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Augmented Reality in Medical Education

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Abstract - *Education in the medical field involves workplace training and knowledge of complex skills that require effective performance up to professional standards in the work environment. Augmented Reality (AR) uses computer vision, computer graphics techniques and image processing to integrate digital content into the real world. It allows real-time interaction between the real objects, virtual objects and the user. AR can be used to embed 3D graphics into a video in such a way as if the virtual elements were part of the real environment. The use of AR in industry is increasing with applications being developed for education, entertainment, retail and marketing, gaming, military, healthcare, travel and tourism, manufacturing, automotive industry, architecture and engineering. AR provides remote learning and interactive simulations; thus AR-based teaching programs are widely being adopted within medical schools across the world.*

Key Words: **augmented reality, medical training, mobile application, Android, Unity, Vuforia.**

1. INTRODUCTION:

The aging population and rising rate of hospitalization are creating a dire demand for additional medical staff and resources. In regards to the foreseen circumstances, immense effort has been taken for the recruitment of medical and nursing students, in addition to the training resources. However, the price of fundamental training tools and equipment's is high. Therefore, there is a continual search for alternative and affordable solutions. For training in different fields, a widely adapted approach is the utilizing of mobile devices and applications which incorporate augmented reality (AR)[1]. AR tends to be characterized as a new type of training, via which this current reality is enhanced or intensified through computer created content that is related with specific spots or potentially occasions. In the end, AR permits the advanced substance to be effortlessly superimposed and blended into our experiences and generation of this present reality [2]. Over the last decade, rapid evolution of technology has yielded new ways to build applications for teaching and learning. Augmented Reality as an educational medium is becoming more and more accessible to young pupils at elementary school and professional learners alike. Education usually intersects with the AR evolution as AR has the following features:

1. AR provides users with an authentic and situated experience, when connected with the surrounding real-world environment.

2. AR magnifies the physical environment around users with virtual information that becomes interactive and digital.

3. AR display users an indirect sight of their surroundings and amplifies users' senses through virtual information.

Table 1 provides a comparison between the existing AR systems and our proposed work. The HoloLens (Microsoft) has more advanced features and functions, but it has the highest cost. The Meta 2 has been extensively used in a number of applications such as AR reality. It has the widest field of view. Although comparatively cheaper, it still costs USD 1,495. The Android based Smart Eyeglass (Sony) is much cheaper, but its hardware does not support users with myopia. Considering the need gap and restrictions, our proposed system will be developed based on the Android platform, and do not need proprietary eyewear. Users can just use their own mobile devices with embedded cameras.

TABLE 1. Comparison of AR application devices

	Our System	Microsoft HoloLens	Sony Smart-Eyeglass	Meta 2
OS	Android	Windows	Android	Windows
SDK / API	Unity / Vuforia	Unity / Unreal / Vuforia	Smart-Eyeglass API	Unity SDK
AR Features	Static & Dynamic	Interactive Module	Static & Dynamic	Static & Dynamic
Propriety Hardware	No	Yes (USD 3,500)	Yes (USD 699)	Yes (US 1,495)

2. HISTORY OF AR:

In the late 1950's, Augmented Reality came into existence because of Morton Heilig, a movie director, he believed that film as an art ought to be equipped for illustration the viewer addicted to the on-screen movement. In 1962, Morton set up a design of his thought, which he named it in 1955 as "The Cinema of the Future", called Sensorama that existed before computerized registering [3]. The Sensorama provided sounds, visuals, vibration and smell to the viewer but it wasn't computer controlled.

Then in 1968, Ivan Sutherland, the American computer scientist, discovered the head-mounted display as a kind of opening into a virtual world. The technology used was unrealistic for mass use. In 1975, the first "virtual reality" interface was developed by Myron Krueger, an American computer artist in the form of "Video place" which enabled its users to manipulate and interact with virtual objects in real-time. Tom Caudell, a Boeing researcher coined the term augmented reality in 1990.

The first properly functioning AR was designed by Louis Rosenberg at USAF Armstrong's Research Lab in 1992. It was called Virtual Fixtures and was a difficult and an incredibly complex robotic system which was developed to compensate for the lack of high-speed 3D graphics processing power in the early 90s. It allowed the overlay of sensory information on a workspace to improve human productivity.

3. PROPOSED SYSTEM:

In this AR based project, we will build a "Smart Education App" which will have features of good resolution, easy for handling, object information visibility, object movability and will also bring objects to the real world. This project will not only reduce teachers' work but also gain teaching skills and facilities and students will gain more accurate knowledge, easy to understand the concept. This project will provide rich contextual education for medical students to help in achieving core competencies, such as decision making, effective teamwork and creative adaptation of global resources towards addressing local priorities. The patient's safety is safeguarded if mistakes are made during skills training with AR.

3. Implementation:

I System Development:

First, a Vuforia Developer Portal, a Vuforia engine, and the corresponding target image database were established. The target image,

Placed on a target object or location, is a nonsymmetrical pattern predefined by the developer. When it is detected by the application via the device's camera, AR effects (Game Objects) are automatically initiated and overlaid onto the target object in the device's display. The target image, restricted to 35MB in size and stored in the portal, facilitates calculation of the target object's orientation and distance from the camera [1].

