Journal of Engineering and Applied Sciences 11 (3): 635-639, 2016
ISSN: 1816-949X

Augmented Reality for Information Retrieval Aimed at Museum Exhibitions using Smartphones

Aruneswaran Selvam, Timothy Tzen-Vun Yap, Hu Ng, Hau-Lee Tong and Chiung-Ching Ho
Faculty of Computing and Informatics, Multimedia University, 63100 Cyberjaya, Malaysia

Abstract: This research aims to develop an information retrieval application based on Augmented Reality (AR) technologies to enhance visitors' experience in a museum exhibition. The purpose of developing this application is to give visitors of museums a customized interactive experience through a handheld smartphone. The application recognizes objects of interest and retrieve information of such objects for display through feeds from a smartphone's camera in real time and overlays the information over the object. This is achieved with vision-based AR, utilizing 3D object tracking, thus eliminating the use of markers which could prove unreliable due to obfuscation or damage.

Key words: Augmented reality, information retrieval, smart devices, 3D tracking, object recognition

INTRODUCTION

Augmented Reality (AR) is a representation of the physical real-world environment, either directly or indirectly, where entities are augmented by sensory inputs generated by computers. These inputs include GPS, sound, video and graphics. Its function is to enhance one's current perception of reality. The basic idea of AR is to mix reality with virtual reality. AR enables the user interact with virtual images which is a computer generated graphic that is put over into a user's field of view in a device to provide additional information about their surroundings (Livingston *et al*., 2005).

Currently in most museums, information related to the gallery are presented by speech or on the information panel at the gallery. In this research, by using augmented reality, visitors of the museum can obtain information of the exhibits through the use of a smartphone or a tablet.

Visitors will be not only able to see the exhibit but the experience will also be enhanced with overlaying virtual objects that provides further information of the exhibit with potentials in multimedia and multimodal presentations. With this, visitors will be able to know how the exhibit came about with even deeper and more exclusive information (Watanabe *et al*., 2011).

Many AR applications have been utilizing image processing in the applications to process images and to overlay objects onto the image in a particular displayed space. By combining these technologies, there is a basis for developing smart phone applications that utilizes technologies such as face recognition, marker recognition and augmented reality. Visitors of museums are often faced with difficulties in recognizing historical artifacts, portraits and statues, etc. More often than not, the cause of this is due insufficient or unavailable description tags. This leads to a dependency on the Internet for information.

People, today, are increasingly dependent on the Internet and their smartphones to obtain information. Most of the information that are available on the Internet are not cited and the sources cannot be trusted at times. In addition, obtaining information from an unknown object can be difficult especially when the object is completely oblivious and not known to the user. A more reliable source as well as a more accurate method of obtaining information and recognizing an unknown object should be made available.

This research aims to provide visitors with the convenience of object recognition to identify an exhibit. In most cases, specific markers are needed for AR work. In this research, AR works by treating the object of interest as the marker, irrespective of the angle its image is captured. In addition, visitors are presented with a more efficient and trusted manner in obtaining information through direct retrieval of information of the exhibit. Information is obtained from a trustworthy source and is displayed without any interruption or action in-between. Furthermore, information overlay is automatic and digital tags are available for further refinements.

Corresponding Author: Aruneswaran Selvam, Faculty of Computing and Informatics, Multimedia University, 63100 Cyberjaya, Malaysia

Literature review: AR applications can take the form of vision-based, GPS-based or hybrid AR. Vision-based AR makes use of computer vision to process feature points of markers, be they 2D planes or 3D polygons, from camera images and outlaying content on them. In the case of museums, vision-based AR is the norm as indoor locations have difficulty obtaining GPS signals. Platforms that support vision-based AR include ARToolkit (Abawi *et al*., 2004). ARToolkit supports tracking of 2D markers with output displays in openGL, while BazAR supports feature points detection and matching. Vuforia supports mobile AR applications that track 2D planar images or 3D cubic and cylindrical objects.

One of the currently existing applications that uses AR technology in museums is the Acropolis Museum in Athens, Greece, where the technology is used to restore the colors and lost features of a collection of architectural and sculptural relics using AR. Similarly, at the Cité de l'Espace in Toulouse, France, the project was used to project space flight and the representation of the universe.

In Japan, the Tokyo University Digital Museum has developed an information-providing system for exhibited materials using AR technologies. In their system, visitors of their museum will be wearing a Head Mounted Display (HMD) which allows visitors to view realistic images through it. When visitors wander around the museum with the glass the visitor will be able to see the explanation and information of the exhibition through the Head Mounted Display (HMD) called the 'Glass'. Through this 'Glass', visitors can see the projected images. As the 'Glass' has an LCD screen, the users can see display information from a computer over the actual scene. Aural information will be played as visitors walk through the gallery through earphones. As the visitors approach the exhibits, more detailed explanation of the exhibits will be displayed.

