Design of Learning Media in Mixed Reality for Lao Education

Kalaphath Kounlaxay[1] and Soo Kyun Kim[2, *]

Abstract: To improve and develop education systems, the communication between instructors and learners in a class during the learning process is of utmost importance. Currently the presentations of 3D models using mixed reality (MR) technology can be used to avoid misinterpretations of oral and 2D model presentations. As an independent concept and MR applications, MR combines the excellent of each virtual reality (VR) and augmented reality (AR). This work aims to present the descriptions of MR systems, which include its devices, applications, and literature reviews and proposes computer vision tracking using the AR Toolkit Tracking Library. The focus of this work will be on creating 3D models and implementing in Unity 3D using the Vuforia SDK platform to develop VR and AR applications for architectural presentations.

Keywords: Mixed reality, virtual reality, augmented reality, Vuforia, head-mounted displays.

1 Introduction

Education is the core of human resource development that contributes to the country's socio-economic development. Modern, scientific, and interpersonal characteristics are needed in the enhancement of human resource development. Learners or students should gain a good balance between theoretical and practical knowledge and should be encouraged to learn in both the classroom and real-life situations. Communication between instructors and learners in the class during learning processes is very important for improving and developing education systems.

Traditional teaching techniques involve the presentation of distinctive disciplines in front of several students. People, such as teachers or scholars, that are proficient in these disciplines, transfer knowledge to the students. Since the quality of education depends on the teacher-student ratio, students diversely perceive information. Larger courses or training require an overview of the content material and an expansion of the teacher's basic workload when talking about support for individual students [Kember and Gow (1994)]. For students to find out about new skills, cognitive help furnished at appropriate times, the place visualizations are appeared in-situ to parallel going on lecture notes [Azuma (1997)]. This can have an overall negative effect on the students' understanding of novel topics.

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Instead, to display information on a screen, AR technology provides a new possibility to directly interact with interactive virtual content introduced in an actual environment. Although paper textbooks have many interesting pictures and stories, generally, students dislike them and consider them boring [Gibbs and Jenkins (2014)]. However, the case is not the same for MR. There are various MR devices whose application gives a more immersive experience where children learn through a gaming process. The learning process is much more interesting, and the information is better perceived.

2 Literature review

This work aims to present the descriptions of MR systems, which include its devices and applications. Therefore, this section will present the basic knowledge required for this research, which includes the basic concept, basic principles and methods related to application development.

2.1 *Mixed reality*

MR is an art and technology of merging actual and virtual worlds. It can create new scenes and visualizations so that physical and virtual objects can coexist and interact in real-time. Depend on mentioned in the reality-virtuality continuum (shown as Fig. 1), that used as an independent concept or used to distinguish the spectrum of reality technology [Milgram, Takemura, Utsumi et al. (1994)]. MR not only overlays but also attaches virtual objects to actual-world objects and permits the user to interact with combined them. As an independent concept, MR has combined the merits of both VR and AR. When used to distinguish a wider range of reality technologies, it represents a range of all viable forms and elements of actual and virtual objects. MR may additionally be a solitary notion or used to refer to the whole spectrum of conditions between AR and VR while trying to mix the high-quality of each VR and AR. When each actual and virtual world are combined, new environments and visualizations emerge as feasible the place physically and virtual objects can cohabit and interact in real-time.
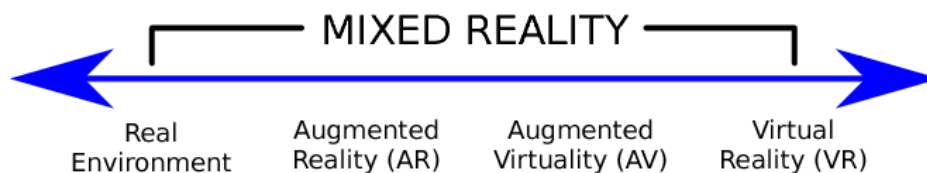

Figure 1: Mixed reality continuum [Milgram, Takemura, Utsumi et al. (1994)]

Fig. 1. Shows the MR spectrum covers all feasible types and elements of actual and virtual objects. Inside the spectrum starting from the far left is a natural world without computer generation. At the far right of the spectrum is a computer-created virtual environment. Below, we demonstrate the other types of reality technologies that this spectrum was created:

-The real environment is known as the "natural environment" meaning the natural world that we live in every day, which consists of everything such as living and non-living things on earth. Therefore, the most of virtual scenes are modeled based on actual environments, or virtual representations of real environment objects (such as people, natural landscapes)

are re-created and can be more deeply integrated into virtual worlds (shown as Fig. 2).

Figure 2: Real environment in Paichai university campus

-AR is the interaction of graphics, overlay, sound, and other senses in real-time, displayed the real-world environment in which real-world objects "augmented" through the perceive information by computer audiovisual and olfaction [Schueffel (2017)]. In the spectrum of reality technology, AR is closer to the actual environment than the virtual environment. Thus, AR users are still in the actual world (such as the natural environment) while experiencing real-time visualizations, haptics, and emotions. AR does this by placing virtual data and/or graphics on top of a user's perspective in a real scene.

-Augmented virtuality (AV) refers to an environment where actual objects are penetrated a virtual scene created on the computer. The real environment is pleasantly described as the inverse of AR layered across the virtual environment. An example of AV is a kitchen remodeling scenario. By utilizing AV technology, a homeowner can digitally present modern kitchens to visualize and interact with virtual home equipment and easily manipulate various layouts. (shown as Fig. 3).

Figure 3: Application of AV [Billinghurst (2012)]

-VR seeks to grant customers with the biggest stage of immersion probable complete immersion. This deepened immersion is great from different reality technologies. Immersing experience in VR requires all the sensory stimulation of the user in the perfect experience as long as the brain accepts the virtual environment as the actual environment. In a VR environment, users living in a synthetic world may also or might also no longer imitate the features of a real environment.

