

Augmented Reality: A Survey In Educational Environment

Zarwina Yusoff and Mohd Shahrizal Sunar

Abstract— The progress in mobile application development had emphasized it to be embedded in technology especially in educational environment. In parallel, technology enhanced learning where the function was to engage the student focus, enhances the learning experiences and memorable. However, the current mobile learning systems are lacking of interactivity in term of learning content which causes student's lack of focus and memorable. So, this article is about a survey of mobile learning application through Augmented Reality (AR) which consists of the technology in Augmented Reality, and the concept of visualization of AR in education. In this article, the framework design and integration of mobile based learning system through AR for educational environment is identified and the concept of AR Books are applied to enhances student's experiences during learning process..

Index Terms— Mobile learning; augmented reality; visualization; framework integration,

1 INTRODUCTION

The concept of Mobile Learning started from E-learning and Distance learning revolution on 18th and 19th Century. The mobile revolution of the late 1990s changed the distance student from a citizen who chooses not to go to campus, but is moving at a distance from the campus [1]. The term mobile is similar with mobile phones where it is a device that has ubiquitous features which can be brought in any places and have a communication systems. Parallel with the development of computer technology, mobile phone goes one step further and it is remarked as a new organ in evolutionary of time line because it have directly integrates with the brain [2].

Mobile learning refers to the use of mobile or wireless devices for the purpose of learning while on the move. Typical examples of the devices used for mobile learning include cell phones, smart phones, palmtops, and handheld computers; tablet PCs, laptops, and personal media players can also fall within this scope [3]. Mobile based learning system through AR is an effective ways in enhancing the learning experience among students through visualization concept. The feature of AR is visualized learning content which can make students possess focus and interesting to learn during the learning process. AR allows the user to see the real world, with virtual object superimposed upon or composite with the real world [4]. Augmented reality is the interesting topic because the object will appear in real environment and user can see the virtual object and according to Azuma 1997, the three characteristics of AR are registered in 3D, interactive in real time and combines and real and

virtual object [4].

The emergence of AR on mobile platform started when Philippe Kahn invented the camera phone, a mobile phone which was able to capture still photographs [5]. Based on the progress in mobile phone version, there are many researchers trying to integrate the AR application on mobile environment when Mohring presented a system for tracking 3D markers on a mobile phone where this work showed a first video see-through augmented reality system on a consumer cell-phone. It supports the detection and differentiation of different 3D markers, and corrects integration of rendered 3D graphics into the live video stream [6].

AR is widely used in many applications such as architecture, maintaining and repairing, medical and surgery, entertainment and games and education and training. This paper made survey on AR in educational environment as an effective way to be embedded in mobile learning system. With Mobile learning system through AR, it can appeal to students at a more personnel level, and promoting both engagement and motivation among its user [7] [8]. Application of mobile augmented reality (MAR) in education is primarily focused on games, simulations, book application and not limited to portable mobile devices, but also in context of social interactivity among their groups [28]. This paper contains five section, section I is the introduction the concept of mobile learning, section II explains about the previous research of AR in education. Section III in this paper explained the concept of mobile based learning through AR. The proposed framework for design and integration are explained in section IV and finally, the conclusion about this paper is presented in section V.

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2 AUGMENTED REALITY IN EDUCATION

The usage of AR in education began since Billinghamurst created the Magic Book, where it made this fantasy a reality by using a normal book as the main interface object and user can read the text normally [9]. Figure 1 visually presented Magic Book.



Fig. 1. The usage of magic book to move between reality and virtual reality

In Magic Book, if they see the book through handheld displays, they can see the virtual object appear on the display the models can be of any size and are also animated, so the AR view is an enhanced version of a traditional three-dimensional of the "pop-up" book as to emphasize that AR was applied in education to make the learning process more interactive and reliable. Besides Magic Book, MARIE (Multimedia AR Interface For E-Learning) was developed in 2002 with superimposing virtual multimedia Content (VMC) information in AR Table Top environment. A user can interact with VMC which consists of 3D object, images, animation, text and sound. This enables educators in using more sophisticated techniques and significantly, helps students to learn more effectively through VMC [10].