The 'Ultimate Dinosaurs' application of the Royal Ontario Museum uses AR to virtually add flesh to the physical dinosaur bones and allows the dinosaurs to move around in the phone. Visitors make use of a smartphone application that can make creatures pop out of markers around the exhibit. The markers are placed around the museum, including on the floor. In addition, visitors can use iPads provided by the museum to show fossils as their fleshed-out counterparts. Along the walls, animated interactive projections of dinosaurs are also shown. With the help of a Kinect 3-D camera, the eyes of these projections follow the visitors' every move.

'A Gift for Athena' was created in partnership with Samsung and the British Museum and developed by a company called Gamar. This application gives visitors especially children a chance to learn more about Greek culture through games. This way they will be able to help the children to learn more about the museum's Parthenon gallery. One of the main objectives of this application is to identify statues and artifacts within the gallery by their shape. The application makes use the camera on a Samsung tablet recognize objects in the gallery by creating an outline of the object which in turn reveals a game or additional information. One of the features of this app is having different actions whenever a different object is detected.

Kounavis *et al*. (2012) discussed the use of AR applications for tourism. The discussions were on the application development as well as the delivery of the content for superior experience. The paper looked at the concerns of development and the various limitations that hinder the adoption of AR in tourism as well as proposed a model for AR applications in tourism. This is achieved through four steps which include the representation of the situation, the design of the mental model, the design of the activity model and the design of the class diagram.

As pervasive and wearable computing are gaining momentum, these technologies also intersects with AR. Zheng *et al*. (2015) commented that for a typical AR application, a most comprehensive system is required, thus AR applications can be divided into three categories: acquisition of data of environment, registration of virtual objects in real environment and presentation of composite data, regardless of technologies employed.

MATERIALS AND METHODS

There are different types of Augmented Reality (AR) markers. Most AR markers are usually black and white as it is easier for the camera to recognize the pattern or the colors. Together with a camera, the AR Software detects the marker as the position for the computer-generated objects. This will result in an image or object that can be viewed on a screen. The digital images and objects are positioned at the location of the markers as part of the scene. However, these types of augmented reality markers are limited by the software that can recognize them. The markers need to be simple for error correction but they can include different images from a wide range.

In order to recognize the objects on the camera, image/object processing will also need to be used. An object in image processing is an identifiable portion of an image that can be translated as a single unit. The most common types of markers are two-dimensional black and white images. More advanced augmented reality markers can include color and images. Colors are used carefully in AR to make sure the contrast between them is high so that it is easier for the camera to recognize it.

Most AR markers are placed at certain locations. If these markers are obscured, the AR applications will not work. In this research, the object of interest works as the marker and the markers will work irrespective of the angle the images are captured. In essence, the object of interest works as 3D markers. As such, the AR application can work around obscuration as multiple angles of capture are available. Visitors of the museum will be able to walk around the museum with the application turned on, on a smartphone and the application will give explanation and information of the exhibit or gallery that the visitor is pointing at with the smartphone's camera. This will be the primary function of the application. Additional features such as objective based games can be added to improve the user experience especially for children to make their visit more enjoyable and beneficial. This is achieved with the Vuforia AR platform.

Vuforia System Development Kit (SDK): The Vuforia SDK is available for smartphones and it allows the execution of AR applications from real-time video acquired from them. It uses computer vision technology to recognize and track objects from the video. These objects are called image targets and the SDK detect and track the features inherent in the image target itself and recognize the object by comparing the features with those in its resource database. The features are based on the corner or edges of the image target. As such, an object with more corners or edges will have more features.

The resource database is created from the Vuforia Target Management System (TMS). Image targets are uploaded to the TMS and the features are analyzed and qualified by the system. In use, the image captured from the camera are actually compared to those in the resource database for tracking to be successful.

System design: The data flow diagram in Fig. 1 illustrates the flow of data between the user, the application and the administrator as well as the processes involved. The administrator prepares the resource database (D1 – Trackable Object) for each object as well as the corresponding information database (D2 – Image Details) pertaining to the objects. The main input is from the camera, where the features in an image is compared against the resource database for identification, and correspondingly the information of the identified object of interest is formatted and presented to the user.

For preparation of the resource database, multiple angles of images can be used to eliminate obfuscation, and the multiple features correspond to the same object. However, for true 3D object recognition, the object can be scanned using the Vuforia object scanner application, available on Android phones.

The sequence diagram in Fig. 2 describes the sequence of messages between objects and processes with the starting object of the sequence being the 'User', the user of the application. At 'GetObject', if the camera does not pick up any trackable object, the sequence return to 'Camera' to continue tracking.

