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Applications of Augmented Reality to Provide Quality Education: A Survey

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Abstract: ***Traditional methods of learning such as reading books and copying texts is becoming a thing of the past. Everything is becoming increasingly digitized and is being driven by technology innovations. Bringing new learning formats based on technology in the classrooms can lead to increased student engagement which in turn will make the knowledge and skills stay longer. Thus, adapting technological solutions to education is very important. Augmented Reality (AR) is an enhanced version of the real world which is achieved using digital visual elements, audio and other sensory stimuli. This is a growing technology. Since it provides many powerful visualizations, AR can be used as a powerful learning tool. This paper will provide an overview of AR and the hardware required for AR application and some of the AR techniques required to successfully overlay virtual contents over the real-world objects. Further, it explains the importance of AR in education and evaluate the impact of AR in education through various works.***

Keywords: Augmented Reality, Unity

I. INTRODUCTION

Augmented reality (AR) technology has seen a great growth since 2020. It has come a long way from fiction to reality. It provides an interactive experience between the user and his/her environment, where the physical world elements in the environment is enhanced by a computer-generated input. The inputs range from images to sound to videos to graphics and so on. To put in simple words, AR is a technology that puts virtual objects in the real world. It can be experienced through AR glasses or through mobile devices. It is a growing trend among mobile computing companies.

II. TECHNOLOGY HARDWARE

The necessary hardware components for the AR are, a processor, display, sensors and input devices. Various technologies are used in AR rendering such as mobile phone, monitors, head-mounted display, smart AR eyeglasses, head-up display (HUD), etc. AR glasses are very expensive. The device which we can get our hands on easily for AR applications is mobile phone. Long [5] did a research to compare a needle placement AR performance between smartphone and AR glass. The smartphone used was iphone-7(Apple product) and the AR glass used was Hololens-1(Microsoft product). The placement time of virtual objects for both these devices were almost same and very less compared to the placement time of other AR platforms. Hence for affordability purpose, the smartphone for AR is the most preferred choice. Siriwardhana [8] explains by enhancing the quality of user experience, Mobile-AR applications can bring value to various application domains. The extreme high Bandwidth and ultra-low latency offered by 5G system can give a promising high-quality cloud-based AR Applications.

Smart phones may be ordinary looking on the outside, but on the inside, they have various sensors like accelerometer, gyroscope, camera, light sensor and magnetometer which play a very important role in AR. Accelerometer is a motion sensor. It is used to measure the change in velocity across a single axis (linear Acceleration along a particular direction). It also measures gravity like a downward force.

This determines if the device is moving up or down. For AR, this sensor is needed as it can track the change in motion. Gyroscopes are motion sensors that detect and measure the angular motion of the object. They measure the rate of rotation around a particular axis. Since accelerometer can only detect linear changes in motion, in order to use AR, we need gyroscope to check the tilt or twist movements.

Magnetometer is a device which measures magnetic fields. Therefore, it can detect the north pole, so we know in which direction we are facing on the earth. It is necessary for location-based AR apps. Camera gives the live feed of the user's surrounding environment where the virtual AR objects will be overlaid. Figure 1 gives the block diagram of the overall AR process.

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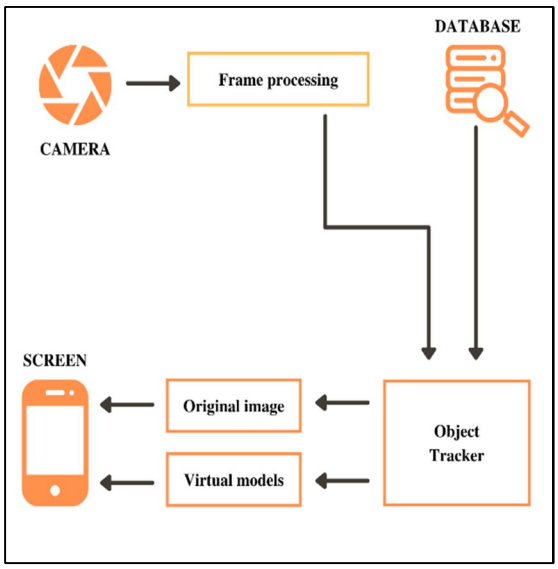


Figure 1. Block Diagram for AR process

III. AR TECHNIQUES

There are various techniques to make AR feel real and interactive.

A. Slam

Simultaneous Localisation and Mapping (SLAM) gets data from the environment in forms of dots and points. These data are fed to the devices thus helping the devices to understand what is going on in the surroundings. It maps the entire physical space or object. This is done using sensors like gyroscope and accelerometer.

