Dear Classmate,

The report entitled *Augmented Reality and its Applications in Patient Care* was to be written and submitted by February 25th, 2020 for the ENG2003 Assignment 4 create phase.

The purpose of the report is to describe the benefits and uses of Augmented Reality (AR) in surgical procedures and patient care, and to give more insight about the technology and how it can improved. In this report, I will be talking about how AR has been included in medicine and medical procedures, as well as its current uses. I will also be discussing the complexity of performing a surgery and how AR simplifies this procedure. The inspiration for this report came from the challenges in the Global Grand Challenge that was funded by Bill & Melinda Gates Foundation to help developing countries.

If there are an questions or uncertainties, I would be happy to answer any questions or clear up any misunderstandings.

I hope this report has given you more information about the benefits and uses of AR in medicine.

Sincerely,

A Fellow Student

Augmented Reality and its Applications in Patient Care

York University

Faculty of Engineering

Submission Date

February 25th, 2020

Executive Summary

Augmented reality (AR) is the result of mixing the digital world with our world. Through some sort of lens we can look through, we are able to place virtual objects all around us and interact with them. What we thought was impossible 20 years ago has become a reality, and the possibilities are endless. Generating the animation of a heart beating in real time is just one of the many things augmented reality can do. The ability to predict the location of a tumor during surgery is technology that is currently being used. Though there are many applications to AR in the field of health care, it has some negatives. AR technology has not been perfected yet, so it is not fully reliable. Things such as lighting or a faulty sensor could change the outcome of the scan. This report was written to address the fact that AR is emerging technology that has potential to solve one of the global health priorities that were based on the Global Grand Challenge that was funded by Bill and Melinda Gates foundation. This technology has the potential to help spread knowledge and education across the globe, saving many lives in the process.

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1. Introduction

Augmented reality (AR) is what we get when we combine our world with computers, which is usually viewed through some see-through optical device [1]. This optical device has a computer displaying some sort of information in addition to the real world. The uses for AR are endless and mostly easy to apply to our real world. One of the ways AR is changing the world is through its applications in medicine. AR has many applications, some of which include assisting in patient check-ups or assisting in complicated surgical procedures. Augmented reality is also applicable to the educational side of health care by simulating situations that potential doctors may face during their career, such as scanning ultrasounds. This device will allow for the spread of knowledge to many people, elevating the quality of health care that can be provided to the general public.

2. Usage in Patient Care Today

Medicine and medical practises are changing every day, and the use of augmented reality in health care is proof of that. One of the most notable uses of AR in health care is during surgery, more specifically neurosurgery. Doctors apply sensors to the patient and use augmented reality equipment to scan and detect different issues that present themselves. Because of this, unnecessary incisions and mistakes can be eliminated, leading to a more efficient surgical procedure. For general surgery, students can be taught the locations of the different organs through AR, giving them a more visual representation of the organs before making an incision, as shown in Figure 1.

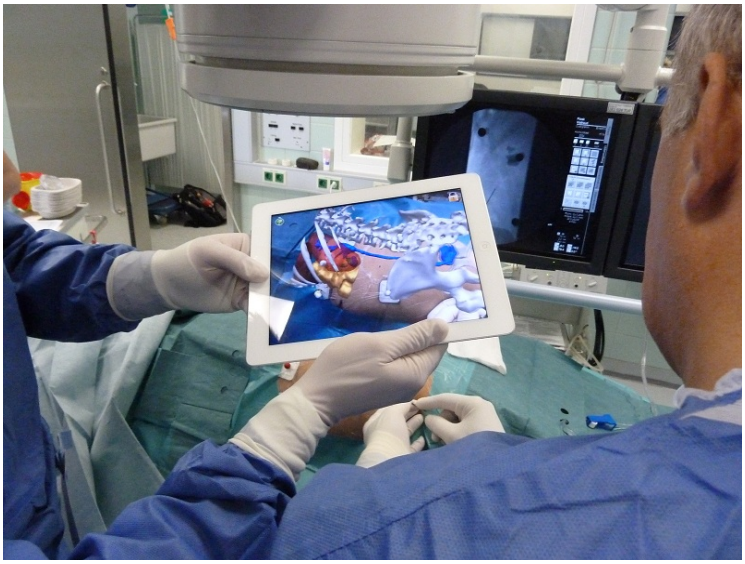

Figure 1: AR in Surgery [3]

