



## Marker Based Augmented Reality Using Android OS

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**Abstract—** Augmented Reality or AR is an emerging technology in which one's perception of the real-time environment is enhanced by superimposing computer-generated information such as graphical, textual, or audio content, as well as objects onto a display screen. The proposed application is an android mobile based application which will be compatible with all the existing and upcoming versions of the operating system. The idea is to allow the user to view the virtual object in the real world using a marker based AR system. The user could provide images of the object which would be the front, back, top, bottom, left and right side pictures of the object. They will be placed onto a 3D cube which will make up the complete virtual object. Thus an extended environment will be created through the amalgamation of real world and generated object and it will appear as though the real-world object and virtual object coexist within the environment. The advantages of this application as compared to the already existing 2D application are that it would display object in 3D and enable the user to rotate it virtually. It is inexpensive as the user need not actually purchase the object to see how it fits in the environment, instead he can try before the purchase itself.

**Keywords—** Augmented Reality, Android, Marker, Operating System, Virtual Reality.

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### I. INTRODUCTION

Augmented reality (AR) 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 [1]. Augmented Reality is a type of virtual reality that aims to duplicate the world's environment in a computer. Virtual reality (VR) is a virtual space in which players immerse themselves into that space and exceed the bounds of physical reality [2]. It adds information and meaning to a real object or place. Augmented reality is characterized by the incorporation of artificial or virtual elements into the physical world as shown by the live feed of the camera, in real-time. Common types of augmented reality include projection, recognition, location and outline [3].

**Projection:** It is the most common type of augmented reality, projection uses virtual imagery to augment what you see live. Some mobile devices can track movements and sounds with a camera and then respond. Virtual or projection keyboards, which one can project onto to almost any flat surface and use, are examples of augmented reality devices that use interactive projection.

**Recognition:** Recognition is a type of augmented reality that uses the recognition of shapes, faces or other real world items to provide supplementary virtual information to the user in real-time. A handheld device such as a smart phone with the proper software could use recognition to read product bar codes and provide relevant information such as reviews and prices or to read faces and then provide links to a person's social networking profiles.

**Location:** Location uses GPS technology to instantaneously provide you with relevant directional information. For example, one can use a smart phone with GPS to determine his location, and then have onscreen arrows superimposed over a live image of what's in front of the user and point him in the direction of where you need to go. This technology can also be used to locate nearby public transportation stations.

**Outline:** Outline is a type of augmented reality that merges the outline of the human body or a part of the body with virtual materials, allowing the user to pick up and otherwise manipulate objects that do not exist in reality. One example of this can be found at some museums and science centers in the form of virtual volleyball. Although the player can stand and move on an actual court, the ball is projected on a wall behind him, and he can control it with an outline of himself, which is also projected on the wall. Using the concept of augmented reality our project focuses on creating a very useful android mobile based application. The idea is to allow the user to view the virtual object in the real world. The user could provide images of the object which would be the front, back, top, bottom, and left and right side pictures of the object. They will be placed onto a 3D cube which will make up the complete virtual object. Thus an extended environment will be created through the amalgamation of real world and generated object and it will appear as though the real-world object and virtual object coexist within the environment. In order to use this application, the user will first need to acquire a marker. A marker is a piece of paper with black and white markings. This is used to display the augmented object on your mobile phone's screen. Marker-based augmented reality uses a camera and a visual marker which determines the centre, orientation, and range of its spherical coordinate system. Once the marker is present one can view augmented

objects. Virtual object interaction is another added feature wherein the user can rotate or change the orientation of the object according to his requirements.

## II. VIRTUAL REALITY

The term "artificial reality", coined by Myron Krueger, has been in use since the 1970s; however, the origin of the term "virtual reality" can be traced back to the French playwright, poet, actor, and director Antonin Artaud. Virtual Reality is a computerized simulation of natural or imaginary reality. Often the user of VR is fully or partially immersed in the environment. Full immersion refers to someone using a machine to shield herself from the real world. VE is the term used to describe the scene created by any computer program in which the user plays an interactive role within the context of the computer generated three dimensional world. The user represents an actor within the system and has an essential presence within the virtual world. Virtual reality (VR) is a term that applies to computer-simulated environments that can simulate physical presence in places in the real world, as well as in imaginary worlds.

### *Advantages:*

Many different fields can use VR as a way to train students without actually putting anyone in harm's way. This includes the fields of medicine, law enforcement, architecture and aviation. VR also helps those that can't get out of the house experience a much fuller life.