2.2 Virtuality continuum

The virtuality continuum is the constant scale that possible combinations of reality, virtual, virtuality, and the actual. AR and VR are schemas of the virtuality continuum. In AR, the interactive objects are layered on top of the physical environment without the ability to manipulate the augmented objects. AR overlays digital information into the real world. In VR, the real world is hidden and the user is completely immersed in a virtual experience, creating a digital simulation of an actual environment. Reality is defined as something that considered to be the real or actual thing as opposed to that the obvious or exists thing, independent of thought [Piekarski (1999)]. Recently, in Ong [Ong (2004)], VR has been described as a synthetic environment experienced through sensory stimulation, that is created by computers and any part of the decision about what is going on in the environment. Krevelen [Krevelen (1994)] defines VR is a computer-generated scene that can interact like an actual environment (Fig. 4).

Figure 4: Adapted schema of a virtuality continuum [Milgram, Takemura, Utsumi et al. (1994)]

2.3 Immersive experience in VR

The VR design focuses on communicating the functionality of the virtual world, control of that world with objects and the connection between the users and the content that allows them to become a part of this virtual world or be immersed within its environment, as well as manipulate objects or operate a series of actions. Therefore, VR is a 3D computer simulation environment that uses devices to allow users to experience their existence in the environment. It causes feelings that can be perceived but do not exist in a virtual simulation scene. In a VR scene, users can experience real-world experiences in a parallel and interaction with 3D objects through the transition to an avatar, the digital avatars that work through a synthetic brain system. In addition to visual immersion, the perfect VR environment is notable for sound, touch, smell, and unique perception. The essential functions of VR are defined by three things: immersion, interaction, and imagination [Burdea and Coiffet (2003)]. Another feature of VR is that it can enable immersion in a synthetic environment instead of viewing the environment from an outside perspective. The immersive experience that takes place through VR depends on the potential of 3D images, head movement tracking, hand movement tracking, and stereo sound [Earnshaw (2014)].

VR technology is mainly used to improve product development in the entertainment industry, such as games and movies. VR can also generate sensory experiences that consist of virtual flavors, image, smell, sound and touch. VR uses virtual reality environments built with computer software, while VR technology built with computer hardware provides the experience of having moved to another 'world', a virtual world. At the end of the set, these

immersive devices have been developed with tracking tools and navigation devices that allow through simulation space, and head-mounted displays (HMDs) that enable the virtual world to be seen through the eyes of a person [Joshua, Ian and Salmon (2017)]. The HMD design is extremely important to the immersive nature of early VR. In addition to bringing the visuals closer, HMD also excluded the visuals of the actual world, creating insulated areas that the simulated world can play without being a reality. While the VR era has been used in the last decade by most game developers, educators and moviemakers no longer use HMDs, but it is an alternative to flat-screen that is prevalent in front of users.

2.4 VR devices

In recent years, there have been sizable advances in customer VR devices such as the Oculus Rift, HTC Vive, Leap Motion controller, and HoloLens, conducting immersive VR experiences into consumers' homes on demand. Cost and space are lower than previous VR devices. These new devices also reduce the limitations of VR engineering applications [Jerald (2016)]. This work focuses on reviewing the categories and components of VR as follows:

-Oculus Rift: Oculus Rift, released on March 28, 2016, it is a type of VR headset developed and manufactured by Oculus VR, a division of Facebook Inc. The company's first product is the Oculus Rift VR headset. VR is known as the technology that creates a virtual environment by using computer simulation and allows a 3D pseudo-experience within that environment [Karthika (2017)]. VR uses VR environments built with computer software and VR technology built with computer hardware to make it feel like one has moved to another 'world', a virtual world. The environments are run on computer software, and the Oculus headset is connected to the computer via a USB port and an HDMI cable, after which the user experiences a 3D world (shown as Fig. 5).
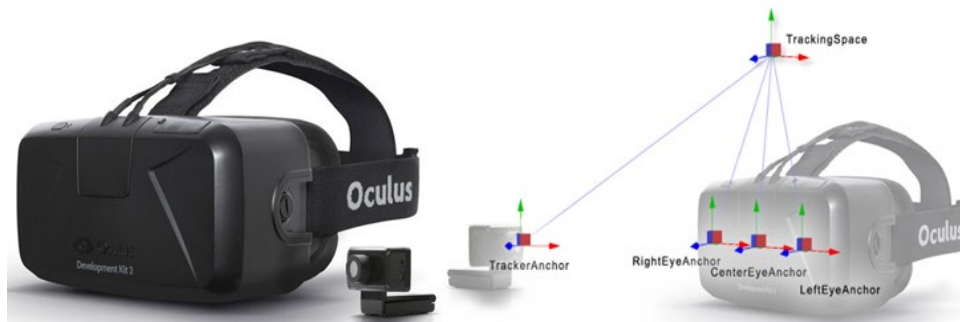

Figure 5: Oculus rift headset [https://www.lancerspiritonline.com/7668/a-e/commentary-the-nebulous-possibilities-of-virtual-reality/#photo]

Oculus Rift teardown consists of 3 elements. The fist is vision correction which can attach additional lenses to the HMD to correct the differences in vision between each eye. The second is a high-resolution display screen that is only a few inches away from the user and creates a dimensional image or two warped images or distorted on each half of the screen to ensure perfect 3D effects. The third is a circuit board/Motherboard, which the headset uses to translate data to the computer from the sensors.

