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VR Application for Appendectomy Surgery Training

Kholoud Bahashwan
College of Engineering, EFFAT University
An Nazlah Al Yamaniyyah, Jeddah, 22332, Saudi Arabia
kbahashwan@effatuniversity.edu.sa

Shahad Alnasser
College of Engineering, EFFAT University
An Nazlah Al Yamaniyyah, Jeddah, 22332, Saudi Arabia
salnasser@effatuniversity.edu.sa

Rabea F. Kurdi
College of Engineering, EFFAT University
An Nazlah Al Yamaniyyah, Jeddah, 22332, Saudi Arabia
msradhwan@effatuniversity.edu.sa

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Abstract:

Currently, Virtual Reality (VR) has been used in various areas such as entertainment, research, military training, medical training, etc. Also, people realize that VR could help in education. The trainer can have full interaction within an environment that VR provide it as a summation. VR gives an area to practice surgery that cost much less, and it is environmentally safe. This study aim to improve the healthcare in Saudi Arabia by enhances the student Appendectomy surgery skill in a 3D environment in King Abdul-Aziz University. This study encourages student's performance and skills that lead to decrease time of surgery and risk.

Keywords: *Virtual reality, Healthcare, Surgical training, Appendectomy surgery, Appendix*

1. Introduction

Virtual reality term describes using of computer technology to create three-dimensional computer environment in which makes human interact within virtual world in where the virtual reality are believable, interactive, exportable, immersive and computer generated [1]. The user can use specific tools to interact with the virtual environment easily, that makes user able to contort and modify the any object exist in that environment. Mikkonen (2016) believes that the demand for the use of technology in the healthcare sector is increasing over the years and it will have a huge effect on all people involved in the healthcare environment including doctors, nurses, medical students and patients [2].

Virtual reality is an effective tool of learning and being a successful doctor as the trainees don't have to imagine themselves doing a surgery they can actually live it [3]. According to Cortez (2016), using simulation as a learning tool has increased the amount of knowledge that the students might gain moreover, the students become more confident in making decisions related to the surgery as their skills have been improved [4]. In addition, the abilities to work within a team have been increased [4]. Merchant (2014) ran a meta-analysis study on the effect of virtual reality on the learning outcome; the study has shown that the use of virtual reality increased the gain of learning outcomes [5].

Hayhurst (2017) illustrated the use of virtual reality in Western University of Health sciences and how the students are allowed to look for the different parts of the body and even the sensitive organs [6]. Studies have shown that being involved in virtual reality surgeries will improve training time and the student's will be able to learn faster and gain skills that they couldn't gain inside the classrooms [7]. Appendectomy surgery is very wide and known in

the field of medicine and a lot of people need to have this surgery in daily bases, so it's very important surgery for the medical to be familiar to and to accomplish it skill perfectly. Therefore this study aims to develop an effective VR environment for Appendectomy surgery training that help in improve the medical student's performance by using effective tools.

2. Methodology

2.1 User Role

Our End users which are the sergeants or the medicine students well be able to choose the surgery scenario from the interface and the moment they choose they well see it in the virtual glasses and start the operation through the virtual glasses using the gloves as an input tool.

The App will allow the users to register or make a quick visit to the VR world to perform a surgery or being part of it, the system also allow the users to seek advice according to the user situation.

The database will be holding information about each user and will keep it as a record, users are consisting of: professors, lecturers, doctors, medical students and also patients. However, the main key users are the medical students.

The admin area allows professors or lecturers to manage and arrange surgeries including different scenarios for medical students and run tests and evaluate them. The system should automatically save each user's information and keep it as a record.

The Application will allow the users to choose what kind of procedures they need to be involved of and then the user will have to wear the camera" Samsung Gear" and wear the special gloves and then the user will be transferred to the VR world.

2.2 Functional Requirements:

There are main functional requirements that will be used in the system:

- Allow doctors (lecturers) to create and update Appendectomy surgery scenarios (including practice and tests)
- Allow medical students to register
- Automatic result recoding
- Allow medical students to seek advice related to Appendectomy situations from different sources
- Allow medical students to perform surgery
- Allow medical student to diagnose and evaluate different patients' Appendectomy situation (both open Appendectomy and Laparoscopic Appendectomy)

2.3 General constraints:

The product will be hosted as an Application, the users will have to buy the Gear Glasses and download the App from the store. The hosting also includes server management which will ensure that the system is up to date and secure.