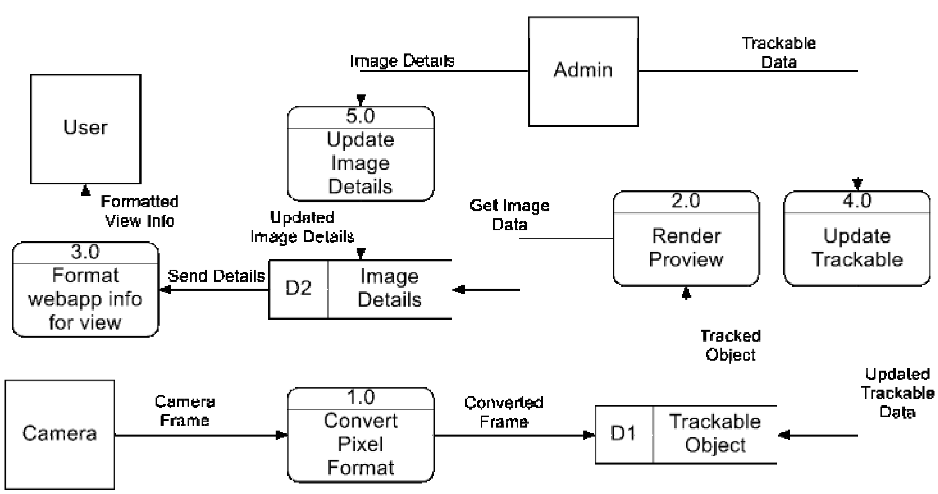

Fig. 1: Data flow diagram

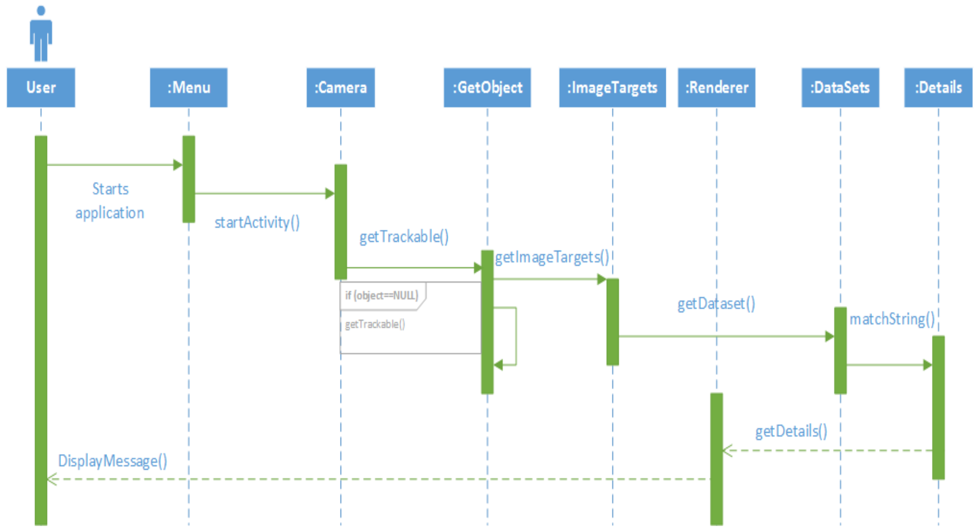

Fig. 2: Sequence diagram

Fig. 3: Sample object along with trackable features used in recognition. Left; side view, middle; front view, right; rear view

RESULTS AND DISCUSSION

The sample object of interest is shown in Fig. 3. The application is able to recognize the object based on any of its flank (front, rear and side) and the corresponding features tracked by the application is also shown (Fig. 3). Based on the features, the recognition of the object invokes the application to retrieve details of the object and is subsequently displayed.

However, there are several limitation in the recognition The system is only able to detect object that has rich surface features (points, edges, etc.) as it does not depend on shapes for recognition. 3D tracking is dependent on the definition and relation of spatial relationship between the dimensions of the object which slightly reduces recognition capabilities as well.

Lighting can also influence the capability of recognition by a small margin as features are less visible under poor lighting.

CONCLUSION

In this study, an application for use in museums that recognizes objects of interest and retrieve information of such objects for display is presented. Most systems available in museums are only confined to a certain exhibition instead of the whole museum. In addition, some systems do not have 3D tracking, thus requiring the use of markers which are unreliable due to obfuscation. With the ease of having an application that recognizes and displays information of over any exhibit, the experience can be very educational and intuitive. In future, plans to evaluate user study are considered.

REFERENCES

Abawi, D.F., J. Bienwald and R. Dorner, 2004. Accuracy in optical tracking with fiducial markers: An accuracy function for ARToolKit. Proceedings of the 3rd IEEE/ACM International Symposium on Mixed and Augmented Reality, November 2004, Washington, DC., pp: 260-261.

Kounavis, C.D., A.E. Kasimati and E.D. Zamani, 2012. Enhancing the tourism experience through mobile augmented reality: Challenges and prospects. Int. J. Eng. Bus. Manage., Vol. 4.

Livingston, M.A., C. Zanbaka, J.E. Swan and H.S. Smallman, 2005. Objective measures for the effectiveness of augmented reality. Proceedings of the Virtual Reality, March 12-16, 2005, Bonn, pp: 287-288.

Watanabe, T., K. Inose, M. Ando, T. Kajinami, T. Narumi, T. Tanikawa and M. Hirose, 2011.. Digital display case: A study on the realization of a virtual transportation system for a museum collection. Proceedings of the International Conference on Virtual and Mixed Reality, July 9-14, 2011, Orlando, FL., pp: 206-214.

Zheng, R., D. Zhang and G. Yang, 2015. Seam the real with the virtual: A review of augmented reality. Proceedings of the Information Technology and Mechatronics Engineering Conference, March 28-29, 2015, China, pp: 77-80.