-HoloLens: Known beneath improvement as Project Baraboo, it is a pair of MR smart glasses innovated and produced by Microsoft. As one of the first computer systems to run the Windows Holographic platform under Windows 10, HoloLens has earned a reputation [Kim (2015)]. HoloLens is designed as an HMD unit, which is connected to an adaptable internal headband that tilts it up and down and forward and backward. To put on the device, users wear it on their heads by using the adaptable wheel on the back of the headband to keep it around the coronet, while supporting and dispersing the weight of the device for convenience, and then facing the visor forward sloping eyes [Karthika (2017)]. There are many sensors and correlated device on the front, including cameras and processors. The visor is tinted; it contains a pair of combined transparent lenses through which the projected images are displayed in the bottom half. HoloLens should be calibrated based on inter-pupillary distance (IPD) or visual vision. A pair of small red 3D audio speakers are located on the bottom edges of the side, close to the user's ears. Competing with common sound systems, the speakers do not interfere with external sounds, enable users to hear the sounds as well as ambient sounds. Using the preferred transfer function, HoloLens produces audio that can simulate spatial effects; this means that the user can become aware of and detect sound as if it got here from a virtual point. At the pinnacle edge, there are two pairs of buttons: the screen brightness and volume button above the left and right ear. The adjacent buttons have different shapes for concave and convex. On the left forearm is the power button and five small aligned LED, where each one indicates system status and power management by specifying the battery power and power setting. USB 2.0 micro-B socket is placed on the bottom edge. A 3.5 mm audio jack is placed along the bottom edge of the right arm [Thomas (2016)] (shown as Fig. 6).
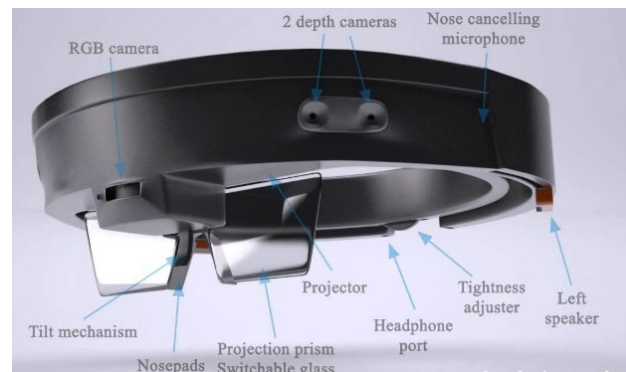

Figure 6: HoloLens set and components [Const Flash (2015)]

HoloLens ca run on almost all Universal Windows Platforms and can utilize to develop 2D and 3D applications. HoloLens does not currently support all Windows 10 APIs, but in most cases, the similar applications will work on all Windows 10 devices. The same tools utilize to develop personal computer Windows or mobile phone Windows applications can be utilized to develop a HoloLens application. The 3D application or "holographic" application takes advantage of the Windows Holographic APIs. Microsoft suggests that the Unity Engine and Vuforia can generate a 3D application for HoloLens. However, developers can also build engines using DirectX and Windows APIs. According to

Microsoft HoloLens, Gaze Input has developed the Microsoft HoloLens utilities for personal computer Windows 10 running on the operating system of mobile devices in April 2016 that allows developers to launch applications using their mobile phone or personal computer keyboard for typing, viewing a live stream from the HoloLens: The uses demonstrated in the Microsoft HoloLens is shown in Fig. 7: (a) Remote Instruction, (b) 3D computer-Aided Design, (c) Gaming, (d) Decorating, (e) Holographic Attractions and Entertainment, (f) Heads Up GPS.
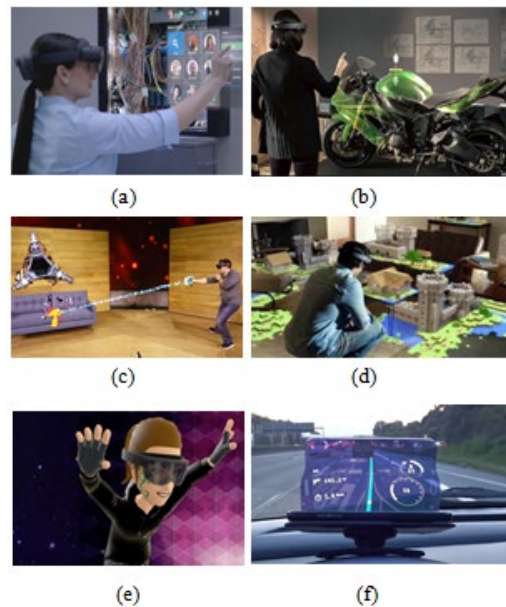

Figure 7: Microsoft HoloLens

2.5 Immersive experience of MR for education

The immersive experience of MR in education, under the National Educational Technology Plan [Dingler, Agroudy, Le et al. (2016)] that enables personalized learning permits each learner to learn at the right speed with an educational approach that is tailored to their individual needs. Learning experience by MR, this concept can be modified and further developed. Interactive learning media currently follows this concept and adapt learning materials to be appropriate and meaningful. While using difficult material or proceeding advanced experiments, learners can be adjusted to instant feedback via AR overlays, at the time of learning or running experiments assisted by MR technology, the system can record video environments experiment, and virtual overlay.

Human reminiscence and recall lookup recommend spreading out the studying procedure and information presentation when making efforts to improve one's learning ability [Beheshti, Kim, Ecanow et al. (2017)]. Recent findings of a lab find out about the usage of MR glasses point out that complicated experiments should gain from augmentation. It enhances learning material further, leads motivation to foster a higher perception of complicated relationships. The application of these new technologies in practical lab courses

has great potentials. We recommend developing MR applications for students to review and understand. A special detector can gauge environmental data or test status. Voltage and current can be displayed directly on all cables through electrical engineering classes [Martin, Michael, Sebastian et al. (2018)] or during heat propagation in metals within physic classes [Billinghurst (2002)]. The combination of MR displays sensors enables us to expand the area of human vision and visualize in-depth details where it occurred.

