AUGMENTED REALITY GUIDE APP FOR CST

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Abstract

Augmented Reality (AR) has been established as one of the technologies with highest potential to revolutionalize the world. It is the combination of real and the virtual world that is viewed using an AR device. It is a new age technology and has a wide range of applications such as in education, tourism, gaming and entertainment. This project focuses on building an AR software application for detection of a location and provide text and audio feedback. The College of Science and Technology is used as a pilot area for the current work. Five locations identified for testing the prototype are the gate, lab, library, ATM junction and the library junction. The model was designed using Blender software with the reference image designed with Krita. The model was then imported into Unity Environment with Vuforia Plug-in. A text plane and an audio button was also added to the environment. The application on android platform provides high precision with a delay of less than one second to detect an image target and ideal sensitivity of 100% at 8m, 5m and 3m for gate, lab and library, respectively, under optimal condition of bright lightings with the angle of the phone camera at 90 degrees to the image target.

Key Words : *Augmented Reality, mobile guide application, Blender, Krita, Unity, Vuforia*

1. INTRODUCTION

Augmented Reality (AR) is one of the newest technologies that is found to be appealing to an individual regardless of their age. It is emerging as a new platform to view reality, which can be controlled, managed and experienced. AR is the combination of real and the virtual world, which enhances the features of a particular place or object of importance. Considering the availability of required information and resources, this approach can further be enhanced to greater levels (Ibrahim Ilhan, 2016). Since Augmented Reality gained popularity, mobile computing, wireless internet and location-based technologies have been facilated in mobile devices to aid in creating an augmented reality platform. Hardware components such as Global Positioning System, compass and accelerometer are also some of the techologies that support AR in smartphones (Amogh Sangamesh Kuruwatti, 2020).

The features of a smartphone such as portability, being lightweight and the ability to support high processing capabilities enable the users to explore the world to higher extent. Augmented reality has established an utmost importance in education, tourism, medicine, entertainment and other fields. Any experience is made much more informative as well as full of amusement and excitement with enhanced visualization of every detail using AR (Rashidi Bin, 2017). The benefits of AR further extend to providing better classroom education with exceptional and more interactive environment, as it enables to come up with virtual examples of concepts and add gaming elements to provide the materials required. This indeed helps the students to learn faster and retain information if AR is used in education.

The arts center in Christchurch, New Zealand consists of a dusty old room where the guests are given a one-of-a-kind experience. They hear a voice telling them to get closer to the darkness when they enter. When they do, they are confronted with a life-sized virtual representation of an older person. The man describes what it was like working in the identical room one hundred years ago. The virtual

image depicts Ernest Rutherford, a Nobel Laureate in Physics from New Zealand, in the room where he conducted his first study as an undergraduate at university of Canterbury (Bilinghurst, 2002). An empty room is transformed into a very rich educational experience owing to the application of innovative technologies.

2. BACKGROUND

Augmented Reality Technology started off as an impractical head mounted display which was illogical for mass use. In alignment with evolution, it has proved to be one of the most versatile technologies of all time. It is one of the present day technologies which posessess numerous applications in tourism, education, medicine, entertainment and other fields.

2.1 Augmented reality and virtual reality

Augmented reality is a combination of the real and the virtual world. AR merges the real enviroment with virtual objects to further enhance the experience of a user. It supplies the user with innovations along with reality. On the contrary, Virtual reality, involves a user to be immersed into a totally different environment. Virtual reality uses a digital interface, which is capable of transforming the physical world. VR requires the use of a headset, whereby the user is immersed in an actual location or an animated scene, which is created using a virtual reality app. The users become unaware of the real world and can view the virtual reality in 3D, as if they were actually present in that location.

2.2 History of augmented reality

This technology was first developed in the 1960s. In 1968, Harvard professor and computer scientist, Ivan Sutherland invented the first head mounted display, dubbed 'The Sword of Democles'. The display was designed to be a portal into the virtual world. The innovation utilized at the time rendered the work unsuitable for mass use. Then, in 1975, an American computer researcher and artist, Myron Krueger, developed the first virtual reality interface as 'Videoplace' at the laboratory of the University of Connecticut, which permitted its clients to control and collaborate with virtual objects in real-time (Azuma R, 2001).

