Visual learning through Augmented Reality

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Abstract— Education is the most important thing in everyone's life. Traditional approaches like using blackboards and static textbooks are still being followed. Research shows that students are getting bored and fed up with these old methods in this new technological era. For educational institutions, labs are the backbone of teaching students how things work in the real world. this could be expensive and not everyone can afford it. New ways need to be introduced and integrated into education with the help of technology to make learning easy and fun. With the help of Unity 3d, spark AR, and Vuforia SDK. we are going to develop immersive augmented reality experiences so that students can get access to quality education. Augmented reality labs are immersive, interactive, and lifelike, which means they may help students to understand and learn how to control things in a real environment.

Keywords— *Augmented reality, Vuforia, Unity 3d.*

I. INTRODUCTION

In the field of educational technology, there is a wide variety of technologies and approaches being used around the world to provide better support for teaching and learning processes. Among these approaches, augmented reality (AR) is a technology that is gaining momentum around the globe. AR allows users to see the real world with digital information superimposed (Azuma, 1997). AR has been an active area of research in the educational setting as a supporting technology for learning and teaching processes. AR has attracted a lot of interest in the research community because it provides unique learning experiences that cannot be achieved using other technologies or approaches. AR offers new forms of interactivity with content, improved visualisations of scientific phenomena, and a reduced cognitive load. Many AR applications have been developed for a wide variety of learning domains, such as science, engineering, and social sciences (Cipresso et al., 2018; Garzón & Acevedo, 2019). Research on AR in education has demonstrated that AR has a positive effect on students' learning outcomes (Akçayır & Akçayır, 2017; Bernal et al., 2019; Cano et al., 2019; Radu, 2014) and motivation (Arici et al., 2019; Bacca et al., 2018; Chiang et al., 2014; Ibañez et al., 2020).

According to the reality-virtuality continuum by Milgram and Kishino (1994), AR is one significant part of the general representation of mixed reality. The area between two extremes, where both the real environment and the virtual environment are mixed, is called mixed reality or hybrid reality. It consists of both augmented reality and augmented virtuality. Augmented Reality is becoming an emerging multi-platform application. Augmented Reality is an extension of virtual reality with more advancement in our day-to-day life. VR attempts to create an artificial world a person can experience and explore, through his or her sense of vision, audio, and other different forms of feedback. AR brings about a similar interactive experience, but also aims to supplement the real world, instead of creating an entirely artificial environment. The physical objects in the individual's real-life surroundings acts as the backdrop and target images for computer-generated illustrations. In Augmented Reality, the user is more aware of the real-world environment than in Virtual Reality. Augmented Reality is a relatively young technology and is the way of future technologies and innovations. It has large number of applications in the fields of medical, marketing, advertisement, entertainment, education and training, industrial design, manufacturing and maintenance, architecture, navigation, emergency search and rescue systems, interactive gaming and tourism. Scripting is the most important aspect of unity 3D and has the advantage of quick prototyping and better organization of code.
Unity supports two programming languages which are C# and Unity Script. Everything from the creation of 3D models to the enhancement of features like rotation, Scaling, Zooming and showing the simple movements of 3D models, applying materials and textures require the use of scripts.

This project focuses on Augmented Reality and its related application in the field of education. We attempt to create a new education tool that combines a mobile application for the learning of new concepts that are hard to visualize, with augmented reality technique. The textbooks, newspaper, magazines, comics and other reading materials can contain certain images or markers when scanned by any AR device such as mobile phone, tablet or a computer system supported by and platform produces additional information in the multimedia format. The textual, graphical, audio and visual information superimposes on the student's real time environment. Such application enables the students to actively participate and interact with computer generated simulations. We introduce an application that presents new and exciting ways to get students involved in learning concepts related to science, math etc.

This application can change the way students learn things with the technology of Augmented Reality. The technology helps interleaving the concepts of theoretical and practical learning. Augmentation can serve to aid and enhance individual's knowledge and understanding of concepts. It enhanced the educational potential that scholars, teachers and students are embracing. AR is bringing a revolution to the entire education system and way we teach and learn.

