A New Approach to Simulate Operation Rooms based on Medical Devices used in Surgical Procedures

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Abstract

Patient safety is one of the greatest challenges in healthcare. In the operating rooms (ORs), errors are frequent and often consequential. Medical devices and specially advanced technologies have a key role in improving patient outcomes in ORs.

In this paper, a new approach is presented to simulate operating theater based on different types of surgeries and medical technologies used in different surgical cases.

In the first step, clinical background of different surgical procedures such as: General, Cardiac, Neuro and Laparoscopic surgeries are collected and analyzed. Then all relevant medical devices of each procedure are categorized based on complexity of technologies and surgical procedures. All technical information such as: physics and technical basics, technical specifications, block diagrams, type of devices, top manufacturers and troubleshooting are gathered. Finally, a graphical user interface (GUI) is developed by C++ to implement all collected data in an interactive application.

Keywords: Graphical User Interface (GUI), Surgical Procedure, Operating Room, Biomedical Engineering

Introduction

The Heart of Hospital is another name given to the Operation Room in Hospitals nowadays. This is because of the number of operations done per annum worldwide. According to a research done by WHO (World Health Organization) organization, it was estimated that 234 million major surgical procedures are undertaken every year worldwide which quiet large number [1] [2]. During these surgeries due to some mistakes such as machine errors, surgeon mistakes, or OT technicians mistakes many patients die. According to a research done by IOM (Institute Of Medicine) 32 Thousand patients die per annum worldwide [3] during the surgeries caused by man made errors which is a noticeable number.

By considering these matters and studying the reasons for all these failures we have come up with an idea of creating a user friendly program in which the OT technicians, surgeons, and biomedical engineers can learn and trouble shoot the machines within no time. We have also gathered clinical related information as well as technical related information which can be used by technicians, surgeons, and biomedical engineers at the same time. The program which we have designed will make sure the patient safety and ensure the success of operation which is believed that it’s a great innovation in operation rooms.

In the year 2010 the first similar application was created by Allis Technology Company called ScrubUp. And they were the first practical mobile resource tool targeted to assist surgical technicians, instrument & circulating nurses. ScrubUp provides preloaded information that aims to guide the surgical nurse/technician in being able to confidently prepare & set up an operating room capturing all the
intraoperative details required. Surgical preferences can be updated, changed & reviewed, anywhere, anytime. The ScrubUp application is a one dimensional program whereas our program is a multidimensional.

This simulator is an effective tool to train and update all healthcare workers and especially biomedical engineers to utilize medical device technologies in a very efficient and safe way during surgical procedures. This GUI can also be used for educational purpose for medical and biomedical students.

This project is the mixture of technical and clinical parts of an operation room. This fills the empty space in an application similar to ScrubUp. We focus on both the technical aspect and clinical aspect in which the technicians, surgeons, and biomedical engineers utilize it.

The rest of this paper is structured as follows. Section 2 describes the framework of proposed method for data collection, classification and simulation. Section 3 shows experimental results of the proposed method. Finally Section 4 discusses the advantages of proposed simulator and concludes the paper.

Method

There are three steps in this project as shown in Fig1. In the first step data such as basic information, Standards of surgery and clinical data were collected from the theatre to describe different procedures. Further to this, technical data were also obtained to describe advanced technologies and medical equipment which is used for each surgical operation. Next, categorization was done based on the type and complexity of a surgery. The data that is collected are from different sources such as clinical websites, companies and textbook. The second step, all the collected data are presented by the use of power point and converted into a program. In the third step, after finalizing, this application was given to a number of professors and biomedical students, and their opinions were collected as feedback.

Fig.1-Three steps in this project

Step1

In this article, we surveyed 3 operation rooms based on 3 different surgical procedures. Since the majority of surgical operations are general surgeries [4], neurosurgery [5], and cardiovascular surgery [5], this study mostly focus on 3 operating rooms namely general operation room, cardiovascular operation room and neurosurgery operation room.

I. Clinical:

In this section, the most common surgeries such as: endocrine surgery, breast surgery and so on were studied. In addition, there is more emphasis on more sophisticated surgeries such as heart valve disease, biopsy, craniotomy and etc.

II. Technical:

In this part, medical devices have been divided into 2 categories. In general surgery, we have referred to the names of all the equipment needed to perform flawless operations in the theatre. For each piece of equipment information such as different types of the equipment, faults and troubleshooting, block diagram, various parts of the equipment, and the operation have been
added. The application and usage of each piece of equipment has been independently discussed.

The equipment referred to in this study includes Anesthesia machine [6] [7], Electrocautery [8], surgical light and etc. In cardiovascular surgeries apart from the set of equipment in a general surgery theatre, all the specialized equipment such as heart-lung machine [9], advance image guided, cerebral oximetry[10], and so on have been pointed out.

**Step 2**

The language used to write the program is C#, which has been used to interpret the data into an application. Visual Studio supports the ability to create different dialog boxes from a form or a different dialog box, the ability to make calculations, and creating different forms all while maintaining the true performance of the GUI.

Windows Forms provide the project with components, such as dialog boxes, menus, buttons, and many other controls, that make up a standard Windows application user interface (UI).

Also, the designer view in Visual C# Express Edition enables us to drag the controls onto our application's main form and adjust their size and position.

This section of the code below handles an important piece of the interface; it directly connects the user interface to the functionality of the program. This function handles what happens when something on the form is clicked.

```csharp
private void button_Click(object sender, EventArgs e)
{
FormSuction f1 = new FormSuction();
    f1.Show();
    this.Hide();
}
```

**Step 3**

The program was given to 3 groups of biomedical engineers to work with the technical part, healthcare clinicians to work with clinical part of program, and biomedical engineering students to work with both parts of the application. They were requested to use this application for a period of time to collect their opinion based on user friendly and complexity. They were also asked to comment whether there is a workable link between the clinical and the technical parts of the application.

**Result**

When the program was run as shown in Fig2. The program starts with the three main surgical categories of general surgeries, cardiovascular surgeries, and neurosurgeries. (Fig.2)

![Fig.2-Three main surgical procedures](image)

A Click on each button gives the user the two options of entering into either clinical or technical sections. (Fig.3)
Clinical section contains information about various diseases and the surgeries associated with them. (Fig.4)

Also the technical section supplies information about the types of surgical equipment and the table of troubleshooting (Fig.5), how to use the equipment and its block diagram and components of the equipment (Fig6).

The findings from the survey indicates that the majority of biomedical engineering students know about medical surgeries and devices related to that; however, less than 50 percent of the respondents have information about devices used in neurosurgery and cardiovascular surgery and the diseases associated with them.

Also clinicians and biomedical engineers mostly were satisfied with this application.

**Shortcoming**

This study was only based on the simulation of operating room and it has potential to upgrade according to new technology and devices. For future study simulation of NICU [11] and simulation of
Radiology can be added to this application to design and make a comprehensive hospital simulator (Fig.7). Also a graphical design for medical equipment needs to be added to provide 3D images, which allows user to view the product in 360’ degree review.

![Operation Room, NICU, Radiology](image)

Fig.7- Future study part

**Conclusion**

A user friendly simulation with essential information of both clinical and technical part of operation room, known as the heart of hospital, is an innovative idea. This simulator can be used to train nurses and technicians in order to be familiar with advanced technology and increase patient safety. Also, this program is a knowledge resource for biomedical engineering students and biomedical engineers to learn about different components of medical equipment, trouble shooting, and their functions. Finally, the cutting edge of this application is that it can be easily upgraded to cope with the new technology. In fact this program enables user to have comprehensive and multidimensional information about operation room.

**References**


