Augmented Reality Application for Home Shopping in M-Commerce using Markerless Tracking

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***Abstract*—Augmented reality brings components of the digital world into a person's perception of the real world. Mcommerce is constantly changing and those wanting to get ahead in the market need to have their finger on the pulse. More than half number of shoppers abandon their carts before completing a purchase or return a particular product saying that it was not as expected. This indicates that retailers need to do a lot more to convince customers to follow through with their choice and purchase items online. Augmented reality has the potential to reshape the world of retail.**

The Augmented Reality Application for Home Shopping will help users to get a better view of the product by providing it's virtual representation. It gives the user a mocked-up version of how their home could look when fitted out with various items or products. The major problems that Mcommerce sites face is user's feedback that the product was not as expected. The entire scene that users see is a virtually generated version of a home, and the immersive experience allows them to become spatially aware of how various products would appear. The current market works on Marker-based Tracking which hampers the true value of Augmented Reality. The proposed idea provides an idea of using Markerless Tracking which is more efficient and requires less effort from user's side as compared to Marker-based Tracking.

Keywords— Augmented Reality, M-commerce, Markerless Tracking , Neural Network , Feature Matching .

I. Introduction

Augmented Reality is a technology which helps to enhance the real world environment by providing Virtual elements, sound effects and any other form of visual stimuli. The basic advantage of using AR is that it enhances the features of the real world environment. This helps in understanding the real world environment in a more better way by boosting users imaginative skills. AR provides a better insight of the real world which can help the retailers to a greater extent. The retailers can understand customers buying pattern,habits,etc and then provide better visualization to the customers of the products they intend to buy. AR works by changing the physical world by adding superimposing computer-generated images. The computer-generated images are 3D models which are dropped onto the physical view of the environment. This superimposing of images on the physical view can be done using either of the 4 types of AR. These 4 types are:

1. Marker-based AR.
2. Markerless AR.
3. Projection-based AR.
4. Superimposition-based AR.

These virtual images must be tracked on the physical view and the view must be rendered continuously. The major tracking techniques are marker-based tracking and marker-less tracking. The main disadvantage of marker-based tracking is that it requires a special visual object on which the virtual images are superimposed. This visual object can be anything from QR code to special signs. This visual object acts as a marker. The camera then scans this marker and calculates the position and orientation to drop the virtual image on the view. Considering an online shopping application, it is not always convenient for the user to carry a marker to view a particular product. This is where Markerless Tracking comes into view. Markerless Tracking does not require a marker rather it calculates the desired parameters based on users current location. Markerless Tracking uses SLAM - simultaneous location and mapping.

AR can be developed on various platforms like Unity, Blender, etc. Many SDK's are available to make the possible usage out of AR. The best SDK's that are currently available in the market are Wikitude, Vuforia, Kundan, ARToolkit, Apple ARKit and many more. Each SDK has it's own way of using AR applications. Based on our research, we are using Unity Engine and Vuforia SDK for our applications implementation. Vuforia is one of the best SDK available which is free and is available for both Android and iOS. Also, the basic features required for our application ,i.e , 3D Object Tracking, GPS, Cloud Storage and compatibility with Unity Engine are satisfied by this SDK. So considering all the alternatives, this the best choice for our particular application.

The application is being developed with the intention of providing a better shopping experience to the users. The disadvantage of online shopping is that users don't get what they expected. This leads to lots of rejections and the users may abandon the usage of the site which in turn may lead to decrease in the user base of the retailer. The application provides a virtual view of the products which the user intents to buy. As it uses Markerless Tracking, it provides a greater scope to the user to drag and drop the product in the physical view, as and where required.