To tackle the problems faced by the traditional approach of education we create a new way of immersive student experience with augmented reality. We create these AR experiences using Unity 3d and Spark AR and deploy them as an APK using Vuforia SDK. With the help of the app, students can scan the target images to visualize high-quality 3d/2d objects in the real world. This helps teachers to offer interactive experiences and boost students' creativity, learning, and quality of education.

II. LITERATURE REVIEW

Augmented Reality in Education: An Overview of Twenty-Five Years of Research
Published in: Avila-Garzon et al. / Contemporary Educational Technology.

The analysis presented in this study addresses journal articles and other types of papers, such as conference papers, books, and book chapters (a total of 3,475 studies were considered). The research questions that this study aims to answer are as follows:

• RQ1: How has AR in education evolved in terms of annual scientific growth, the countries that contribute the most, and the most relevant publication sources?

• RQ2: Who are the authors that have contributed the most to AR in education as measured by the number of publications and citations per year?

• RQ3: What are the future research directions in AR in education?

Overall, the results show that there has been an increase in the number of systematic literature reviews in the field of AR in education. For instance, to date, seven systematic literature reviews have been published in 2019, and for 2018, we found that 14 systematic literature reviews were published. This is a positive result because it reveals researchers' interest in uncovering the benefits, advantages, and potentialities of this technology in education. However, most of these literature reviews were conducted in a particular field, such as science education, informal education, STEM education, and game-based learning, among others. Consequently, the findings of these literature reviews provide a narrow overview of particular areas of interest but do not provide a general overview of the current state of research on AR in education. The primary benefit of taking education as a whole and see how AR has been used in this field is that a general overview of the field might help to identify trends in research, emergent topics and topics that have not been explored yet. A bibliometric analysis of AR in education as a whole field may uncover trends, strategic areas for research, current research problems, the potential impact of certain research areas within the field and the expansion of knowledge in that field (Oliveira et al., 2019) as well as the quality of research in that field (Bornmann & Leydesdorff, 2014).

The results of the bibliometric study show that the annual growth rate of publications in journals and conferences on the topic of AR in education is approximately 21%. This result suggests that not only has there been continuous interest in this topic, the number of related articles is increasing, thus confirming the findings of Akçayır and Akçayır (2017), Herpich et al. (2019), and López et al. (2019) regarding the increase in the number of publications in the field of AR in education.

A Systematic Literature Review: Learning with Visual by The Help of Augmented Reality Helps Students Learn Better

Published in: 5th International Conference on Computer Science and Computational Intelligence 2020

We know that one of the best learning methods is to use visualization. By using visualization, students find the subject more interesting and makes it easier for them to understand the underlying concepts. This advantage can solve the difficulties in the teaching process due to various special educational needs, such as the lack of student's concentration, attention, confidence and background knowledge. Based on the fact, AR is a promising solution. The main objective of AR is to improve and enhances perfection of surroundings by combining visual, audio and tactile perception. AR also improves a lot of empty gaps in certain activities which requires a high level of immersion experience which once could not be achieved. Positive effects have been found when using AR in education are enhanced learning performance and motivation, higher enjoyment and engagement, more positive attitudes towards the learning material, and a better collaboration between learners Regarding to these effects, many studies have reported AR's effectiveness in primary, secondary and higher education to increase student motivation, learning outcomes, collaboration, interactions, learning attitudes and enjoyment.

This knowledge should bring a good opportunity to utilize AR in boosting the student's motivation to study. AR application is built by replicating the real world with digital images or text. The traditional textbook, which the teacher uses to explain, employ a 2D model to explain an abstract concept. With this textbook, the students are required in their mind to make picture view of something they might never be able to experience. There is an experiment in one preschool classroom where the teacher gives cameras as a tool to enhance visual experience of the students. It is proved that using new technology makes the students more creative, even develop their social skills. AR makes it possible to create realistic 3D figure as representation of the abstract concept, which the textbook cannot. This new technology could open the student's eyes to many possibilities they did not know before.

III. METHODOLOGY

A. *Software and algorithm*

Dynamic image registration is the methodology that is used here. After the process, the software needs to get the real-world co-ordinates independent from the scanned camera. This can be possible using two steps.

