MOBILE AR GPS–BASED FOR NAVIGATION PURPOSE

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ABSTRACT*: The ability of a mobile phone to support navigation systems and powerful operating systems creates an opportunity to explore the newly introduced technology – Augmented Reality – and its application with navigation systems. Augmented reality allows 3D Virtual Images to appear in a 3D real environment in real time and allow more interactivity for the users. In some ways Augmented reality navigation may be taken in with comparison to GPS navigation, but it concentrates more on enhancing reality than simply generating a map. Difference being seen in the way that the maps are created or generated, augmented Reality navigation displays a map through the use of the device's camera and GPS displays a 2D map. Instructions or commands for navigation are also of immense importance between the two, augmented navigation has easier commands to follow and GPS commands are just instructions, that is, augmented navigation will show the user where exactly to make a turn adding a safety feature of not letting the user get their eyes off the road as everything is in real time, so the user sees real driving conditions through their device.*

Keyword: Mobile Technology, GPS, Augmented Reality, Navigation System

1. Introduction

Throughout the years technology has advanced drastically with the sole purpose of bettering the lives of people that are highly involved in the use of sophisticated technology. In this regard, augmented reality has taken the levels of technology to another whole new level. Augmented reality has transformed the real world and virtual world creating a real life experience (Omar Choudary, Vincent Charvillat, Romulus Grigoras, Pierre Gurdjons) which is both in real-time, 3Dimensional and highly interactive. The Figure 1 shows the concept behind Augmented Reality.

But in order to fully understand the concept of augmented reality we have to explore its origins, the way it was initially designed, the graphics, and how it blended into the industry. Augmented Reality has a wide range of applications that have been implemented. The implementation of these applications has been in various working environments adding simplicity within that field. These environments range from aviation, medicine, education to advertising, navigation and manufacturing.

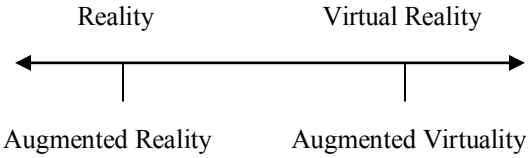

Figure 1: Concept of Augmented Reality

Augmented reality's main objective is to insert information and connotation to an actual object or situate (Educause Learning, 2005). Fortunately, the contrasting thing between virtual reality and augmented reality is that, augmented reality, suppresses the creation of a simulation of reality (Daniel Wagner and Dieter Schmalstieg, 2009). However, it uses a real object or space as the base and implements the use of technologies that add additional information that will increase the users understanding of the object (Educause Learning, 2005).

An augmented reality system is a system which creates a view of a real scene by incorporating digital virtual objects with full three-dimensional properties, into a scene (James Vallino, 1998). As the user of the system moves changes positions in the real scene the virtual objects somewhat appear just as they would as something that exists in a real world. These virtual objects should be able to interact with the user and real objects present in the scene in a normal, natural style. This way, we can see that augmented reality increases the user's performance and perception both in the real world (James Vallino, 1998).

In this paper, the authors discuss how a mobile Augmented

Reality navigation system is modeled to compensate for the needs of students within widely expanded universities. The users of the application will be able to Search for various places within a university, provided they have to idea of how to reach that place. The application will also allow its users to make transitions between theory related navigation, map navigation or the augmented navigation.

2. Problem Statement

Universities around the world are expanding structurally at a rapid rate especially when the number of students gets greater and greater with every enrollment period. As a result of being tremendous in size there is a great chance that some students would not be able to find their way around the campus with parents and newly enrolled students being the ones greatly affected. Data gathered from a research conducted in table 1 below madewith reference to Limkokwing University located in Malaysia, shows that from a pole of 100 students (50 being newly enrolled students and 50 old students of which 25 are males and 25 are females);

Gender	Find it hard to find a place around the University	
	New Students	Old Students
Males	22	15
Females	20	15

Table 1: Summary of Newly enrolled and old students that have issues related to getting around the University

The table above shows that forty two (42) newly enrolled students of the fifty (50) found it very hard to find a place and thirty (30) current students of the fifty (50) found it hard as well to navigate around the campus. This shows that student's do really have an issue of getting around the University. So it concludes that every student within the University if affected.