I. Literature Survey

1. *Implementation of Mobile Augmented Reality Based on Vuforia and Rawajali by Cheng Xiao, Zhang Lifeng* :
   This paper proposes an application framework, the function of system core class and application workflow. This paper illustrates the use of Vuforia SDK for image recognition, to trace and register image markers and the working and Architecture of Vuforia.[5]

2. *Augmented Reality in E-commerce with Markerless Tracking by Xinyu Li, Dongyi Chen :*
   This paper proposes an approach to feature point correspondence of image sequence based on transient chaotic neural networks. Through this approach a new markerless visual tracking technology with image feature can be used in AR E-commerce applications. [2]

3. *Implementation of Augmented Reality System for Smartphone Advertisements by Young-geun Kim, Won-jung Kim :*
   This paper has used the markerless augmented reality system on smartphones to design and implement the smartphone application service aimed at efficiently conveying information on advertisements to users. This paper has also elaborated a few examples of Markers and Non-markers in Augmented Reality[3]

4. *Augmented Reality Using Vuforia for Marketing Residence by Dennise Adrianto, Monica Hidajat,Violitta Yesmaya :*
   This study paper was made to produce an application by applying Augmented Reality on the Android platform that is intended for marketing promotions of residence. This paper uses a software named Vuforia (QCAR) to implement augmented reality in mobile applications for marketing residence.[6]

II. Market Potential

This application has been designed by keeping in mind the growth of online shopping, hence it has greater market potential. It will help to increase user base of retailers, provide better shopping experience and high return on investment. These points are illustrated as follows :

A. *Increasing User Base of online retailers*

The application aims at providing a better shopping experience to the user by enhancing the users imaginative skills. It gives a virtual view of the product by superimposing the models on the physical environment. This will help the user in shopping and also will be considered as a fun way of shopping. Such an application will be appreciated by many users and will definitely help the retailers to increase their user base.

B. *Better Shopping Experience*

The application will provide a virtual view of the models and the users can drag and drop the models in the physical view, wherever they desire to. This will provide a very interactive way of shopping from the users perspective.

C. *Return on Investment*

As the application will help to increase the user base, the return on investment will definitely increase. The users will turn more towards online shopping and this will provide an opportunity to the online retailers to increase their sales and thus, finally will lead to achieve high return on investment.

III. Unity and Vuforia

Unity 2017.3 offers out-of-the-box support for Vuforia 7. Developers can build cross-platform AR apps that blend 3D graphics with all types of physical objects and environments directly from the Unity editor. Vuforia provides cross-platform Augmented Reality support for Android, iOS, and UWP devices, through a single API, allowing developers to write their apps once and run them using the best available core technology. Starting with Unity 2017.2, Unity Developers have been able to create Vuforia-enabled apps using a simple authoring workflow and event-driven scripting directly in the Unity Editor. The Vuforia integration included performance optimizations, tight ongoing synchronization of features and fixes, and a native Unity workflow that enables developers to focus on creating the best AR experiences. With Unity 2017.3, support for Vuforia 7 have been introduced enabling developers to attach digital content to even more types of objects and environments using Model Targets and Ground Plane, while ensuring the best possible experiences on the broadest range of devices and operating systems. While ARCore and ARKit introduced baseline capabilities to enable AR at scale, Unity 2017.3 and Vuforia 7, provides the building blocks to create cutting edge AR experiences and unlock new categories of interactive applications.

Vuforia supports many types of targets that helps to provide a better virtual experience. These targets represent different types of virtual objects according to their various specifications, positions or orientations.

Vuforia-7 features or targets :

1) *Vuforia Ground Plane :*

   It enables to attach digital content to horizontal surfaces, like floors and tabletops, in everyday environments.

2) *Model Targets :*

   It is the latest evolution of Vuforia Object Recognition capabilities. Model Targets attaches content to objects based on their shape rather than detailed visual design to digital content. Model Targets also offers real-time 360º tracking and outstanding tracking robustness across a range of environments, lighting conditions, distances.With Model Targets, you can do things like replacing a user manual with visual instructions overlaid on the object.

3) *Image Targets :*

   Image Targets are the easiest way to put AR content on flat objects, such as magazine pages, trading cards, and photographs.

4) *Cloud Targets :*

   It enables to manage large collections of Image Targets from your own CMS. They are the best way to support product catalogs, print advertising, and any other application that benefits from easy versioning of large image sets.

5) *Multi Targets :*

   They are the best way to put AR content on objects with flat surfaces that may be viewed from multiple sides, or that contain multiple images. Product packaging, posters, and murals all make great Multi Targets.

