Mobile Application Development with Augmented Reality

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Abstract—Recently, because of the rapid development of mobile devices, augmented reality has extended from personal computers to mobile devices. They are getting popular as a platform for Augmented Reality (AR) application such as a Smartphone. The highly interactive nature of augmented reality with its user has given rise to various augmented reality applications for mobile devices, ranging from mere interaction to marketing, games, navigation, and so on. Mobile AR is mainly available whenever people require an informational support for a focused task. The combination of mobile applications and collaborative Augmented Reality into a single system makes the power of computer enhanced interaction and communication in the real world accessible anytime and everywhere. The objectives of the proposed work include main aspects of Augmented Reality (AR) for development of mobile applications. It describes the main fields in which mobile applications are developed using AR devices & systems. A mobile platform implementing the described features and collaboration between mobile and augmented reality is being demonstrated.

Keywords- Augmented Reality, Virtual Reality, Scientific Visualization, Unity Game Engine, Application Development

I. Introduction

Augmented Reality (AR) is a new technology that involves the overlay of computer graphics on the real world. One of the best overviews of the technology is [1], that it defines the field, describes many problems and summarizes the developments up to the point. This paper provides a starting point for anyone interested in researching or using Augmented Reality for mobile application development. The roots of Augmented Reality dates back to 1962 while AR based application development for mobile devices started around 10 years back. There has been exponential growth in mobile application development since the iPhone AppStore opened in July, 2008. Since then, device makers have created application outlets for other mobile platforms, including Android, BlackBerry, Nokia Ovi, Windows Phone, and more. Industry analysts estimate that there are millions of applications available through the various application stores, many of which are available cross-platform.

Augmented Reality has entered into its mobile era through the emergence and advances of geo-tagging. AR can redefine the way of those geo-tags as information can be displayed into users' real-world view more cognition-effectively [2]. With the emergence of advanced and affordable head-mounted display such as Google Glass, AR can be made more accessible and effective to the general public.

Augmented Reality has great potentials in eLearning; forming the basis of augmented learning. It expands the definition and scope of augmented learning, which is brought into a next level. Augmented Reality can create a new era for situated learning by integrating itself with mobile learning and other concepts and technologies. With AR, there would be no need to define the learning contexts and environments, as the real-world environment will be embedded with virtual technologies. A comprehensive one-suit-all learning materials would no longer be useful as each individual can be the teacher and learner for themselves [3].

II. General Concepts

A. What is Augmented Reality?

Augmented Reality (AR) is the augmentation or superimposing of elements by computer generated sensory such as video, GPS data or graphics over the real world environment. It can be understand more precisely by a concept called mediated reality in which artificial information can be add or subtract or manipulate or overlaid on the real world. With the help of advanced AR technology, information about the real world becomes interactive and manipulable to/by the user.

Augmented Reality in Mobile applications lets user interact in real time by overlaying digital information onto the real

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world. Mobile Augmented Reality application projects explores utilizing camera equipped mobile devices as platforms for sensor-based, video see-through mobile augmented reality. The project also investigates new and exciting applications enabled by this technology, and UI solutions and paradigms motivated by the restrictions of the mobile devices.[4]

B. How Augmented Reality works?
Video games have been entertaining us for nearly 30 years, ever since Pong was introduced to arcades in the early 1970s.Computer graphics have become much more sophisticated since then, and game graphics are pushing the barriers of photorealism. Now, researchers and engineers are pulling graphics out of your television screen or computer display and integrating them into real-world environments. This new technology, called augmented reality, [5][6] blurs the line between what's real and what's computer-generated by enhancing what we see, hear, feel and smell.

On the spectrum between virtual reality, which creates immersive, computer-generated environments, and the real world, augmented reality is closer to the real world. Augmented reality adds graphics, sounds, haptic feedback and smell to the natural world as it exists. Both video games and cell phones are driving the development of augmented reality. Everyone from tourists, to soldiers, to someone looking for the closest subway stop can now benefit from the ability to place computer-generated graphics in their field of vision.