Medical students are required to login using a User Name and Password, as they have to register before they use it, lecturers who teach medical students and willing to use VR as a training tool will also have Login using a User Name and Password. Other users who want to give advice or just try to perform some of the surgeries for one time, they don't have to register however, and they must download the Application.

The Application must be easy to use and navigate for all types of users including lecturers, medical students and doctors.

2.4 User characteristics

The main users of the system will be Medical students and Doctors. Medical students are the key users of the system as they will be using the App more frequently than the other users therefore, medical students will reach expert level as they will be using the system as a training tool. In addition, the system will be also easy to use and navigate for visitor users. The specific requirements are:

2.4.1 Admin (doctor)

Should be able to access the Administration features and have the abilities to check students' records and add and change surgeries scenarios. Each doctor will register using the following information:

- First Name
- Last Name
- Username
- Password
- Email
- Teaching group

Each doctor will be given unique ID by the system and the doctor will be able to Add students, Add tests and change surgery's Appendectomy scenarios as well as adding marks and given feedback to the students.

2.4.2 Main users (Medical students):

Students are able to register and insert the following information

- First name
- Last name
- User name
- Password
- Study level
- Lecturer name

Each student will be given unique ID by the system to be used for regular access. Students can perform surgeries and start quizzes. Students can seek advice from different doctors. Students can diagnose Appendectomy situations and provide feedback.

2.4.3 Visitors (Doctors):

Without having to register, visitors such as doctors can go live in the VR world and run a chat with the medical students and with each other's. Visitors cannot monitor students' records. Visitors cannot add or delete surgeries. Visitors cannot view member's details.

2.4.4 Symptoms:

A medical student will be able to choose a patient and evaluate the situation. Medical student can re-evaluate the same situation. The admin can add different situations. The admin can edit the symptoms. The admin can delete the situation

2.4.5 Adding student results

After each surgery performance which have been done by the students, the admin shall be able to add results. After each situation diagnoses which will be done by the students, the admin shall be able to add results.

2.4.6 Results

The system allows the students to view results and admit to edit the results. The system should be capable of generating a report of students' results after the performance and diagnoses have completed, including:

- Grade
- Average marks
- Student level
- Doctor comments

2.4.7 Group performance

Group of students can perform in the same surgery using unique ID; all team members shall be able to view results and performance report.

2.5 Non- Functional Requirements

2.5.1 Hardware

App store is responsible for hosting. The System shall be hosted with enough bandwidth. The server hardware should be powerful to handle many Surgeries performance and live chats all over the world

2.5.2 Documentation

The design of the App will be well documented. If the system is going to be implemented then the source code of the system will be well documented

2.5.3 Security

Students are required to login using passwords to be able to perform surgeries. Visitors cannot change anything including students' details. Admin cannot access the system without their unique ID and password. The App must be secured from any viruses.

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2.5.4 Usability

The App should not be for technical users, it must be useable for non-technical users. Manual for users could be included for both students and the doctor.

