Context Awareness Campus Tour Application via Junaio Augmented Reality (AR) Browser

by

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the work contained herein have not been undertaken or done by unspecified sources or persons.

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ABSTRACT

Context-aware application plays an important role with the advancement of technology. Junaio AR browser is one of the popular user-centric AR browsers which are capable of delivering a context-aware application. The aim of this project is to reduce the number of manpower for campus tour and develop a context-aware application using the Junaio AR browser. Ineffective use of human resource in campus tour and lack of context-aware application are the two main concerns in this research project. Thus, the scope of the project is limited to the 3 definite areas which includes Junaio AR browser, Android OS Smartphone and the target location would be UTP campus. The channel is developed, test and validate in Junaio site, perform debugging for errors and submit the channel to Junaio site to be made it available for users. Junaio developer Google group is another place for the developer to refer and report of any bug or damage of the channel. The wireless connection need to be provided for free in all places to encourage the development and implementation new technology. The project has a good prospect to further expand its scope outside the campus in future.

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CHAPTER 1: INTRODUCTION

Technologies evolve rapidly in the speed of light. The increase of computing processing speed results to a decrease in size of the computing device and applications. [8] Augmented Reality (AR) would be one of the emerging technologies that transform the user view of the real world. The Juniper Research from United Kingdom reported there is an increasing number of an investment in mobile augmented reality applications and services by leading brands, retailers and mobile vendors. [13]

In addition, ABI Research study titled "Augmented Reality: Adding Information to Our View of the World" revealed that handheld platform will amend the AR environment, with revenue growing from $6 million in 2008 to more than $350 million in 2014. [12] This application enables users to access to information regardless of geographical location and time.

Furthermore, the increasing invasiveness of smartphones, AR has become a ubiquitous service for leisure, learning and more. [17] Thus, it opens the market for mobile AR applications and services such as AR browsers. Junaio, Layar and Wikitude are among the leading AR browsers in the industry. AR browser facilitates the users to scan the real world environment using their smartphone to obtain information or subscribe to a channel built around a specific geographical location.

The Introduction chapter basically describes the overview, objective, scope and viability of the project. This chapter consists of the following topics:

1.1 Background of Study

1.2 Problem Statement

1.3 Objectives

1.4 Scope of Study

1.5 Relevancy and Feasibility of the Project

1.1 Project Background

1.1.1 Context Awareness

Context awareness computing system aims to provide users with information that are integrated with real world objects and locations. In simple terms context awareness is any information that can be used to characterize the situation of an entity. Context awareness application adapts to the location, nearby people, hosts and accessible devices those changes over time. It has the capacity to scan the computing environment and react to the changes to the environment. There are three main aspects of context awareness applications which include the following: [14]

- Where you are?
- Who are you with?
- What resources are nearby?

In this case, the first and the last aspects play an important role in this project. The first question informs the application of the user location. Location of the user is vital to determine the answer for the third aspect which is the resources nearby. The application provides the user with the necessary information according to the user locality.

Furthermore, context awareness applications encompasses of network connectivity, noise level, communication bandwidth and social location of the user. [14] This topic has been widely discussed and used in a considerable number of research investigations which involves the interaction between human and computers. [20] Context awareness applications are closely related to augmented reality, immersive systems, mixed reality and personal adaptation. [17] In this case, augmented reality would be one of the focal interest in this project.

1.1.2 Augmented Reality (AR)

Augmented Reality (AR) is a developing technology which augments the physical world with a layer of computer generated text, objects and graphics to the user to view the contextual information. In this context, examples of contextual information can include geo-located information, visual/audio overlays or 3D enhancements. [17] In short, it is a virtual layer of information which is tied which the user location and appears on top of the real world view of the user. [13]

In addition, similar to context awareness systems, augmented reality applications are also capable to filter information and present information overlays relative to the user current location. [17] Thus, AR acts as a good platform of User Interface (UI) for context awareness applications. [8]

The concept and application of AR is widely used in Education, Training, Medicine, Military, Film Industry and Tourism. The movie "The Terminator" shows a good example on the implementation of AR technology which allows a terminator to scan the environment with a pair of glasses and view the information integrated with the real world objects. Today, the invention of Smartphone and AR technology simply allows users to see the real world just like the view of a Terminator. [2]

The fundamental understanding of technical components and role in mobile AR system is vital in a conceptual model of AR applications. The following are the vital part of a mobile AR system: [16]

- Flexible display system
- Sensor systems in mobile devices
- Wireless networking protocol
- High computational power
- Tagging and tracking technologies
- Linking of location-based AR information
- Flexible layer-based AR browsers

Flexible display system enables the augmentation of the real world to the vision of mobile users. The invention of phones with camera is current trend which is used in research as it is more flexible, light and cheaper compared to head-mounted display and handheld projectors which consumes a higher cost.

Sensor systems embedded in mobile devices such as global positioning system (GPS) and electronic compass are vital to locate the user location. Indoor and outdoor tracking systems are different in nature so, the indoor location tracking system will be useful for indoor AR applications and vice versa.

Next, wireless networking protocol enables the multi-user interaction in an AR application. Wireless network is vital for mobile based applications which will ease the user to use the applications. The connection setting should support both indoor and outdoor AR applications.

Tagging and tracking technologies is a must for an outdoor AR applications as it allows the user perform the desired actions on an AR channel. Most researchers describe this as a challenge of linking the real world perception of a mobile AR user and the augmented layer of virtual information.

Linking of location-based AR information is widely used in an instructional AR application such as storytelling, navigation, learning and gaming applications. In this case, a tour AR applications needs this element to display contextual information to the users on location-based.

Lastly, flexible layer-based AR browser where the AR system are built on existing information channel and present it to the users in a good user interface utilizing the virtual elements such as 3D objects, images, audio and text.

In this context, AR Browsers is a Marker-less augmented reality which uses the Smartphone Global Positioning System (GPS) to achieve high accuracy and Point of Interest (POI) which appears as 'floaticons' on the screen which helps in navigation. According to a study, a GPS location service is vital to accommodate the need of augmented reality to place the virtual objects display near other corresponding real objects. [12] AR browsers are booming and applied across all other fields of study.

Layar and Junaio are the two fast-developing AR Browsers in the field which provides a good platform and engages developers in their team. These two browsers support iPhone and Android mobile platform. Junaio teams are currently working on Junaio AR browser on Symbian phones while Layar already have their AR browser available on Nokia OVI. According to the recent report, there are more upcoming AR browser produced by company kooaba and ETH Zurich. Koo AR browser uses image recognition technique compared to GPS and compass reading used by the existing AR browser. [19] The object is indentified on kooaba's server and is tracked live on the phone. The figure below illustrates the comparison between different types of AR browser. [18]

Product	GPS/sensor	Mrkr based	Mrkr Less	Built-in User Actions	Pblsh API	App API	AR View Content	POI actions	Offline mode	Pltfrm
Layar	yes	No	No	web view	open key	custom	3d, 3d-anim 2d	Info Audio Music Video Call Email SMS Map Event	Online only	iPhone Android
Junaio	yes	yes	yes	Post text Post Image Post photo Post 3d social	open key + crowd	custom	3d, 2d	Info Audio Video Map Event	Online only	iPhone Android
Wikitude API	yes	No	No		Bundle	open	2d, 3d	Info Event	offline	
Wikitude Worlds	yes	No	No		open key	custom	2d	Info Map email Call	cachble	
Sekai Camera	yes	No	no	Post text Post photo Post sound social	open key + crowd	custom	2d	Info Audio Map Social	Online	iPhone Android iPad
Libre Geo Social	yes	arc	plugin	Post text post picture post sound social	crowd + open src	open	2d	Info Audio Map Social	Online only	Android
Kooaba	yes	no	no	Visual search	Commercial key	Restricted key	2d	Info social	Online only	iPhone

Figure 1.1: Comparison of AR browsers

In figure 1.1, Junaio supports registration and tracking with GPS sensor, maker-based and markerless. On the other side, Layar only support GPS sensor and does not provide for marker-based and markerless AR applications.

Next, built-in user actions vary between these two AR browsers. Junaio enables wide range of user action such as post text, post image, post photo, post 3D and social. Layar limits their user actions to web and view. [18]

Junaio covers open and crowd for its publish Application Programmers Interface while Layar only covers open. In this context, open means the platform provides its developer with API to publish their own channel without any fee. Crowd refers to the crowd source content is available for regular users using the facilities of the browser itself. [18]

Both the AR browser is using the custom Application API where the developers are not allowed to add any real functionality to the application. [18] The developers are only allowed to change the visual appearance and optional functionality switch.