II. Marker-based Applications:

Marker-based apps are based on image recognition. Hence Marker-based AR is also known as recognition-based AR. It requires a marker to start an augmentation. Markers are distinct shapes or patterns that cameras can easily recognize and process. They can be paper based or physical objects that are present in the real world. To see the augmented component, you have to scan a marker which can be an object, text, video or animation using a device's camera feed. Once the marker is recognized by the device, an app overlay the digital data on this marker and you can see the augmented object.

To build a marker-based app, you should provide the images or their descriptors in advance to make the process of searching them easier when the camera data is being analyzed. That means the objects are already hard-coded in your app, so they are easier to recognize. Hence today, the majority of AR apps are marker-based. They are especially popular in advertising.

III. 3D Recognition and Tracking:

3D image recognition and tracking is one of the most important characteristics of any AR SDK. Due to the tracking, an app can "understand" and enhance the large spaces around the user inside of large buildings such as resorts, airports, railway stations, malls, etc. Applications which support 3D Recognition and Tracking can recognize three-dimensional objects like cubes, cups, cylinders, spheres, toys etc. Currently, this technology is commonly used in e-commerce and mobile games.

IV. Unity Support:

Unity is a cross-platform game engine. Today it is the most popular and powerful game engine worldwide. Though it's mainly used for developing computer games, it can also be used for making AR apps with powerful effects. Unity is a multipurpose tool which helps us to create a cutting-edge experience or extend a more traditional idea with new techniques.

V. Tools:

Wikitude has recently introduced its SDK7, which includes support for simultaneous localization and Mapping. Currently, the tool provides the following features:

- Create real-time AR applications
- 3D recognition and tracking
- Image recognition and tracking
- Cloud recognition (allows to work with thousands of target images hosted in the cloud)
- Location-based services
- Smart glasses integration
- Integration with external plugins, including Unity.

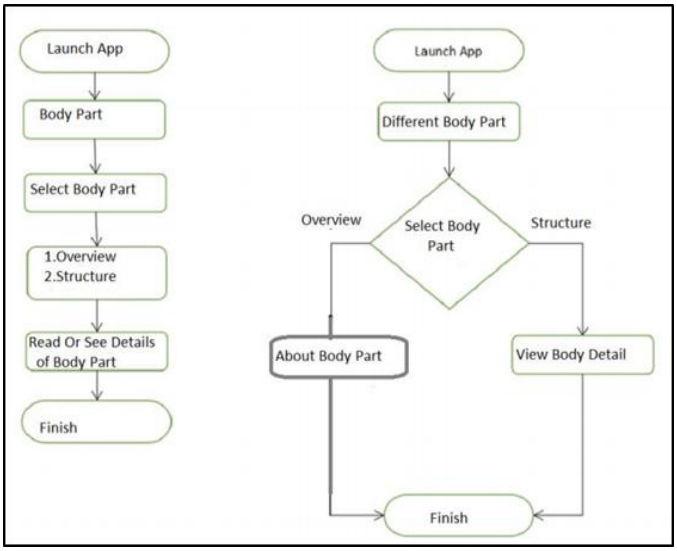

Fig1. Flowchart

5. RESULT:

Here we have successfully implemented the augmented reality and it's applications by creating an app that can detect human body parts such as heart, kidney, stomach, liver in a 3D manner. This application would help the aspiring medical practitioners in a better way.