Some studies investigated how chemistry student made interactions with AR and physical model and the evaluations of students were implemented based on their perception about the amino acids and student felt easier and portable because the more detail observation and bigger image [11]. Some empirical studies presented in this research had move forward in many area of application includes; educational environment where mobile as a technology to enhance learning either during formal or informal learning session. The characteristics of mobile learning consist of six criteria; where three of the criteria are blended, interactive and portable were emphasize that mobile learning is a suitable platform to be used in Augmented Reality Environment [12].

Mobile Augmented Reality Games (MARG) is also a famous application that embedded AR games in mobile. Explore! Is the MARG application that enables interactive explorations of archaeological sites in Italy. This application are used for middle student school that consisted of 3-5 people where each of group is given by 2 cell phones, where the first cell phones have a function to give some information about to play the games and the others cell phone are functioned to show the hints to

detect the place in the park that contains of 3D reconstructions [28].

3 MOBILE BASED LEARNING THROUGH AUGMENTED REALITY TECHNOLOGY

The effective ways in educational environment in AR was proven by Seijin who developed Augmented Gardening System [13]. Through Personalized Pedagogical Agent, he developed one AR Gardening System through animated pedagogical agents to improve students' learning experience. The pedagogical agents are based on the augmented blue bird character in giving some guidelines to learners and can interact with learner. Besides that, learners can simulate the effect of physiological and environmental factors on gardening in choosing the simulated factors such as water, nutrition and light. Figure 2 shows the Augmented Gardening System that was developing by Seijin where using marker based tracking techniques to augment the virtual object as a learning content. Each of markers has its own function and object to be displayed in the mobile phones. The three important phases in AR are tracking, registration of object process and display the virtual object to real environment. All these three phases can be called as the process to realize AR in real environment.



Fig. 2. Object augmentation by marker based tracking techniques [13]

3.1 Technology in Augmented Reality

The features of m-learning through AR are mostly interactive, blended with real environment, ubiquities and portable. All the features can be adapted with AR environment because the character of AR is also interactive, and blended the virtual and real environment. The three important phases in AR are tracking, registration and displaying the virtual object into real environment. Figure 3 presented the process in AR.



Fig. 3.Process in Augmented Reality

There are three tracking technique that can be applied as a registration approaches in AR environment [14]. The three of tracking techniques are sensor-based tracking, vision based tracking and hybrid based tracking techniques. For mobile, it uses vision based tracking techniques because it uses camera to capture the marker through tracking process. Vision based tracking technique are using image processing methods to calculate the camera pose relative to real world objects and are analogous to close loop systems which correct errors dynamically [15] Figure 4 illustrates the tracking method in mobile AR where it can be adapted in Smartphone's environment.

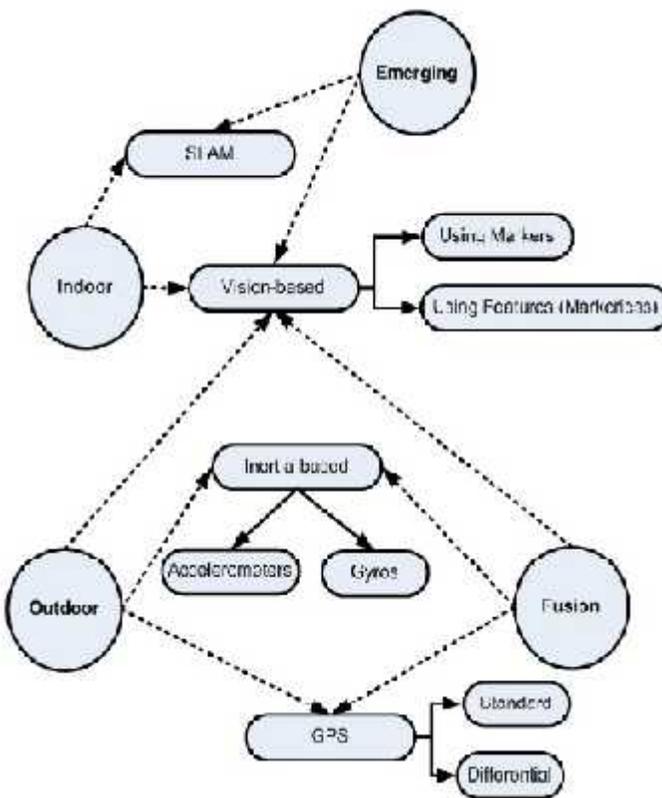


Fig. 4.Tracking method in Smartphone's environment [16]

Currently, the AR application on mobile can be divided into two types; indoor and outdoor environments [16]. Bostanci stated that tracking is the process of locating a user's position and orientation in an environment. It can be more complicated to AR as it creates the realistic results that can be achieved when the registration of real and synthetic is accurate during the process. As presented in figure 5, the tracking in AR consists of two main categories: indoor and outdoor methods, which all the methods are suitable to adapt in Smartphone's environments.

