Graphical User Interface Design for Collaborative Virtual Environments

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Abstract- The project aims to study, evaluate, analysis a Collaborative Virtual Environments (CVE’s) software also known as Networked Virtual Environments (NVE’s), and suggest how to improve the existing user interface by designing an alternative graphical user interface (GUI) for CVE’s software. To reduce cost, most current and operative CVE’s use the Internet and standard PC to create a visual Virtual Environment (VE), which can be shared by a large number of users. This project discusses CVE’s and the importance of using a good GUI for a CVE system.

I. INTRODUCTION

The aim of this research is to study and evaluate Collaborative Virtual Environment (CVE) also known as Networked Virtual Environments (NVE) software and suggest a better or suitable Graphical User Interfaces. This will include a software analysis and evaluation, updating the software if and when necessary or is possible. Outcome of this project is important for improvement of better CVE software in the next phase. It will discuss what has been gathered from the research and the analysis of the CVE user interfaces. It also discusses and addresses some of the issues from the research.

In this project, user interface not only refers to the graphical interface (Graphical User Interface (GUI)) between the user and the system, but includes other interfaces for communication such as aura communication, voice or video interface communication, facial expression and also standard tools used for communication (e.g. keyboard, mouse, etc).

The CVE software in this report refers to the software designs by Oliver Wennel at School of Computing Sciences, University of East Anglia United Kingdom.

1 A graphical user interface (or GUI, pronounced "gooey") is a method of interacting with a computer through a metaphor of direct manipulation of graphical images and widgets in addition to text. The GUI was invented by researchers at the Stanford Research Institute (including Doug Engelbart) for use in its On-Line System [1].

II. BACKGROUND STUDY

A Collaborative Virtual Environment (CVE) can be defined as a tool that supports collaboration between multiple users over a computer network. According to Churchill et al. [2] a CVE is a computer-based, distributed, virtual space or set of places. In such places, people can meet and interact with each other, with agents or with virtual objects. A CVE might vary in its representational richness from 3D graphical spaces, 2.5D and 2D environments, to test-based environments. Access to CVE’s is by no means limited to desktop devices, but might well include mobile or wearable devices, public kiosks, etc.

This study focuses on a 3D virtual world of CVE systems. A CVE can provide a more naturally shared system, by supporting interactive human collaboration and integrating different media in real time in a single 3D surrounding [3]. Nowadays, a CVE is not only visible to research laboratories with expensive equipment, but it could also be accessed by the public via the Internet.

Examples of CVE systems available on the market are DIVE [4], MASSIVE [5], NPSNET [6], SPLINE [7], etc. Each system has its own strengths and weaknesses. With the enhancement of current technologies, it could not be denied that a CVE could support collaborative work. However to make it work in practical conditions, customized design and development are necessary. Some of these issues will be discussed in detail in the next part of this report, in particular the user interface design in a CVE system.

Human Computer Interaction (HCI) is a study of how humans interact with computers, and how to design computer systems that are easy, quick and productive for humans to use [8]. Research in HCI has changed the way user interfaces are currently designed. However, research in this area has not only focused on the design of user interfaces but is also concerned with human factors as a consequence of using the system.

HCI could be defined as the study, evaluating, planning, and design of what happens between a user and a computer when they are working together [9]. In order to enable an interaction between human and computer, the interaction must consist of at least three
basic elements: the user, the computer, and the interaction between them [10].

The communication between human and computers could be an interaction when a user is making a data entry input to the computer or an interaction between human and the input devices (e.g. keyboard or mouse) when the process is in progress.

Designing a CVEs application is not a trivial work, there are many requirements need to be taken into consideration. According to Sayers et al. [11] the requirements to enable a collaborative work in CVEs include the following:

- Users in CVEs should be able to seamlessly move between individual and collaborative tasks.
- Users in CVE should be aware of others and their activities within the virtual environment. Participants should be aware of others without having to make any special effort.
- Shared object should be made visible and available to all participants in a CVE.
- It should be clear where the user has focused his/her attention.
- It is necessary for each user to convey what they are currently doing.

In order to ensure the collaborations are effective, the systems should support various communication types such as aura communication [12-13], visual communication [14], textual communication [15], social communication [13], [16] and spatial awareness [17].

Design principles could be used as a guideline when designing an interface for a system. To date, there is no standard or user interface guideline available for designing an intuitive interface design for CVE. Early attempts have been made; e.g. Kaur [18]. Others have tried to design guidelines for usability in VE/CVE; e.g. Hinckley [19], [20], Bricken [21], Hannaford and Venema [22]. Attempt has been made to promote the importance of user-centered design and evaluation of VE by introducing a methodology that need to be incorporated in the design process of development of VE system; e.g. Gabbard et al. [23], [24]. However, there are no standard guidelines a designer could use when designing a VE.