6) *Cylinder Targets :*

   They enable to put AR content on objects with cylindrical and conical shapes. Soda cans, bottles, and tubes with printed designs are great candidates for Cylinder Targets.

7) *User Defined Targets :*

   They enable to place content in the real world using a camera image shot at runtime as the target. Users can create targets from images and surfaces found in their environment.

8) *Object Targets :*

   They are 3D objects that can be recognized and tracked 3D objects when scanned. Object Recognition works best with objects that are geometrically stable and have surface details.

According to the needs of our applications, the best options are Image targets and Multi-Image targets as they will provide a way to put the models on a flat surface and visualize them through all the directions and rotations.

IV. Proposed Architecture

A. *Input :*

The physical view of the environment (frame) where the user desires to view the virtual object is as shown in Figure[1.1]. The input view is captured through Mobile camera or Headset. It captures the images frame by frame and later all the operations are performed on these frames.

Figure 1.1 Input Frame

B. *Methodology :*

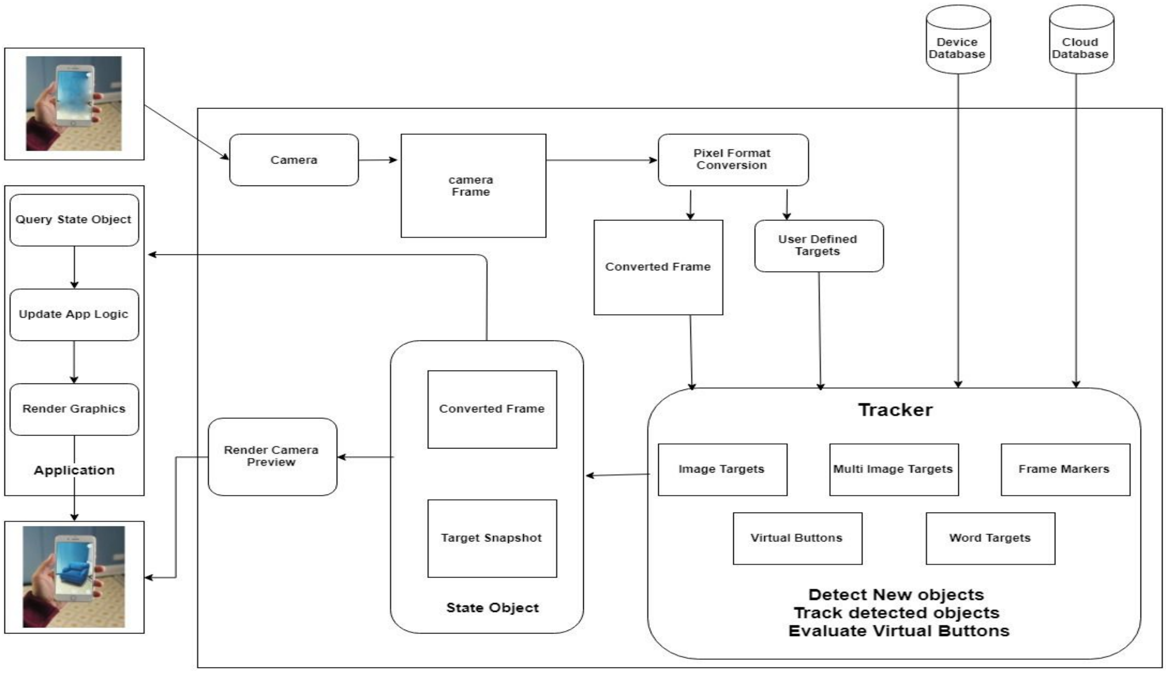

Figure 1.2 Architectiure Diagram

The input frame is processed through many steps to get the output frame. The input frame is firstly converted into pixel format. The reason to perform this conversion is that the application will be used on different platforms which will be having different hardware and graphics card specifications. To match this incompatibility, the frames are converted into Pixel Format. There are various formats available like rgb, bgr, gray scale, etc. Usually gray scale conversion is used for frame markers and RGB/BGR is used for other types of targets. For this application, we are using Image Targets, therefore we will be using RGB/BGR conversion. This converted frame along with user defined targets is provided as input to the tracker module as shown in the Figure[1.2]. The vuforia tracker module uses **QCAR** algorithm.