For indoor tracking, vision based technique are affordable to implement but it lack robustness. It contains stracking by marker or natural features of environment. SLAM was manipulated to be used in many AR applications where EKF SLAM (Simultaneous Localization and Mapping) was applied to AR game where a ninja tries to jump from one plane to another until found a target plane but SLAM can used in small workspace area. The emergence of technologies in mobile area was created the Outdoor AR environments. The fusion method was created by [16] where it derived from inertial -based and GPS navigation systems. There are some previous researches that were done in tracking methods to build the AR application in mobile environment. From the previous research that was done in few years ago, several approaches for monocular AR have been explored in the computer vision areas and it was divided into three main approaches; which are markers based, model based, and structure from motion based approaches [17]. Figure 5 below shows the taxonomy of the methods.

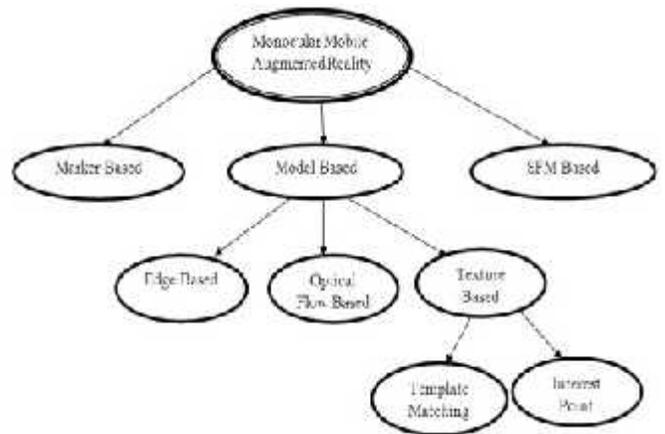


Fig. 5.Online monocular MAR taxonomy [17]

The Marker based methods in AR areas have been studied for a long time either this method was applied in desktop or mobile platform. It is more robust and efficient tracking technology compare to others methods because the tracking and detection can be done accurately based on the marker. But, it is not quite interesting to put the marker in the environment to make the interaction between the used and the scene and it is the conventional way since the AR tracking are on mobile was successfully run firstly using this method by [18] and AR Tennis by [19]. Figure 6 shows the multiple object tracking that detect by marker



Fig. 6. Marker based tracking [17] and AR Tennis [18]

The black and white square markers are used in tracking technique in mobile device to integrate with basic image processing process in recognize the high contrast marker. This basic operation is using camera position in tracking the outer black border and the orientation by tracking the black figure.

Tracking techniques is followed by registration process where registration process is not limited to object only, the registration also included of alignment and synchronization of virtual cues like haptic, auditory and visual with corresponding the real world events [19]. Registrations will be considered an error when the virtual environment system is not synchronized with the user's real world actions as an effects, it will reduce the effectiveness of direct manipulation. Registered in 3D is a one of AR characteristics that means registration is one of the important parts in AR in any tracking techniques. Figure 7 shows the registration process in Augmented Reality System.

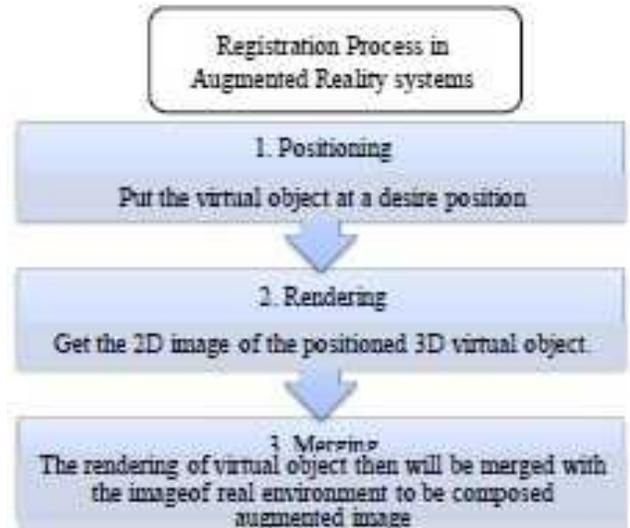


Fig. 7. Registration process in AR System [4]