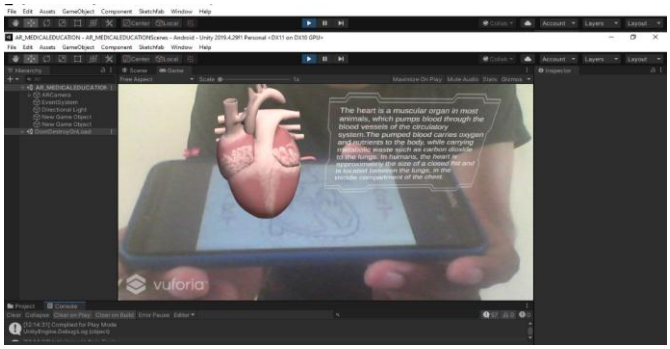

Fig. 1 Heart

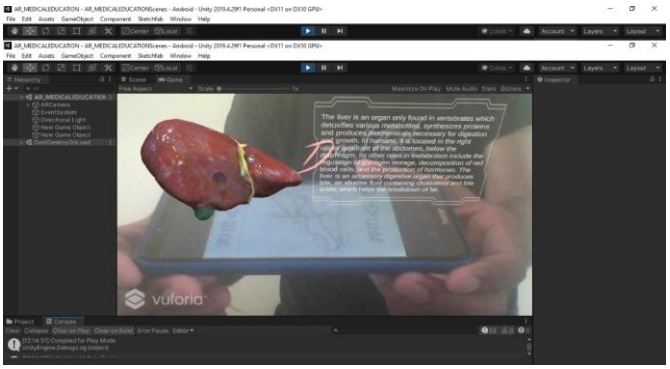

Fig. 2 Liver

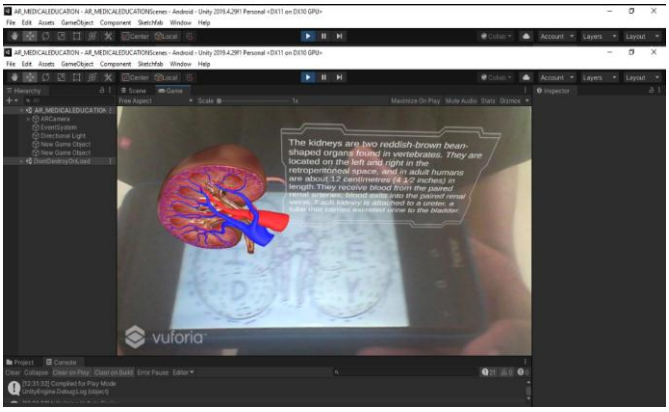

Fig. 3 Kidney

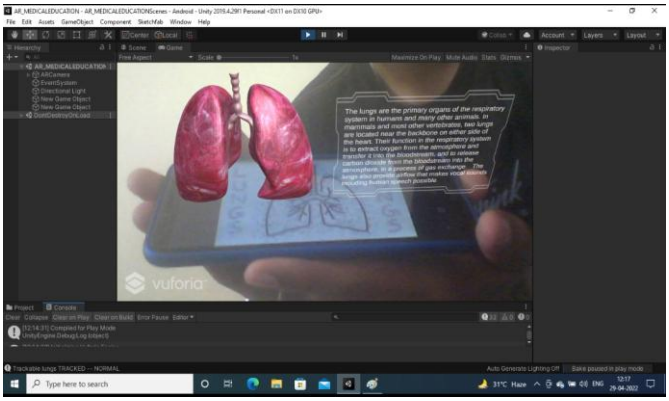

Fig. 4 Lungs

6. APPLICATIONS:

I. Healthcare:

Augmented reality is widely adopted in the area of healthcare and medical field. The healthcare industry has openly adopted the AR expertise to convert it into business opportunities. AR in healthcare provides an advantage for the medical staff to improve the medical condition of the patient and visually show and explain to him the real condition. AR aids Healthcare workers in understanding the human anatomy and the functions of the body in a better way. AR also assists surgeons in performing their surgery as they can visualize the area in advance [4].

II. Education:

The education industry has also leaped with the aid of AR technology, which has given rise to new possibilities and opportunities in the industry. AR has brought a revolution by providing visual effects in the teaching and learning pedagogy used by teaching staff. The integration of the virtual objects with real environments helps the students to understand ideas and concepts which would not have been possible to experience in the real scenario [5].

III. Tourism Industry:

Tourism is important in many countries as it is one of the largest industries which is contributing to their domestic economy. The tourist business has always aimed to keep up with the latest technologies. AR in the tourism industry has shown great potential to enrich the learning experience of travelers. AR apps have also provided useful information, guides, navigation tips and translation to make the life of the tourists very convenient in the new place.

IV. Navigation:

Augmented reality provides navigation in an environment. Augmented reality has two navigation systems: indoor and outdoor system. Gerhard Reitmayr developed an outdoor navigation system that helps people to get the location in an urban environment. Similarly, Alessandro Mulloni provided an indoor navigation system. It is one of the emerging applications of augmented reality [6].

7. CHALLENGES AND ISSUES WITH AR:

I. Technical Challenges:

AR system handles huge data on a daily basis to run the business successfully and also to get the organization fully functional. The hardware used to fetch the information should be easy to deal and easily portable for faster display of information. The hardware needed for the AR technology needs to be resolved for practical use and also for mass adoption.

II. Lack of public awareness:

AR technology is still in its initial phase as consumers are unaware of the benefits of this technology. The common man is still not aware of the advantages of AR and thus they do not promote its usability in their daily lives. Thus, the consumers of AR are only trying out wardrobe, glasses and accessories.

III. Lack of regulation:

AR technology is not very common and thus there is no regulations designed to support the business applications. The standards are not available to aware the consumers on how to safely use the AR in their daily business activities. The consumers are also confused with the processing of data, security and storage features of AR. Hence, one of the significant challenges seen in using augmented reality is the available guideline and standards which ensures the privacy and security of consumers.

IV. Visualization Issues:

In the AR system registration errors are very common and also unavoidable and therefore rendering an object assists in displaying the area in the screen space where the object can stay by considering expected tracking and measuring. Also, in the case of rendering, the key consideration is improving the quality of virtual objects in the AR applications [4].

8. CONCLUSION:

For future development, the app can be enhanced by developing this system to the large scale in different fields. AR is in the early stages of application within healthcare education but it has enormous potential for promoting learning in healthcare based on AR studies. AR is more effective at teaching students compared to other media such as books, videos, or PC desktop experiences. All observations and tests prove that AR is very effective in making it easier to learn complex spatial structures and functions such as in geometrical shapes, chemical structures, mechanical machinery, astronomy configurations, or spatial configuration of human organs. Implementation of such systems in the field can definitely help to improve the quality of education and will make improvement in all the fields.

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