Thomas Caudell, a Boeing researcher, coined the phrase Augmented Reality in 1990. Later in 1992. Louis Rosenburg, a researcher/analyst in the USAF Armstrong's research lab, invented 'Virtual Fixtures' and is one of the earliest, fully functional augmented reality systems. This system allowed the military people to digitally supervise and manage the machines, allowing them to complete duties such as educating US Air Force pilots on safer flying techniques. In 1994, a writer and producer, Julie Martin, produced a theatrical performance titled Dancing in Cyberspace, which featured the infusion of AR technology with the entertainment industry for the very first time. This performance presented acrobats dancing along with extended virtual objects on the actual stage (Poetker, 2019).

The unveiling of the yellow yard marker, a virtual graphic system, in a live NFL game telecast by Sportvision in 1998 was the first time AR technology was used in the sports sector. This new feature overlays a yellow line on top of the video so that spectators can quickly identify where the team is just moving forward to get a first down. NASA's design of a hybrid synthetic vision system for the X-38 spacecraft is the most recent innovation in AR technology from the end of 1990s. This system used augmented reality (AR) to aid test flights and improve navigation (Clemens Arth, 2015).

With the completion of a century, AR technology further evolved, extending its features and applications. HiroKazu Kato created ARToolKit, an open-source software library, in the year 2000 to assist developers in creating augmented reality software programs. The first attempt to incorporate AR technology in print media was initiated by Esquire Magazine, in 2009, in an attempt to give life to the pages. It featured, one of the most popular entertainers, Robert Downey Jr. speaking to the readers as they scan through the pages (Scheinerman, 2009).

Since then, there has been various breakthrough in AR technology, which includes, debut of MARTA app (Mobile Augmented Reality Technical Assistance) by Volkswagen in 2013, launch of google glass device, which is a pair of augmented reality glass by Google in 2014. Later in 2016, Microsoft levelled up the game by developing HoloLens, which is an advanced version of the earlier designed google glass device. The very first AR application in the retail industry was developed by IKEA, which is called IKEA Place and permits the customers to virtually preview all the home décor alternatives before making a purchase (Berryman, 2012).

2.3 Tourism in Bhutan

Bhutan opened its border to foreign countries in 1974, which embarked the beginning of

tourism in the country. This initiative was taken in order to raise revenue and to promote the unique culture and traditions to the outside world. In the first year, a total of 287 tourists visited the country. In 1992, the number of tourists visiting the country increased to 2850 and in 1999, it increased considerably to 7158. Since then, the number of visitors has been increasing with each passing year. Today, Bhutan is one of the most popular tourist destinations in the world, owing to its core values, astounding flora and fauna and distinctive culture and traditions. In the present-day scenario, tourism is considered as a remarkable source of income with a high potential for further growth and advancement (Bhutan's Economy, 2020)

2.4 AR for tourism in Bhutan

Tourism in Bhutan is a notable source of revenue. With the number of tourists vising the increasing every year, it is vital to enhance the experience of visitors by incorporating new age technology such as AR. Till date, the travel industries in Bhutan have not launched any AR applications. Tourists visiting the country are accompanied by guides, who provides them with informations on sites and places. However, there are limits to the clarity a guide can provide about a subject. A guide is able to verbally educate the visitors about the places of importance, but, with the use of AR technology, the verbal information along with virtual graphics can be displayed through the screens of handheld devices. This will not only relay important information but also aid in supplying a fun and realistic experience. For example, if a conventional guide is explaining about an incident of importance, the information is only provided through verbal means and it creates room for imagination, but if the information is provided verbally along with the animation of the exact same incident, the experience is made much more informative and exciting.

Conventional tour guides are unable to portray realistic experiences on cultural heritage sites. A tour guide can say, “This is where the Tertoen (a person who discovers old secret texts, also known as terma) found the treasure”, but he cannot show what the treasure looked like on that space. With the AR, it is possible to build a model of the Tertoen holding that treasure, so that the tourist can have a clear picture of the story. It is also possible to animate, Trongsa Poenlop, Ugyen Wangchuck, live in the battle of Changlimithang. Therefore, AR provides a more realistic and fun experience.

