Use of Augmented Reality in Serious Game for Training Medical Personnel

Arun Kumar Karthikeyan, Praveen Kumar Mani,
Suresh Kumar Balasubramaniyan, and Praveen Jelish Panneer Selvam

Blekinge Tekniska Högskola,
School of Computing (Sektionen för datavetenskap och kommunikation),
37179-Karlskrona, Sweden
{aruncs08,praveencse88,suresh.draco,
2007praveen.jelish}@gmail.com

Abstract. Serious games are games focused on learning other than pure entertainment. The potential of serious games for training of personnel is considered in many fields. The serious games differ from regular games, by helping the player to learn from the game rather than only entertainment. This paper focuses on the potential of serious game to train medical personnel and the use of augmented reality to enhance the training process. We also prove that the use of augmented reality in the serious games can improve the training of medical personnel and give them real world experience. This paper elaborates the use of serious game for training medical personal and the efficiency of using augmented reality in serious games.

Keywords: Serious games, medical education, augmented reality.

1 Introduction

Serious games differ from ordinary games in the use of learning element in the game, which helps the user to learn a process from the game. Serious games have applications in wide areas such as military, education, government, organization, healthcare, etc. The major purpose of using serious games for training is that it aids in the learning process, the use of augmented reality in the games increases the users real world experience and improve the training. The application of serious games in the field of medical education is wide. Serious games [3] are used in medical field to train and rehabilitate patients. The literature helped us to show the possibility of using serious games for training medical personal.

The main problem in medical training is that they cannot train with live patients. In such cases we can use serious games to train medical personnel. Previously serious games used for training use virtual reality to stimulate the real world experience for the users. Medical training is a very delicate operation and it needs high precision before they can operate on real patients. In this paper we propose using serious games to train medical personnel. Previous researches were done using virtual reality in serious games for training purposes. There has been efforts made to use augmented reality for gaming purpose but it has not been fully achieved.

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Augmented reality allows the user to see the real world with virtual objects super imposed on each other. Augmented reality enhances the user's perception of the real world [8]. It provides the medical field with potential to display text based medical data graphically combined with real world data. For example consider the case of performing a CPR on a patient in this case augmented reality can be used to project life critical data simultaneously. Using traditional method of gaming in serious games may not be efficient for training in medical field. By using the augmented reality in the games we can simulate the patient virtually and the physician can operate on this virtual patient as in the real world. We propose the use of augmented reality in the serious games to improve the training and give the users a real world experience. The experience of the user is measured using the following aspects such as physical, mental, social and emotional. We finally evaluate the experience gained by the users from the game.

2 Background and Related Work

The application of serious games in the field of medical education is promising. The serious games can be used to train medical personnel in emergency conditions and other delicate things, which cannot be trained in the real world. Augmented reality can be effective when combined with serious games and used for training in emergency situations. Augmented reality integrates virtual information with real environment [1]. The application of games for training people in medical field is in practice for a long time, by using augmented reality in serious games the training process can be made more interactive and help in faster learning [1].

The use of augmented reality in serious games can increase the user's interaction with the game and make the serious game more entertaining. By using I/O controllers such as pinch gloves and 3D glasses the users can be able to feel the virtual objects in the game environment [2]. Stroke causes partial paralyses in some parts of the body; this affects the capability of the people to move around. In such cases the patients should be motivated to undergo therapy. The serious game can be used for rehabilitation of patients affected by stroke. By using this training application of serious game, it can be used for training medical personnel in important medical procedures.

The application of serious game in healthcare education is also the current research going on in the field of medical [4]. Training of medical personnel using live medical subjects is not possible in real world, so to address this problem the serious games can be designed to train them in operations. This paper focuses on using serious games for training medical personnel and the use of augmented reality in the game. The training can be made more interactive and gives the user real world experience of the procedure. Further augmented reality displays the real time medical data which can provide them the essential information during the training in the form of visual projections, such as ECG and Heart Beat sensor data. These data checks the patient's life signs during operation.

In this paper we will focus on the serious game for training medical personnel and how the use of augmented reality in the game will improve the training. Augmented

reality creates innovative and interactive interfaces in serious games. Augmented reality makes new ways of interacting with serious games possible [5]. It also improves collaboration and interaction for the game environment.

3 Research Question

Based on the literature review we are able to find the application areas of serious games and how the games can be used to train personals. We formulated the following research questions.

- Can the use of Augmented Reality along with serious games improve the medical training process and user experience?
- How effective is the system (Augmented Reality along with serious games for medical training)?

The effectiveness is measured on a scale of 1 to 5 from the user's feedback about the system.

