Multimedia based Mobile AR System

Edmund Ng Giap Weng, Md. Abdullah - Al - Jubair and Oon Yin Bee

Abstract— Augmented Reality (AR) is a technology that generates virtual information to the real world to the user's perception and interaction to perform the tasks. Multimedia based mobile augmented reality is a Human Computer Interaction technology where user can view the multimedia content (like video, 2D, 3D, text, animation) with audio visuals in augmented environment. This research has developed a mobile AR system where all the multimedia content built in this system. Hence the users can developed their own Augmented Reality applications and games using this builder. This system based on Symbian and Android Smartphone where the users can use their Smartphone's camera for real time video capturing and rendering virtual object augmented environments. Users can interact and control the virtual objects by touch in touch enable phone or by button in non touch phone. The general purpose of this technology is to introduce multimedia base Mobile Augmented Reality to user. This paper describes the potential of AR in mobiles and how the various useful features like 2D/3D object, audio, video can be implemented in Mobile AR.

Index Terms— Augmented Reality; Android; Symbian; Multimedia; Interactions; ARToolKitPlus, Virtual Object, OpenGLES

1 INTRODUCTION

Technology in the area of virtual reality and it is increasingly acquiring greater relevance as a research and development area [1][2]. Fueled by the increase of available mobile phone hardware and software, handheld Augmented Reality (AR) has become a paradigm for mobile AR applications. In recent years, mobile AR has also become a test paradigm for industrial applications in many area like tourism, learning, advertisement the products, gaming, educational etc [3]. These applications requirements many features like 2D, 3D model, text, animations, audio, video etc to fulfill the various types of Augmented Reality application's demand. Our work has focused to bring these multimedia based features in mobile Augmented Reality platform with building simple Augmented Reality system. This AR system allows the users to develop many multimedia based AR applications and games. An interactions system has built in this mobile AR engine which allows users to interact the computer generated virtual objects and Graphical User Interface smoothly through finger touch..

Several prototypes based multimedia based Augmented Reality applications were developed by using mobile AR system where end user evaluated these applications in their Smartphone successfully. The result of the evaluation by user showed that the potential of multimedia based Mobile Augmented Reality System for Smartphone.

- *F.A. Author is with CoESTAR Lab, Universiti Malaysia Sarawak, Malaysia, Sarawak, 94300. E-mail: gwng@fcs.unimas.my*
- *S.B. Author is with CoESTAR Lab, Universiti Malaysia Sarawak, Malaysia, Sarawak, 94300. E-mail: rassall_jubair@yahoo.com*
- *T.C. Author is with CoESTAR Lab, Universiti Malaysia Sarawak, Malaysia, Sarawak, 94300. E-mail: yinbee@fcs.unimas.my*

2 LITERATURE REVIEW

2.1 Augmented Reality

AR is a deviation of Virtual Reality (VR) [4]. AR is a technology that allows the users to see, hear, feel, and smell the virtual objects, which are integrated in the real world [5]. AR technology generates 2D and 3D computer graphics which are accurately integrated into the real environment [6]

Augmented Reality system generally require some kind of tracking the user's or display's Pose in order to register it in respect to the real world. Tracking must be robust under many conditions such as varying lighting. In case tracking is lost, the system must be able to recover quickly [7].

2.2 Virtual Object and Multimedia in AR

3D virtual object is very important aspect in mobile AR especially with superimposed in the 3D real world. Open source graphics library "OpenGLES" is on its way to become a solid base for 3D on mobile devices, most existing portable 3D applications rely on OpenGL ES [9].Animations of the 3D objects are used in AR system [8][9][10][11][12]. Animation is a series of successive frames and each frame is a still image. To create the illusion of motion animation techniques are used. This process works by producing successive still images [13]. 3D user interfaces is the most natural UI method for AR applications. In the past much research concentrated on using data gloves in VR and AR setups, on gesture recognition [14] and object manipulation [15]. While data gloves can be used to create natural and fully 3D user interfaces [16]. Audio and video is very important feature of multimedia based Augmented Reality system to make environment alive with other virtual reality. Mobile guides, considered as one of the last descendants of digital, sophisticated audio guides, are becoming more and more popular throughout the world [17]. Audio based mobile AR technology can offer an attractive replacement for the traditional audio-tape tour guide [7].