In 2019, an Indian tourist climbed on one of our precious stupas (Shukhla, 2019), which ignited anger and rage in the Bhutanese community. This happened because he did not know the importance of that stupa. He ended up disrespecting our spiritual site, unintentionally. If he had an AR guide application then he would have played around with it, hovering the camera over various areas and would have understood the values of stupas and this situation could have been prevented.

Augmented Reality is one of the technologies that His Majesty mentioned as a technology to provide enomous potential for the future (His Majesty the King's Address at the 14th RUB Convocation, 2019).

3. SOFTWARE IDENTIFICATION

The software to serve the purpose of designing a reference image, a 3D model and a software to support an Augmented Reality Environment were researched. Hence, through literature review and testing, a few software were identified.

3.1 Krita

A 2D reference image can assist and benefit in the process of designing a 3D model. The reference image could be designed hand-drawn on paper but it would lack precision in terms of different views matching each other. Hence, a software to design the required reference image with greater precision and accuracy was determined.

Krita was chosen as the software to design a 2D referencing image for the 3D model due to it being free, open-source and having a very simple interface since the reference image needed to have minimal features for simplicity of the design in 3D.

3.2 Blender

Blender is a 3D modelling software. 3D modeling is a computer graphics approach for creating a three-dimensional digital representation of any object or surface. 3D models are used in a variety of applications, including video games, movies, architecture, art, engineering, and commercial advertising. The 3D modeling method provides a digital entity that can be fully animated, which is required for character animation and special effects (Petty, 2021).

Among all the 3D modelling software, blender was chosen as the platform to design the 3D model for this project since it was found that blender is a software that is free but can perform the task with quality exceeding the performance of the software

which are highly priced (Tate, 2019).

3.3 Unity and Vuforia

Some of the game engines that supports Augmented reality are Unreal Engine developed by epic games, CryEngine developed by CryTek and Unity developed by Unity Technologies. Unity was preferred for this project since Unity has a user-friendly interface, Unity game can be developed in most platforms such as Windows, Mac OS, and Linux and it can be developed into 23 platforms which includes android and iOS (Render, n.d.).

Developers may use an augmented reality software development kit, or AR SDK, to create digital objects that tend to merge with the real world. Any company that produces augmented reality environments requires an AR SDK. Some of the AR SDKs are Google ARCore, AR Foundation, ARKit, Wikitude and Vuforia. Vuforia AR was chosen after testing the other SDKs for compatibility in the used devices out of which the other SDKs were resulting in Gradle error.

4. DESIGNING THE 3D MASCOT

4.1 2D reference image

Krita was used to design a 2D reference image with minimal features for the mascot that was to be designed in 3D using Blender at the later stage. The designed reference image, Fig.1, was then exported in *.png format.

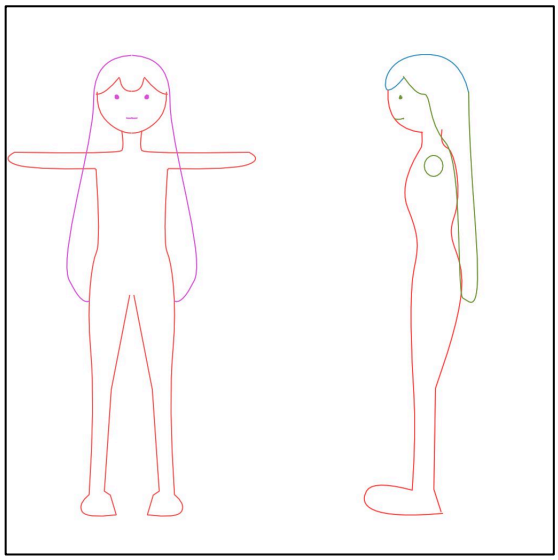

Fig.2 2D reference image with Krita

4.2 3D modelling and animation

Using the 2D reference image designed with Krita, a 3D model was designed in Blender 3D software. A skeleton was designed for the model and the 3D model was rigged accordingly. A 10 second animation was designed for the model and made possible to loop continuously. The designed model along with the animation as seen in Fig.4 was exported in *.fbx format due to its interoperability with different software.

