cognitive psychology, social sciences, linguistics, communication theory, graphic and industrial design disciplines, and human performance are relevant. HCI is also closely related to UI. UI or simply called interface is the intermediary between human and computer. Interface is also considered as an interpreter or guider to the complexities of a site between user and content through physical interface and software interface.

HCI principles are crucial in designing a good UI in terms of usability, information architecture and individual operation where UI can be simple and obvious [4]. The famous HCI principle is Shneiderman's eight golden rules; strive for consistency, enable frequent users to use shortcuts, offer informative feedback, design dialog to yield closure, offer simple error handling, permit easy reversal of actions, support internal locus of control and reduce short-term memory load [2]. However, UI principles can also be applied such as simplicity, structure, visibility, flexible or tolerance and reuse to maintain the consistency so that the need for user to rethink and remember can be reduced [5]. This ten general UI principles or also called "heuristics" are more in the nature of rules of thumb than specific usability guideline. Nevertheless, Norman [6] developed a number of models of user interaction based on theories of cognitive processing arising out of cognitive science, that were intended to explain the way users interacted with interactive technologies.

Another highly influential model based on cognitive theory that made its mark in the 1980s was Card, Moran and Newell's keystroke level model [7]. This was used by a number of researchers and designers as a predictive way of analysing user performance for different interfaces to determine which would be the most effective. More recent models developed in interaction design are user models, that predict what information users want in their interactions, and models that characterise core components of the user experience, such as Norman's model of emotional design [8].

All the principles and guidelines can be used in any UI including collaborative application such as computer games and e-Learning system. For example, in order to

develop an effective interface for e-Learning application, several issues must be considered such as the convenient way of students to give high concentration without facing any complex process, dynamic transformation of content and size (balanced information) and active participation of students through their characteristics (any action detected from interface) [9].

2.2 Networked Collaborative Virtual Environment

Networked Collaborative Virtual Environment (NCVE) allows people to cooperate and work with each other from different locations. Communication and computing technologies are highly interdependent and closely related to each other [10]. Meanwhile, collaborative applications are the set of tools which support the communication between the learners, using asynchronous collaboration and/or synchronous collaboration as well [11]. Besides, the way multimedia elements are integrated is also crucial in making collaborative activities successful.

The collaborative virtual environment (CVE) provides the platform for performing activities and communication tasks. CVE is also known as distributed virtual reality systems and it offers a space or digital landscape. Within this landscape, individual and data can interact with each other and make it as a share place for work and leisure. Individuals or users, artifacts and data object can encounter each other by navigate through the space. In this case, they are communicating using verbal and non-verbal communication which they can see each other, orient their body to each other and converse together through visual and auditory channels [12].

Recently, many collaborative applications are broadly used to develop projects, negotiate business deals, promote products, conduct meetings and also as a medium for teaching and learning [13]. This shows that collaborative community from different countries can exchange ideas and work together effectively to support a particular set of goals. Meanwhile enterprises are looking at collaborative applications and technologies to address these drivers for business transformation: the impact of the empowered user, the demand for secure, real-time information, and the concept of a borderless enterprise [1].

3 Exploratory Study

In networked collaborative virtual environment (NCVE), people work together as a group and share the same UI. This collaborative work is supported by computer supported cooperative work (CSCW) and allows people to collaborate with each other through UI that supports all those information exchange and at the same time being user friendly and easy to use.

There are two different scenarios in NCVE that include synchronous and asynchronous [1]. In e-learning collaborative system, the most important part is a set of tools which favours the communication between the learners. Such collaboration can be in asynchronous or/and synchronous scenario [11]. Various techniques and technologies are used in synchronous collaboration such as the whiteboard due to its communication is held at real-time. These activities can facilitate people to work with each other since the information can be exchanged in a faster way. Meanwhile in

asynchronous collaboration, the last changes performed are always stored in the system when users leave the session. In this way, collaborators can continue to work later with the information of the latest session [11].

There is much researches undertaken to construct a real-world-like interface (Wouter [14]), such as to develop an architecture for Discovery Learning. It defines how they can be supported by collaboration, and how the new types of instructional support can be created from the interaction between collaborative support measures and the specific learning processes involved in discovery learning. Table 1 shows the features of Discovery Learning.