4 Research Methods

The research is conducted in the following steps to prove our hypothesis

- ❖ Discussing the possibility of using augmented reality in serious games for training medical personnel.
- ❖ Finding a proper metrics to express the effectiveness of the method.
- ❖ Performing an evaluation of our proposed system by using EGM and GSR sensors to record user experience.
- ❖ Using questionnaires to gather user experience data, to complement the result.
- ❖ Discussing the outcome of our experiment.

Research is the systematic way to find solution to the problems. We used both qualitative and quantitative research method to answer our research question.

4.1 Qualitative Methodology

The qualitative method is used for gaining needed background knowledge about serious games and training methods in serious games. Systematic literature review is done to find the possibility of using augmented reality in serious games [1] for training medical personnel. The literature review also gave us idea about the metrics that can be used for measuring the effectiveness of our proposed method. From the literature review we show that augmented reality can be used with serious games for training in medical field. We are also able to identify a metric system for measuring the effectiveness of our system. The qualitative research is done on the data collected from the literature review which is taken from the research databases like ACM, IEEE and Engineering Village.

4.2 Quantitative Methodology

The quantitative research is done by conducting experiment using the augmented reality system with a group of medical personnel and collecting the user experience from them. We would collect the parameters such as physical, mental, social and emotional experience from the medical personnel. Experiment with human subjects and a questionnaire survey are conducted. The experimentation is conducted to evaluate the system and gather user experience data using EMG [11] and GSR sensors.

The sensors are used to measure the user's excitement and arousal. It's hard to intercept what the signal means with just the sensor data, so in order to complement the result we use questionnaires to collect user experience data. The metrics we use for measuring the user experience is formulated from the literature review. The answers for the questionnaire are in the scale of 1 to 10. The result of the experiment is used to plot a learning graph.

4.3 Hypothesis

A null and alternate hypothesis is formulated based on the literature review.

Null hypothesis. The use of augmented reality in serious games for medical training will not affect or improve the training process.

Alternate hypothesis. The use of augmented reality in serious games for medical training improves the learning process and increase user interaction.

4.4 Motivation

The effectiveness of a system can be measured only by testing the system with users and gathering their feedback about the system.

The experimentation is the best method suited for finding the effectiveness of the system.

5 Qualitative Analysis

A systematic literature review is to gain background knowledge about the serious games and augmented reality.

5.1 Literature Review Synthesis

Serious Games for Upper Limb Rehabilitation Following Stroke [2] discusses about using serious games for engaging people in therapy for rehabilitation. The results of their analysis show that people are more engaged in therapy when they do it in the game. This gave us an idea of using serious games for training process of medical personnel. This will make the personnel more engaged in their training process.

A Pervasive Augmented Reality Serious Game [1] discusses about implementing augmented reality for serious games. The paper gave us an idea for using of

augmented reality for training process in medical field. The authors have success fully integrated augmented reality system with a car race game. The authors have use AR tool kit [7] for integrating the augmented reality system with the game.

From the synthesis of the above two papers we are able to answer our first research question. The use of augmented reality in serious games is possible and their use will improve the training process.

The metrics system we use for determine the effectiveness is on a scale of 1 to 10. The metrics will be discussed in the questionnaire section. The average for each session for a user is calculated and a learning curve is plotted. The quantitative part deals with proving the effectiveness of the system.

6 Quantitative Analysis

6.1 Context Selection

The experiment context is using augmented reality in serious games for training medical personnel. Attributes of the experiment is how the use of augmented reality in the game affects the leaning process.

6.2 Experimentation Process

The experiment is conducted using Humansim serious game and AR tool kit. The experiment is conducted in sessions of one hour. The users are given two scenarios to work in one hour and their progress and actions are recorded. The user's emotional and mental states during the session are also recorded by using EMG and GSR sensors [11]. After the experiment the actions of the user are reviewed and a report is generated. After the session the user is presented with a questionnaire. The user's answers are recorded and they are compared with the report to find the outcome of the training. The need for using the questionnaire apart from the experiment is to get a feedback from the user to improve the system further.

Table 1. Experiment plan

Session Name	Session Time	Events
Session 1	30 mins	Scenario 1
Session 2	30 mins	Scenario 2
Questionnaire	10 – 20 mins	Answer the questionnaire

6.3 Preparation

Based on the qualitative research we formulated the questions and they are reviewed. The necessary training is given to the participants, to familiarize them with the augmented reality system.

6.4 Execution

The execution of the experiment is done after doing the basic preparations. The participants were made to play the game and their collective user experience in gathered from them using the questionnaire.