2.5.1 Immersive VR for education

VR is an immersive experience with simulated environments that permits us to change the enclosed environment while cutting off most of it from the actual world. MR, in the continuous spectrum from VR to AR, is still an active pursuit. With the popularity of smart devices in the public, access to instructional content has become ubiquitous. For instance, Billinghurst [Billinghurst (2012)] reviewed and validated the use of an inexpensive device to furnish immersive VR experiences at some point in unique studying scenarios. However, the information provided is still static and does not often offer to interact with users, which makes it very similar to a regular textbook. Although the prospect of pervasive computing remains an active research challenge [Santos (2014)], current trendy teaching methods do not integrate educational information with their scene. With the availability of improved hardware and software solutions, various researchers have explored MR applications outside the laboratory. For example, recent research has shown that using VR glasses to visualize the current experiments in physics classes can promote a better realization of textbooks. However, a comprehensive review of 87 MR learning applications, including a meticulous analysis of seven applications, shows that MR applications have multiple effects on student's motivation [Frein and Ott (2015)]. The impact of the deployment of MR applications in educational environments should be critically discussed because the design of such applications for education opens up new wide areas for design. Previous work has shown that MR applications are becoming more popular due to cheaper devices and low prototyping costs. However, the effects of MR technology should be examined with caution as long-term effects are unknown.

2.5.2 Advantages of VR for education

VR has numerous advantages over other forms of education. In comparison to textbooks, videos, and computer programs and video games, VR is more immersive, interactive and lifelike, respectively. It can be used as a one-to-many medium for lectures and practicum alike, and each experience is repeatable without using new resources, allowing every student to learn and grow. It places educational concepts in context and works in tandem with the imagination to expand possibilities for students from pre-school to Ph.D. Not only is VR more engaging, but it also improves long-term retention of information and simulated skills. Given the latest commercial applications of VR, it is not surprising that research on its use in classes has been limited [Potkonjak, Michael, Victor et al. (2016)]. There is literature about using VR in higher education, particularly in science and engineering, some of these applications may affect the use of VR in schools. For instance, Makransky et al. [Makransky, Lilleholt and Aaby (2017)] reviewed the advantages of virtual laboratories in science and engineering, then focused on the prospective value of

high-quality virtual laboratories and how multiple students access virtual devices that are different from physical devices that resistant to damage. It also suggests that virtual labs can reveal the 'unseen' things because the device cover can be easily removed or can be transparentized to visualize the functioning of internal structures. However, there are concerns that the development of virtual labs is often taking time-consuming. Moreover, students may not value simulator proficiency as much as real peoples, and in the final or advanced stages of learning, there is nothing to replace experience with actual equipment. The results of a recent scientific experiment were that college students compared learning with desktop VR and the results show that even if students feel about the experience of VR, they experience overload awareness problems that reduce test efficiency [Ke and Carafano (2016)]. Interestingly, the problems of cognitive load and extremely realistic simulator were explored in experiments at the age of 14 and 15 years, some of whom had desktop computers and had experience with space flight simulators in classes (lower immersion), while others can use the custom truck for large-scale realistic space flight simulations (higher immersion) [Fotaris, Pellas, Kazanidis et al. (2017)]. The study found that the degree of immersion does not impact learning issues, but a higher sensory immersion may hinder the processing of concepts. Although its number is very small, the method of using desktop VR in STEM school (Science, Technology, Engineering; and Mathematics) has rigorously studied the situation. The STEM's classrooms have proven that technology can help increase the abilities to ask questions in students [Minocha, Tudor and Tillings (2017)]. Most of the literature on school immersive VR is mostly described in nature. For instance, [Olmos-Raya, Ferreira-Cavalcanti, Manuel et al. (2018)] survey showed that using Google Expeditions in the classroom has a small experimental study for education. For example, when some conditions such as mood induction and immersion levels change during short-term storage measurements [Bower and Sturman (2015)]. The issue was found in an international learner survey of the learning possibilities of portable technologies such as HMDs. These things include privacy; the potential to shift learner values; equipment costs; fear that the novelty of using new 'gadget' will replace the need for teaching and learning design; and a lack of appropriate educational software [Southgate, Shamus, Chris et al. (2018)]. Observational data on the use of VR in school research indicates that some students are so indicated to virtual effects that they avoid monitoring the system designed to protect users from warnings when they leave determined safety area. It also revealed that continuous monitoring by the researchers or other students is necessary for safety. Moreover, the measure of helping students put on/off VR devices has resulted in the development of a child protection protocol that is proper for touch-sensitive students. The data also exposed that girls were less likely to experiment with VR than boys, and a few girls initially wore HMD embarrassingly and were seen by them: it was not obvious in boys. The study also found that by integrating a game into the curriculum, students needed more time to become familiar with the benefits of VR experiences and technical learning [Chang, Wu and Hsu (2013)].

2.5.3 Immersive AR for education
In January 2019, The InkSmith Team presented that as the society moved towards a more tech-focused learning environment, based around STEM competencies, introducing our students to new technology will only help to foster their growth and creativity in the digital

age. If you are someone who has never used VR for teaching or do not understand its application in education, keep reading the article below. We have established 10 ways by which using VR in the classroom will benefit students and their learning experience: Students gain firsthand experience, an experience they will remember, bring the field trip to the classroom, time travel to historical places, low barriers to learning, go where it is not humanly possible, explore the inside of the human body, learn about animals up close, minimize learning distractions, and promote engagement and curiosity.

Educational researchers are becoming more aware of the teaching method prepared by AR. The coexistence of virtual and actual environments permits students to visualize complicated spatial relationships and abstract concepts [Thomas, Nigel and Delieu (2010); Kim (2017)], experience phenomena that are impossible in the actual world, interact with 2D and 3D objects in MR and development is an important practice that cannot be developed and implemented in learning environments that are improved with other technology [Johnson, Levine, Smith et al. (2010)]. These educational advantages have made AR one of the key technologies for education in the future [Brooks (1996)].