It is in this regard that the campus navigation system will be designed using a new technology referred to as Augmented Reality (AR). Augmented Reality will basically create a scenario whereby it will bring the virtual world into the real world. This will be an innovative way to make GPS navigation stand out – implementing Augmented Realityinto it. It will work by picking up video from the camera of an Android Smartphone or tablet and enhancing it using some Augmented Reality. This navigation system will be usable within campus with pre-determined destinations embedded into it.

Students will select a specific target location such as the clinic, library, and coffee shop and also restaurants and other recreational facilities situated within a particular area of the university. The system then computes the shortest path in a known network of possible routes. The information will be displayed as a series of waypoints that are visualized icons standing in the environment. These icons will be connected by arrows to show the direction the students should move between the waypoints. Simple directional information will also be displayed if the student is not able to distinguish the next waypoint if they are looking into the wrong direction.

3. Related Work

3.1. Mobile Augmented Reality

A vast area of technologies can be used together with augmented reality. In this year, plentiful augmented reality projects use handheld devices, especially mobile phones, in which they view data into the user's field of vision in conjunction with the object that the user is observing. These portable devices can use for example GPS data to provide users with context—including visual, audio, or text-based data—about real objects or places. Augmented reality is not an escort of text or multimedia files but a technology premeditated to view real objects or places and offer user's with appropriate information at the right time (Wagner, 2003).

One of the first ever created AR application embedded into a handheld device (Mobile phone) and dispatched to the public was the "invincible train" game (MiroslavAndel, Alexander Petrovski, 2006). The user would control the virtual scene, in this case the trains and be able to manipulate them to what they saw fit, unfortunately at this time the only form of interaction was via the use of a stylus pen.

Figure 2: Invincible train game

Augmented reality therefore stretches beyond personal computer platforms, there are mobile applications that have been created and are being used in various fields (Omar Choudary, Vincent Charvillat, Romulus Grigoras, Pierre Gurdjons, 2009).Augmented Reality delivers a highly visual interactive area for its users within a mobile computing application (Gerhard Reitmayr, Dieter Schmastieg, 2009).
Together with mobile devices, augmented reality has transformed the real world and virtual world creating a real life experience (Omar Choudary, Vincent Charvillat, Romulus Grigoras, Pierre Gurdjons, 2009).

3.2. Applications Of Mobile Augmented Reality

Augmented reality has been put to use in a number of areas, including medical imaging, where doctors can access data about patients; aviation, where tools show pilots important data about the landscape they are viewing; training, in which technology provides students or technicians with necessary data about particular objects they are working with; and in museums, where artifacts can be tagged with information such as the artifact's historical context or where it was discovered.
Within the academic section, AR is used for learning, mobile learning or web based learning. Educators are beginning to provide students with deeper, more meaningful experiences by linking educational content with specific places and objects(Oblinger, D, 2004). In many disciplines, field trips are part of the course; by supplementing these explorations with mobile technologies and data-collection devices (including digital cameras), the lessons can be extended beyond the trip (Manfred Bogen, Jürgen Wind and Angele Giuliano, 2006).
In some cases, augmented reality technologies have been integrated into educational games. In MIT's Environmental Detectives, for example, students learn about environmental sciences and ecosystems by finding clues and solving a mystery on the MIT campus using PDAs fitted with GPS devices.

3.3. Augmented Reality And Navigation Systems

One of the best applications designed for a mobile system to date is by far thee most effective for those individuals that travel frequently. The way we navigate around have evolved from written directions to atlases to GPS systems and now available on mobile phones. The introduction of navigation systems provides users with useful tools for navigation, communication and interaction.

Figure 3: Mobile Augmented Reality Navigation

Augmented Reality in navigation gives users the ability to move about in an area and be able to interact with that area in order to attain the guidance they require (Gerhard Reitmayr, Dieter Schmastieg, 2009). The users are required to carry their handheld device as they move through the augmented scene. In order to aid the user during movement there is a pin that is placed around and identifies the current location that the user is standing at and the final destination that they have selected. The plus side of this is that Augmented Reality Navigation can be used with GPRS systems depending on their location, indoors, GPS cannot be used as compared to when you are outside (Nicola Lenihan, 2004).