2.3 Interaction in AR

AR technology improves the users perception and the interaction with the real world [4]. The mobile applications typically use the touch screen or devices buttons rather than data gloves or 3D pointing devices as traditional AR setups do [7].

3 MULTIMEDIA BASED MOBILE AR SYSTEM FOR HANDHELD DEVICES

Multimedia based Mobile AR system is an Augmented Reality application builder for Symbian and Android Smartphone where the general AR users can developed their own multimedia based mobile AR applications by using this AR builder. An interaction system has integrated into mobile AR builder which allow users to interact the virtual objects in augmented environment. This section presents the core components of mobile AR system and an interaction method which has implemented in this mobile AR system.

3.1 Video Capturing

Video capturing is the first step of this Augmented Reality system. Symbian and Android Smartphone's built-in camera is used as a video capturing device. Camera API (Application Protocol Interface) is a part of Symbian and Android SDK. The entire camera related operations such that video capture, image capture can be done by using camera API. Hence, Symbian and Android camera API is integrated in mobile AR builder to perform video capturing operation. The marker tracker library "ARToolKitPlus" defined resolutions 256X192 [Width X Height] is used for video capturing in all Smartphone.

3.2 Tracking

Open source ARToolKitPlus is used in this AR system as a tracking library. ARToolKitPlus is a well known tracking library for mobile Augmented Reality. According to the author [18], ARToolKitPlus library has no longer update since June'2006. Due to absence of continuing development, ARToolKitPlus is lacking some features and has compatible issue with latest Symbian^3. According to systems requirements, ARToolKitPlus source code was modified and rewritten the function for loading multiple marker, detect multiple marker, detect pattern image and increased frame per second (FPS) rate for better video rendering. Hence modified ARToolKitPlus library is built-in into the AR builder and offered better tracking performance.

3.3 Multimedia Based Virtual Object Generation

The main purpose of AR is to create the 3D virtual objects which are realistic so that the augmented objects will integrate into the visual perception of the perceiver [4]. The open source graphics library "OpenGLES" is the core of any mobile AR rendering system. In order to achieve the purpose, several OpenGLES features play an important role in mobile AR graphics. OpenGLES features like texturing, shading, lighting makes the virtual object true realistic. Texturing is a very important component for mobile graphics which will improve the visual perception in mobile AR rendering. Texture mapping is a technique that maps a 2D image on a 3D objects so that the 3D objects will be displayed with specific texture. As a result, the surface of the 3D objects will be perceived as rough instead of completely smooth. In addition, lighting, condition and surface reflection needs to be calculated in real-time during the AR rendering. Therefore, the performance of AR rendering depends on lighting affect.

Furthermore, a mirror can be used in order to calculate the light source correctly [18]. Hence, computer generated lighting can be reflected properly and produce the shading which is compatible in the real environment. As a result, the virtual objects become truly realistic .All these OpenGLES features is included into mobile AR rendering engine. So users can easily use these OpenGLES features according to their application and games developing requirements.

3D virtual object is very important aspect in mobile AR. Now a day, modern Smartphone is developing with 3D graphics accelerator. Therefore, 3D object rendering in mobile AR become easier and smoother. 3D virtual object can generate using OpenGLES and 3D studio max. Basically 3D object generate from 3D studio max looks more eye-candy and smoother. 3D object can be generated in 3D studio max including animations. According to the mobile AR rendering engine, the entire graphics model data has to convert into OpenGLES format. It is always been difficult to find better solution to export 3D model data into OpenGLES format from 3D Studio Max. The open source graphics library PowerVR is one of the easiest solutions to export 3D data. Therefore, we have chosen PowerVR graphics library as 3D model exporter and integrated it into mobile AR builder. This solution also allow users to draw 3D model with key frame animation in 3D Studio Max and export the 3D data with animations in their rendering engine.