On the subject of training, medical students now have a way to get practical training so that they can become more confident with there skills. There are two ways to train ultrasound (US) scanning. The first is to use the probe as an “interaction method to explore the basics of US” [4] and the second is more complicated as it uses AR after the US scan is complete to compare a trainee’s and an expert’s performance. Augmented reality allows for professionals to assess how well a student is performing an ultrasound on a doll in real time by displaying the direction of the waves the student is performing, as shown in Figure 2. Students can also record their scan and compare it to a professional’s scan so that they can see how they can assess their performance and continue to improve upon it. To get a direct comparison, “a synchronized replay of the trainee and an expert is shown” [4] to allow for a better way to analyze feedback. This program does not require an internet connection so results can be assessed at any time without the need for the AR equipment. Having this technique to train students makes it easier to train people in developing countries so that they can have easier access to better health care to those in need. The fact that the results can be analyzed without the equipment is crucial as a professional can get the video sent to them and they can analyze the results and provide feedback easily.

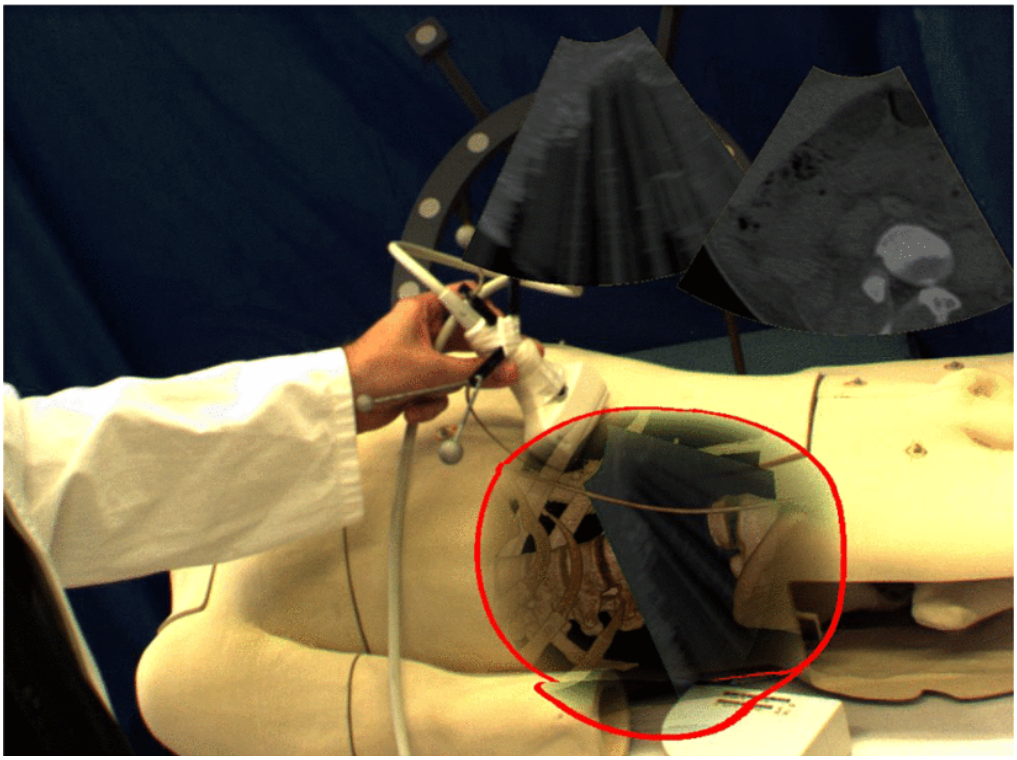

Figure 2: Application of the ultrasound training [4]

Furthermore, another way augmented reality is improving the medical field is through the introduction of a program that helps interpret cardiological data. This program provides a new way to visualize and interpret signals from the heart. By

uploading an image of an electrocardiogram (ECG), an ECG file and a pulse, a beating heart can be generated to match the data inputted. This is done by creating a sensor that has a unique code on it that a camera scans for information. The sensor is worn by a patient and then the AR program generates different images of the heart, which then displays them as an animation of a heart where the sensor is, as shown in Figure 3. The goal of this program is to be able to have students, professionals and even patients understand the way the heart behaves. The intuitive design allows for a more visual way to view the heart and what issues it may have. This new concept on how the heart is shown can also benefit doctors as they are able to analyze any potential heart diseases that may be present from interpreting the cardiological media presented to them by the program.