Furthermore, in terms of AR content view Layar supports 2D, 3D and 3D animated objects compared to Junaio that only supports 2D and 3D objects. [18] These objects are superimposed on the real world to create an environment such as the virtual objects are part of the real world.

Layar covers a wide range of POI actions which includes info, audio, music, video, call, email, sms, map and event. On the other hand, Junaio wraps some actions such as info, audio, video, map and event. [18]

Lastly, both Junaio and Layar work on online mode where the application requires a network connection all the time. The two AR browsers support iPhone and Android platform users.

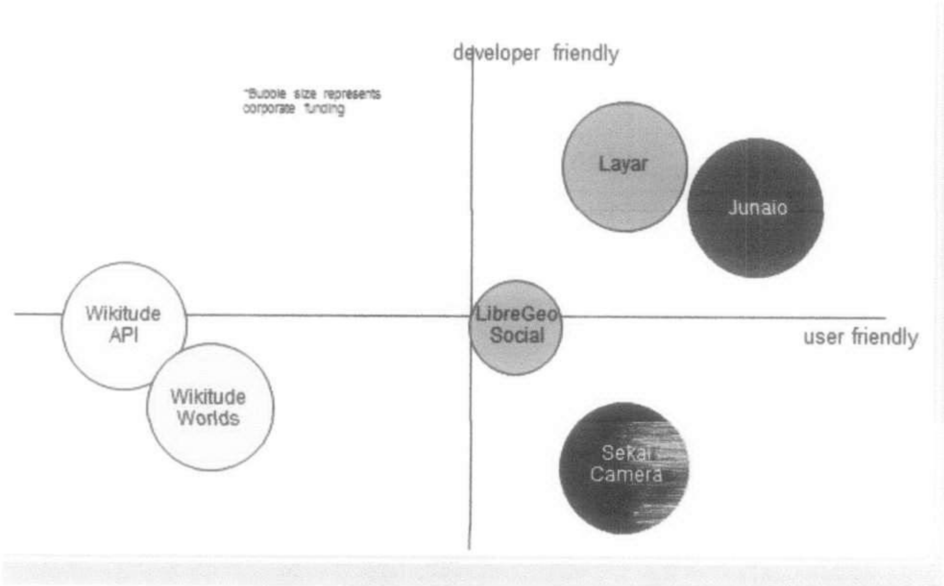

Figure 1.2: Measurement of AR browsers

Figure 1.2 basically depicts the position of AR browser in a matrix comparison which has developer friendly as the y-axis and user friendly as the x-axis. Layar and Junaio are located in the positive region for both developer friendly and user friendly. Junaio is more user friendly than developer friendly.

Junaio is popularly known for its user-centric AR browsers allow the user to create geo-tagged Point of Interest (POI) composed of text, 3D graphics and images. Users are able to upload and share the content with others at Junaio. The browser provides user with interesting content according to the respective location. Besides, it acts as an instant source of information for the users regarding the objects in the real environment. AR browsers are commonly used for tour applications on mobile phones.

1.1.3 Tour Applications

There is a number of increasing tour application for mobile phones. A tour application helps the tourists to locate their current location and also their desired locations while navigating the application. USATODAY 360 Stadium Tour from Junaio is one of the popular channel which include a 360 degree view of Dallas Cowboys stadium. It also allows the user to view the entrance of the players to the stadium, down to the locker room to see the interior view of the stadium. Similar applications were in presence in Columbia Campus but it uses the old technology of AR consists of a backpack of computing devices, head mounted display and screen. This application is a campus tour application for Columbia Campus.

The main idea of this project is to develop an Android based context awareness campus tour application in Universiti Teknologi PETRONAS (UTP) using Junaio AR browser. In short, UTP Campus Tour which is the name of channel submitted to Junaio. Junaio application supports both iPhone and Android platform smartphone but in this case Android smartphone is chosen because of its increasing selling rate according to the Gartner's report in the year 2010. Furthermore, the use of Smartphone has become a necessity to browse Internet, social networking and to jot down information. A study was conducted in the University of Edinburgh where 49.2 percent of the students owned a Smartphone with 60 percent of them says accessing Internet meets their needs. [2]

1.2 Problem Statement

1.2.1 Current method of Campus Tour

The current method of campus tour in UTP is a group tour which consumes time, manpower and limits the scope of information to the guests. The group tour is conducted by UTPHOST who are under the UTP Corporate Services Department (CRPA). They are specialized in corporate tours, facilitation and ceremony and protocol.

The UTP campus is huge and consists of lot buildings which include the Academic Blocks, Chancellor Complex, Lecture Theatres, Residential Villages, Sport Complex and Mosque. Thus, the campus tour consumes time which is essential for each individual in different manner.

Next, usually one guide can manage up to 10 people around the campus for tour. The guide can be student or staffs that need to put aside their works and bring the guests around the campus. This wills results to an increasing unproductive works among staffs and students.

Lastly, the guide only able to convey the information of the places in the campus in the form of speech or in certain case the guests will be able to enter the place and look around. So, there is not much alternative ways of conveying information to the guests during the campus tour.

1.3 Objectives

The main objectives to be achieved in this project:

- To research on context awareness augmented reality applications.
- To develop UTP Campus Tour Channel using Junaio AR Browser.
- To test the effectiveness use of the channel around the campus.

The first objective is to do research on context awareness augmented reality applications. Context Awareness and Augmented Reality (AR) are closely related where context awareness is applied in AR applications. For instance, the Columbia Campus tour application aims to provide context awareness of the places around the campus with the implementation of AR technology.

Next, to develop UTP Campus Tour Channel using Junaio AR browser is the second objective of the project. In previous research works, the campus tour is developed as a backpack computing devices with head mounted displays and screen. Now, with the advancement of technology devices shrank in size where the same campus tour can be developed using a mobile phone. The project chooses Junaio AR browser as a platform to develop the campus tour because the Junaio application is free, user friendly and widely available.

The last objective is to test the effectiveness use of the channel around the campus. The testing for UTP Campus Tour is done in a form of questionnaire which consists of five parts. The first part collects the demographic data of the user, followed by the knowledge and technology awareness of the user, System Usability Scale (SUS), Generic User Interface questionnaire (QUIS) and finally the comments from the user for further improvement of the project.

1.4 Scope of Study

The scope of the project covers three important elements:

- Location: UTP Campus
- Phone Platform: Android
- Channel Platform: Junaio
- Target users: UTP students and visitors

The location of the project scope only covers UTP Campus as it is limited to a small number of Point of Interest (POI) compared to a larger area. Next, the chosen phone platform was Android phones which have an increasing number of selling rate in the year 2010 from Gartner's report. Besides, generally smartphones are more suitable for a AR tour application as it is more personal to the user and accessible at any time and location with a wireless network. Junaio has always been the leading organization in AR technology which provides both developer and users to use their application for free. The Junaio application can be downloaded to mobile phone and use it provided that there is a channel near the area of the user. The target users for the UTP Campus Tour applications are the students and professionals who visit the campus. The UTP Campus Tour will impress the visitors with the development and implementation of technology used around the campus.

1.4 Relevancy and Feacibility of the Project

The feasibility and success of a project closely related to the scope and objectives of the project itself. In this context, the project is highly achievable referring to the scope of the project which utilizes the Juanio AR browser to develop the UTP Campus Tour Channel. The application consists of minimum of 10 POI around the campus and is used on Android platform mobile phones.

Gartner reported the total sales of worldwide mobile devices in the year 2010 worth 1.6 billion units which has a positive increase of 31.8 percent compared to previous year. According to Gartner, Inc there were strong significant sales of Smartphone at the fourth quarter of the year. The sales of Smartphone were up 72.1 percent which contributes a 19 percent to the total percentage of mobile communication device sales in 2010. [10]

The sales of Smartphone by Operating System show a positive climb for Android platform phones. The platform grew 888.8 percent and made it to the second rank in the table. Gartner says that the huge sales of Android platform phones are driven by its availability in high-end phones. [10]

Worldwide Smartphone Sales to End Users by Operating System in 2010 (Thousands of Units)

Company	2010 Units	2010 Market Share (%)	2009 Units	2009 Market Share (%)
Symbian	111,576.7	37.6	80,878.3	46.9
Android	67,224.5	22.7	6,798.4	3.9
Research In Motion	47,451.6	16.0	34,346.6	19.9
iOS	46,598.3	15.7	24,889.7	14.4
Microsoft	12,378.2	4.2	15,031.0	8.7
Other Oss	11417.4	3.8	10432.1	6.1
Total	**296,646.6**	**100.0**	**172,376.1**	**100.0**

Source: Gartner (February 2011)

Figure 1.3: Worldwide Mobile Device Sales by OS in 2010

According to Gartner, the sales of Android platform Smartphone will grow tremendously and may exceed the iPhone market in the year 2012. This shows that the number of Android platform Smartphone will be more than other OS. Hence, there is a need of applications for and highly relevant to do project for Android OS Smartphone.