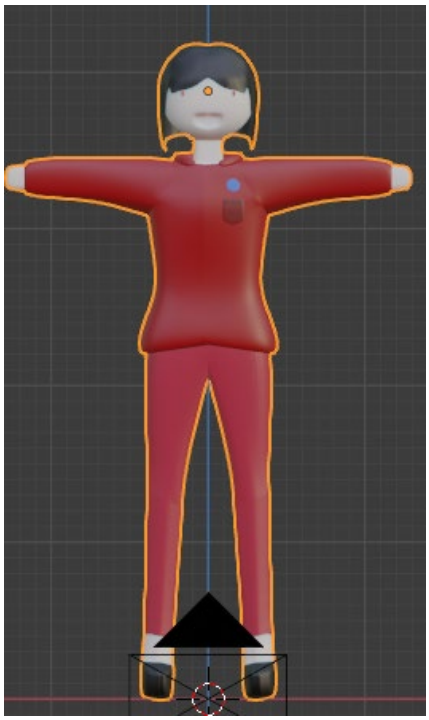

Fig.3 Final 3D model designed in Blender

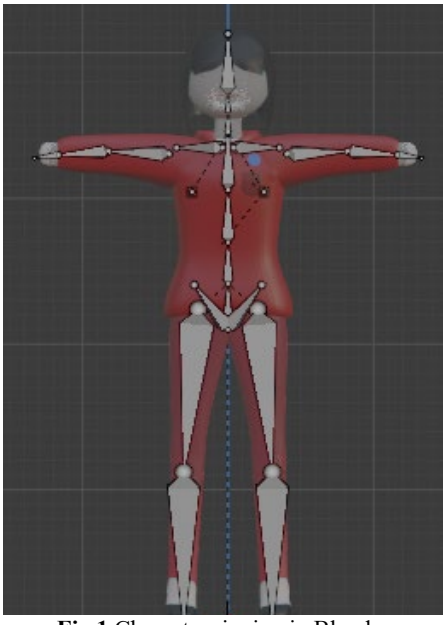

Fig.1 Character rigging in Blender

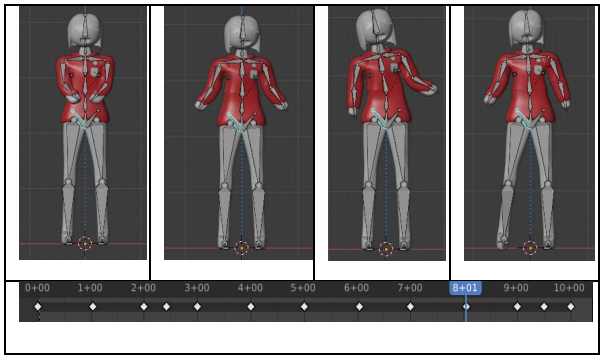

Fig.4 10 seconds loop animation design

5. DESIGNING THE FINAL APP

The designed model in Fig.2 and the animation as seen in Fig.4 was exported from Blender and then imported into Unity environment. The Unity environemnet was set up to support Augmented Reality by downloading Vuforia plug-in and other required packages. The app was designed for three test areas which are the CST laboratory, College library and the gate. Other minor areas such as the ATM junction and the library junction were also included. Voice recordings and text planes were also added into the environment. The app was deployed in those areas and tested for calibration. The screenshots taken of the working system built into android mobile phones is displayed in Fig.5, Fig.6, Fig.7, Fig.8 and Fig.9 for each planned location. The sensitivity of the app was also tested as seen in Table 1.