Doctors are using VR to help reteach muscle movement such as walking and grabbing as well as smaller physical movements such as pointing. The doctors use the malleable computerized environments to increase or decrease the motion needed to grab or move an object. This also helps record exactly how quickly a patient is learning and recovering.

- Total immersion within environment.
- Increased user presence perception within system.
- Facilitated production of an entirely designed environment.
- Existing technologies for advanced interaction.
- Real-time graphical environment generation possible.

### *Disadvantages:*

The hardware needed to create a fully immersed VR experience is still cost prohibitive. The technology for such an experience is still new and experimental. VR is becoming much more commonplace but programmers are still grappling with how to interact with virtual environments. The idea of escapism is common place among those that use VR environments and people often live in the virtual world instead of dealing with the real one.

One worry is that as VR environments become much higher quality and immersive, they will become attractive to those wishing to escape real life. Another concern is VR training. Training with a VR environment does not have the same consequences as training and working in the real world. This means that even if someone does well with simulated tasks in a VR environment, that person might not do well in the real world.

- Not suited to real-world interaction.
- Despite advances in technology equipment is still expensive.
- Auxiliary senses not stimulated.
- Possible lag in motion-display system.

## III. AUGMENTED REALITY

Augmented Reality (AR), also known as Mixed Reality, aims to combine virtual and real scene together to achieve that virtual ones are belong to the real world. Being characteristic of integration of virtual and real scene, many applications of Augmented Reality are emerging, such as in field of education, medical treatment and entertainment [4].



**Fig 1: Real desk with virtual lamp and two virtual chairs [5].**

Figure 1 shows an example of what this might look like. It shows a real desk with a real phone. Inside this room there are also a virtual lamp and two virtual chairs. Note that the objects are combined in 3-D, so that the virtual lamp covers

the real table, and the real table covers parts of the two virtual chairs. AR can be thought of as the "middle ground" between VE (completely synthetic) and telepresence (completely real).

#### **Goals of Augmented Reality:**

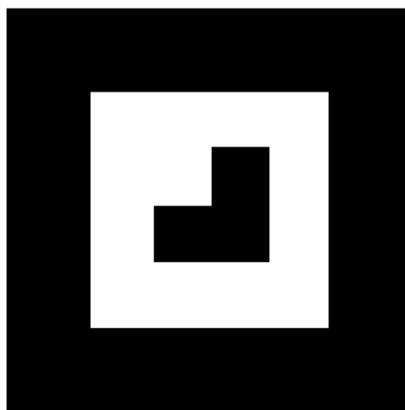
- To challenge the impossible.
- To create virtual environment for a more rich user experience.
- To integrate it into daily lives to help the masses.
- To achieve feats which are limited in real world.
- To enhance imagination of youths.

#### **Types of Augmented reality:**

There are two types of simple augmented reality: marker-based which uses cameras and visual cues, and marker less which use positional data such as a mobile's GPS and compass. (Johnson et al, 2010)

#### **Marker based**

Different types of Augmented Reality (AR) markers are images that can be detected by a camera and used with software as the location for virtual assets placed in a scene. Most are black and white, though colours can be used as long as the contrast between them can be properly recognized by a camera. Simple augmented reality markers can consist of one or more basic shapes made up of black squares against a white background. More elaborate markers can be created using simple images that are still read properly by a camera, and these codes can even take the form of tattoos.



**Fig 2: A simple marker**

A camera is used with AR software to detect augmented reality markers as the location for virtual objects. The result is that an image can be viewed, even live, on a screen and digital assets are placed into the scene at the location of the markers. Limitations on the types of augmented reality markers that can be used are based on the software that recognizes them. While they need to remain fairly simple for error correction, they can include a wide range of different images. The simplest types of augmented reality markers are black and white images that consist of two-dimensional (2D) barcodes.

#### **Marker less**

In marker-less augmented reality the image is gathered through internet and displayed on any specific location (can be gathered using GPS). The application doesn't require a marker to display the content. It is more interactive than marker based augmentation.



**Fig 3: Marker less AR**

The only real difference from a consumer's perspective is that the surface the object is sculpted on doesn't have to have that.

#### IV. MARKER DESIGN , DETECTION AND RECOGNITION METHOD

Markers are square and constituting of black thick border and black graphics within its white internal region. The advantage of using black and white colour is to separate marker from background in grabbed frame easily. Internal region of a marker marks identifier of it. In term of projective geometry, square markers in real world could not be square after projecting onto image plane, in other words, internal graphics in markers often display in distortion. When recognizing them, image unwrapping is necessary.[4] The procedure of unwrapping image is shown in Fig.4.