Pervasive game is something, where the gaming experience is extended out in the real world. Pervasive gaming is an emerging genre in which traditional real world games are augmented with computing functionality. There are several types of pervasive games as:

Smart toys: Most toys are equipped with simple sensing technologies linked to computer logic. Logic reacts according to the change in toy's physical state by either playing sound as displaying graphical information.

Affecting Gaming: Affecting computing is described as "computing that relates to, arises from, or deliberately influence emotions" and effective gaming aims to integrate a player's emotional state into a game environment to create a magical gaming experience.

Table-top Games: While affective gaming mainly focuses on using physiology state parameters to exchange information with virtual game elements, augmented table top games also integrate the state of players as central to the gaming experience (in virtual domain).

Augmented reality is changing the way we view the world -- or at least the way its users see the world. Picture yourself walking or driving down the street. With augmented-reality

displays, which will eventually look much like a normal pair of glasses, informative graphics will appear in your field of view, and audio will coincide with whatever you see. These enhancements will be refreshed continually to reflect the movements of your head. Similar devices and applications already exist, particularly on smartphones like the iPhone.[7]

Augmented Reality on Cell Phones While it may be some time before you buy a device like Sixth Sense, more primitive versions of augmented reality are already here on some cell phones, particularly in applications for the iPhone and phones with the Android operating system. In the Netherlands, cell phone owners can download an application called Layar that uses the phone's camera and GPS capabilities to gather information about the surrounding area. Layar then shows information about restaurants or other sites in the area, overlaying this information on the phone's screen. You can even point the phone at a building, and Layar will tell you if any companies in that building are hiring, or it might be able to find photos of the building on Flickr or to locate its history on Wikipedia.

Layar isn't the only application of its type. In August 2009, some iPhone users were surprised to find an augmented-reality "easter egg" hidden within the Yelp application. Yelp is known for its user reviews of restaurants and other businesses, but its hidden augmented-reality component, called Monocle, takes things one step further. Just start up the Yelp app, shake your iPhone 3GS three times and Monocle activates. Using your phone's GPS and compass, Monocle will display information about local restaurants, including ratings and reviews, on your cell phone screen. You can touch one of the listings to find out more about a particular restaurant. [8]

There are other augmented reality apps out there for the iPhone and other similar phones -- and many more in development. Urbanspoon has much of the same functionality as Yelp's Monocle. Then there's Wikitude, which finds information from Wikipedia about sites in the area. Underlying most of these applications are a phone's GPS and compass; by knowing where you are, these applications can make sure to offer information relevant to you. We're still not quite at the stage of full-on image recognition, but trust us, people are working on it.[9]

C. Handheld Augmented Reality
Handheld Augmented reality is the interaction between users and real world through overlaid augmented information onto the real environment in handheld devices such as mobile phones, tablets.
Augmented reality is categorised into 3 display technologies in which Handheld display technology has better advantage over other. The reason is:
- Handheld technology is extremely portable and widespread.

- Handheld technology adequate processing power and local network makes it a suboptimal platform for rich and unambiguous Augmented Reality applications.
- As the touch screen input mechanism is familiar, Users finds it effortless and socially acceptable.
- Handheld technology can be used in both indoor as well as outdoor environment.

Handheld Augmented reality is an exciting perception for AR gaming, Navigation, learning in handheld devices. It uses the computational/graphical power, compass, tilt, GPS, integrated camera and such of Handheld Devices.

III.   Related Works

A. Some famous AR based apps
There are various renowned applications that uses augmented reality as their base to develop mobile applications. Some of them are-

- *Here City Lens:*

Here City Lens (formerly Nokia City Lens) is AR based app for Windows Phone 8. It allows user to find things to do – and get more information about a location – simply by pointing their phone's camera at a location. [10] The app was released in beta back in May, 2012 and the final version of the app is currently available in the Windows Phone store. The app uses the compass and camera view finder sensors to locate places and superimpose the right information on right place.