Registration process ideally allows the virtual and real objects to co-exist in the same space, and merge together seamlessly. To augment the 3D virtual object into the real world, the model must be created first and placed with the real objects in the same references frame. After the process, the 3D virtual object is transformed to the camera reference frame sequent it will project onto the camera image plane. The process of registration in AR must be successful so that it can be displayed in real environment. Display is a subsystem in an AR technology where the display technology enables user to see or view the augmented environment. These technologies include optical see-through, video see-through, Virtual Retinal Systems and Monitor based AR. Display technologies are the fundamental equipment for accessing the technology visually [20]. According to Fiala, there has two paradigms to see the virtual object in AR environment; magic lens and magic mirror [21]. Magic lens can be described as a one metaphor to brings the 3D computer data into the real world; where it enables human to explore the computer graphic world through their tablet/PDA, using their camera object, and mouse action to explore around the augmented world. Besides that, magic mirror in AR environment occurs when a user uses projection screen like mirror and the digital video camera as presented in figure 8. The cameras will detect the markers from the coordinates object and will show the augmented object at projection screen.



Fig. 8. The build of Monitor-based as one of Magic Mirror paradigm [22]

4 THE CONCEPT OF VISUALIZATION IN ENHANCES LEARNING

Augmented Reality (AR) can be designed for educational purpose based on some aspects that are proposed by [23] where there are three AR aspects for educational purposes. Firstly, AR enhances the learning experiences by using 3D synthetic objects for students where students can see the object in front of their eye through mobile interfaces; the 3D object can be manipulated to make the interaction. Secondly, student can use handheld computers in AR to interact with the object; it can gain knowledge in handling the new devices among student.

Thirdly, researcher Wu stated that the designing of AR in educational purpose can offer affordances of presence, immediacy and immersion where it provides the mediated space that give student a sense of being in a place with others [23]. The immediacy factors could be achieved when AR system gives the real time feedback and provides verbal and nonverbal cues to gain student's sense and the realistic experience can give through a sense of immersion when it enables the visualization of invisible concepts or events. AR system could superimpose virtual object or information onto physical objects or environment.

US Junghare give the definition about visualization where it is graphical representation of data or information on mobile devices where it includes text, picture, maps, physical objects and the abstract of data [24]. According to [24], the visualization techniques for learning in mobile devices can be divided into two categories; scientific visualization and information visualization. He also proposed the visualization techniques that are implemented in mobile learning through four approaches; content adaptation approach, interactive visualization, and Flash lite and information visualization.

The effectiveness of using visualization in mobile learning are firstly, visual data can be displayed effectively in small space, the complexity of data can be

reduced by visualization, learners can more better understand through the visualized data, more interested in learning and learning process can be ubiquitous, learning anywhere and anytime

4.1 Visualization enhances learning experiences

The implementation of AR through visualization in mobile learning are giving the best effects in mental models where the concept will give an educational experience for students to develop an understanding of some principle or concept and they able to apply it in various situations. This is because mental models capture a type of memory that instructors want to build. The concept of mental models is very importing to bring in this architecture because it can influence the factors of learning through three attribute; cognitive engagement, interactivity, and multimedia learning [25].

Cognitive engagement is the first factor of influence learning whereas the engagements are focusing in the all of topics during class session. Students are likely to be involved in the task of learning, stay and like to learn. In other words, engagements means by increasing motivation and a deeper level of cognitive activity and the results, is can construct mental model in memory. Besides that, the second factor of influence learning are interactivity, where this situation exist s when students response during learning sessions. The interactive elements make the learning situations more dynamic where in the sense; they can change in a variety of ways based on the needs of the student and instructor.

The last factor for enhancing learning is through multimedia based learning in presenting the information where it can make the connections in memory. In conveying the data, all the multimedia elements are contained inside of the system where it can generate more interesting learning situations and will be affected in mental models.