6.5 Instrumentation and Serious Game Used

The experiment is conducted using Humansim serious games and augmented reality toolkit. Humansim is a serious game designed by Virtual Heroes Inc for medical training [9]. The AR toolkit is used for building the augmented reality controls for the serious game. The AR toolkit also provides support for the use of controls such as AR glasses and gloves that is used to interact with the game environment [6]. The game is then tested with a group of participants allowing them to train with the game. The player's arousal and excitement levels are measured using the EMG and GSR sensors. The signals are recorded and stored for future reference and analysis.

6.6 Quantitative Questionnaire

The questionnaire is an inexpensive way to collect data from the participants in the experiment. The questionnaire is used to effectively gather data about the overall performance and the game play experience of the users. There are different stages involved in preparing a questionnaire. To make the questionnaire effective every step must be designed carefully [10].

i. Objective of the survey.

ii. Determining the Participants group.

iii. Writing the questionnaire.

iv. Presenting the questionnaire to the participants.

v. Interpretation of result.

i. Objective. The objective of this questionnaire is to gather the user experience after playing the game using augmented reality. The questionnaire collects information about the game play experience? How real does the game appear to you? Etc.

ii. Determining participants group. The participants are selected based on their previous medical training.

iii. Writing the questionnaire. The questionnaire is designed in way so that we can capture the quantitative data of game play experience the user had while playing the game. The questionnaire is a written in a closed format where the user can select an option. The options for the question are in the range of 1 to 5.

iv. Presenting the questionnaire. The questionnaire is presented to the users of the system after the experiment session. This is done to capture the user experience after using the system.

v. Interpretation of result. The result collected from the user is then evaluated and a rating is prepared for the each user. From the overall rating from the users, we then evaluate the efficiency of the system for training medical personnel.

The metrics used

The metrics used in the questions is in the scale of 1 to 5.

There are also some yes or no questions in the questionnaire.

Each value has a corresponding meaning

1 - Very bad
2 – bad
3 – Satisfactory
4 – good
5 – Very good.

6.6.1 Questionnaire for the Survey. The following is the list of questions that had asked to the medical personnel participated in the experiment.

1. Have you trained previously using augmented reality systems?
2. How would you rate your level of involvement in the game compared to your previous training methods?
3. How well did the training method help you in training process?
4. Rate the quality of the game environment?
5. Breath of learning outcome for serious games using augmented reality and serious games with other methods.
6. How real does the game environment appear to you?
7. How would you rate your overall experience with the learning method using augmented reality?
8. Do you prefer augmented reality system over other training methods?

7 Hypothesis Testing

From the experiment conducted we are able to gather data from the users about their experience with the system.

Null hypothesis. Based on the data from the users we are able to plot a learning curve and show that the use of augmented reality in serious games in medical training improves the learning process. Therefore the null hypothesis is not valid.

Alternate hypothesis. The learning curve below shows that the learning process of the participants increases gradually. We are able to prove that the use of augmented reality in serious games for medical training will improve the learning process and overall user experience. Thus alternate hypothesis is proved.

The learning curve is slow during the initial trail session but once the user gets familiar with the system the learning curve raises rapidly which shows that the use of augmented reality improves the learning process.

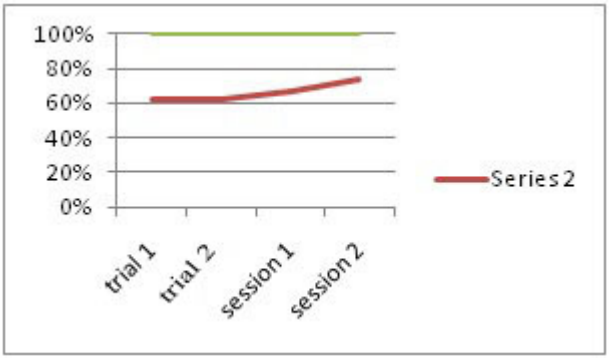

Fig. 1. The learning curve for one participant

8 Recommendations

From the result experiment above we recommend the following:

- The use of augmented reality in serious games will improve the learning process and also allows the user to interact with the game environment freely.

The augmented reality systems are not fully developed for serious games we have to adapt the existing augmented reality systems for serious games.

9 Conclusions

The result of the experiment shows that the use of augmented reality in serious games for training medical personnel will improve the learning process. The users also are excited when they use the system from the EMG and GSR data we collected. The use of augmented reality in games gives the user a real world feeling about the environment as the game elements are superimposed on real world objects. The interaction of the user with the game is improved greatly. We are able to prove our hypothesis from the research that the use of augmented reality in serious games for medical training improves the learning process and user interaction.

9.1 Future Work

Further work is needed to enhance the visual elements of the game to make it more realistic. The current augmented reality system gives the user only two degree of freedom we plan to improve the system to give the users three degrees of freedom.

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