2.5.4 Advantages of AR for education

AR technology, the place interactive 3D content material is developed and combined with traditional printed substances to enhance the visualization and perception of technical material carried by the virtual objects, to helps a user accomplish actual tasks. AR is a concrete example of what Fred Brooks indicated Intelligence Amplification (IA); use the computer as a device to facilitate the performance of a task by human beings [Billinghurst (1996)]. AR is a new technology that educational researchers have just published a formal analysis of media-specific interests, one of which proposed by the University of Cologne, which systematically reviews the latest use of AR in education. Otherwise, these experts specify some of the specific duties of the educational experience of AR as below:

-Discovery learning: The user points a device towards an object or a parameter for which they want more information.

-Object modeling: Students can manage or create 3D models, and in some cases, they can test the model's behavior in some situations.

-AR books: AR books use distinctive viewing gadgets to add content, interactive content and 3D media to decorate the text and print media.

-Practice Skills: AR is already available in many industries and healthcare that require practical skills.

-Gamification: By using the power of video game technology, students can accumulate knowledge through the rewards and inspiring game theory.

2.5.5 Benefits of using AR in the classroom

AR can be used for many resolutions, such as supported students can easily access, process, and bear in mind. Besides, AR conducts education more fun and stimulating, not limited to a single age group or education levels and can be used well for an entire education, such as from kindergarten to school and even at work. The benefits of AR for education are that, AR can aid education in several ways such as teaching spatial concepts, visualizing

knowledge objects, improving literacy and numeracy, and increase understanding of the real environment. AR allows students to view and interact with spatial content in a seamless manner, which emphasizes educational content rather than learning the computer interface. AR advantages are many and include:

-Learning media accessible: AR is an affordable learning medium that can replace textbooks, physical models, posters, and printing. As a result, education becomes more accessible.

-No special equipment required: Unlike VR, AR does not require any expensive hardware. Nowadays, all of the teenagers have a smartphone that can support the AR application.

-Higher student participation and interest: Interactive learning in AR will have a very optimistic impact on students, which helps them participate through the course and give easy and entertaining.

-Enhanced collaboration: AR applications provide a wealth of many chances to spread and shudder uninteresting classes. Interactive lessons in which all students participate in the class at the same time can improve collaboration skills.

-Faster and more efficient learning process: AR can support students to obtain better outcomes through visualization and fulfillment. As the saying goes, a picture is worth a thousand words. Therefore, students can learn the theory of certain things without hands but can be view.

-Practical learning: Apart from schooling, vocational training also benefits appreciably from using AR. Instance, precise duplication of arena circumstances can help to understand the realistic capabilities required for a particular job.

-Safe and efficient workplace training: Visualize being able to perform heart surgery or use a shuttle if something goes wrong without risking others or damage without a budget. AR can be achieved.

-Applicable to all levels of schooling: Whether it is a learning game for kindergarten or AR practice, it is not inadequate to a single use case or application.

2.5.6 Challenge of AR in education

Perhaps the most popular applications of AR in education are using AR applications in the class directly because It can help teachers explicate topics, provide visual representations of materials, and help students assess knowledge. Furthermore, AR applications can be found in almost every subject, such as chemistry, mathematics, physics, animal husbandry, linguistic and even programming. Despite the benefits listed, there are still some pitfalls to consider when AR create and EdTech solutions with:

-Lack of necessary training: It may be difficult to use these new technologies, as some teachers do not provide the required skills. Only the most open-minded teachers and innovative educational institutions are ready to apply AR applications for education.

-Hardware Dependence: Using AR in the classroom requires a certain resource base, as some students may not have smartphones that support AR applications.

-Content portability issues: The AR applications that build are required to run properly on all platforms and devices. However, it is not possible to provide identical quality AR content material on any device.

3 Methods

The purpose of this paper is to propose a method of computer vision tracking using the AR Toolkit tracking library. We also briefly explain the SketchUp for 3D modeling and how to export 3D models into Unity 3D as New Asset. The main concept of this paper focuses on how to create 3D models and implement them in Unity 3D by using Vuforia SDK software as a platform to develop VR and AR applications for architecture presentation. We have especially designed this system for the Lao traditional housing style in the 3D model presentation. This is a new method for communication between instructors and learners in the classroom during the learning process.

3.1 Method of computer vision tracking

The ARToolKit Library, which was developed in 1999, is a software library for building AR applications containing virtual images in the real world. This method of computer vision tracking, AR is run in the application and scans the target images. A video is streamed from a camera by following a template image in an image sequence. By estimating the warped image and searching for markers, the image is converted to a binary image. Identify the black marker frame and calculate the 3D position and orientation of the markers relative to the camera. The positions and orientations of the markers give the template T_i which we want to track; take all pixels i from the template and warp them by using function $T_i=\{P_i, R_i\}$. The symbol inside the marker matches the templates in memory. By using a T_i transform 3D virtual objects to align it with a marker, identify the IDs of the marker, position, and orientation object. A virtual object or a rendered 3D object is rendered to the user HMD in a video frame (shown as Fig. 8).
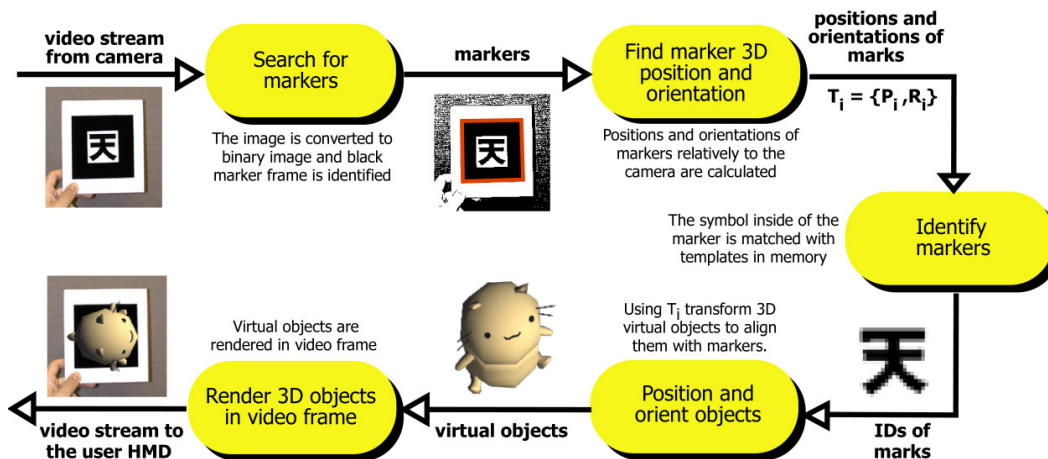