In order to design an intuitive interface design for a CVE system, a designer should use the eight golden rules of interface design. The eight golden rules of interface design are consistency, enable shortcuts, informative feedback, design dialogs to yield closure, error prevention and simple error handling, easy reversal of actions, support internal locus of control and reduce short-term memory load [25].

### III. SOFTWARE EVALUATION AND ANALYSIS

The CVE’s system was developed as a means of communication for those who can’t meet physically but they want to discuss, argue or do collaborative work together. CVE’s are the best option they have. In order to make interaction and communication in a CVE system between user more realistic and natural, it must allow gestures and postures in communication. For example, a user pats or rubs another user on the back when talking to each other to convey that the user is happy with the other user actions. Software Evaluation and Analysis

The evaluation and analysis of the current software was made to identify its weaknesses, which are crucial for further improvement in the development phase. The evaluation and analysis phase focused on elements such as:

- The Graphical User Interface (GUI) Design.
- Communication between users in the CVE.
- Methods of Communication (e.g. voice, chat, video, etc).
- The strengths and weaknesses of the CVE system.
- Interaction between user and the system.

The main functionality and features of the current CVE software are as follows; The CVE’s software allows many users to interact with one another in a shared environment. Users are represented by humanoids embodiment called avatars and the interaction between users happened in real-time state. Apart from that; the communication between users will take place using the short text message services.

The result of the evaluation and analysis was concluded in the next section with the solution on how to improve the current system.

Communication is an important aspect of our daily life and designing an interface for interaction in a virtual world needs to follow strict interface design guidelines. Most designers tend to design an interface that suits their developed systems without taking into account the user’s ability to adapt to these different user interfaces.

Communication between users in CVE plays an important role for the systems to be successful. The communication in CVE is not limited to the interaction/communication between user in the environment but also between the user and the system itself. The system should provide a better way for user to communicate with it. Currently the system does allow only one-way communication between users in the environment using text message. The systems should have a multimodal communication, which can improve the communication between users in the
CVE. The systems should map the human communication in daily life, which used more than text message for communication. This will include any other types of communication, e.g. voice, video, facial expressions, body gestures, etc.

For interactive systems, the GUI design is the crucial part and the display’s parts are the key to a successful interface system. GUI design for current system is too simple and quite confusing for new user. Good GUI designs are designs, which are not too simple or too cluttered. GUI for a system should have a clear and unambiguous design. A good GUI designs only consist of important features of the system and used a graphical representation (e.g. icon, button, shortcut) for action the user need to perform. This will help users from remembering all the command to execute any action. GUI for current chat mode only has one icon to show the users are currently on the chat mode. This GUI designs should use more than one icon to represent the function of its features. The chat mode should have an instruction on how to use the text messaging service. This will help a new user when using the software for the first time.

There is aspect of the systems that could be considered as the weaknesses. These are:

• Collision detection between users and object.
• GUI designs.
• Communication mode applied.
• Interaction between users.
• No storyboard was used when designing current software.

IV. DISCUSSIONS

The success of CVEs is not only determined by a number of users using the system or a good technical aspect of the system, but also by a good interface for communication between the multiple users in the VE. In order to achieve this goal, new architectures of the CVEs must be developed to provide a new module to be integrated into the CVEs and a new interface for communication must be introduced to provide functionality and to exploit the main characteristics of CVEs as much as possible.

There is a lot of improvement needed to be done to the current system/software created, but in this research improvement will focus on the HCI aspect of the CVE especially GUI and these includes:

• The communication between users will not be limited only to short text-messaging service but allow other types of communication such as aura communication, voice communication, body postures and gestures, etc.
• Interaction between the users and the system will not be restricted to the mouse, keyboard and standard monitor. Additional devices such as motion capture system and tracking gear, 3D spaceball, electronic write pad, etc could be used. Motion captures system is used to capture human body for their postures and gestures. This will enhance the interaction between users and between users and the system.
• Communication with the avatars can be enhanced with added emotions using predefined facial expressions. The system only enables four basic facial expressions and this could be improved by creating more facial expressions. The use of facial expressions will help the user to communicate better in a VE. Other techniques of creating facial expressions also could be used to create more facial expressions (e.g. cry, shame, blush, etc) and probably could produce a more realistic facial expression.
• Collision detection between users (avatars) and the collision between avatars and the objects in the environment can be improved.
• Interaction between avatars and the objects in the environment can be improved by using physical based simulation, e.g. picking up the object or bouncing ball, etc.
• Using a better GUI for interaction, e.g. using less command prompt or remember a command for each action to be performed.
• The system only enables six basic facial expressions and this could be improved by creating more facial expressions. Realistic facial expressions can be created using live facial expressions captured with a camera where a live human facial can be mapped to the human face avatar.

