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An Implementation of a Cloud Service based Augmented Reality for Improved Interactivity

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Abstract

Objectives: Implementation of Augmented Reality together with Cloud Service to improve flexibility and interactivity either for the end users as well as developers. **Method/Statistical Analysis:** Android has their precompiled OpenGL ES to draw graphics. Combining with OpenCV, it can result into a powerful enough Augmented Reality application and it is free to use. OpenCV provides feature detection and recognition and tracking for markers and OpenGL to draw 3D graphics. **Findings:** Implementing cloud service with smartphone application proves to be more efficient and flexible instead of general closed environment application. Adding markers and 3D data doesn't require the users to update their application each time, but it can automatically detect which marker are available in the server and display the appropriate 3D model depending on the marker detected. This provides the user with lower storage in their Smartphone's and better usage of the Augmented Reality application. **Application/Implementation:** This can be applied in all sorts of Virtual Reality or Augmented Reality application where the developers may add much data according to the users' needs.

Keywords: Augmented Reality, Cloud Service, Object Homography, Object Tracking, Open Environment System

1. Introduction

Augmented Reality is a live, direct or indirect, view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data. Research on Augmented Reality has undergone a long way about algorithms, implementations and even ethics implications[1]. With the advancement of high-end smartphones with fast processing Central Processing Unit (CPU) and large sized Random Access Memory (RAM) made it possible to create a real-time calculation of key points and marker position to project augmented 2D or 3D objects.

In this paper, we are implementing Augmented Reality software using cloud service database for data storage. We are using Parse, a cloud service database, to save marker images. By using a cloud service database, we are hoping to reduce software size and increase usability since using cloud service means the data can be accessed anywhere and anytime the client need to use it. As there are several types of Augmented Reality such as: Geo-location based, marker based and marker less augmented reality. We are using the marker based Augmented Reality where the augmented object could only appear when the software actively detect and recognize certain surrounding objects.

We will be using OpenCV for feature detection to obtain similar key points between the saved marker and the image from camera. After having the detected key points, the software will provide the homogeneous matrix to show translation, rotation and the scale difference between the marker and the camera image. The homogeneous matrix can be used to improve interactivity of augmented reality. By changing the camera position based on the marker, the augmented objects can have different animations and different interactions based on the rotation, translation and scale difference between the marker and the camera. Experimental results show the robustness of the real-time application of the cloud based service.

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In[2] proposed the term Augmented Reality to define clearly the difference between Augmented Reality and virtual reality. They designed a scale between Augmented Reality and Virtual Reality where these two topics located on the very end of the scale, shown in Figure 1. The middle of the scale is called 'mixed reality'. 'Augmented Reality' is closer to the real environment and 'Augmented Virtuality' is closer to the virtual environment.

According to[3], Augmented Reality needs to have three main properties: Combination of real and virtual, Interactivity in real time and Registering in 3-D.

Compared to the traditional Virtual Reality (VR) technology, Augmented Reality technology have several main advantages where Augmented Reality has a better sense of reality and Augmented Reality has better interactivity[4].

One of the key technologies about Augmented Reality is the ability to have good interaction between the user in real scene and interaction with virtual objects. Interactive technology using space points, command and special tools and other ways to implement interaction between user and virtual objects[4].

Augmented Reality has been used in many different areas. The most successful implementations are education[5–7], entertainment[8,9], medical[10], manufacture and maintenance[11].

In Figure 2,[12] propose system architecture of Augmented Reality. The function of Augmented Reality starts from the main requirement of tracking and positioning of images, 3D graphics, human computer interactions, presentation and creative demonstration.

Figure 1. Scale designed.

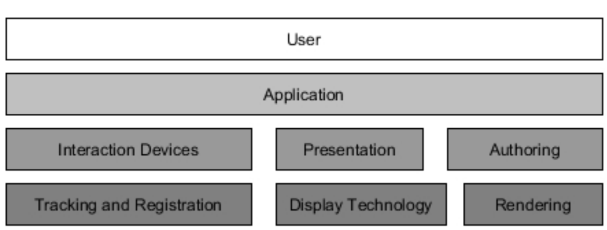

Figure 2. Augmented Reality system architecture.

2. Methods and Implementations

This section is going to explain the methods and the implementations of the cloud service based Augmented Reality system.

2.1 System Architecture

Figure 3 shows the system architecture for our software. We are using a cloud database to save the image data. In this case, we are using a REST API to communicate between smartphones and the cloud database.

All the images in the database are kept as a base64 string. Keeping images in this format keeps the database smaller and it is faster to send string rather than to buffer files so that the connection between client and server require less bandwidth.