Figure 8: AR ToolKit tracking library [http: artoolkit.sourceforge.net (2013)]

3.2 SketchUp

SketchUp is a type of 3D model design software for drawing various graphics such as architecture, interior design, landscape design, civil and mechanical engineering. It is uncomplicated access level programs that can be used for prototype game design & modeling through its 3D visualization and physics-based simulation tools. SketchUp can help designers or developers create realistic, virtual scenes, levels and props. A game designer can get presentations and concepts quickly, easily and reasonably. SketchUp includes a layout drawing features, which is very useful for storyboards. With SketchUp, game developers can quickly develop games by inserting realistic details. They can competently manage each shot using 3D drawings [Menard (2012)]. SketchUp includes advantages in modeling, which facilitates the application & development of free and open-source 3D models, as well as assets and surfaces. Wholly 3D models created using SketchUp can be imported into third-party game engines such as Meshlab, GIMP and Unity 3D.

3.3 Unity 3D

The solution of VR game development seems to be Unity Technologies' Unity 3D because the development platform is flexible and powerful for creating a multiplatform of 2D and 3D games and interactive experiences. It is a complete ecology system for developers whose goal is to provide business opportunities to create high-end content and connect with the most loyal and enthusiastic players and customers. Unity 3D is the best for VR game developers. It also is a unique development tool, which comes in a variety of versions and natively supports multiple platforms [Amin and Govilkar (2015)]. The best-known feature of Unity is its rapid development and deployment capabilities. Some applications are developed or built once and their porting process on different platforms is very simple thanks to Mono.

3.4 Importing SketchUp model into unity 3D

SketchUp is one of the commonly used software for architectural modeling. Using the SketchUp 3D model for visualization in Unity 3D, the users will need to convert to a supported medium format using Unity 3D and import the converted layout into Unity 3D to solve this problem. Unity 3D now supports the import of SketchUp files directly without the need for conversion and allowing users to access certain features of SketchUp files within Unity 3D, which was not previously possible. Importing a SketchUp file into Unity 3D is comparable to importing 3D models supported by Unity 3D. Three ways that can be used to import a SketchUp file:

-Import from New Asset from the menu bar in Unity 3D.

-Drag and drop the file into the project windows in Unity 3D.

-Import New Asset via the project window's context menu in Unity 3D.

In this project, we have used these steps, to prepare an asset and designed Lao House Style models in SketchUp then imported them into Unity 3D for implementation (shown as Fig. 9).
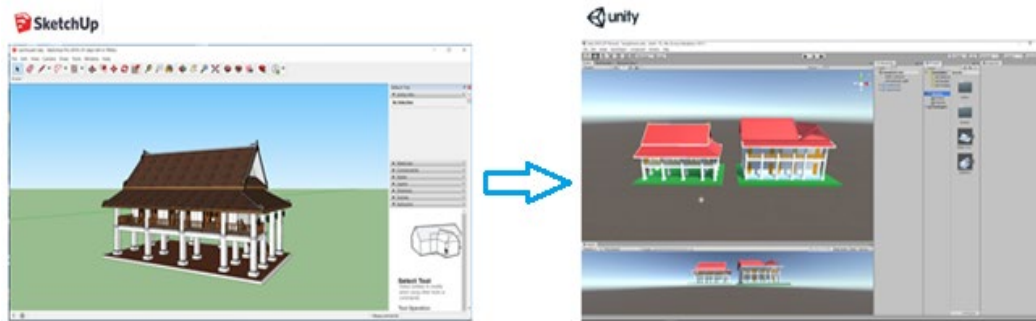
Figure 9: Imported 3D models from SketchUp into unity 3D

3.5 Vuforia engine

Vuforia Engine is the most popular SDK and platform for developing AR applications on a wide selection of devices. The content of the image-based target needs to have specific features to make for a good target. Developers can add advanced computer vision capabilities to any application, enabling them to recognize and interact with actual spaces. Vuforia was founded and developed by Qualcomm then bought by PTC in late 2015 [Amin and Govilkar (2015)]. Although it is such a widespread tool, there is not much documentation on the performance of Vuforia on the Unity platform and its operation on different devices such as Android or iOS. Thus, for the growth of AR support and use of mobile AR applications, it is important to evaluate the performance of tools such as Vuforia, to better understand how the software affects factors such as resource consumption and frame rate, which have a significant impact for user's experience [Dobrian, Awan, Joseph et al. (2011)].