The visualizations concept is applied through Augmented Reality Technology where it represented the 3D models of science education to make the learning more reliable. Visualization can be defined as a novel visual presentation of data. According to Gilbert, it can include line drawings of data patterns, detailed 3-dimensional mappings of concept spaces, and hypermedia based environments [25]. First it is often quite engaging where it can be quite impressive, using graphics and animation to present information in ways that people have not seen before. Secondly, it also can make the learning interactive through the construction of mental models. All the concept of interactivity and visualization can be implemented through the AR Book to show the visualization technique that are used in AR are improving the learning content through interactivity and visualization.

4.1 A framework of design and integration of mobile based AR in educational environment

The conceptual of mobile based AR is derived from Prasertsilp where mobile learning was based on two factors, mobile learning environment and learning outcomes [26]. This research identified the model to be integrated with mobile learning system so that it can contribute in improving the limitation of current mobile learning system because it covers the three aspects of mobile learning environment; users, technology and pedagogy to be implement through AR. Figure 9 presents the framework for design and integration of mobile learning environment with AR in education environment.

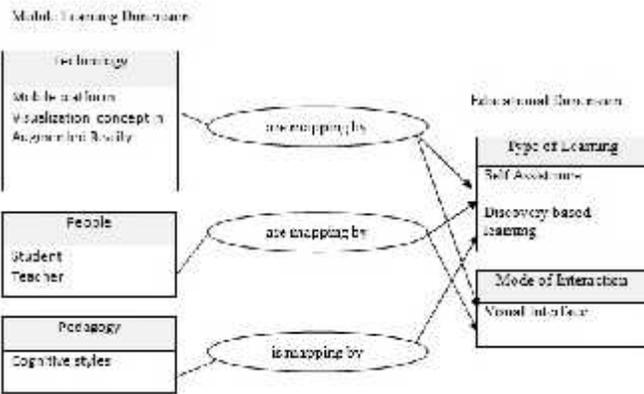


Fig. 9. A Framework of design and integration mobile learning through AR for educational environment

The framework of integration is the mapping process by two elements which is mobile learning dimension and educational dimension. This two factors are dependencies each others in creating the framework of integration. . In the framework, the type of learning and mode of interaction is an educational dimension as factors to be mapped with mobile learning dimension which emphasizes the heuristic approach using AR in mobile for learning environment to influence learning experiences.

Mobile Learning dimension consists of technology, people and pedagogical elements while educational dimension consists of type of learning and mode of interaction. Technology that is proposed in the framework is AR, where it can be visualized through information visualization and interactivity among student into the mobile platform as devices. Both of these two factors have a relationship with user as an action or player in the learning environment. This framework has a strong relation with mobile devices to be connected with AR process.

People are the target of user who will use the mobile learning application which consisted by student in any related subject to enhance their learning experiences during class. Two types of learning are identified; self assistance and discovery based learning are implemented through AR that enhances the student's motivation.

Students can solve the problem situations based on their experiences by interacting with their environment by exploring and manipulating the content of learning. Mode of interaction consists of visual interface where this element provides the method of interaction between technology and people through the visual interfaces.

The embedding of educational elements in the mobile AR for learning system derived from Ramdas where he developed the AR Eco System where the concepts of modules are based on four categories; player, context awareness, type of learning and mode of interaction [27]. To get the effective ways in enhancing learning experience among learners; we proposed that, the integration of AR in mobile learning will be implementing through AR Book. This concept are similar that proposed by [27]. The conceptual of AR Books through mobile is presented in figure 10.



Fig.10. Concept of AR Book to enhance learning experience among learners [27]

visualization through the AR Book, where its focus on visualization and interactivity to improve student learning experience in educational systems. For this system, it is appropriate to primary schools students, and allows them to experience the object in garden such as live object or non live object with environmental surrounding. It provides learners with opportunity to explore physiological and environmental considerations living and non living environment surrounding.

5 CONCLUSION

As a contribution, the mobile based learning through AR is the appropriate way in delivering the information through visualization approaches in enhancing student's experiences. The framework for design and integration of mobile learning environment with AR in education environment is the approach to get student involvement to participate in learning process either through formal or

informal ways. Learners can feel more experiences when they can interact with the learning content through the visualization concept in AR. In conclusion, the combination of elements in mobile learning is adopted by elements in educational dimension to be integrated in the mobile based learning through AR. The concept of AR Book through mobile is the appropriate concept in enhancing student's motivation through the concept of visualization in education environment.

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