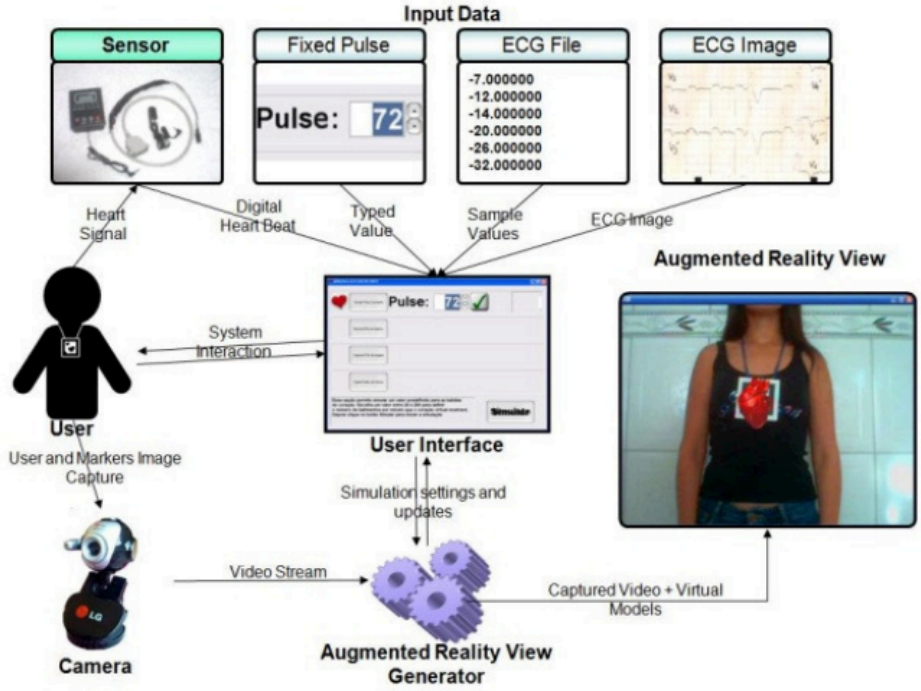

Figure 3: Proposed system architecture [5]

The intuitive interface easily shows the user if there is a sensor or not and what the pulse of the patient is, as described in Figure 4. Since the program is so easy to understand, it is very convenient to share this program to countries that do not have the technology or education to easily understand the functionalities of the heart. Even the general public can use this AR system to learn more about their hearts and understand what it looks like so that misconceptions can be erased.

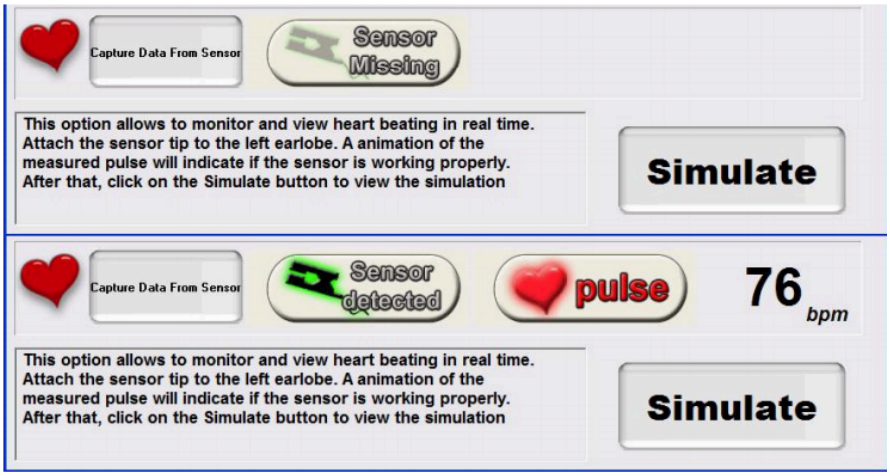

Figure 4: Interface when sensor is and is not detected [5]

3. Strengths and Weaknesses

AR is a very useful tool that should be implemented into our health care system, but it comes with some downfalls. This section will discuss the advantages and disadvantages of having AR in health care.