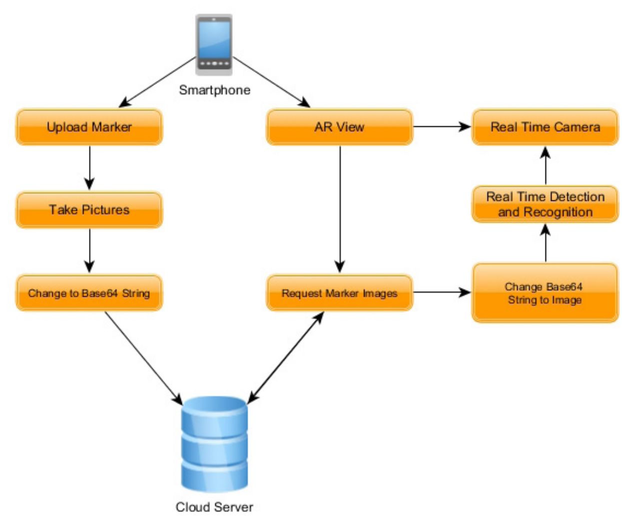

Figure 3. System architecture.

2.2 Key Point Matching

In this paper, we are using OpenCV instead of other Augmented Reality libraries, such as the well-known ARToolKit, Vuforia, etc. Even though OpenCV is not a standalone Augmented Reality library, we believe OpenCV can also do Augmented Reality algorithms.

OpenCV provides functions to do object tracking, such as SURF, SIFT, ORB etc. In this paper, we are using SURF (Speeded up Robust Features) for key point's detection. We have compared the performance between these three key points detection algorithms and came up that SIFT (Scale Invariant Feature Transform) is not suitable for a real-time detection. The choice falls to SURF and ORB (Oriented FAST and Rotated BRIEF).

After some comparison between SURF and ORB, we decided to use SURF for the feature detection since SURF has a better performance in terms of the key point detection. After detection, these key points are matched to the real-time camera frames where we are using a brute-force Matcher with Euclidean Norm (L2 Norm). Figures 4 and 5 shows comparisons between the SURF and ORB feature matching results.

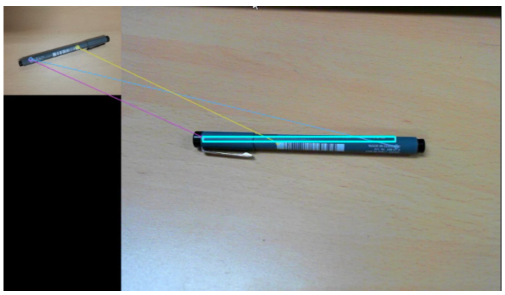

Figure 4. Key points matching with ORB.

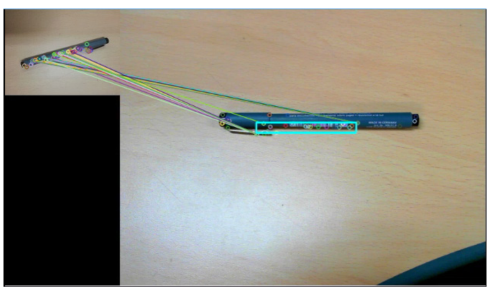

Figure 5. Key points matching with SURF.

After the matching, the homography matrix between the camera frame and the marker is found by using the OpenCV function. Equation 1 shows the relationship between reference points, target points and the homography matrix.

$$X = HX' \tag{1}$$

Where X is the reference point and X' is the target point. H is represented by a 3 x 3 matrix as below:

$$H = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \tag{2}$$

In the Equation 2, $h_{11} - h_{33}$ is the corresponding homogeneous coordinates from the points in an image to the real-time camera images. These values allow the vector operations such as translation, rotation and scaling. To further get each value of these geometric transformations, these values inside **H** needs to be decomposed into each of their components. After decomposing, we can get the value of each of the geometric transformation factors.

3. Results and Discussions

Figure 6 by using cloud storage to save data, the application has a much smaller size compared to that when saving the data in the application itself. When using the homography factors for improving the interactivity, the augmented 3D object knows the position of the camera when it is tapped on. So, the object can adjust its animation to rotate itself towards the direction of the camera. Changing the height of the camera can also affect the scaling between the marker and the detected object, thus it can show different 3D objects at different heights, for example. Figure 6 shows the homography lines created from the homography matrix comparing the marker in the left part with the scene from the camera.

Figure 6. Green line showing the homography between the object with the scene.

5. Conclusions

In this paper, we proposed a cloud based Augmented Reality application which is capable to create an Augmented Reality environment while being able to track objects and provide a homography matrix. With the use of a cloud service database, users can easily add markers and projected 3D objects without changing the core application. This allows more flexibility and usability of using augmented reality. Furthermore, with the change in the three factors like scale, rotation and translation, provided by the users, it can create a more interactive way to process animations and interactions. The cloud provides also for marker data sharing such that multiple smartphones can use the same marker and the same 3-D contents without having the internal markers to be installed in the phones.

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7. References

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