CHAPTER 2: LITERATURE REVIEW

The chapter mainly discusses on the related works done by researchers and experts in this field of study. Since, the works are done in different stages and equipments there are a common pattern which can be identified in their research. Besides, it will also include the proposed solution for the problem highlighted in the former chapter. This section encompasses of the following subjects:

2.1 Context Awareness

2.2 Augmented Reality (AR)

2.3 Augmented Reality (AR) Context Awareness Applications

2.4 Tour Applications

2.5 Proposed Solution

The diagram below simplifies the content flow of this chapter:

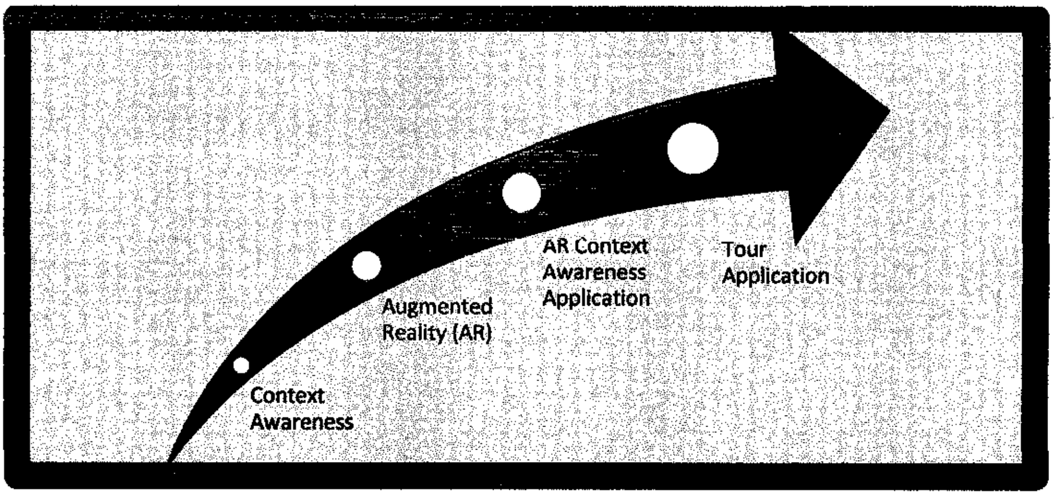

Figure 2.1: Literature review

2.1 Context Awareness

The use of context has become increasing popular in the field of handheld and ubiquitous computing. In this case, the user's context changes rapidly. Context Awareness can be defined as any information that can be used to characterize the situation of an entity. The entity can be a person, place, physical or computational objects.

Context Awareness are closely related to context-aware computing where the use of context to provide task-relevant information or services to the user. There are three important elements of a context awareness application should have:

- The presentation of information and services to a user
- The automatic execution of a service
- The tagging of context to information to later retrieval

The topic of context awareness has been a central focus in a number of research works which involves Human Computer Interaction (HCI). There is a various ways the context is adapted in research works.

Firstly, it allows to perform the technical opportunities with the falling costs, sizes of devices and power requirements and advancement in sensor technology. Besides, it allows to develop a new form interaction which uses the AR technology.

Next, the recognition of mutual influence of the real world and human activities enables to provide likely actions of the user using a specialized computing support.

Moreover, there is an increasing understanding of the system developers on human activities. It is done through the computation which involves a variety of practices and relations to make a meaningful by setting a context.

Lastly, the design draws the attention with the instrumental use of technologies plays an important role in the design and deployment of a context aware computing application.

Furthermore, there are several research challenges of context awareness applications highlighted in the previous research works:

- The development of a taxonomy and uniform representation of the context types.
- The development of infrastructures to promote the design, implementation and evolution of context awareness applications.
- The discovery of context awareness applications that assist users interactions with ubiquitous computational services.

2.2 Augmented Reality (AR)

Augmented Reality (AR) is a subset of Virtual Environment (VE). VE is a completely immerse the user inside the virtual environment. In contrast, AR enables the user to see the real world where the virtual information is superimposed on the real world.

Researchers have done a survey to determine an AR system. The AR system consists of the following characteristics:

- Combination on real world and virtual
- Interactive and real time
- 3D view

Augmented Reality (AR) enhances the user's perception and interaction with the real world. The virtual object that is superimposed information that a user cannot detect it directly. The information in AR helps the user to perform real world tasks.

AR is used in many fields and there are a lot of applications developed. Medical is one of the fields which use the AR technology. The figure below shows a virtual fetus inside womb of a pregnant patient. The goal of the application is to see the moving fetus inside the womb.

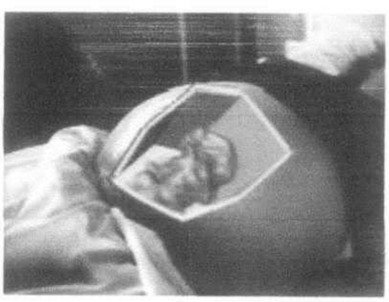

Figure 2.2: virtual fetus inside womb of a pregnant patient

There are also another research done for terrestrial navigation using the support of augmented reality and a wearable computer system. The research reports a set of examples using an off the shelf wearable computer system installed with custom navigation software called "map-in-the-hat". [15]

The objective of the research is to extend the use of GPS and AR to outdoor environment. There are three main elements in this project which covers GPS, wearable computer and software.

GPS gives an accurate location of the user in one place. This allows the system to locate the user correctly and plot the user position on a map. The GPS system used is Trimble SVeeSix-CM3 Core module and Aztec RD3000 as GPS receiver module.

Next, wearable computer utilized in this project is the Phoenix 2 which consists of Cyrix 486DX2/66 processor, 32MB RAM and 85MB hard disk. The operating system used by the wearable computer is Slackware Linux v3.3 with kernel version2.0.30. Besides, it consists of an electronic compass Precision Navigation TCM2 and a dual colour SonyPLM-100 LCD monitor. [15]

Lastly, software which plays as a role of producing navigation information based on the GPS compass. The user enters a list of points of latitude and longitude in the form of WGS84. The "map-in-the-hat" will produce the navigation information on the inputs entered by the user. The image below is the user screen view which will direct the user. The value under the small triangle indicates the exact direction in degrees for the user.

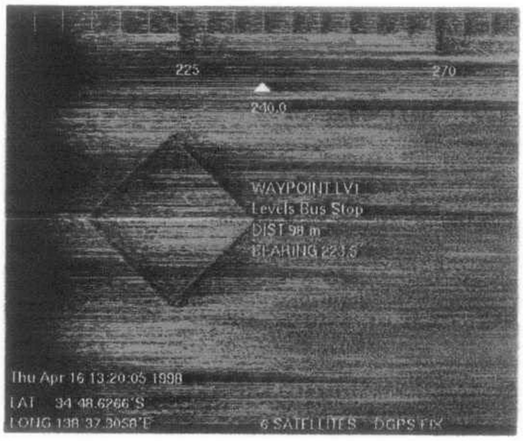

Figure 2.3: User screen view

The project provides a useful visual sign for navigational task. The project can be further improved especially form of information presented in visual cues. Besides, with the limited technology the lighting or excessive sunlight makes the image produced on the Sony LCD screen unclear. [15]

2.3 AR Context Awareness Applications

Ubiquitous Mobile Augmented Reality (UMAR) is a conceptual framework discusses on the use of marker based AR for context-aware applications on mobile phones. This project is developed using the ARToolkit and runs on Symbian platform mobile phone. ARToolkit is an open source toolkit for optical tracking which also has camera calibration software.

The software works by identifying the marker, calculate the orientation and translation of the camera in the in the reference coordinate which is placed at the center of the marker image.

Ubiquitous Mobile Augmented Reality (UMAR) is a conceptual framework developed using ARToolkit integrates digital and real domains with context aware information. [9] In this context, the relevant information is obtained and displayed together with the context using spatial relationship. Then, a comparison and conditional decision is made if the spatial relationship is close AR will be used while if it is big a 2D map will be used. If there is no spatial relationship the information will be displayed according to the user preferences. Information retrieval based on context awareness is not made the primary focus, but it is important for the overall UMAR framework. Below is the overview of UMAR framework.