- *Wikitude World Browser:*

Wikitude World Browser is an augmented reality based app which is available on Windows Phone, iOS and Android. While using your smartphone's camera in a given area, the virtual browser — along with more than 3,500 associated content providers — offers you just about any geographically-relevant information you may find valuable in your travels. Useful information is often presented in the form of Wikipedia articles detailing the hallmarks of a specific landmark, or directions to the nearest ATM location or five-star restaurant.[11]

- *Google Ingress:*

Google ingress application is only available for android. It is an MMO(massively multiplayer online) game that puts players into two factions – the Enlightened and the Resistance – and has them fight of virtual territories in a giant game of king of the hill.[12]

B. Working of "Here City Lens"
We have studied a mobile application based on Augmented Reality namely HERE City Lens.

- *User Interface*

Here City Lens has a simple user interface. Using the phone's camera viewfinder, Nokia City Lens provides an augmented reality overlay view of buildings and instantly highlights places of interest.

It basically turns sight into the next interface for searching the world around the user. The app then provides information about each building or landmark in the area giving the user an at-a-glance understanding of what restaurants, museums, shops and others places of interest are nearby. Seeing a place of interest through augmented reality provides a wealth of information not available with the naked eye, allowing the user to see the world around him/her using smartphone instead of having to perform web searches.

Fig. 1: Seeing the world around through Here City Lens using the camera of smartphone
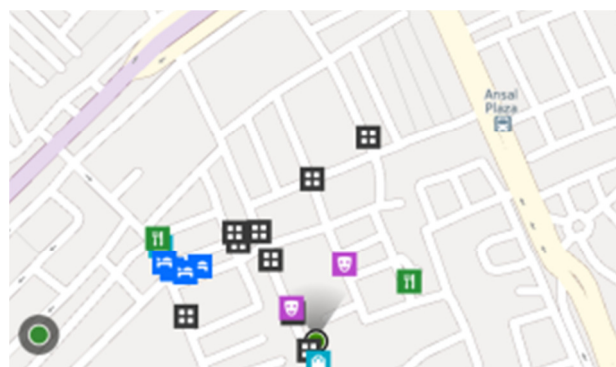

Fig. 2: Seeing the locations on map while holding the device lying down on palm

The here city lens uses new 3D icons layout, which makes the augmented reality experience look even more realistic. It also fixes a common problem of augmented reality apps. If the user doesn't see a place in real life, because it's hidden behind a building, he/she might want to see it or not among nearby search results. It gives user the choice: he/she is able to filter search results so that only those in the line of sights are visible.
It also gives option to find the route to selected destination using Nokia's here drive turn-by-turn GPS navigation.[12]

- *Components*
  - Here City Lens uses following components of smartphone to give information to user:
  - Camera: Used to view around and information is superimposed on live video stream of camera.

o Compass: Used in superimposing information on right places. Compass lets the application have direction information of nearby places with respect to user.
o GPS: Used by application to retrieve location of user and then get the information of nearby places.
o Maps: Used by application to show direction to selected direction and provide user with turn-by-turn navigation.
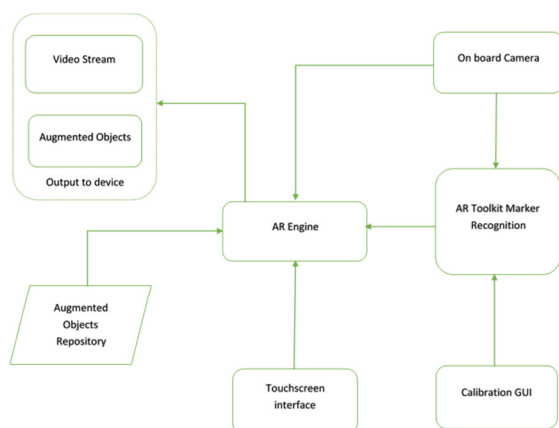
- *Working*

Nokia City Lens App uses Location-Based Augmented reality Technology.