Multimedia mobile AR builder has included 3D Graphical User Interface (GUI) feature in its rendering engine. 3D user interfaces seem to be the most natural User Interface (UI) method for AR applications. We have already developed some application which has used 3D UI. The User Interface of these applications and games look very pleasing to watch in AR view. The mobile AR builder has included some 3D GUI patterns for users to use their applications and games.

Text is another useful feature of mobile Augmented Reality. Any information can overlay by using text on real world image. Normally text act as very important role in tourism, games, advertisement related AR applications. A 2D text engine has developed using OpenGLES bitmap and included this text engine into mobile AR builder. Therefore, user can develop any text base mobile AR apps using text engine.

In multimedia based mobile Augmented Reality, audio and video visual is mandatory component. In game related AR applications, audio can play very important role. Audio visuals can provide the real gaming performance for AR user. Audio can also implement in

various types of AR applications such that educations, tourism, navigations, guided, museum based AR applications. An audio module has implemented in mobile AR engine using Symbian and Android audio API. User can chosen variety of sound format like .mp3, .wav, .amr from this mobile AR builder to develop their own multimedia based AR apps.

Video is another important feature of mobile AR. It is very useful feature for advertisement, educational, museum guide based AR applications. The predefined video clips can overlay on real time image once application detect the marker. The video clips can contain useful information. Video clips can include in the installable (.sisx for Symbian, .apk for Android) file or Video clips can store in Smartphone memory drive for larger size video. A video module has implemented in mobile AR engine using Symbian and Android video API. User can chosen variety of video format like .mp4, .3gp from this mobile AR builder to develop their own multimedia based AR apps.

3.4 Interactions

Interactions with mobile AR applications are supplemented by simpler techniques, like displaying classical 3D interfaces on the Smartphone. This allows integrating classical e-learning methods such as multiple choice questions, which are more rapidly produced. An own interactions system is implemented based on color picking algorithm for Symbian and Android Smartphone which is integrated with mobile AR builder. User can use this interaction feature of mobile AR builder to develop their own interaction based mobile AR applications and games. This interaction feature is very easy to use. Users just need to define the RGBA (Red, Green, Blue, and Alpha) color value of every virtual object's vertex using OpenGLES color functions. Multimedia base mobile AR builder supports two type of interaction. Button based interaction and finger touch based interaction.

Smartphone button can be used for interaction the virtual object in non touch Smartphone. The most of Symbian phone is non touch based. Smartphone has several buttons which can be used for navigate virtual object on real time image. All the buttons access code from SDK (Software Development Kit) has integrated into mobile AR builder. Therefore user can use mobile button to interact the virtual object in augmented environment.

Modern Smartphone normally comes with touch screen enabled. Interaction on touch screen is more flexible and interesting than button based interaction. Virtual object can easily navigate by finger touch in mobile AR environment. The finger interaction technique uses the touch reader API of SDK. Therefore color picking algorithm is applied to interact the specific virtual object and GUI.