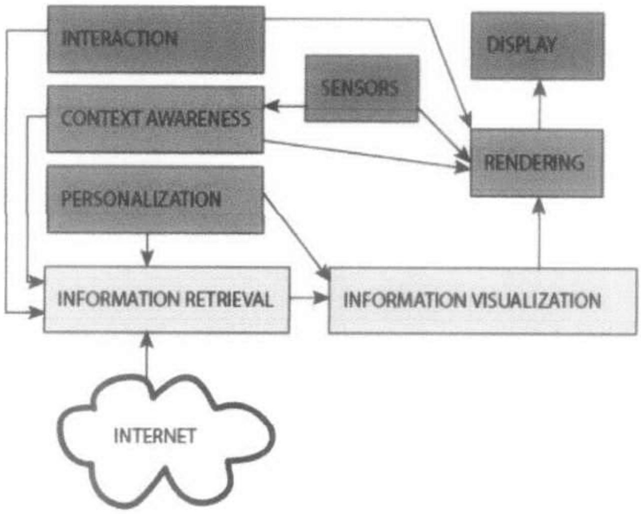

Figure 2.4: Overview of UMAR framework

The UMAR framework was successfully implanted in the Symbian platform and encounters performance issues. The result of the system shows that the AR can be implemented in Smartphone without any assistance of server. [9] The testing platform used for UMAR is Symbian but, a test for Android OS due to most of the Smartphone produced uses Android OS.

The other experiment discusses on providing a multimodal framework for tourist with a context-aware guide. This project proposed three different maps – digital map, virtual map and augmented reality assistance. It uses a lightweight handheld mobile to locate the user's position in the environment. [1]

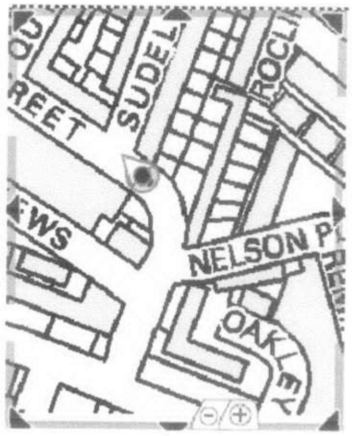

Figure 2.5: Digital map mobile interface

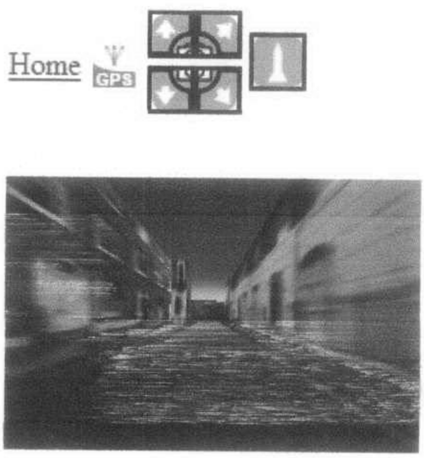

Figure 2.6: Virtual Reality mobile interface

Figure 2.7: Augmented Reality mobile interface

In this project, a location aware mobile cultural guide was implemented in the Swiss National Park. Later on, the project is expanded to the City University Guide. [1] In this project, the third map which uses the AR technology is to be focused more as it relates to Campus Tour project compared to the other two.

Information filtering is a core part of this research as the main aim of mobile augmented reality application is to provide users with contextual information on real-world objects. The DIVE and MASSIVE originally assumed there were only three type of media – text, audio and graphics. In a multimodal environment, there a number of media available to enable the user to interact with the real world. [4]

The Information and Navigation Systems through Augmented Reality (INSTAR) system describes that there are two methods of location and orientation sensitivity – active and passive. Active sensitivity system discovers their position and orientation automatically; the best example would be GPS. A passive sensitivity needs a reference station to track the position and orientation.

Figure 2.8: INSTAR Pedestrian Navigation

Overall, the INSTAR system encompasses on pedestrian navigation system using Personal Digital Assistance (PDA). The output of this experiment is the same as this research paper focus on which is a mobile device.

2.4 Tour Applications

There were a number of research and experiments have been conducted in previous years on Mobile Augmented Reality. Mobile Augmented Reality System (MARS) is a backpack system to tour around the Columbia's Campus. The system satisfies three conditions [3]:

i. It is within the range of the local base station where they have the real-time kinematic GPS system which tracks user's position in the Campus.
ii. It must be in wireless area for Internet access.
iii. It must be within the 3D environment model developed by the developers.

Furthermore, the system occupies four different User Interface (UI) [3]:

- Indoor
- immersive version of the Indoor UI
- Outdoor
- Hand-held

Indoor UI most probably use the desktop or projection displays which is based on the 3D environment model. The users are allowed to create the virtual objects and gloss it to the real objects for the outdoors users to see. On the other side, the outdoor users can point at any interesting objects or event to let the indoor people to view it. The figure below illustrates the user actions to create and edit the virtual information on real objects and locations.

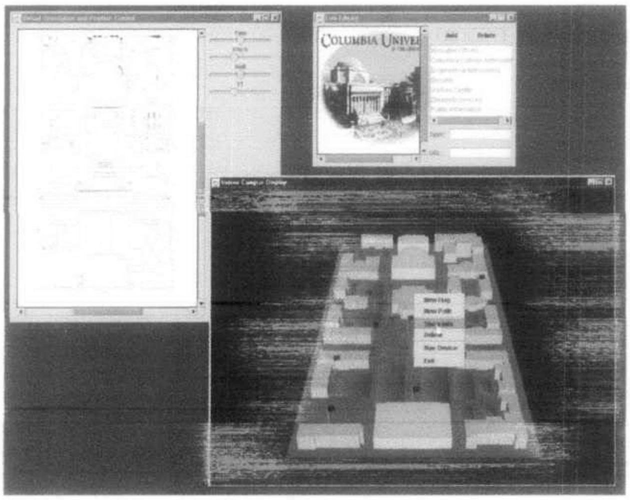

Figure 2.9: Indoor UI

Moreover, there is another version of Indoor UI which involves the immersive concept. It uses a transparent head-worn display together with a 3 Degree of Freedom (DOF) of object trackers and 6 DOF of head and hand trackers to manipulate the virtual information on the physical desk. The figure below shows the immersive Indoor UI.

Figure 2.10: Immersive Indoor UI

The Outdoor users are tracked by using the centimeter-level real-time kinematic global positioning system (GPS), an inertial orientation sensor and provided with a backpack computer system. The users experience the world of AR with the aid of see-through and hear through head-mounted display. Below is an illustration of outdoor user for the MARS project.

Figure 2.11: Outdoor user

Next, the handheld UI in this context only offers a map-based UI for the virtual information. It is also equipped with either a backpack computer system or a standalone one. The image for a handheld UI is shown as below.

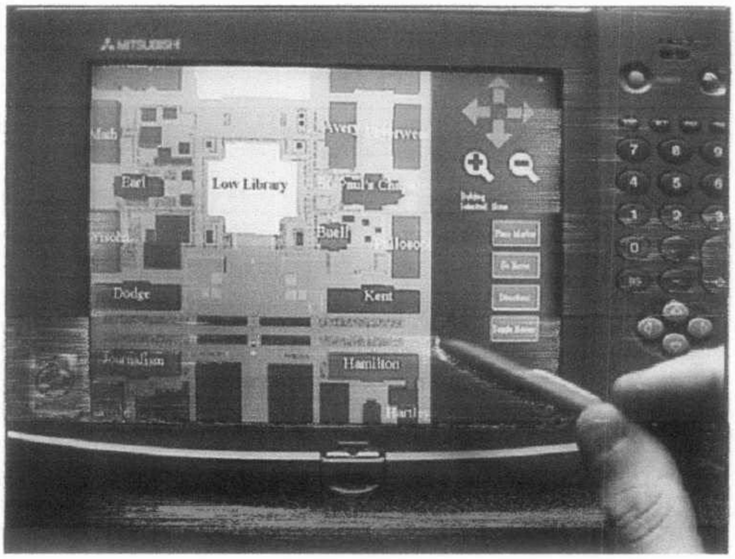

Figure 2.12: Handheld UI

The MARS architecture is divided into two parts which includes indoor and outdoor platforms. The outdoor backpack system and the indoor simulation version uses the Coterie distributed virtual environment structure based on Modula-3 while Java/Java 3D is applied for the development of indoor desktop, indoor immersive UI and the main database interface. The handheld map UI is developed using Coterie. Below is the image of the MARS architecture.