The image target represents as picture which Vuforia Engine can detect and track it. Unlike regular fiducial markers, there is no necessity to recognize special black and white areas or codes for data matrix codes and QR codes and image targets. The engine compares these natural features with a database of recognizing the features of these images to detect and track the natural features found in the image. Once an image target is detected, the Vuforia Engine will track the images as long as it is at least part of the camera's perspective. We can use Vuforia Target Manager to create image targets using RGB or grayscale file types as JPG or PNG image. The image size should be 2 MB or smaller. The features extracted from images are stored in the Vuforia database which can then be downloaded and wrapped by the Vuforia image database for use with various applications. The database can then be used for runtime comparisons by using Vuforia Engine (shown as Fig. 10).
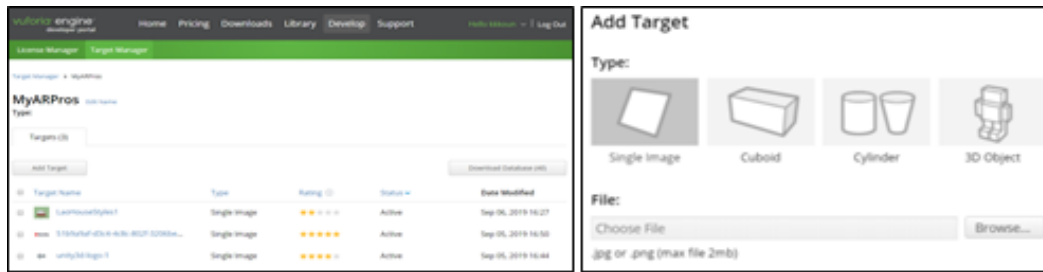
Figure 10: Configure the Vuforia image database

3.6 System overview

In this paper, we have proposed a method that uses VR and AR technology for architectural presentation. This system used the ARToolKit Library as the method of computer vision tracking. The AR code or markers are used to determine the location or position of an object. The position of the AR code is observed using the eye or video camera, a webcam, a mobile phone camera or other sensors. Data is sent to the AR engine, in which the video stream from the camera follows a template image in an image sequence by estimating warp and then searches for markers. The existing target image will be converted to a binary format and specify the black marker frame, and then the 3D position and direction of the identified markers will be calculated relative to the camera. The AR engine is a data transmitter that can be read through software or processing. The results that the AR engine sends in the form of images or videos (shown as Fig. 11).
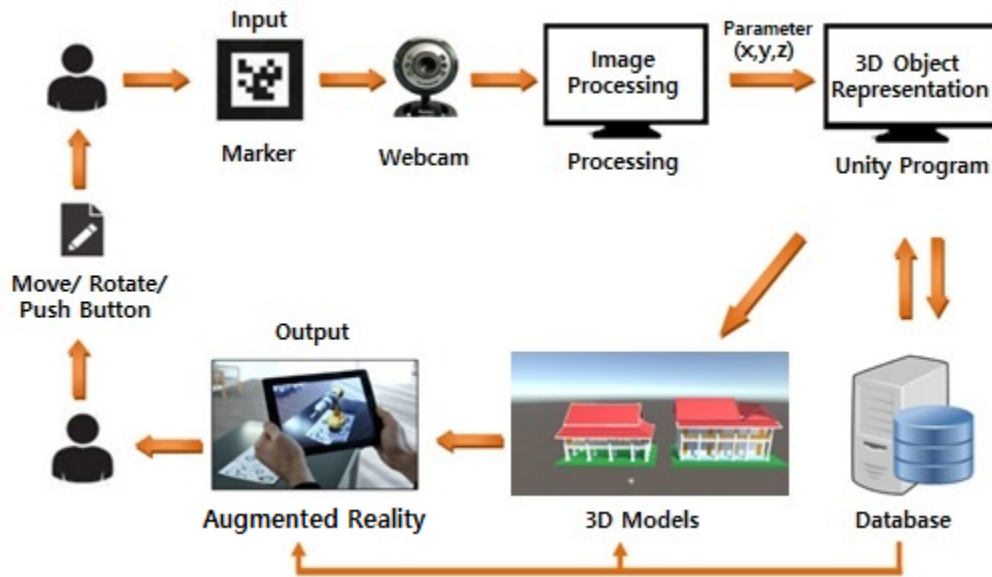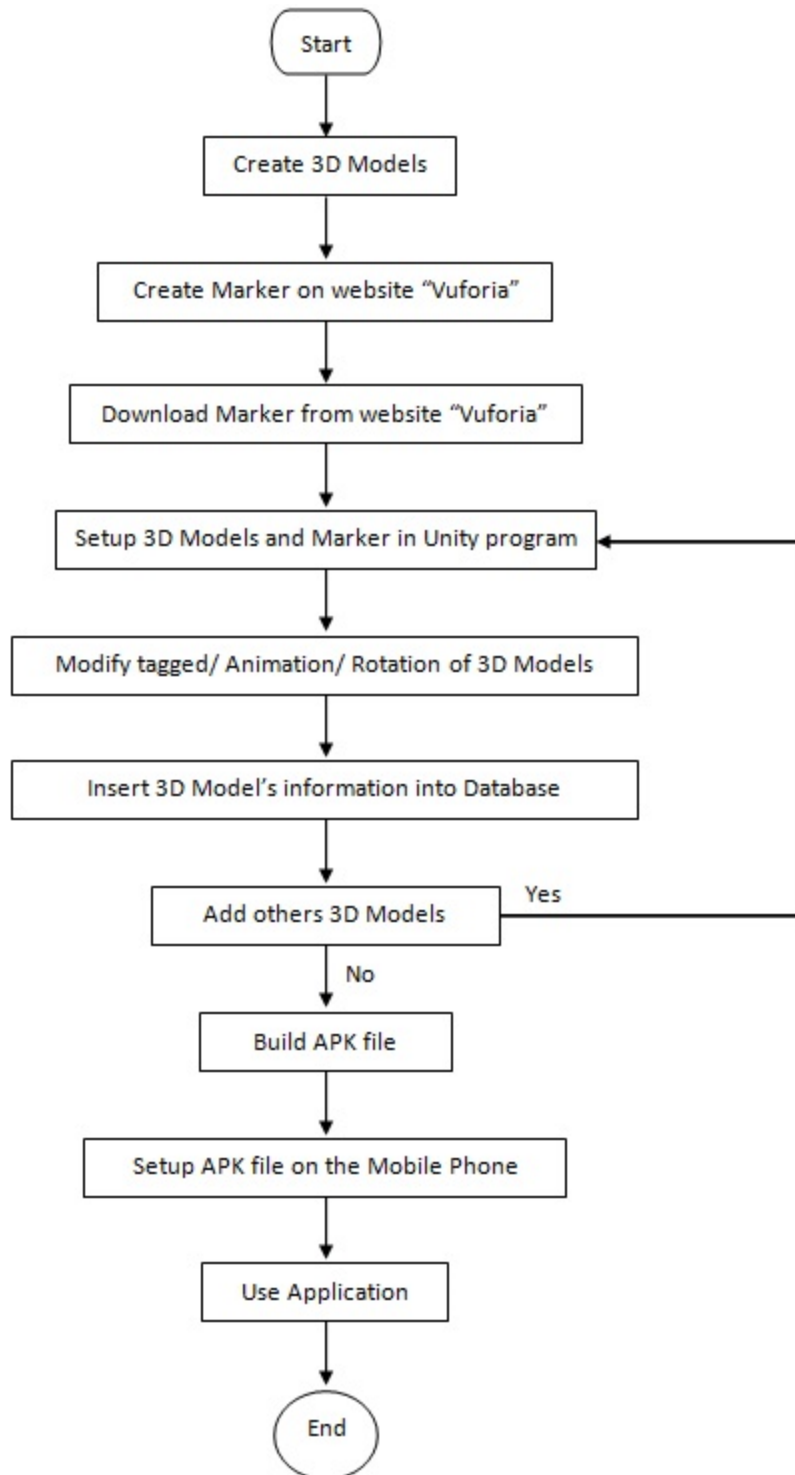