Location-Based Services are accessible with mobile devices through the mobile network and which uses information on the geographical position of the mobile device, it can detect your position using the GIS-Geographic Information System- of your device then it gets the nearby locations for the restaurants, hotels, and etc. form Nokia Maps, then it converts it to Augmented Reality.

- *Mapping Process*

We can propose a working algorithm for Here City Lens on the basis of a general algorithm for mobile applications.

Here City Lens works on simple algorithm. It has its AR Engine in the core of application. The City Lens application now takes input from the On board Camera and by calibrating it with the help of Calibrating GUIputs the information in the AR Toolkit Marker Recognition system. AR Toolkit Marker Recognition System now feeds to information to AR Engine which then goes into the Augmented Objects Repository and fetches relevant data and creates information from it. AR Engine then superimposes live feed from camera with the relevant information and puts it on the display of the device in the form of Video Stream (from camera) + Augmented Objects. The user now sees the information of places in his/her screen superimposed over the feed from camera viewfinder.

IV. AR Apps Framework

A. Defining framework

Broadly Augmented Reality based applications can be divided into two categories:

- *Marker Based/ Image recognition:*

In marker/image based recognition, we create a marker and save its data into the application. This marker can be in the form of a bitmap image. While using the application, when the camera finds that image in the viewfinder, it gets to know from its marker repository that this image has been marked as a marker and then it pulls the information from its database about that marker. This information can be in the form of a 3D model or text about that image. This data is superimposed over the image to show the data.

List of development tools and SDKs for developing these applications:

o ARToolkit[13]- Android, iOS and Java Library
o SLARToolkit[14]- Silverlight and Windows Phone AR Toolkit
o Metaio Creator[15]- Applications for Junaio AR Browser

- *GPS Based:*

GPS based AR apps use the location of device retrieved using geo-location and then superimpose the information on screen about the nearby places.

For example, Here City Lens is a GPS Based AR application. These apps have a repository of information about places indexed according to location coordinates.

List of development tools and SDKs for developing GPS based applications

o Layar SDK [16]
o Wikitude SDK [17]
o Junaio [18]

B. Available SDKs to develop AR based apps

- *Metaio Creator:*

Metaio Creator is an excellent tool to build image/tracker based apps. The apps created using Metaio Creator can run on Junaio AR browser. Apart from this, Metaio Creator also gives capability to create apps in Eclipse or xCode environment and then deploy it using mobile Cloud-based application. The developer can also create AR scenario and export it to Metaio SDK to finalize it as a full offline mobile app. The developers can also create apps for Windows PC.

Metaio Creator takes an image to create the marker. In cloud based app this data is deployed over metaio cloud. A 3D object model is associated with the image. When the camera viewfinder finds the image which is already present in its repository, it fetches the associated 3D model and superimpose the 2D image with 3D model and display it on the screen. [15]

- *METAIO SDK:*

Metaio SDK is a complete solution to build Augmented Reality apps. Metaio SDK can help in building AR based apps for 3 platforms namely:
  - o Android
  - o iOS
  - o Windows PC

Apart from these, Metaio SDK also gives an option of building apps using Unity3D game engine. Unity3D is a very famous cross platform game development SDK which lets developer code just once and then deploy it on any of the multiple environments such as iOS, Android, Windows Phone, Windows PC, Web, xBox, PS3 etc. The integration of Metaio with Unity makes it easy to develop cross-platform AR apps.[19]

- *LAYAR SDK:*

The LAYAR app is also very famous in iOS environment but with the help of LAYAR SDK, developers can build AR based apps for multiple platforms. [16] LAYAR offers two types of SDKs

- VISION SDK:

LAYAR VISION SDK is image/marker based AR app creator. The developers can include content from LAYAR Creator or content which is built using LAYAR API.

- GEO SDK:

Geo LAYARS let developers create the location based AR apps. Developers create the layer of maps with location based data which is superimposed upon the map. The map can be found using the camera (to see nearby locations) or by opening a 2D map.