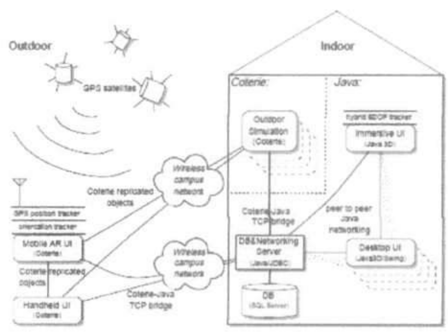

Figure 2.13: MARS architecture

Furthermore, one of the final output and objective of MARS project is a tour around Columbia campus which is similar to the project conducted by the author except for the equipments. The image below shows the outdoor UI of a building in Columbia campus.

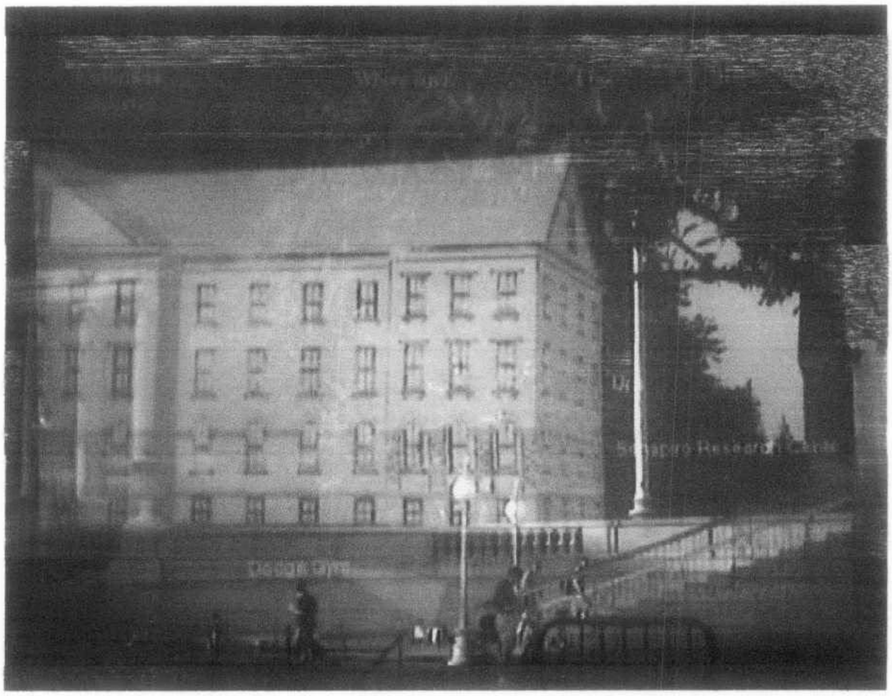

Figure 2.14: Outdoor UI of Columbia Campus

There are also another research done for terrestrial navigation using the support of augmented reality and a wearable computer system. The research reports a set of examples using an off the shelf wearable computer system installed with custom navigation software called "map-in-the-hat". [15]

MobiAR is a project aims to provide service application based on AR technology. It is an Android service based platform which provides information via implementing AR technology. It enables the users to browse information and multimedia content of a city using their smartphone. The project displays location-based information as well as catering the user preferences with the advantage of computer vision technologies. [6]

The system is useful for both the tourist and the local people to know further about a place they visit in an urban environment. [6] AR system has got a huge market since the launch of smartphones. Smartphones like iPhone 3GS and Android smartphone employs the wireless networking and location-based technologies such as GPS, accelerometer and camera on this device present a high processing capabilities enables the growth of AR technology.

Layar, Junaio, Wikitude and Acrossair are among the top AR browsers in the market. MobiAR browser uses a combination of GPS, accelerometer and camera to identify the user location, retrieve the data based on the location and display is on the camera view for the users. MobiAR has its competitive advantage compared to the AR browsers in the market which is the computer vision technology. This technique is used to improve the accuracy of the location and its landmarks. [6]

The MobiAR architecture follows the mobile client-server architecture. The mobile application acts as an user interface to visualize and interact with the virtual content while the server manages the object recognition, user and multimedia content and find the user location. [6]

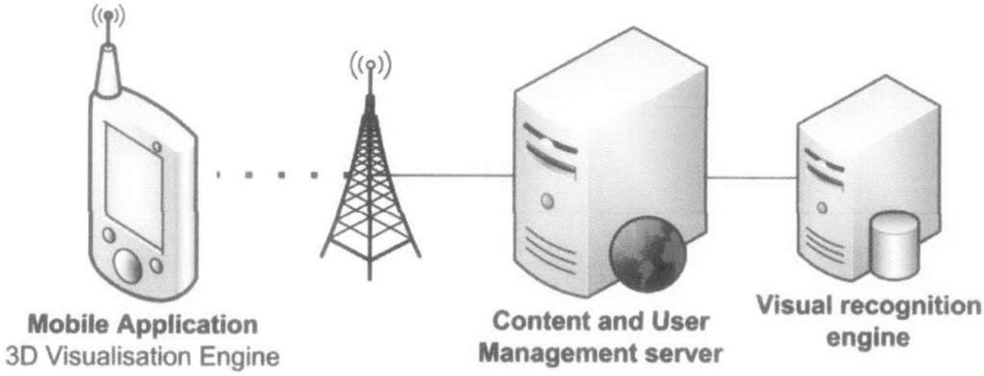

Figure 2.15: MobiAR platform

The application provide two main features, first is the environment browsing with POI and the second part, it enables the user to access multimedia content of a location. The former one is common across all AR browsers which is browsing the POI in an environment. The second feature is an interesting point where the users can access the multimedia content related to the POI. This signifies the amount of information that can be stored and captured using the AR technology. [6]

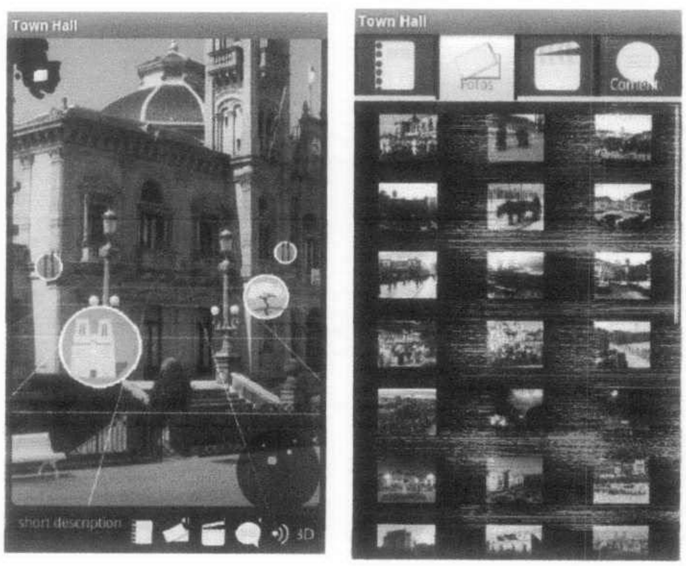

Figure 2.16: Snapshot of MobiAR application. (Left) AR view of the environment.
(Right) Access to multimedia content related to that POI.

The MobiAR is a project has a few similarities with the Campus Tour project in terms of the Smartphone OS platform and scope. The difference between MobiAR and this project would be the computer vision technologies element used in MobiAR. It displays POI and images based on user preferences. For instance, there is a museum and a park located near to each other.

The user preferences POI will be displayed in bigger circles compared to the other POI's. Besides, it also has a visual recognition engine which captures the image and displays the information regarding to the image. In this case, the project developed by the author does not have the rights to change any functionalities provided by Junaio except for the visual appearance. Furthermore, Junaio AR browser supports the first feature of the MobiAR.

2.5 Proposed Solution

In this project, Junaio AR browser is chosen to the platform to develop the channel for UTP Campus Tour. This would be a good solution to develop a context-aware application. The channel built will consists of POI around the campus. POI is a location-based which means the information displayed will be according to the geographical location of the POI which will be discussed in detail in chapter 4.

Junaio AR browser is a user-centric AR browser which provides the developers with a good tutorial and examples to start building their own channel. In the view of the author, this project will be useful and have a good user acceptance from the community who are always updated with the latest technology.

Besides, the increasing number of Android based smartphone in the market would increase the demand for context-aware applications. The channel is created using the Junaio developer tools provided on the site. Besides, there is a Junaio developer group to post any enquiries or report any defects of the channel.