A more realistic facial expressions can be created by using live facial expressions captured with a camera where a live human facial can be mapped to the human face avatar. Another option that could be considered when using live facial expressions is using the video where user’s facial expression can be directly displayed on the facial expression window. This option enables users to see real facial expressions of other users not the expressions on the avatar.

Communication using live facial expressions will improve the communication between users in the CVE system. As we know, this option is not always a good option as it also has the weakness when it implemented to the CVE system. The main problem when using this option is that there could be problems with the network, as it requires a sufficient bandwidth between users. Heterogeneity is another problem that could arise. These problems were discussed earlier in the previous section.
Animated facial expression is another option that could be considered for a better communication where the animated facial expression will enhance the facial expression of an avatar and make it more attractive and effective for communication between users. Animated facial expression can also be the alternative to life facial expressions, as animated facial expression not only can convey user expression, but it is also more interactive and effective for communication.

Text-based communication in a 3D environment, especially in a shared or CVEs, is not realistic because there are other kinds of interaction or communication (e.g. voice, face expressions, gestures communication, avatar, aura, etc) that could be used in 3D as a means of interactive and functional communication. Voice communication could solve the divided attention problem with text-based communication. This is because the user could talk and at the same time could focus on what other users are doing in the environment.

There are some problems that arise when using text based only for the means of communications and because of these problems the new user interface design would overcome this. The common problems in a text-based communication are divided attention and turn taking.

If the system only allows a text-based communication, users will spend more time on the text window (chat area) rather than see what was happening in the 3D environment and this causes divided attention between window chat (chat area) and the environment itself. Turn taking is a problem in a text based CVE’s system. There are no specific rules that could ensure every user in the CVE’s system had a chance to speak. If one user is trying to explain a step-by-step action, users need to ensure other users do not interfere when an explanation has been made to avoid misunderstanding.

Nowadays, researchers are more concerned about human performance, health and safety and often neglect indirect effects of new technology, and social impact issues. A CVE is a technology that has the potential for negative social impacts, e.g. video games where a user mimics violent behaviors in virtual world to the real world. A typical CVE system does not offer face-to-face communication between users or real face expression (e.g. anger, sad, grin, laugh, etc) like normal communication and this could affect the benefit of communication.

Human performance in the CVE is also influenced by the user interface design constraints. Such interface is not suitable for the user especially if the user has to learn from the basics of how to operate the system. There is a concern about the health and safety issues that could affect the user’s quality of life, e.g. a health and safety issues such as eyestrain, fatigue, stress etc. In order to counteract these problems, graphical user interfaces that could improve the communication and human performance were proposed as in Fig. 1.

In Fig. 1, the design of the GUI was divided into the following categories: a chat area, pop up window, icons, and a facial expression window. The chat area is the main area in the chat mode and this is a crucial part of the chat mode. A pop up window will appear when some action triggers the pop-up window such as users starting to engage or users wanting to leave the chat mode. This kind of interface will help users because sometimes the user unintentionally presses the wrong key and undesired actions occur. Users only need to click on the pop up button to confirm the action. Facial expression windows were designed separately from the main chat area to reduce the space covered by the facial expression in the chat area.

A small icon used in the graphical interface (smile icon for facial expression options and fonts options) reduces users mental loads where users don’t have to remember all the keys for each function. If there are more than 10 facial expressions used in the system this will not help the user to remember all the key functions. This could ultimately lead to using the wrong facial expression at the wrong place and defeat the purpose of using a facial expression as tools to improve communication in CVE systems.

In this project, using predefined keyboard keys is a good choice compared to the use of a small icon because the implementation was meant to use OpenGL programming. In the context of GUI, using predefined keyboard keys is not a good option as the users need to remember all the keys for each action need to carried out. The use of a small icon that represents a facial expression and an option of a...
desired facial expression drop down menu from the icon is a good alternative and more user friendly. This could also reduce mental load for users because users do not only have to focus on the conversations, but also have to remember all the instructions for each individual action.

V. CONCLUSION AND FUTURE WORK

This research has been carried out to design a new graphical user interface for Collaborative Virtual Environment (CVE) software and some components have been implemented to the existing software. If the desired user interface that has been suggested to improve the existing software were successfully implemented, this will produce a very good piece of work in the CVE field.

Future research work could also be extended to improve the facial expression techniques by increasing the number of facial expressions used within the system. This could be done by using techniques described in the previous section of the research. The future work also must not limit the communication between avatars in the CVE by the facial expressions but also must consider other options such as audio, gestures and body postures etc.

The impact of the social interaction within CVE should be studied in details in the future to improve the interaction between users in the system. This includes the impact of such interfaces to the users and it is important to know what are the specific tools needed to make a CVE which will be valuable in different research disciplines and applications. Social interaction using aura must be taken into a consideration when improving current system or when designing a new CVE system.

REFERENCES