B. Depth Tracking

This is used to measure the distance between AR camera to the object or space. Then, like any other camera focusing, the desired object is focused and the rest of the surrounding is blurred. After SLAM and depth tracking is over, the AR application will process the image and will project it on the user's screen (Halolens or mobile). This image will be processed by the backend of the AR application. Both SLAM and depth tracking allows the image rendering in the right dimension at the right location. Apart from SLAM and depth tracking, other type pf technologies are used to detect objects, they are, Trigger-based augmentation and location-based augmentation.

C. Trigger Based Augmentation

This kind of object detection uses triggers to activate the augmentation by detecting AR markers, symbols, location, icons, etc. Trigger based augmentation works with the help of marker based, location based and dynamic based augmentation. In marker-based augmentation, the AR device scans and recognizes AR markers. Most AR markers are paper based markers. They look like barcodes and they enable the AR app to create digitally enhanced 360-degree images on the AR device. In location-based augmentation AR taken in the real time location data and combines it with the app backend. Dynamic augmentation is the most responsive form of augmentation compared to others. With the help of motion tracking sensors, it super imposes the real-world objects with digital media.

D. View Based Augmentation

The dynamic surfaces like the building and natural surroundings are detected by the AR app which in turn connects this view to its backend to match reference points and shows the appropriate images on the screen. It is superimposition based or generic based. Superimposition based AR detects objects which are already fed into the application database. Digital information is relayed on the physical object. Generic based or marker less AR doesn't need prior knowledge of the user's environment to show the 3D model. It eliminates the need for capturing physical markers to trigger the virtual 3D interaction. It increases the range of motion.

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IV. AR IN EDCUATION

Though the actual world is 3 dimensional, we learn about it using two-dimensional media. The problem with two-dimensional media is that, it is static and doesn't offer a dynamic approach. Due to the absence of realism, learning is less interactive and boring sometimes. AR can change the way of learning in the classroom. It can bring extra creativity and engagement to any subject. It can help in easy understanding because, using AR applications, students can grasp any topics easily irrespective of the complexity. Students can gain a very good practical knowledge which they will be unlikely to forget. Since AR glasses are highly expensive, the affordable choice as discussed earlier is AR application via smartphones.

De Miguel [2] did a non-experimental research with 1716 subjects to see the usability of phones among students between primary education to university. His analyses revealed the perception of higher use in an intermediate age. Though high usage can be seen in middle age students, children by two years of age gets access to smartphone says Yadav [10]. He and his team developed an AR smart phone app in C# and studied the interaction of 60 children aged between 2 and 8 years with it. Their study concluded that the children developed the necessary skills to use AR software by the age of seven years. Hence AR educational apps can be used for children aged 7 and above to enhance their learning experience. In another study performed by Sahin [7], it was understood that the AR was indeed a game changing in education. He and his team developed a science booklet and an AR application for the booklet. Two different schools were chosen, where the study was done on 7th grade students. Students of one school studied the science booklet, in a traditional way. Students of the other school, studied the same book with AR technology. The study concluded that the student who completed the booklet using AR had a positive attitude towards the booklet and the AR application. They were pleased and willing to use it. People have been engaging in creating various models and applications for providing good AR content to increase the interest of students in various topics. Varun [4] and his team created an interesting and interactive 3D model of the solar system using a very popular game engine called Unity for middle school students. The algorithm they used to implement their model was marker-less AR which gave a localized map of the surrounding environment where the solar system model was overlaid.

Midak [6] developed a mobile application to visualize the chemical structure of water and to represent video materials of lab experiments. This helped students to better understand the concept. The algorithm used here is marker-based AR on the LiCo STEM application located on the lapbook. Flores [3] proposed an AR application aiming to help students understand the geometric shapes better. Flores's study aimed in exploring the potential of AR among the 6th grade (age 11 to 12 years old) students. The result of the study showed the effectiveness of AR among the students. The students had a better understanding of geometric and spatial concepts better. Arslan [1], in his study examined the techniques to increase the learning performance in biology. So, he developed an application using Unity3D. The main aim of his study is to help students learn the anatomy and dissection of animals without actually injuring the animal. The algorithm used in this study is a marker-based AR. In the test phase of the application, interviews were conducted with limited number of users. It was understood at the end that the 3D AR experiments were fun to learn, hence students were more interested.

V. CONCLUSION

By analysing various works, it is understood that AR in education serve a number of purposes. With AR, boring classes becomes engaging and fun. Hence, it helps the students to easily grasp, process and remember the information. It is not limited to a particular age group. It can be used in all schools of learning or even at work. AR has a potential to replace paper textbooks, hence education becomes more accessible. It doesn't require any expensive hardware because 73% percent of teens currently own smartphone which is sufficient to use AR applications. To sum it all, AR pushes the traditional limits and provides a fun way to learn thus creating a powerful impact among the learners.