4 SYSTEM DESIGN

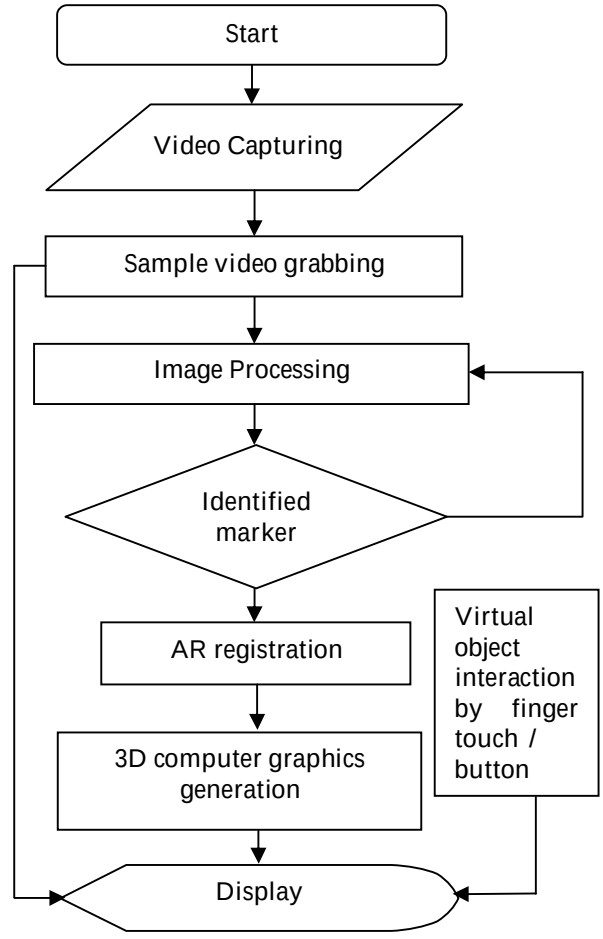

Fig.1. Flowchart of the Mobile AR system

The Fig. 1 shows the total flow of this system. At first video capturing is started and sample video is grabbed by using Smartphone camera. At this time user is able to see the real time video in screen. Then this sample video is further processed by image processing task to detect the predefined marker. If marker is detected, the AR registration is done between real world and 3D world. AR registration is a method to enable the virtual objects aligns properly in the real environment so that the users can perceive the virtual objects in the correct position and orientation. After that 3D computer graphics are generated on top of real world video. Now user is able to see the complete AR environment of mixture of real world and virtual world in Smartphone display. At the same time user can interact the virtual 2D/3D/GUI object by hand figure touch and menu button in AR environment. This whole procedure is continued until specific markers are detected.

5 DISCUSSION AND EVALUATION

There were number of AR applications and games [Figure 2] were built using this multimedia based mobile AR builder in various area like shooting games, tourism, local road sign recognition, educational, advertisement, personal information etc. All the multimedia features, interaction, 2D/3D animations, graphics were used in these applications and games. These applications and games were awarded by some gold and silver medal at national and international exhibitions.

Multimedia based mobile AR system was evaluated by the number of students from the faculty of cognitive sciences and human development (FSKPM), Universiti Malaysia Sarawak and faculty of computer science, Limkokwing University. The students have used this system to implement their final year project on mobile AR in Symbian and Android Smartphone. The system was successfully used by the student's project and evaluated in their thesis accordingly.

6 FUTURE WORK AND CONCLUSION

Our future plan is to develop an own tracking system and integrated it with the database system. This tracking system should overcome the existing tracking system problem like remove four square black border boundary, lighting problem, improved (frame per second) FPS on video and better registration between real world image and 3D world. This tracking system will also able to recognize the human faces by using natural feature technique. The network connectivity will be implemented into AR system which will allow mobile AR applications to connect internet and download/upload the data in real time.

This paper has described the multimedia based mobile AR system for Symbian and Android system and also has given the future plane of our research on Mobile AR. Demand of Mobile AR is increasing day by day in the mass market. We are also going forward to bring our Mobile AR applications in Mass market.

ACKNOWLEDGMENT

I would like to express our appreciation to Universiti Malaysia Sarawak (UNIMAS) and Mimos Berhed for providing financial support for this research through Research Grant Scheme.

REFERENCES

[1] Augmented Reality Homepage, "Augmented Reality", Retrieved January 26, 2011, retrieved from http://www.augmented-reality.org/

[2] Technology Review published by MIT, Especial Issue "10 Emerging Technologies 2007", Mobile Augmented Reality (2007)

[3] E.V. Eduardo and E. Kruijff, "Handheld Devices for Mobile Augmented Reality", Institute for Computer Graphics and Vision, Graz University of Technology, Graz, Austria

[4] R. Nicole, and Azuma, "A survey of augmented reality", Teleoperators and virtual environments., 6(4), 355-385.(1997)

[5] K. Bonsor, "How augmented reality will work", Retrieved January 26, 2007, from http://www.howstuffworks.com/augmentedreality.htm/printable. (2001)

[6] S. Malik, "Robust registration of virtual objects for real-time augmented reality", Carleton University, Retrieved February 1 (2002)