Furthermore, this project will be able to guide tourist and visitors around the campus by just using their Smartphone. The implementation of this project will upgrade the standard of the varsity to be parallel with the advancement of technology. The project will be further discussed in the chapter 4 – results and discussion.

CHAPTER 3: METHODOLOGY

This chapter describes the research methods used throughout the project. In general, research methodology refers to a set of procedures used to conduct a research project. It consists of the following topics:

3.1 Research Methodology

3.2 Project Activities

3.3 Key Milestone

3.4 Gantt Chart

3.5 Tools

3.6 Evaluation

3.1 Research Methodology

The research methodology starts with the analysis of literature review on Context Awareness and Augmented Reality (AR). The literature review emphasizes on this two elements as they are the core part of the research project. Besides, there were also some review on the AR Context Awareness applications and Tour application done by the researchers in the field.

Next, there was some research analysis on Junaio AR brower. Junaio AR browser is free and user friendly to both developers and the user. The analysis requires an understanding on how the Junaio channel is developed, validated and made as an active channel after the certification from the Junaio team. Besides, there was also a need to have knowledge on Extensible MarkUp Language (XML) and how to set up a server to host the data of the channel.

The development of channel is started once all the required data is collected. The data is stored in a XML structure in the client server. The address of the server is used as a callback URL to the Junaio server. The channel is developed using 1 POI, 10 POI and 57 POI which involves the places around the campus.

Then, the channel is validated using the Junaio validation service and submitted to the Juanio team to certify the channel. The channel certification takes around two working days. Meanwhile, the channel can be tested using Google Maps where the channel will be there with the number of POI found in the channel.

Lastly, the channel is tested on mobile phone. Wireless connection is important to access the channel using Junaio application. Once, the application is run the user can scan for the channel nearest to them and use it. In this case, UTP Campus Tour will be available all across Malaysia.

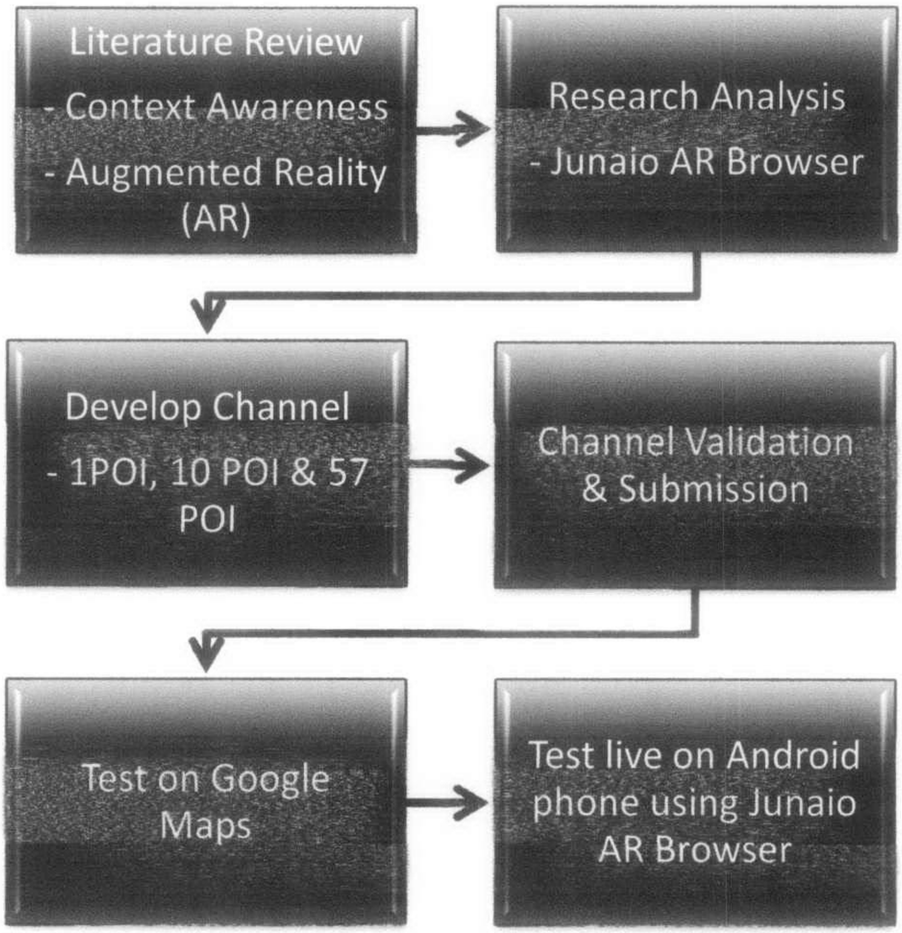

Figure 3.1: Research Methology

3.2 Project Activities

3.2.1 Data Collection

In this case, the geo-location of a place in terms of longitude and latitude is to be recorded in order to create a precise and accurate channel with contextual information.

The POI location is determined using the google maps. The Satellite view of google maps enables to view the position and location of each building around the campus. Each building has a unique point which will be used to display information according to the point of location. Below is an example on how the author acquires the location value of a point from google maps.

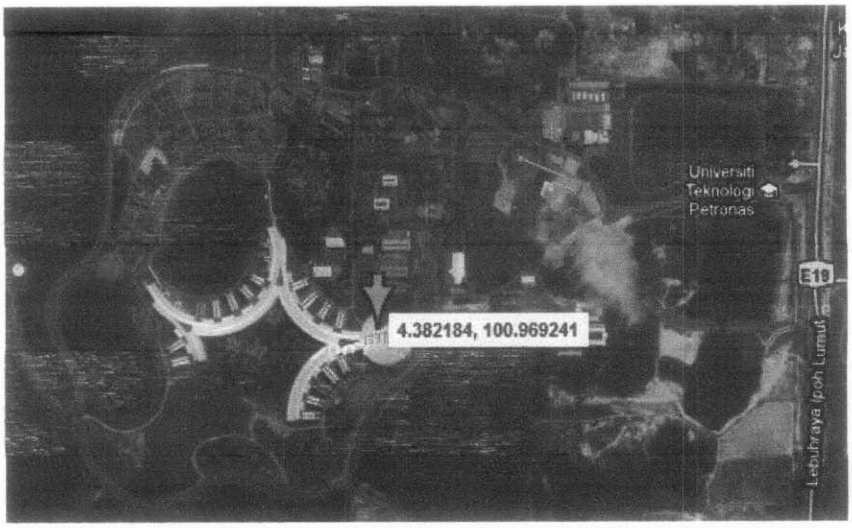

Figure 3.2: POI location value

The POI value for each POI need to be recorded as it will be useful for the testing later. The value of the POI is listed in a table.

POI	Latitude	Longitude	Altitude
Mosque	4.385704	100.973677	0
UTP Field	4.387063	100.977269	0
Sport Complex	4.387341	100.973806	0
Residential College (Village 3)	4.387148	100.966049	0
Cafeteria (Café V2)	4.387790	100.967690	0
Pocket D	4.384131	100.966542	0
Academic Buildings (Block 1)	4.381414	100.973806	0
Chancellor Complex	4.387341	100.973806	0
Registration and Exam Unit	4.385929	100.971918	0
Research Center	4.384335	100.968205	0

Table 3.1: POI Information

3.2.1 Channel Development

The developer need to sign up as a Junaio developer where each developer will be given a developer key. The developer key is important to include in the config.php file. The channel can be created using Junaio developer module provided on the website. The channel developed in external servers need to have a callback URL to Junaio.

Figure 3.3: Creating a Junaio Channel

The callback URL to Junaio server was a major problem encountered during the development of the channel. The client side server, 000webhost does not support mod_rewrite function. So, during the validation of the channel it returns error because there were no authentication can be found in the URL that client server side sends to the Junaio server. To overcome this problem, the callback URL need to add "?=path" to redirect the address to my client side server.

3.2.2 Channel Validation

The channel validation is important to see the outputs of the channel. There are eight steps to validate the channel. The first test is to check the callback URL, the second and third to check on the POI search and return value followed by POI event and return value. Test 6 and 7 not related as it involves visual search and its return value. Lastly, the check on channel subscribe test.