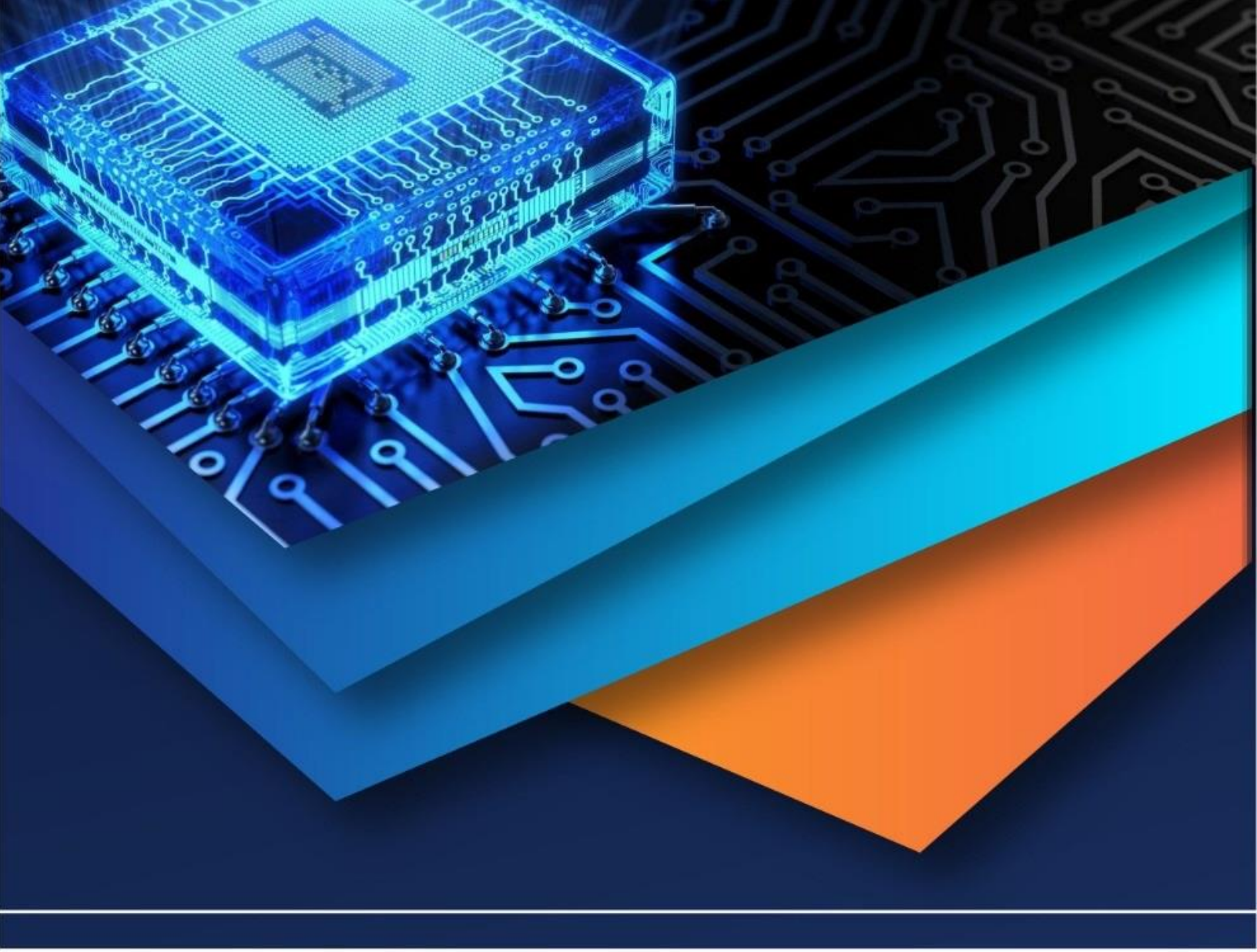
VI. FUTURE ASPECT

The future aim is to create an AR based application in one of the most interesting field of study: space. It is one of the most exciting and rapidly evolving branches of science. Space science encompasses all of the scientific disciplines that involve space exploration and study natural phenomena and physical bodies occurring in outer space. Space science is very important because it has led to development of various technologies such as GPS, weather prediction, solar cells etc. Students are fascinated to understand these. So, I am proposing to develop a whole book from scratch on basics of space science, which will be the physical data. An AR book app will be developed which will detect multiple images. Virtual content will be imposed over the physical data. The digital data and models will be created which will be used to create AR visualizations with Mesh Targeting in Unity which in turn will overlay the digital data over physical data. These visualizations will help to understand the physical data better thus providing a fun way of learning. To make the learning interactive, a chat bot will be added.

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