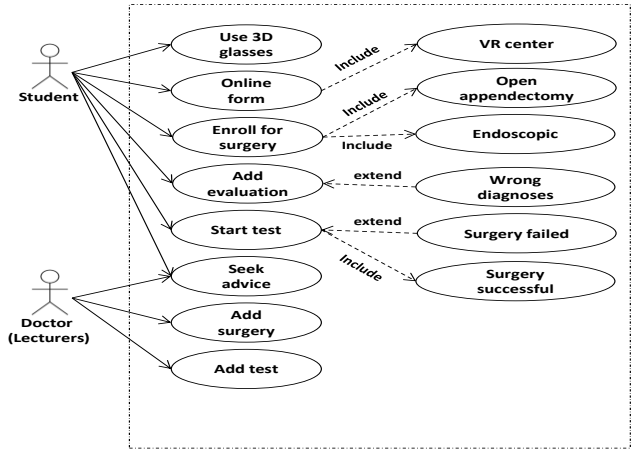

Figure 1. Use case diagram

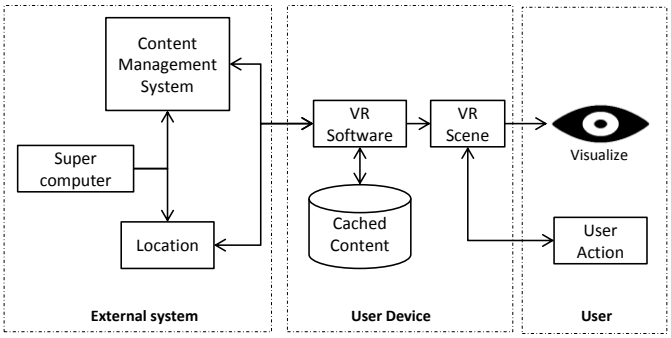

Figure 2. Context diagram

3. Result and discussion

This study used a computer with application such as 3D MAX, Unity and blender for modelling and create database to implement in order to reach the maximum benefit for the user. It has been agreed that Unity is the best option to use to create VR experience, when it comes to VR it has been agreed that it is the same as creating a game however, the developer have to create two points of views, one for each eye. It is a solid tool for beginners and small businesses [8]. Blender is an incredible device for investigating distinctive thoughts that accompany with sculpting, composition and game engine platforms. Blender can be utilized to alter films, shape mythical beasts and even [9].

The VR Game is developed to help medical students to have a close to real time surgery practice. There is a score system to evaluate the student surgery performance. The full environment inside the VR Game is defined as surgery room. User can have the full interaction with the object that excite in room. Then user will see the body of the patient where he must perform the surgery. Kamal, (2016) highlighted the important skills that need to be tested [10]:

a. Hand movement and Hand shaking.
b. Area where they should to cut.
c. The length of cut should be in range between 5- 7.5 CM
d. How much the deep of cut the specific area.
e. Finding the appendix
f. Remove the appendectomy
g. Time taken to perform the surgery

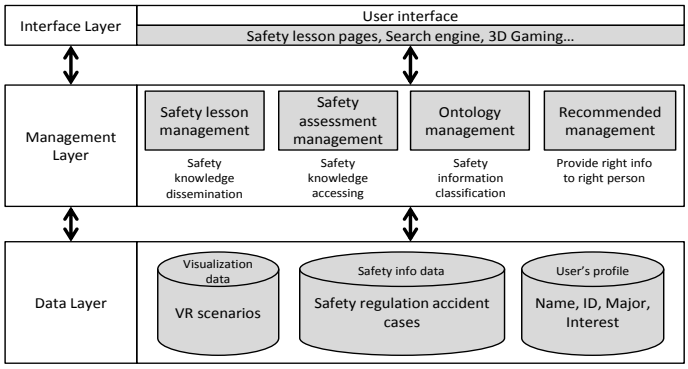

Figure 3. System Architecture

3.1 Prototype

First user will create account and login to the account. All the score or point during the practice will be recorded according to their personal ID. The login page is shown in Figure 4. Figure 5 demonstrate the user hand and the environment around the user view. Figure 6 illustrates the object modelling patient and the target location that plan to undergo operation.

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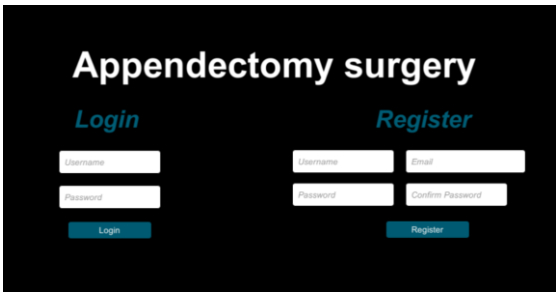

Figure 4. Login page

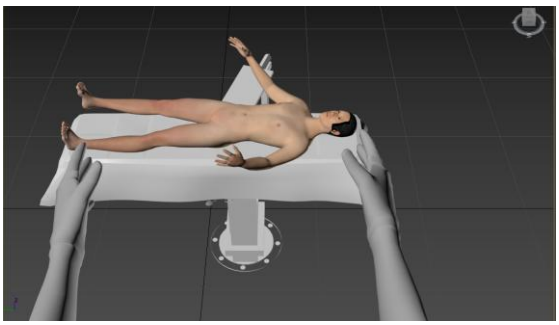

Figure 5. VR environment

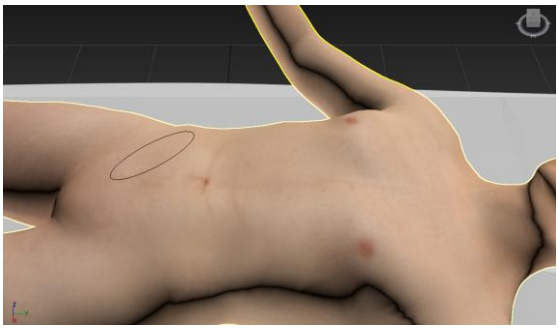

Figure 6. Locate the surgery location

4. Conclusion

This study developed a VR surgical simulation environment and demonstrated the training for appendectomy surgery. This development allows the medical student to practice on preforming appendectomy surgery with less time and mistakes.

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