Table 1. Features of Discovery Learning [14]

Features	Description
Frame of reference	Collaborative tools must be able to interpret the experimental results and hypothesis stated in the simulation environment. At least, they need to know what to do with them.
Collaborative tools	They will be used in order to discuss about new hypothesis, the results of experiments, reasoning about the results, etc. In general, they are responsible for the collaboration between learners.
Experimentation space	It refers to an area in which the experiments are held, providing ways of communication between the experiments and the users' interfaces. More exactly, the results of these experiments are the base in which learners will discuss and reason.
Collaborative scenarios	It refers to the kind of collaboration to support the learning tasks. As we have mentioned before there are two major approaches, the synchronous and the asynchronous.

Collaborative features are embedded in scripting language such as JACIE (Java-based Authoring language for Collaborative Interactive Environment) [3]. JACIE is a scripting language which designed to support the management of multimedia interaction and communication in collaborative applications. Collaborative mechanisms are popular in networked activities. Furthermore, JACIE is also as a practical solution to network programming by focusing on the management of user interaction and communications. It supports communication through the concept of channels and interaction protocols [2], [15]. The special features of JACIE include a single program for client and server, template-based programming style and hiding the low-level networking programming and event management from the programmers [3]. Upon having the connection to the server, it supports server mediated multi user interaction for networked collaboration [2]. Table 2 shows the main features of JACIE language.

Table 2. Features of JACIE [15]

Features	Description
Template based programming style	A JACIE program fits into a prescribed standard template layout that eases the programming task.
Single program for server and client	JACIE allows the integration of the code segments for both server and client in one program. JACIE allows this combination in order to ease the data manipulation between server and clients. It is the compiler's job to generate the separate programs that run on separate computers
Communication channels	There are several built-in communication channels that facilitate different forms of media and communication methods. The channels are canvas, message, chat, voice, video and whiteboard. The last three channels are supported by the Microsoft Netmeeting.
Interaction protocols	All the introduced interaction protocols were built-in and managed by the server. Almost all common collaborative applications to be programmed
Multithreading	JACIE is built using Java which provide multithreading in order to accommodate the computing environment of a networked system.
Interfacing with Java	JACIE have a programming interface with the Java language for more complicated graphics application.

However, from the view of UI design principles, JACIE interface is lack of several factors such as structure, simplicity, visibility, feedback and etc. Therefore, a comparative study on user interface design for collaborative bridge game has been conducted between several bridge game applications, which one of those game applications was developed under JACIE Graphic User Interface (GUI) output [2]. While focusing on various accessibility features and HCI rules, different elements of each feature were compared in an attempt to improve the usability of JACIE's interface.

Since NCVE does not include communication cues such as gesture, body posture, facial expressions, direction of gaze and verbal communication, therefore awareness issues are important to address [16]. More concretely, the absent of social cues brings a lack of sense of social awareness. Thus as stated in [12], control factors (degree of control, immediacy of control, anticipation, mode of control and physical environment modifiability); sensory factors (modality, environmental richness, multimodel presentation, consistency of multimodel presentation, degree of movement and active search) and distraction factors (isolation and selective attention)

are very much contribute to a sense of presence and enhancing levels of social awareness. As described in [13], communication in NCVE can be improved through the use of eight identified awareness models (Refer to Table 3).

Table 3. Eight awareness models [13], [17], [18]

Features	Description
Awareness of presence	Who is in virtual space, how many participants are involved, where they come from and their availability [17].
Awareness of state	User's state of mind [13].
Awareness of role	User's position in virtual space [13].
Awareness of turn taking	Who is talking, who is listening, whose ideas it is and whose turn to talk [13].
Awareness of emotion	Communication cue, gesture, eye contact and tone of voice [13].
Awareness of identities	When user have choices to use different identities in different virtual spaces [18].
Contextual awareness	Users are aware of the task and progress of themselves and others [18].
Conversational awareness	What a user is talking about and what he/she is referring to [13].

In CNVE, many things are shared together. People share information and communicate with task through interaction with each other and data representation [12]. This is also known as shared context, which users will share knowledge, artifacts environment and etc. In this process they are leaded to share understandings with each other. For example, shared activity among users (e.g. shared document).

Communication capabilities, publication and collaborative knowledge, community management services, common application services and collaboration engine (presentation, editing integration, search and mashups) can be shared across application such as blog and wiki [1]. The closest example is an e-learning system where the students form a group to learn together in different places or time and share all the same features in the application [9].

