Augmented Reality And Ubiquitous Computing using HCI

Ashmit Kolli

MS in Data Science
Michigan Technological University
CS5760 Topic Assignment 2
akolli@mtu.edu

Abstract:

Direct use of the hand as an input device without using a screen is an attractive method for providing natural human–computer interaction (HCI). Using of hand is also very efficient because it offers computer to be controlled with high degree of freedom via gestures. Currently, the most effective tools for capturing hand motion are electro-mechanical or magnetic sensing devices. These devices are worn on the hand to measure the location of the hand and the finger joint angles. However, they are very expensive and require complex calibration and setup procedures to be able to obtain precise measurements.

Whereas, Ubiquitous computing and Augmented reality provide Interaction with a computer without realizing that you're interacting with a computer. Imagine a home where you can walk into a different room, and the temperature is adjusted to your preference, and the closest TV turns on and continues playing that sitcom you were watching in the living room this would be possible with ubiquitous computing.

Augmented Reality (AR) is a technology which allows computer generated virtual imagery to exactly overlay physical objects in real time. Unlike virtual reality (VR), where the user is completely immersed in a virtual environment, AR allows the user to interact with the virtual images using real objects in a seamless way.

Introduction:

The first AR prototypes was created by computer graphics pioneer Ivan Sutherland and his students at Harvard University and the University of Utah, in the 1960s.

AR supplements the real world with virtual(computer-generated) objects that appear to coexist in the same space as the real world objects. Augmented reality brings out the components of the digital world into a person's perceived real world.

A marker-based AR works on concept of target recognition. The target can be 3D object, text, image, QR Code called markers. After detection of the marker by AR engine, virtual object can be displayed on the student's application camera screen.[1]
Sensor based AR tracking allows the accelerometer, gyroscope and GPS of the Smartphone capabilities to gather information about the surrounding area and to display virtual objects or texts overlaid in the real world depending on the location of the user.

**Flow From Real Environment To Virtual Environment**

<table>
<thead>
<tr>
<th>Reality</th>
<th>Augmented Reality</th>
<th>Augmented Virtuality</th>
<th>Virtual Reality</th>
</tr>
</thead>
</table>

Figure 1: This shows Flow of different technologies which goes from the real environment to totally computer generated virtual reality.[1]

**Background And Related Work:**

Augmented Reality has a lot of potential to ease the communication between a computer and the user. It is where the entire real world isn't replaced by the virtual objects but where a certain virtual objects are superimposed on the real environment object. Since it merges real world with the virtual world, we need displays which can range from handheld devices to see through head mounted displays to projection based devices a mobile AR UI is context aware and can align itself according to the orientation of the handheld device is being held[2].

Handheld devices are the ones I prefer to run my application on since they’re least expensive of the other options as well as it has a wider reach than the others and could be utilized even by a person who isn’t well versed in the technological field.

Augmented reality objects are shown in three dimension and is processed in real-time.

Early tracking techniques are restricted to indoor use as they require special equipment to be placed around the user. Modern Augmented reality started with the use of square markers to display the virtual object on top it which progressed to QR code being used as the Marker and now markerless augmented reality is possible by utilizing various sensor trackers - one of the most common sensor used is GPS for gathering the location of the user[1].
**Proposed System:**

The textbooks which are used by students have remained the same even with the advent of the technological age. Augmented reality can be used to embed the textbooks of students with videos explaining the concept in greater detail. This technology can also be used to save trees by cutting down on the paper by reducing the number of pictures displayed in the textbook by replacing a cluster of images with a marker which when scanned by the augmented reality application, can display the pictures on the smartphone of the user. The Students of the Architect school could also use this application to see the three dimensional view of their design of the building. Similarly, Mechanical engineers can see the 3D models of the parts they have created in MATLAB superimposed into the real environment and could check whether the part they designed is of the right dimension.