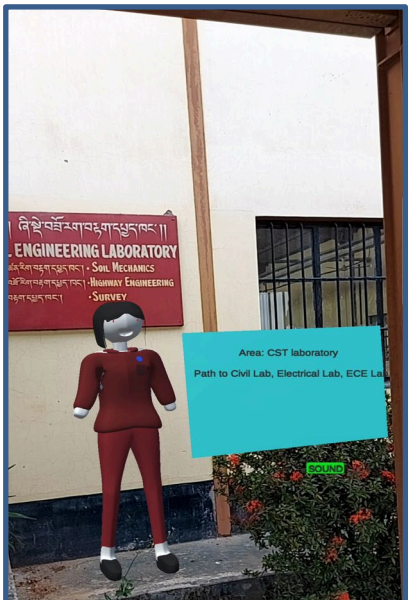

Fig.7 Deployment at Lab

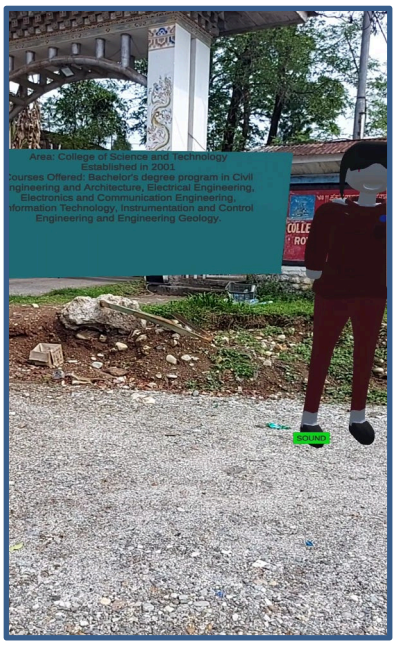

Fig.5 Deployment in gate

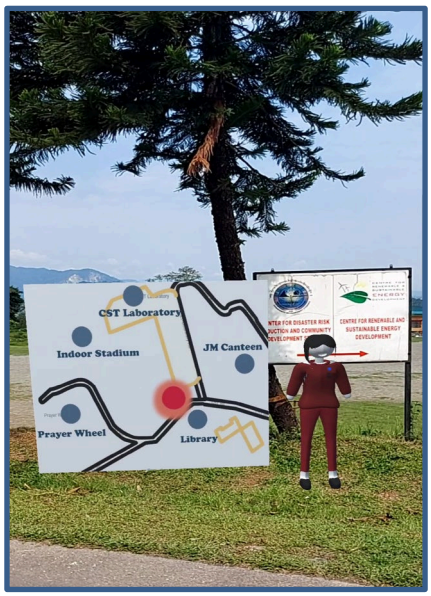

Fig.6 Deployment at library junction

Fig.8 Deployment at ATM junction

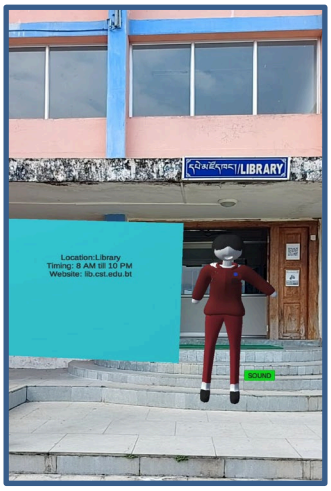

Fig.9 Deployment at library

Table 1: Sensitivity of the app

	CST gate	Library	Lab
a	12	9	6
b	8	5	3
c	90	90	90

In Table 1. 'a' refers to Maximum Distance (in metres), 'b' refers to Optimum Distance (in metres) and 'c' refers to Optimum Angle (in degrees). To test the sensitivity of the app, the tests were carried out for maximum distance the AR device could be placed at from the image target. The optimal distance and the optimal angle were also determined. These tests were carried out 20 times for each location in different lightings. A total of 100 tests were carried out to determine the parameters of interest.

6. FUTURE SCOPE

Using the global positioning system could further enhance the system. However, it has not been integrated into the designed app since the GPS package costs 79 dollars (Unity, 2021).

The app has been designed only for android as of now to decrease the complexity and also the space used up by the system. In the future, by using a better development device, the app can be designed for support by iOS.

7. CONCLUSION

AR technology has proven to be one of the most promising and versatile technologies since it has the ability to merge the physical real world with the virtual animated objects. The College of Science and Technology was used as a pilot area and the virtual objects designed with Blender and Unity were inserted into the environment.

Under ideal conditions of bright lightings with the phone camera angle at 90 degrees to the image target, the application on the Android platform provides high precision with a delay of less than one second to detect an image target and ideal sensitivity of 100 percent at 8m, 5m, and 3m for gate, lab, and library, respectively.

This application can be used as commercial tourist guide application upon incorporation of individual location informations.

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