3.4. Platforms For Navigation

A mobile platform, also known as a mobile operating system is what operates an item, basically it makes it work, in this case a mobile phone. Within these mobile platforms users can perform various tasks which include communication, internet connection and reading documents. Due to the high demand of mobile phones new features are being made or created in order to add more functions and features thus increasing user productivity.(Allan Hammershøj, Antonio Sapuppo and Reza Tadayoni, 2009).
Currently, there are three widely used mobile platforms namely; Symbian, UNIX and Windows. Between the three of these platforms UNIX happens to be the only open source platform and easy to manipulate, whereas Windows and Symbian are underNokia and Microsoft companies.
Under the UNIX operating system there two widely used operating systems; these are the iPhone OS from Apple, Blackberry OS by Blackberry and Android OS from Google. Within each platform there are software development tools (SDKs), these are provided by the producers of that platform to help third party users create their own creative applications which they can later use for their own benefit together with other users on their mobile platforms. The source of the structure of each OS, developers manipulates

different parts of function of the OS through the use of Application Programming Interfaces (APIs).

3.5. Apple OS

Apple OS is developed by the Apple Company. This OS is available on two types of Apple devices; these are the IPhone and the IPod. Currently, the IPhone OS is considered the leading operating system that is widely used on mobile platforms within the market. The IPhone OS is a UNIX based open source platform referred to as Darwin, (EmilianoMiluzzo, James M. H. Oakley, Hong Lu, Nicholas D. Lane, Ronald A. Peterson, and Andrew T. Campbell, 2008).

Figure 4: IPhone OS framework

As shown above the platform framework has four different layers. When application development starts the developers program the application using the SDK that is released the Apple Company. All the programming is done using the Objective-C programming language. Upon completion of the application it is distributed via the App Store which is an open market for application managed by Apple itself.
Advantages of using the IPhone OS platform is that its libraries have open source applications and well organized APIs which help as a guidance for people that are planning on developing certain applications.
The only disadvantage of the platform is that the framework structure of the OS does not allow more than one application to share resources with the others.

3.6. Google Android OS

Emerging greatly from behind the scenes is the Google Android OS, developed and managed by Google, just like the Apple IPhone OS, Android is an open source mobile operating system that is now operational on a wide variety of mobile devices such as HTC Magic, Sony Ericsson Play and Matorola Quench. The Android operating system runs on a Java virtual environment based on a Linux system. The OS being a Linux based OS and combining itself with a Java environment allows its application developers to program using Java (Benjamin Speckmann, 2008). Upon completion of these applications they are published or posted in the Android Market then made available to other Android platform users.

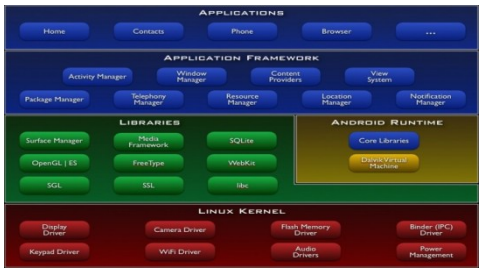

Figure 5: Google Android Framework

The advantage of using the Android OS is the fact that it is an open source and allows its users to connect and communicate using various hardware's. The architecture framework of Android also allows its developers to access the main components of the platform and transfer information from one application to another which unfortunately is not available with the Apple IPhone OS.
The disadvantage of using the Android OS is that it has a few developers that are knowledgeable with its programming language but statistics show that in the future Android will become the widely used mobile OS.

4. Research Objectives

This research aims at providing a simplified solution for students to know their way around the University and its areas through the use of Augmented Reality combined with a navigation system. Students should be able to walk around freely around the campus instead of walking around in circles and not getting any help. Some of the research objectives are;

i. To develop a suitable development methodology model for the development of the Augmented Reality for the navigation system known as the Rapid Application Development Life Cycle (RAD).

ii. To design and develop a suitable model of the Augmented Reality navigation System using the augmented reality techniques.

iii. To implement the Augmented Reality Navigation System giving special attention to its user interface and usability.

iv. To develop the prototype of the Augmented Reality Navigation System based on the Tangible User Interface.

v. To test the strengths and weaknesses of the Augmented Reality Navigation System through Usability testing.