A big advantage that AR brings is that it can be "interactive in real time" [2], so it can be used instantaneously to assess a patient or the results of a procedure. It is also very beneficial in teaching trainees how to perform certain procedures without the risk of harming a patient or damaging equipment. They would also be able to directly compare their results to that of an expert's so that they can continue to improve. Not only does it teach perspective students, it also educates the general public about their body. The way AR can accurately show organs in a body gives a different perspective to medicine and it allows for a visual demonstration of a procedure to calm a patient down. Because of its ease of access, augmented reality can theoretically be used anywhere and at any time, making it a very convenient and portable health care device.

Moving on to weaknesses, during a surgery the result may not be positive, actually "the conditions under which [AR is] introduced may actually lead to the opposite" [2] because of the need for human navigation. A human needs to create the programs in which surgeons rely on to do their procedures, but the person creating that program may not be educated in the medical field and may make a mistake. This mistake could lead to a fatal result, so it needs extensive testing and man power. Another way augmented reality is unreliable is that it is greatly affected by the lighting in the environment, making work outdoors almost impossible. The lack of development in the sensors has caused AR to be useless unless the lighting is artificial and is consistent so

that the scan can be calibrated correctly. Though most programs can be loaded on a tablet or a computer, some AR equipment is more complicated than that, making it more expensive. Since it is an emerging technology in the medical field, it will constantly need to get updated, making it inconvenient and expensive.

4. AR and the Global Health Priority

One of the main benefits of AR is that is portable as it can be easily added to tablets and phones, which are more powerful than they have ever been, making augmented reality more accessible to people around the world. The Global health priority is part of the Global Grand Challenge that was funded by the Bill and Melinda Gates Foundation to try and solve challenges in global health using emerging technology. Augmented reality has made it easier to visualize and interpret information, allowing more people to get experience and education that were not able to before. The ease of access to AR allows developing countries to receive these resources to increase the quality of health care in that area. It is a very simple task to create an augmented reality program that would be compatible to tablet, and because of that, the spread of knowledge and technology is vital to reducing the mortality rates in developing countries. Adding AR to surgical procedures creates a lower percentage of failure as there is an aid to the surgeons that allows them to pinpoint specific areas more accurately.

5. Discussion

A big question that many medical professionals have is if augmented reality can truly be integrated with medicine. Based on the experiences of different professionals in the field, it is safe to say that augmented reality should first be fully integrated into the training side of the medical field. After gaining a better understanding and assessing its usefulness, it would then reasonable to decide whether AR is reliable in a more serious setting, such as surgery. Augmented reality equipment should go through extensive periods of development and testing before it can be released to doctors and medical professionals so that the chance for an bugs or issues to come up is very low. Overall, augmented reality has a lot of potential and its technology is getting improved every day, so the likeliness of AR getting included in the medical field is very high.

6. Conclusion

While AR as a technology is still unreliable, the advances it has made to modern medicine has made the negatives wane in comparison to the positives. Augmented reality has improved by leaps and bounds since its inception in 1992, creating many different uses and applications that have helped better our world today. In the field of medicine, AR has been used during surgical procedures to assist the neurosurgeons in accurately locating different sections of the brain and analyzing them. AR has also been beneficial in educating people involved in health care as it is used as a tool to accurately simulate real life situations, compare a student's and professional's work, and to convert complicated information into interesting and educational visuals. Though there are many uses to AR, not all of them provide purely positive results. The presence of bugs and scanning inaccuracies caused by undeveloped equipment leaves room for doubt about how efficient the programs and equipment are.

7. References

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