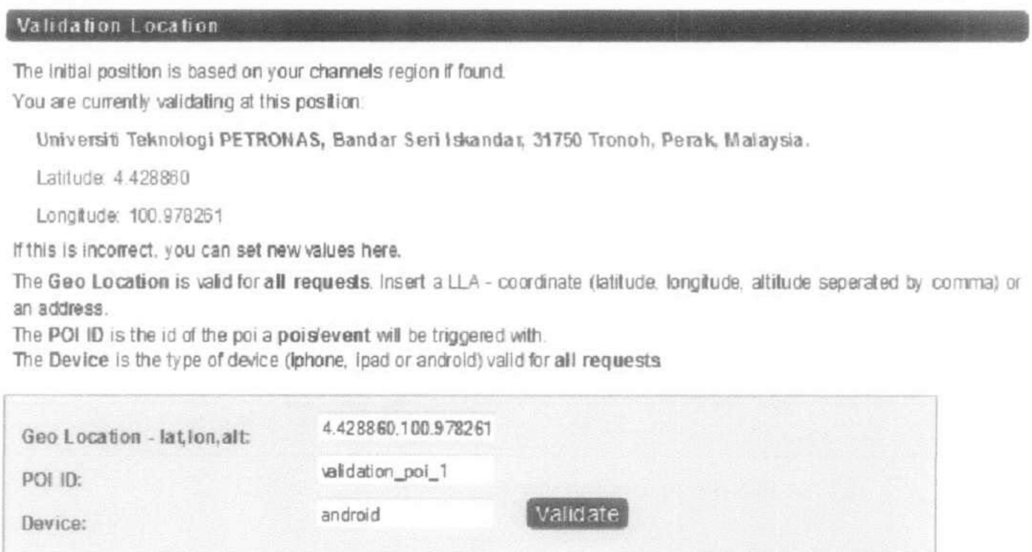

Figure 3.4: Channel Validation

3.2.3 Test on Google Maps

The test on Google maps shows the channel POI found. If the channel consists of 10 POI it will show 10 POI found on Google Maps.

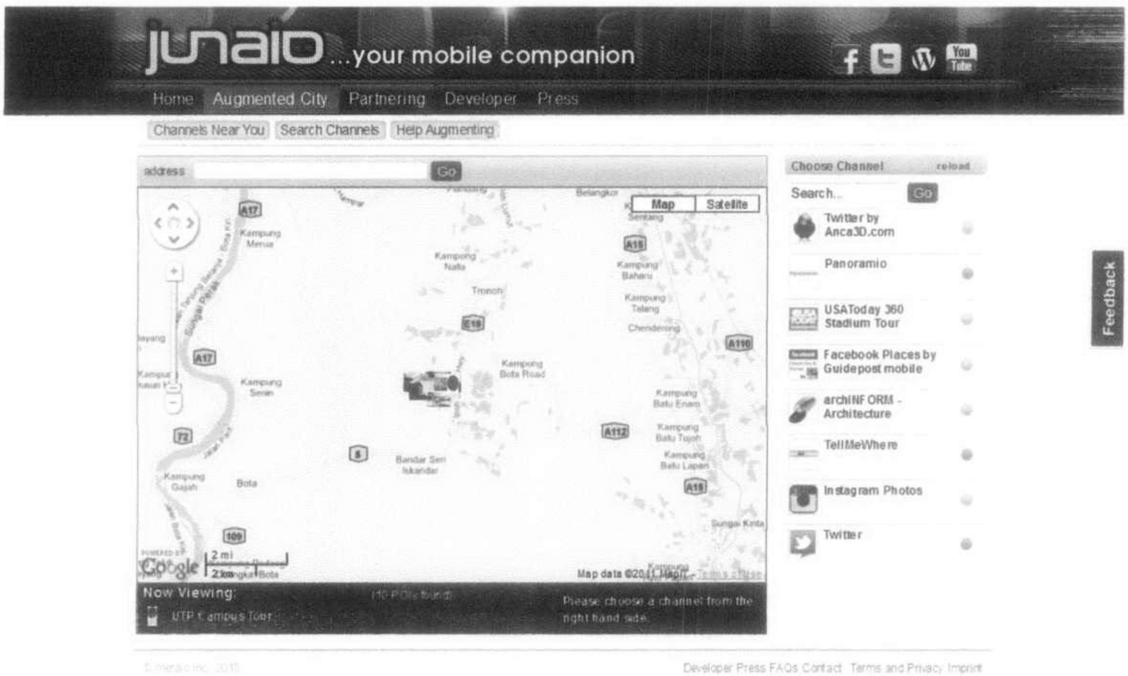

Figure 3.5: Test on Google Maps

The development of each channel can be tested real-time online using Google maps or Junaio application on Smartphone. The whole process need to be repeated while developing more other channels.

3.3 Key Milestone

The Key milestones need to be achieved in the first semester of Final Year Project are as per table below:

Semester 1

Milestone	Week
Project Proposal	Week 3
Literature Review (10%)	Week 6
Proposal Defense (40%)	Week 9
Interim Report (45%)	Week 13

Table 3.2: FYP I Milestone

Semester 2

Milestone	Week
Progress Report	Week 7
Pre-EDX	Week 11
Dissertation	Week 12
Viva	Week 13
Technical Report	Week 14

Table 3.3: FYP II Milestone

3.4 Gantt Chart

GANNT CHART																										
Tasks/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Planning																										
Topic Research			/																							
Analyze																										
Research Journals			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/						
Test Demo					/	/	/	/	/	/	/	/	/													
Develop																										
Develop Channel														/	/	/	/	/	/	/						
Test																										
User Testing																				/	/					
Maintainance																										
Debug Errors																						/	/			
Testing																								/	/	/

Figure 3.6: Gantt chart

3.5 Tools & Equipments

The hardware specifications of this project [5]:

i. In-built rear –facing camera to capture the physical world.

ii. Geo-location awareness can be achieved with GPS.

iii. Compass and accelerometer to determine the horizontal/vertical position of the user.

Nowadays, Smartphone comes with good 3D acceleration for gaming which can be used for Campus Tour. Thus, it reduces the time of rendering the 3D content of an application.

The main tool for the project is an android platform smartphone. In this case, Samsung Galaxy Mini is currently in use for the project. The specification of the phone meets the minimum requirement to execute this project successfully. The device consists of built-in GPS, 240x320 dimension of screen, supports Wi-fi and uses Android OS 2.2.

Figure 3.7 Samsung Galaxy Mini

Furthermore, there is a need for a client side server to host the data of the channel. So, 000webhost and zymic were used as a client side server. There is two client side server to host is to backup the data if any of the server is down. This was a problem faced during the testing of the channel when the client server was down. To overcome the problem an extra client side server is hosted to backup all the data for disaster recovery. The main client side server would be 000webhost and the backup server is zymic.

The data of the channel is hosted in the client side server. When the user open the Junaio application on mobile phone and click UTP Campus Tour, it will send a request to the Junaio server for the information of UTP Campus Tour. The Junaio server will use the callback URL provided during the channel creation to contact the client side server to get the information on UTP Campus Tour. Then, the details on the UTP Campus Tour will be available to the users on their mobile phone. The system architecture of the UTP Campus Tour is represented in the diagram below.

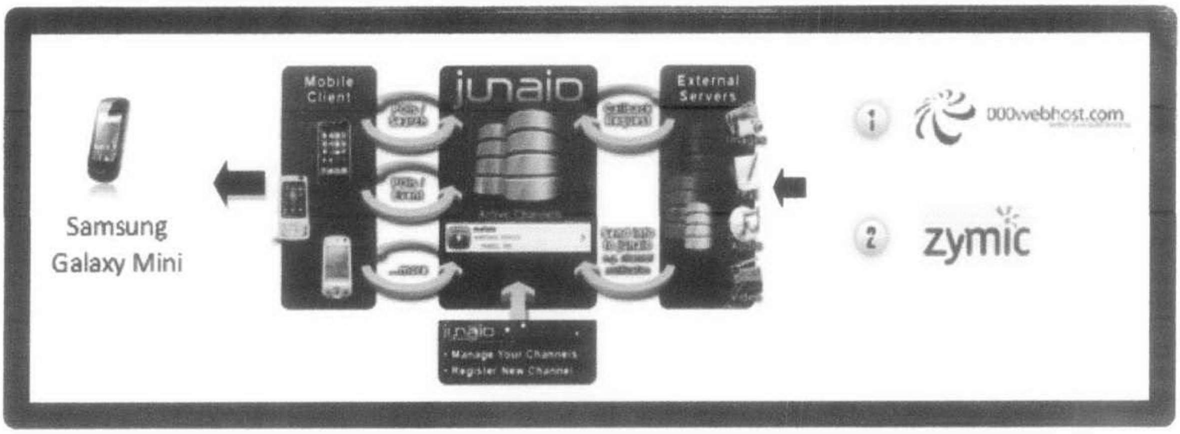

Figure 3.8: System Architecture

3.6 Evaluation

The testing evaluation of usability of this project is done in several parts. The first part consists on collecting the demographic information of the users followed by the technical knowledge of the user. Part C uses the System Usability Scale (SUS) and part D uses the Generic User Interface Questionnaire (QUIS) and lastly part E gets the user comments and feedbacks for further improvement of the project.