1. The first step is the feature detection method, used to detect markers that are fiducial, interest points, or optical flow in the camera images.
2. The second stage restores a real- world coordinate system from the data obtained in the first stage using some mathematical representations.

Some of the software that we have used are Unity 3D, Vuforia and Spark AR

Unity 3d: Unity is a complete 3D engine supporting C# scripting, 3D and 2D graphics, physics, sound and animation. It is one of the most popular engines used for mobile game applications and is progressing steadily in the AR/VR area. The feature Unity is most acknowledged for is its rapid development and deployment capabilities.

Vuforia: Vuforia is the most popular SDK for developing AR-applications on a wide selection of devices. This chapter will explain the main features of Vuforia's Unity version, that will be evaluated. These include tracking, image recognition, object recognition, text recognition, video playback.

Spark AR: We can insert our own 3D objects into projects and use Spark AR Studio to edit them, add interactivity, logic and animation. If we don't have our own 3D objects ready, we can choose from a huge range in the AR Library by Checking the supported file formats first. 3D objects can include bones and joints, which we can use the Patch Editor or scripting to animate. They can also have materials, textures and animations baked into the file.

B. *Hardware*

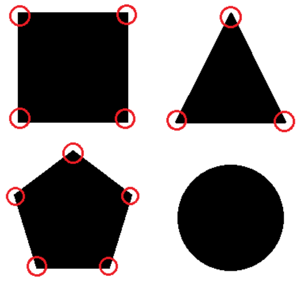
- o Central Processing Unit (CPU) — Intel Core i5 6th Generation processor or higher.
- o RAM — 8 GB minimum, 16 GB or higher.
- o **Storage:** A minimum of **256GB.**
- o **Graphic card:** Nvidia GeForce GTX 1660 or above.
- o An Android mobile phone.

The Augmented reality apps can be designed and deployed in desktops, hand held devices, mounted displays, projection systems, AR gear and so on. The project that we discuss in this paper uses an android mobile, that has a pre-installed AR Book app.

IV. MODULES

A. *Tracking:*

It is not stated explicitly by Vuforia how their tracking Algorithms function, but looking at their documentation it is evident that they utilize some variation of natural feature tracking. Natural features in images are usually sharp details such as high contrast corners or the tips of a triangle.



The technique was introduced in the early 1980s and revolves around splitting an image into several sections. Each section is shifted in several directions and the change in image intensity (RGB value) is measured. For instance, if a section of an image contains a straight line – or edge, as it is more commonly called – a shift along the edge will result in small overall changes in image intensity. However, a shift perpendicular to the edge will cause large changes. A corner, or spot will cause large changes when shifted in any direction. By considering these changes in image intensity, the feature tracking algorithm can determine what is a feature and map the positions of these features in the image. As a result, the algorithm creates a pattern of features. In Vuforia, this pattern of features is what define a target. When the target is detected by the application, the features are matched against pre-defined feature patterns and the pose of that target is estimated. Pose is a common term used in the area of computer vision. It is the combination of position and orientation, often in relation to a 2D coordinate system. In Vuforia's case, the coordinate system is made up of the pattern created by the natural feature tracking.

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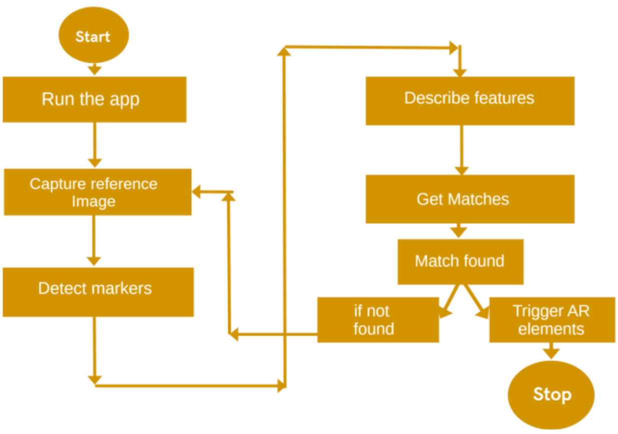
B. *Object recognition:*