[7] D. Wagner, "Handheld Augmented Reality", Graz University of Technology, Graz, Austria, October, (2007)

[8] I. Barakonyi and D. Schmalstieg, "Ubiquitous animated agents for augmented reality", IEEE/ACM International Symposium on Mixed and Augmented Reality (ISMAR 2006), 145-154 (2006)

[9] A. Gillet, M. Sanner, D. Stoffler, D. Goodsell, and A. Olson, "Augmented reality with tangible auto-fabricated models for molecular biology applications", In proceedings of the Conference on Visualization, 235-241 (2004)

[10] C. Geiger, L. Oppermann, and C. Reimann, "3D-registered interaction surface in augmented reality space", IEEE International Augmented Reality, Toolkit Workshop, 5-13(2003)

[11] D. Reiners, D. Stricker, G. Klinker, and S. Müller, "Augmented reality for construction tasks: Doorlock assembly", In proceedings of the International Workshop on Augmented Reality (IWAR'98). Placing artificial objects in real scenes, 31-46 (1998)

[12] D. Kornack and P. Rakic, "Cell Proliferation without Neurogenesis in Adult Primate Neocortex," Science, vol. 294, Dec. 2001, pp. 2127-2130, doi:10.1126/science.1065467.

[13] R.H. Williams, A. Kent, A.G. Holzman, and J.G. Williams, "Encyclopedia of computer science and technology", Volume 29, CRC Press (1993)

[14] G. Heumer, H.B. Amor, M. Weber and B. Jung, "Grasp Recognition with Uncalibrated Data Gloves - A Comparison of Classification Methods", In Proceedings of Virtual Reality Conference (VR'07), pp. 19-26, USA (2007)

[15] Y. Liu, and G. Wan, "Techniques for Selecting and Manipulating Object in Virtual Environment Based on 3-DOF Trackers and Data Glove", In Proceedings of Conference on Artificial Reality and Telexistence, (ICAT '06), pp. 662-665, China (2006)

[16] B. H. Thomas and W. Piekarski, "Glove Based User Interaction Techniques for Augmented Reality in an Outdoor Environment, Virtual Reality", Development, and Applications, Vol. 6, No. 3, (2002)

[17] A.B. Damala, I. Marchal, P. Houlier, "Merging Augmented Reality Based Features in Mobile", University Campus of Beaulieu , 35042 Rennes, CEDEX, France

[18] M. Kanbara, and N. Yokoya, "Geometric and photometric registration for real-time augmented reality", In IEEE and ACM International Symposium on Mixed and Augmented Reality (ISMAR'02), 279(2002)

Edmund Ng Giap Weng obtained his bachelor and master degree in Cognitive Sciences at Universiti Malaysia Sarawak (UNIMAS), Malaysia. He obtained his PhD in advanced interactive technologies at Salford University, UK. He is a senior lecturer at Faculty of Cognitive Sciences and Human Development, Universiti Malaysia Sarawak. He is a director of Center of Excellence for Semantic Technology and Augmented Reality lab (CoESTAR), UNIMAS. His research interests include Augmented Reality and Virtual Reality application, Innovative and Interactive Technologies.

Md. Abdullah - Al - Jubair received his BSc in Computer Engineering from American International University – Bangladesh, Bangladesh in 2006 and MSc in Cognitive Sciences from Universiti Malaysia Sarawak, Sarawak, Malaysia in 2012. He is currently studying PhD at Faculty of Cognitive Sciences and Human Development, Universiti Malaysia Sarawak. His research interests include Augmented Reality, Computer vision and Human factors.

Oon Yin Bee obtained her bachelor degree in Cognitive Sciences from Universiti Malaysia Sarawak, Sarawak, Malaysia, followed by master degree of Cognitive Ergonomics, Faculty of Cognitive Sciences and Human Development, Universiti Malaysia Sarawak, Malaysia. Now, She is a lecturer of Cognitive Sciences and Human Development, Universiti Malaysia Sarawak, Malaysia, Her research interests include Cognitive Ergonomics.