C. Developing an AR Based app using SLAR Toolkit for Windows Phone

- *About SLARToolkit*

SLARToolkit is the Windows Phone and Silverlight library to make real time AR apps. It employs simple squared markers to make AR apps. The markers are pattern images with .pat extension. SLARToolkit is a free OpenSource library based on ARToolkit[13] and NyARToolkit[20].

- *Setting up the environment*

SLARToolkit for Windows Phone is supported on Windows Phone 8. We set up the environment by installing the Windows Phone 8 SDK [21]. Our project is inspired from the sample provided by the official developers [14] but we have created our own marker. SLARToolkit is an Opensource project, the source code and binaries for which can be downloaded from CodePlexhttp://slartoolkit.codeplex.com . We created a Windows Phone project and add references to these libraries in our project
  - o SLARToolkitWinPhone.dll
  - o Matrix3DExWinPhone.dll
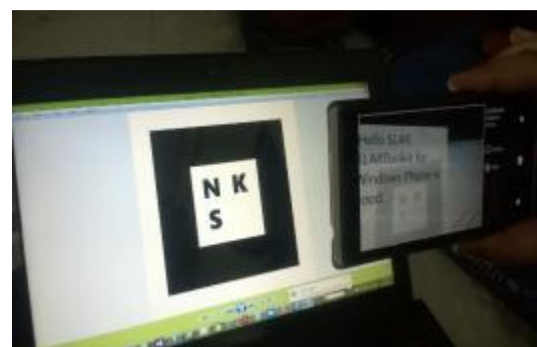
- *Creating the UI*

We create the UI for our app using XAML. In our app, there is a simple viewfinder and two RadioButtons called 'Text' and 'Image', the Text button will overlay the text over our marker and Image button will overlay an image over our marker.

- *The Code-behind*

We create the code behind the XAML in C#. This demo app uses PhotoCamera as resource and then we create an event handler OnNavigatedTo which initiates ARServices when this page is loaded. A snapshot of the current buffer is taken using GetPreviewBufferY [22] method. SLARToolkit'sMarkerDetector detect method then takes input from this buffer and this information is used to transform the UIElement (Text and Image in our demo) perspectivley in 3D.

User can switch between the image and text whichever he/she wants to be displayed.

V.   Future Aspects & Limitations

At present, augmented reality is just in its initial phase. And its future scope in mobile application is never-ending. Detailed studies suggest that it's the beginning of an era where information is just at your mobile glance. Though there

are many issues in mobile AR apps such as range of GPS, certain tracking issues and privacy concerns, still mobile AR apps can be referred as future 'senses'. For example if someone is deaf, mobile AR app can visually explain that person what the speaker is saying. Many of us also thinks that AR mobile applications provides only visual augmentation using camera. Well, this is somewhat inaccurate. Augmented sound, smell and touch are the new possibilities in AR field which ,upto certain extent, have established new checkpoints for future development in AR apps. One of the major problems that was faced by AR app user was the non-standardization of AR apps. user wants to use any app according to his choice without compromising the functionality, as we can use Internet explorer ,Firefox or Google chrome whatever we want but they all serves us same data when we use them, this was not the case with AR apps . The database in one AR browser cannot be operated by the user using another AR browser. But this will be solved soon as three of the most successful augmented reality application. Companies Wikitude, Layar and Metaio are going to be interoperable. It's the first step toward standardizing the AR apps.

VI.   Conclusion

With one in every five people owning a smartphone in the world, Mobile Applications with such a large user base of was just the right medium the concept of augmented reality needed to reach the general public with the support of various tech-aided development kits like ARToolkit, SLARToolkit and other software constituencies. With the wide spectrum of SDK's like Metaio, Layer and Geo coming off age, creation and deployment of augmented applications seems like the eye-candy for the developers.

With apps like Wikitude World Browser, City Lens Apps and Google Ingress being the pioneer s in the field of augmented reality based development for portable devices, the time has arrived for various Augmented reality based apps can aptly be coined as the "next-gen apps" in the department of development of mobile applications and hopefully one can expect a fair increment in the number of augment reality based apps in the near future.

ACKNOWLEDGMENT

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