5. Methodology

In regards to the research, this paper focuses on the Rapid Application Development (RAD) concept. RAD is used due to the strong facts that it is a dynamic system which will allow review and changes to the system requirements whenever deemed necessary along the system development. However the RAD methodology will be used alongside the spiral model as this will allow any referral to any previous phase of the system development. Moreover, by using this methodology, less time is spent on system analysis and system design, and a prototype can be developed to test and evaluate the changes that need to be amended.
Below is an image that shows the concept of RAD.

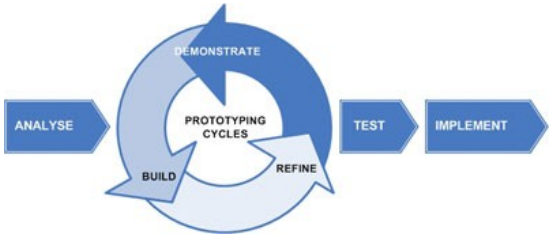

Figure 6: Rapid Application Development Model

The basis of RAD is that the chance of getting things the right time is very slim, but in order to at least give it a short the keys to RAD would be iteration, reasonable time schedules and teamwork.
The time schedules help in assigning the approximate time required to deliver a particular part of the system. You draw up a prioritized list of things that you will attempt to deliver. This list must contain some items that can be removed if the allocated time does not permit to create them. You are not allowed to exceed the time limit. The time schedule is to be measured in days, at most weeks, and never months. Focus is the key.
Given the general statement that you cannot get things right first time, you can have several attempts at using this method. The first iteration uses the first time schedule to get a prototype. The second and third iterations improve (not re-write) the results of the first iteration until the users and developers are happy that that part of the system is complete. You are not allowed to revisit any iteration.
A well-run RAD project will see a steady system grow around you. Everyone can see that the system is becoming more and more complete and can promote confidence in developers. RAD does tend to lead to well-designed systems that have low problem rates and meet the user's true requirements. A badly-run RAD project will produce a large mess faster than other methodologies. You must choose the team well. As communication is an essential part of the success of this process, you should also ensure the users know the business and are not afraid to say when they don't know.
The life cycle model that has been chosen to help in developing the end product of the proposed system is the Spiral model. Spiral is actually a refine model of waterfall model. It recognizes the fact that most software is developed using an iterative or spiral approach rather than a linear approach. Also, since the proposed idea is dynamic in terms that the requirements tend to change along with time, spiral model is more appropriate as we can go back to previous phases. It allows us to repeat the different activities until we are satisfy with the end-result.

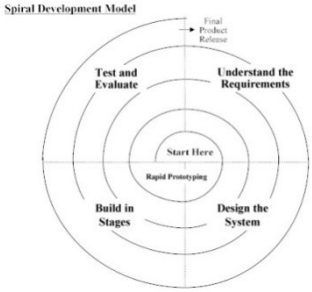

Figure 7: Spiral Model

6. Prototype

The prototype of the system has to accomplish its main goals and provide the user with his/her desired information. The system will use the camera for a mobile phone (provided it has an android platform) and augment various places of interest in and around the area you may be in.

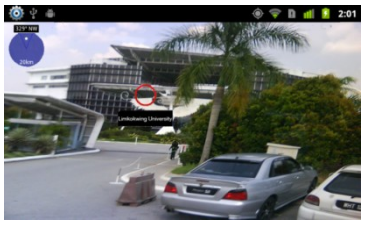

Figure 8: Screen shot of prototype

In the image shown above, the point of interest is marked with the red circular image. When the system is fully operational the object will have the name of the place that is being located together with the distance to be travelled in order to reach that place.

Figure 9: Prototype of GPS system

As also shown above, the system consists of a compass at the top left of the screen which shows the places located within a specific radius. Anything outside the radius will not be displayed.

7. Conclusion

Augmented reality has changed the way we may perceive life especially after its penetration into hand held mobile phones. Its changes over the years have led to the development of various applications on augmented reality that are now being used worldwide. In navigation systems it has proven to be of great importance especially if considered for tourism. Users now have a more interactive and fun way to navigate to their locations.

Since mobile phones are changing day by day we expect the augmented reality era to continue and evolve over the years. We expect user interfaces to be more graphical than they are today, less complex and more powerful so as to compensate for everyone's user-interaction needs and create a pure immersive environment.

When looking at navigation in perspective, augmented reality could be looked at for the next generation of augmented navigation systems. Voice implementation and image overlay for a travel path could be considered.

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