QCAR vuforia consists of a few number of algorithms to identify and to track the target and three-dimensional objects, allowing the user to adjust position of a virtual objects with real world images that displayed through the smartphone screen in real-time[6]. The virtual object will track the position of the image in real-time so that the view of the object and its environment can be in accordance with the user's view in the applications, which create virtual objects that appear similar to the real world [6]. It uses SIFT for feature extraction and neural networks for feature matching.

The working of SIFT and neural networks is given below:

SIFT(Scale Invariant Feature Transformation) :

Feature point extraction is an important preprocessing step in image processing and computer vision for applications such as image registration, object recognition among others [2]. SIFT transforms an image into a large collection of feature vectors, each of which is invariant to image translation, scaling, and rotation, partially invariant to illumination changes and robust to local geometric distortion.

The objects in the frame are detected using SIFT. The features of these objects is extracted considering various viewpoints, scale invariance, rotations and illuminations.

CNN(Convolutional Neural Network) :

CNN is made up of neurons with learnable weights and biases. Each neuron receives several inputs, takes a weighted sum over them, pass it through an activation function and responds with an output.

CNN image classifications takes an input image, processes it and classifies it under certain categories. Computers sees an input image as array of pixels and it depends on the image resolution.Technically, deep learning CNN models to train and test, each input image will pass it through a series of convolution layers with filters, Pooling, fully connected layers and apply Softmax function to classify an object with probabilistic values between 0 and 1.

Using CNN, Vuforia will perform feature matching. Vuforia has an online target resource database in which images of various objects are stored. The user defined targets are compared with the images in this database and accordingly, CNN performs the feature matching.

Using these two algorithms, we are detecting objects in the physical environment which are termed as user defined targets. The user can then select the products they desire to view in the physical environment. These products are stored in he Vuforia Cloud Database and can be fetched from there. There are two types of database which we will be using as shown in Figure[1.2]. The two databases are as follows:

Device Databases :

Vuforia Engine device databases enable the application to rapidly recognize targets. Device databases can be included in the app at installation or updated dynamically from a server.

Cloud Databases :

Vuforia Engine Cloud Recognition Service allows Vuforia Engine-enabled application to recognize image targets through a cloud database, giving the ability to update targets dynamically, integrate with the existing CMS, and manage more than one million image targets for a single app

The virtual models can then be dragged and dropped into the environment. The two algorithms, SIFT and CNN will help to calculate distances from user's point of view in accordance to user defined targets.

The tracker module will return an object consisting of the converted frame and target snapshot. Target snapshot acts as a buffer so that when the user is continuously changing the view (by moving the camera's angle), there won't be any hindrances. This object will be send to the Android Application. The android application's elements are accessed using Query State Object which is a DAO class in Android. Through this, the application logic is updated. Finally the camera's view is rendered so that user can see the Virtual Object.

C. *Output :*

The Figure[1.3] shows desired output of the application is superimposition of virtual object on the physical view of the environment. The virtual model can be dragged and dropped in the environment wherever the user desires to place the product.

Figure 1.3 Output Frame

V. Conclusion

This paper presents the idea of using Augmented Reality for Home Shopping to create a better shopping experience and to avoid rejections and returns of the product. The proposed model uses Markerless Tracking to provide ease to the user. The proposed architecture uses Unity for visualization along with Vuforia SDK. Vuforia SDK uses SIFT for feature extraction using which we can detect objects considering various viewpoint, rotations, scale invariance and illuminations. It uses CNN for feature matching. CNN is feed-forward network which constantly keeps on learning. Using these algorithms, the features of the physical environment are extracted and are mapped using CNN to detect the type of objects in the environment.

The application mainly focuses on changing the way of shopping by using Augmented Reality. Through this application, users can see the virtual images of the product beforehand thus, increasing the M-commerce retail market.

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