Tourists and Travellers can utilize the augmented reality application to get real time information about the monument or the place they’re currently in. This would be possible by the application utilizing the GPS sensor of the Smartphone. Tourists can also get more information about a painting or a fossil when they visit the museum or more information about an animal in the zoo or a fish in the aquarium. This would be possible when the augmented reality application detects the tracker in the form of a QR Code in the description board of the fossil or an animal which shows more information in the form of texts as well as pictures and videos to the user.

**Block Diagram:**

![Block Diagram](image_url)

*Figure 2[1] : AR Framework*

**Components of the Block Diagram:**

- **Environment** (incl. markers, UI, gestures, etc.)
- **Sensing (capturing)**
- **API**
- **Application** (handle markers, UI, gestures, etc.)
- **Tracking (measuring)**
- **Registration (rendering)**
- **Display** (video, audio, haptic, etc.)
**Augmented Reality Application:**

This application has a built-in camera module which can track markers and present the virtual objects to the user. It has the permission to access the Accelerometer, gyroscope and the GPS sensors of the mobile smartphone.

**Scenario 1** - when the user points the camera and the application detects a marker in the form of a QR code in the textbook, it displays the information in the form of videos and pictures to help the student understand the concept better.

**Scenario 2** - The application can detect the location of the user and display the information related to the geolocation of the user. IE - when the user visits Eiffel Tower, the application can detect that the user is in Paris in front of the monument and can display more information about that particular place.
**Scenario 3** - The user can pan the camera, using Geolocation and image processing, the application can display the name and ratings of the places present around the user (Museums, zoo, restaurant, etc.) along with the distance of the place from the location of the user.

![Scenario 3](image1)

**Scenario 4** - The architect Student can import their 2D sketches of the buildings by printing out the square marker or the QR code which contains the information about the model and see it get projected in three dimensional view. Similarly, Mechanical students can directly project their models on real world parts to see whether they are of the appropriate dimension.

![Scenario 4](image2)
Augmented Reality Markers/Target:

Sensor Based Tracking Technique:

Sensor based trackers utilizes the sensors found in the smartphone to present augmented reality to the user. Sensors include the gyroscope, Accelerometer, Camera, GPS sensors found in the smartphone.

Vision Based Tracking Technique:

The most common vision based markers are the square markers which when scanned by the augmented reality application, replaces the square marker with a virtual object which has been programmed to appear when that particular square marker is scanned. Recently, QR codes have been preferred for their ability to store a lot more information which can be presented to the user when it’s scanned.

Application Program Interface(API):

These are the set of routines and protocols which have to be adhered to while getting permission from the user to access their smartphone’s camera and it’s other sensors for the working of the augmented reality application using sensor based tracking.

Challenges:

GPS Inaccuracy - Although, GPS is only accurate to within 30 feet (9 meters) and doesn't work as well indoors, Improved image recognition technology will be able to help by processing the image more efficiently.

Lag - System latency can also be reduced through careful system design, and pre-rendered images that can be pulled up the last instant to reduce the processing load on the smartphone processor and reduce the lag.

Social acceptance - Getting people to use AR may be challenging than expected, and many factors play a role in social acceptance of AR ranging from dangers of using augmented reality on street without paying attention to the surroundings to privacy concerns. A pop up can be displayed on the application start up advising them to be conscious about their environment.
Overload and over-reliance - The user interface must also follow some guidelines as not to overload the user with information and also prevent the user to overly rely on the AR system such that important information from the environment are missed. For Example, The user interface should be designed in such a way that the application only provides additional information but should not be the sole provider of information.[1]

Conclusion and Future Work:

Augmented Reality is used to ease the interaction between the computer and a human being. More research should be done in the rendering and calibration techniques so that the interaction becomes even more smooth. The future of augmented reality points towards Markerless rendering where a virtual object can be superimposed in a real world object without the use of any markers. This technology can be utilized in e-commerce business to sell the products by giving the customer to virtually try on the product (Dress, Spectacles, Etc.) before purchasing them.

References:


Bibliography:

Ashmit Kolli (akolli@mtu.edu) is a graduate student in the department of Data Science at Michigan Technological University. His interest include Data Mining, Data Processing and User Interface Designing.