Figure 11: System overviews

Figure 12: System state chart diagram

Fig. 11. Shows the system overview flowchart that we can draw a state chart diagram to show the working steps of this system's scenario. The system starts by creating 3D models in the SketchUp 3D model design then importing them into the Unity program. The target Marker was designed on the website "Vuforia", downloaded and then setup with the 3D models in the Unity program. Features such as modify tagged values, animation, and rotation of the 3D model's information will be inserted into the case database. If we need to add other 3D models, we have to go back to the 3D model set up and marker in the Unity program, and if not, we can build an APK file and its setup on mobile phones and use the application (shown as Fig. 12).

4 Experiments

In this experiment, we proposed using SketchUp to create a Lao House Style 3D Model then imported it as New Asset into Unity 3D. The language used on the Unity program is C# script. We then used image target or marker by downloading it from Vuforia and set it up using lean touch to move, scale, rotate, etc., in this section, these scenes, are shown in Fig. 13 where (a) Shown the imported 3D model New Asset into Unity 3D and have added the target image from Vuforia, for AR tracking. (b) Shows the 3D model when the target image was matched. (c) Shows the build APK file for AR apps to setup and used in a mobile phone. (d) Created target multi images for AR tracking. (e) Created and build APK file for VR application in architectural interior view. (f) Tested and used VR application.
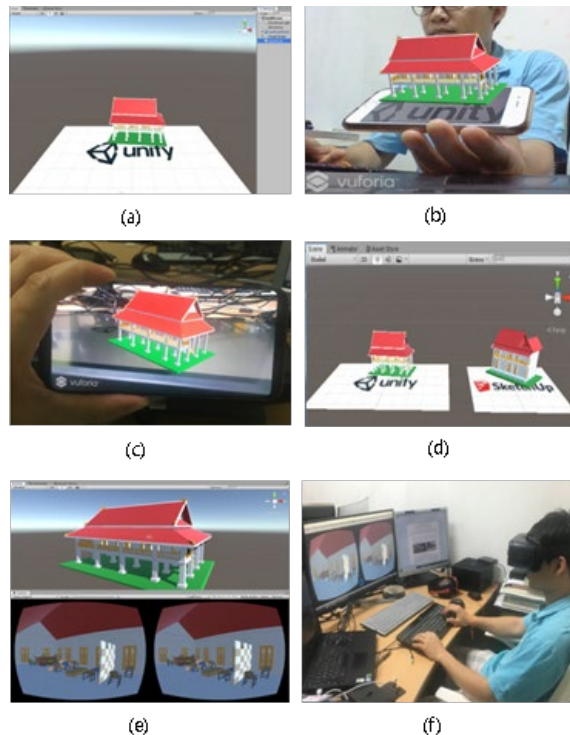

Figure 13: Results

5 Conclusion

The purpose of using MR which combines the best of both VR and AR technologies in education is to achieve a better way for learning rather than using traditional means of teaching and learning processes. In Laos, especially, we have used traditional teaching and learning methods in the education system. Traditional education methods have changed from paper learning to interactive and computer aids methods. However, the creation of educational content applicable in the context of VR or AR can be challenging for an educator. It is necessary to get acquainted with the functionalities of the tool that will be used for authoring the educational content, as well as those that will be used to create or edit various multimedia elements. To develop pedagogically sound VR or AR content, it is recommended to follow the design process models and guidelines of either one of them. MR enables us to develop engaging learning media and can explain complex situations even after careful consideration. We anticipate that MR environments will be available for a broader audience shortly. In this study, we presented the descriptions of categories of MR systems such as devices and their applications. We additionally mentioned how MR systems carry out new challenges and opportunities in education. In particular, we described how MR technology affects human learning processes via VR and AR applications. Therefore, we expect to provide MR systems in the education systems in the future to support personal learning media and participate in a variety of use cases.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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