While Vuforia's object recognition utilizes natural feature tracking at its core, the process of creating object targets is quite different compared to creating image targets. An image target maps features in 2D by analyzing the pixels of the image file provided to the target manager. A 3D object, however, has a third axis to consider. Object targets enable users to view an augmented object from several angles while the object maintains its augmentation. Prior to augmenting 3D objects, they need to be scanned somehow; Vuforia has developed a scanner app that is capable of scanning relatively small objects using a certain "scanning plane" upon which the object is placed (see Figure 5.3.6). This way, the scanner app can tell the orientation of every detected feature in 3D, as the scanner plane works as a spatial reference.

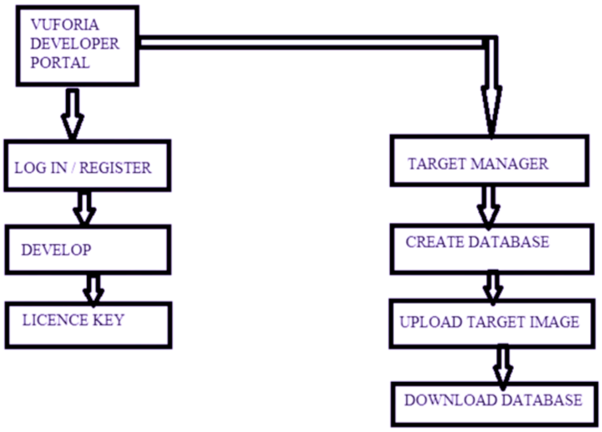
V. FUNCTIONALITY

- We create the AR experiences using Unity 3d and Spark AR and deploy them as an APK using Vuforia SDK.
- With the help of the app, students can scan the target images to visualize high-quality 3d/2d objects in the real world.
- This helps teachers to offer interactive experiences and boost students' creativity, learning, and quality of education.
- The Augmented Reality bridges the gap between theoretical and practical knowledge. Generally, an AR system generates, in real time, a composite view which is a combination of the real scene viewed by the user and a virtual scene generated by the computer that augments it with additional information. It allows the users to control and manipulate the objects that are not real, in an augmented environment.

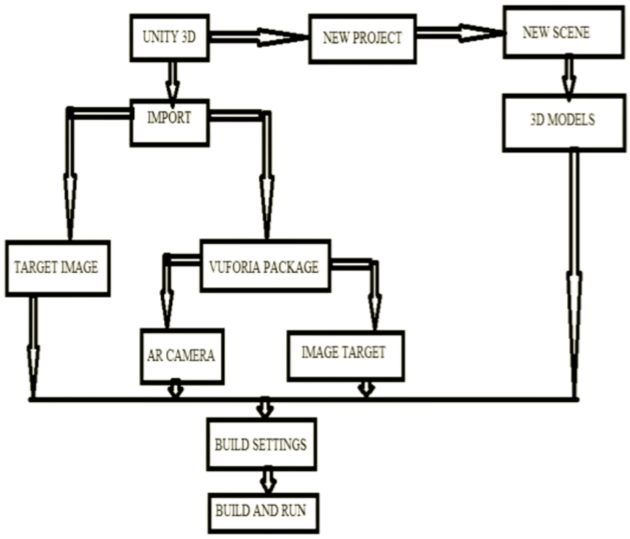
A. Flow chart:



B. Vuforia working:



C. Unity working:



VI. RESULT

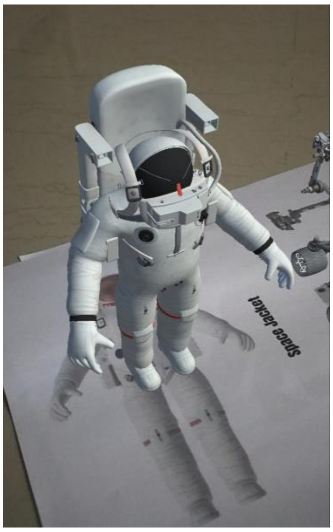


Fig 1: Augmented view of an astronaut after scanning the target image 'space jacket' on the printed book using AR app.