Fig 4: Procedure of unwrapping marker image to find ID

The calculation of marker unwrapping could be described as follows:  $(x_c, y_c), i = 1, 2, 3, 4$  as four corners of a marker are acquired after detecting grabbed frame. Positions of four corners are known in the real world as  $(x_m, y_m), i = 1, 2, 3, 4$ . Homography matrix H could be calculated in (1). By H points in internal region of marker could be unwrapped to formal one.[4]

$$\begin{bmatrix} hx_c \\ hy_c \\ 1 \end{bmatrix} = H \begin{bmatrix} x_m \\ y_m \\ 1 \end{bmatrix} = \begin{bmatrix} N_{11} & N_{12} & N_{13} \\ N_{21} & N_{22} & N_{23} \\ N_{31} & N_{32} & 1 \end{bmatrix} \begin{bmatrix} x_m \\ y_m \\ 1 \end{bmatrix} \quad (1)$$

After that, unwrapping image are used to match templates in matching method or decode in code-decoding method respectively.

#### V. PROBLEM STATEMENT

The proposed system aims to provide an environment that will help the users to place artificial 2D as well as 3D objects into real world through the use of AR Markers. The proposed system also allows the user to decide, where to place the object in real world. Once the object has been placed in the scene, it will be displayed accurately according to the perspective in the original scene, which is especially challenging in the case of 3D virtual objects. The proposed system solves the problem of viewpoint tracking and virtual object interaction. The main advantage of the proposed system is that, it is customer oriented and not product or service oriented thus allowing the users to augment a product of their wish.

#### VI. WHY ANDROID OS

Since the advent of 2010 more and more stress has been given on the usage of Free and Open Source Software (FOSS). Android is leading the current O.S market as shown in figure 5, because it is open source and developed by a consortium of more than 86 leading M.N.C's called Open Handset Alliance (O.H.A). Android also is stated as one the most rapidly growing technologies. More and more applications have been developed and modified by third party user.

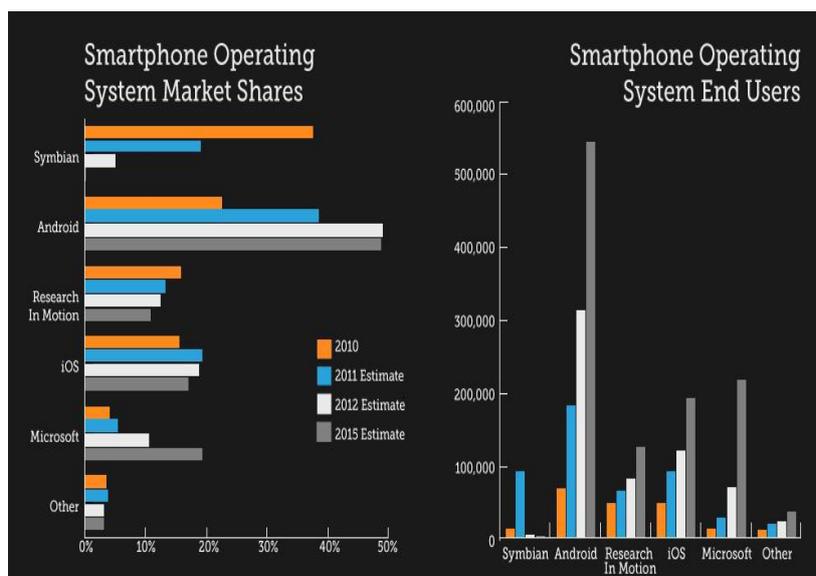
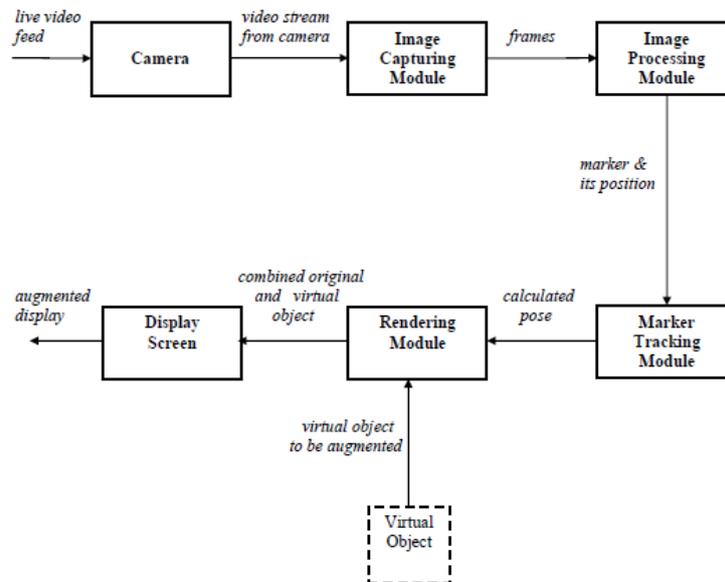