A collaboration tool is an instrument designed to help people involved in a common task to achieve their goals. There are a lot of tools designed to facilitate and manage group activities such as communication and cover all detailed aspects of collaborative activities while working on the overall project [12]. Effective tools are needed for successful interaction and communication [14]. For example, a collaborative game can perform better when the awareness tools are used [19] such as Collabtive, phpGroupWare, Dimdim and eGroupWare.

4 Collaborative Features for New HCI Model

Today, studies of a human and a machine interaction is an attempt to allow task to be performed easily, friendly and fast since many activities are running concomitantly in collaborative environment. However, the designer is required to refer to HCI principle and guideline since it is very much contributed to user interface of many applications. Furthermore, the existence of HCI models that help in terms of UI designation and evaluation should be chosen conscientiously. However the representative of HCI model for collaborative system is one of the possible solutions that can be used in order to build an interface that promising an activity to be performed quickly and effectively.

There are eight issues that have been collected and analysed based on current features and additional criteria gathered from HCI and UI principles. The eight issues are awareness, display style, interaction or communication channel, sound and multimedia, action, accessibility factors, tools, shareability and scenarios. Combination of these features is important for UI collaborative application because it is able to improve usability that plays a great impact of collaborative activities.

Referring to Table 4, the compilation of collaborative features is based on the existing features that cater on e-Learning, JACIE language game collaboration and etc. However, this compilation is for collaborative applications in general and leads to the importance realisation of specific features that can be the guideline for a designer to build any collaborative application.

Awareness features encompass eight of awareness model which are crucial to be adapted in a collaborative application. Representative of users, labeling of users, positioning, blinking element turn visibility/taking and reversibility are the elements that follow the UI principle (visibility of system status) [5]. In addition, consistency rules [2], [5] from HCI principles also should be included for display features and sound and multimedia features. The elements such as text, color, contrast, animation, buttons, response time and sound should be consistent and standardized besides describe the specific visual and textual expression of the interface.

A tool is an important feature to facilitate the management and covers all detailed aspects of collaborative activities. The activities encompassing in successful interaction and communication are closely related with the tools. Therefore, all the communication channels such as canvas, message, online chatting, voice, video and whiteboard are depended on good collaborative tools to perform better UI.

Collaborative scenarios determine the applications whether they are running on real time or vice versa. It can be known through four scenarios that include synchronous, synchronous or distributed, asynchronous and asynchronous or distributed. These scenarios allow the shareability of communication capabilities, publication and collaborative knowledge, community management services, common application services and collaboration engine (presentation, editing integration, search and mashups).

Accessibility features are procedures involved in accessing all the collaborative applications. Unlike some other applications, collaborative systems make the connection between users and the server prior the application. In addition, several collaborative applications require users to insert their usernames before registering; otherwise users have to fill in data entry forms or use confirmation code as security purpose before performing another task (e.g. sending email). It is also existed in several applications that have loading time to start and use the services. However, it is better for a user to click only one button to logging off all collaborative applications.

Table 4. Collaborative Features for New HCI model

Features	Description
Awareness	Representation of users Labeling of users Positioning Blinking element Turn visibility/taking Reversibility
Display Style	Text Colour Contrast Animation Buttons
Sound and Multimedia	Response time Sound
Tools	Facilitate, manage and covers all detailed aspects of collaboration activities
Interaction/Communication Channel	Canvas Message Online Chatting Voice Video Whiteboard
Scenarios	Synchronous – same time/same place Synchronous/Distributed – same time/ different place Asynchronous – same place/different time Asynchronous/Distributed – different place/different time
Shareability	Communication capabilities Publication and collaborative knowledge Common application services Community management services Collaboration engine (presentation, editing integration, search and mashups)
Accessibility Factors	Connection to server User registration User verification Start the application Use the application Logging Off

5 Conclusions

We have explored many essential collaborative features that are common for e-Learning, JACIE language, game collaboration and etc. All of them serve as guideline features that can be embedded into an existing scripting language, JACIE. Therefore, in this paper we have compiled new collaborative features to be used as guidelines in order to develop collaborative applications. There are eight features and their description which can be integrated to any collaborative environment. There are many user interfaces that have been designed by using a design model or framework published in the HCI literatures covering different aspects of user experience in different application domains. However, it is still questionable whether these frameworks or models are applicable to many types of collaborative systems. Thus, this analysis will be an initial effort to develop an UI model for collaborative applications from a software development (language based) perspectives on JACIE.

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