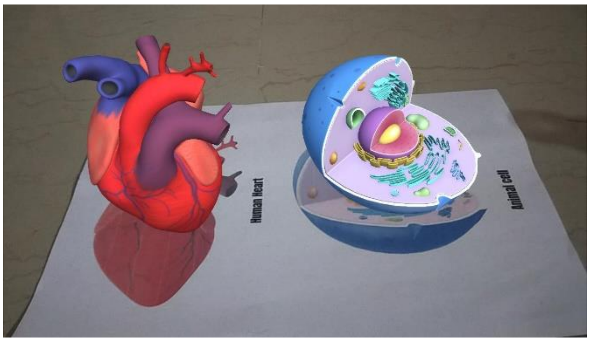


Fig 2: Augmented view of the heart and animal cell (3d model) after scanning their target images.

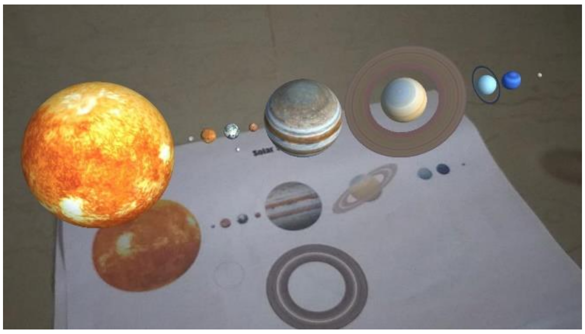


Fig 3: Augmented view of the solar system (3d model) after scanning the target image solar system.

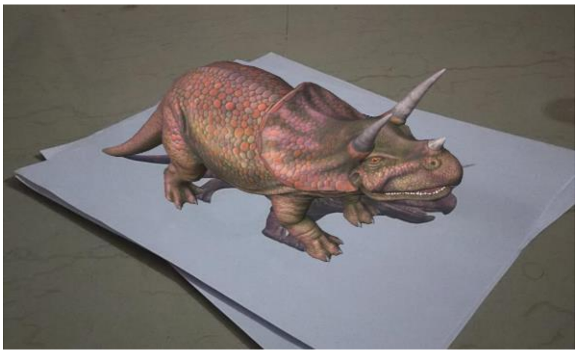


Fig 4: Augmented view of Triceratops in real time after scanning its image target on the printed book using the AR app.

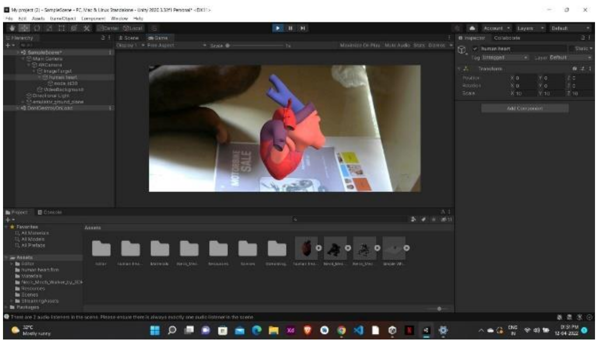


Fig 5: 3d model creation in unity software.

Fig 6: AR book application in android mobile.

VII. CONCLUSION

Augmented reality allows the users to explore layers and layers of digital information over the top of physical information in 3D configuration. This project tries to create a more efficient and learning environment through augmeneted reality. The results from the literature survey indicate that AR systems are a positive step towards reducing the distance between students and knowledge. This prototype of AR application enables the students to increase their creativity, understanding towards complex subject in a simplified manner, enhance their skills and improve memorization.

VIII. FUTURE SCOPE

The AR technology in education is just the beginning to be explored. The educators like scholars and teachers need to work with technology professionals like developers and researchers to incorporate augmented reality in education sector. In future we can add direct navigation using sliders and zoom in and out buttons. Also animated 3d models can be built inside the app to experience in a more effective way. Geo-location-based augmentation can also be implied in-order to lessen the hassle of scanning markers. Gesture and voice control can be added for the 3d visual models for more easy access and interaction. It is possible to develop 3d digital labs so that students can work in safe and immersive virtual environments without expensive infrastructure.

IX. REFERENCES

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