Fig 5: Smartphone OS market shares

Moreover, the Android O.S is user friendly. It has a great performance and processing power. Thus, the proposed system is being developed for the most rapidly emerging and flexible O.S- “ANDROID”

## VII. PROPOSED SYSTEM ARCHITECTURE



**Fig 6: Architecture Block diagram**

The proposed system is a marker based system and its architecture as shown in figure 6 contains following modules.

1. Camera
2. Image Capturing Module
3. Image Processing Module
4. Rendering Module
5. Display Screen

### 1 Camera:

A real-world live video is feed as an input from the Android cell phone camera to the Camera module. Displaying this live feed from the Android cell phone camera is the reality in augmented reality. This live video stream is given as an input to the Image Capturing Module.

### 2 Image Capturing Module:

The input to Image Capturing Module is the live video feed from the camera of a mobile device. This module analyses the camera feed, by analysing each frame in the video. This module generates binary images i.e. a digital image that has only two possible values for each pixel. Typically the two colours used for a binary image are black and white. These binary images are provided as an input to Image Processing Module.

### 3 Image Processing Module:

Inputs to Image Processing Module are the binary images from Image Capturing Module. These binary images are processed using an image processing technique to detect the AR Marker. Detection of AR Marker is essential to determine the position, where to place the virtual object. Once the AR Marker is detected, its location is provided as an input to the Tracking Module.

### 4 Marker Tracking Module:

The tracking module is “the heart” of the augmented reality system; it calculates the relative pose of the camera in real time. The term pose means the six degrees of freedom (DOF) position, i.e. the 3D location and 3D orientation of an object. The calculated pose is provided as an input to Rendering Module.

### 5 Rendering Module:

There are 2 inputs to Rendering Module. First is the calculate pose from the Tracking Module and other is the Virtual Object to be augmented. The Rendering Module combines the original image and the virtual components using the calculated pose and renders the augmented image on the display screen of the mobile device.

## VIII. PROJECT CONSTRAINTS

Augmented reality still has some challenges to overcome. Augmented Reality systems are expected to run in real-time so that a user will be able to move freely within the scene and see a properly rendered augmented image. The application will be built for mobile phones which usually have low screen dimensions and resolution. It also adds additional stress on the O.S because it requires high processing power to augment. Developers of the application are supposed to have a thorough knowledge of Android O.S (Applications developed for) and Windows O.S (Application developed in). Developers are also supposed to be familiar with ADK (Android Development Kit) and Eclipse.

## IX. APPLICATION AREAS

A picture is worth thousand words. The applications of this project are well understood from below snaps which shows virtual objects in real world environment.



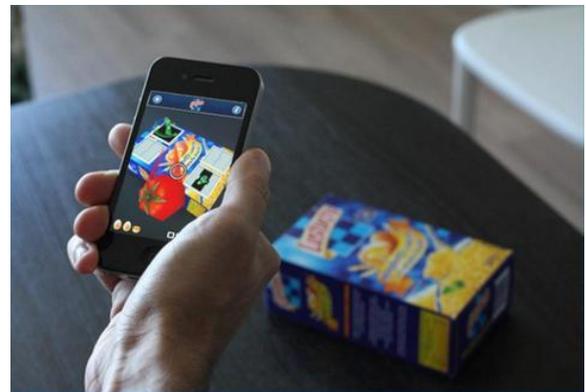
Medical Science [11]



Fashion World [12]



Gaming [13]



Product Information [14]

## X. CONCLUSION AND FUTURE WORK

This paper proposes a marker based augmented reality application using Android operating system which will help to combine virtual objects with the real environment facilitating various applications as mentioned in this paper. The main advantage is use of low cost devices as compared to the costly head mounted display devices. Secondly with the help of this project you need not buy product and then see how it will suit your environment. In future images of objects from various views can be fetched directly from vendor's websites; same could be modelled into a 3D objects and augmented. Also multiple objects will be augmented which is currently a major challenge.

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