PART A: BACKGROUND INFORMATION OF THE USER

1. Age:

   ☐ 18 – 25 years ☐ 26 – 33 years ☐ 34 – 41 years ☐ 42 – 49 years

2. Gender:

   ☐ Male ☐ Female

3. Year of Study:

   ☐ Foundation ☐ First Year ☐ Second Year ☐ Third Year ☐ Final Year

4. Do you own a Smartphone?

   ☐ Yes ☐ No

   If yes, please choose:

   ☐ Android ☐ iPhone ☐ Windows7 ☐ Blackberry

   Others: ______________________

Figure 3.9: Part A

PART B: TECHNOLOGY KNOWLEDGE OF THE USERS

1. Do you know about Context Awareness application?

   ☐ Yes ☐ No

   If yes, have you used a context awareness application before?

   ☐ Yes ☐ No

2. Do you know about Augmented Reality (AR) technology?

   ☐ Yes ☐ No

   If yes, have you used an AR application before?

   ☐ Yes ☐ No

Figure 3.10: Part B

System Usability Scale

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Figure 3.11: Part C

Q.U.I.S Generic Use Interface Questionnaire

OVERALL REACTIONS TO THE SOFTWARE	
terrible *wonderful* 0 1 2 3 4 5 6 7 8 9	*inadequate power* *adequate power* 0 1 2 3 4 5 6 7 8 9
difficult *easy* 0 1 2 3 4 5 6 7 8 9	*dull* *stimulating* 0 1 2 3 4 5 6 7 8 9
frustrating *satisfying* 0 1 2 3 4 5 6 7 8 9	*rigid* *flexible* 0 1 2 3 4 5 6 7 8 9

SCREEN	
Characters on the computer screen hard to read easy to read 0 1 2 3 4 5 6 7 8 9	*Sequence of screens* confusing very clear 0 1 2 3 4 5 6 7 8 9
Highlighting on the screen simplifies task not at all very much 0 1 2 3 4 5 6 7 8 9	*Organization of information on screen* confusing very clear 0 1 2 3 4 5 6 7 8 9

· LEARNING	
Learning to operate the system difficult easy 0 1 2 3 4 5 6 7 8 9	*Tasks can be performed in a straight-forward manner* never always 0 1 2 3 4 5 6 7 8 9
Exploring new features by trial and error difficult easy 0 1 2 3 4 5 6 7 8 9	*Remembering navigation / use of commands* difficult easy 0 1 2 3 4 5 6 7 8 9

· SYSTEM CAPABILITIES	
System speed slow fast enough 0 1 2 3 4 5 6 7 8 9	*Correcting your mistakes* difficult easy 0 1 2 3 4 5 6 7 8 9
System reliability unreliable reliable 0 1 2 3 4 5 6 7 8 9	*Experienced and inexperienced users' needs are taken into consideration* never always 0 1 2 3 4 5 6 7 8 9

Figure 3.12: Part D

PART E: USER FEEDBACK OF THE SYSTEM

1. I think Context Awareness UTP Campus Tour via Junaio Augmented Reality (AR) Browser should be implemented in our University.
   - ☐ Extremely Likely
   - ☐ Slightly Likely
   - ☐ Neither
   - ☐ Slightly Unlikely
   - ☐ Extreme Unlikely

2. Do you have any other comments or suggestions?

____

____

Figure 3.13: Part E

CHAPTER 4: RESULTS AND DISCUSSIONS

This part is the most important section for this project. It encompasses of the channel submission for certification by Junaio team, live testing results of the channel on mobile phone and user testing results. The following are the subjects involved:

4.1 Channel Submission

4.2 Live Testing Results

4.3 User Testing Results

4.1 Channel Submission

The developed Junaio channel needs to be submitted to the Junaio team to certify the channel. It will take two working days to activate the channel all over the regions specified by the developer. The channel will be set to "Active" once the Juanio team certified the channel. In this context, the channel name is displayed as UTP Campus Tour and the region specified is Malaysia. The channel is in active state which means it has been certified by the Junaio team.

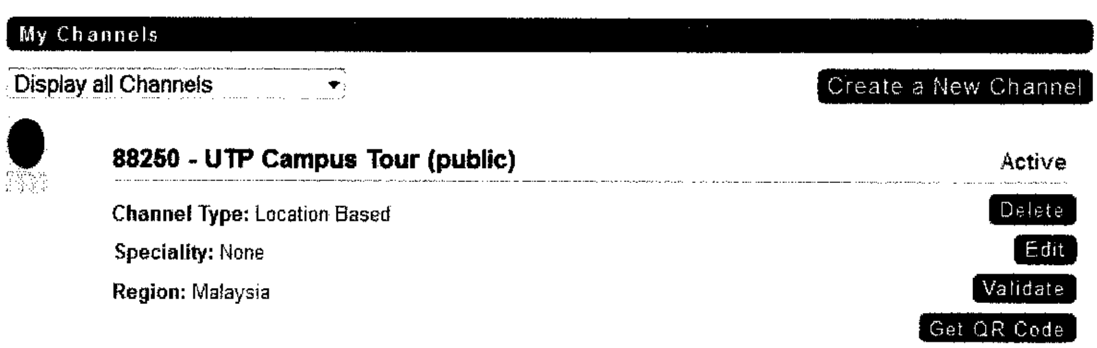

Figure 4.1: Channel Submission

4.2 Live Testing Results

The live testing uses the Samsung Galaxy Mini, an Android platform phone. The Junaio application is downloaded using the Android Market which is available for free. Next, the application is run and scan for the nearest channel around the user. UTP Campus Tour will be one of the results of the nearest channel to the user.

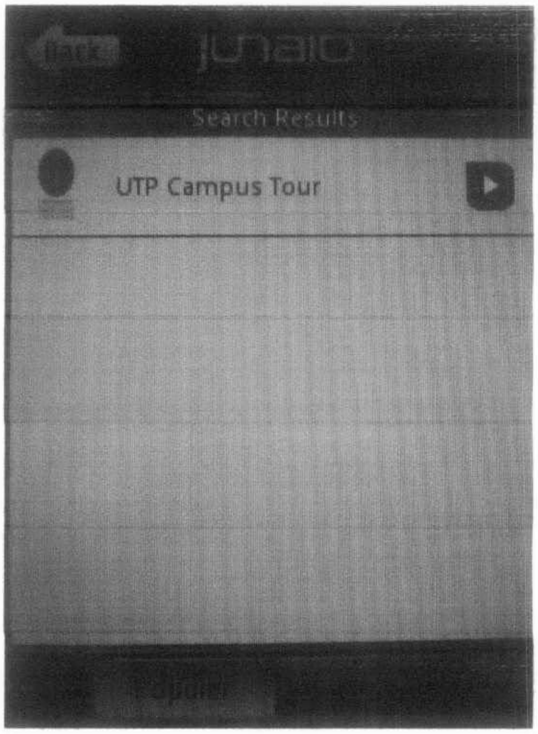

Figure 4.2: Scan search results

Once, the user click on the channel it will load all the POI available for the particular channel. The user can walk around and see the floating POI results around the campus.The POI shows the name of the POI, description and image of the POI. When the user clicks on the POI, it will open the POI and further details of the POI will be displayed there.

Figure 4.3: POI results of the channel

The channel developed is location based channel which shows the point of interest (POI) in the surrounding of the user. The channel can be accessed by simply held the phone with camera on and look around to see the virtual objects floating at the position of POI. The virtual objects can consist of text, thumbnails, animation, static 3D objects.

Furthermore, the channel now consists of minimum 10 POI which cover the places around the campus. The location of the places is determined by using the Global Positioning System (GPS) support. The important information needed for a location is the longitude and latitude. POI will be associated with the respective location from the information from GPS. One of the issues might rise is the accuracy of the location

4.3 User Testing Results

User testing results are vital in determining the usability of a system developed by the developer. In this case the two main usability testing used are:

- System Usability Scale (SUS)
- Generic User Interface Questionnaire (QUIS)

4.3.1 System Usability Scale (SUS)

System Usability Scale (SUS) is a reliable, low cost usability scale that can be used for global assessments of system usability. The figure below illustrates the scale for each questions answered by the user while using the system. The total SUS score is 55.5% which means the system is usable rate is above 50%.

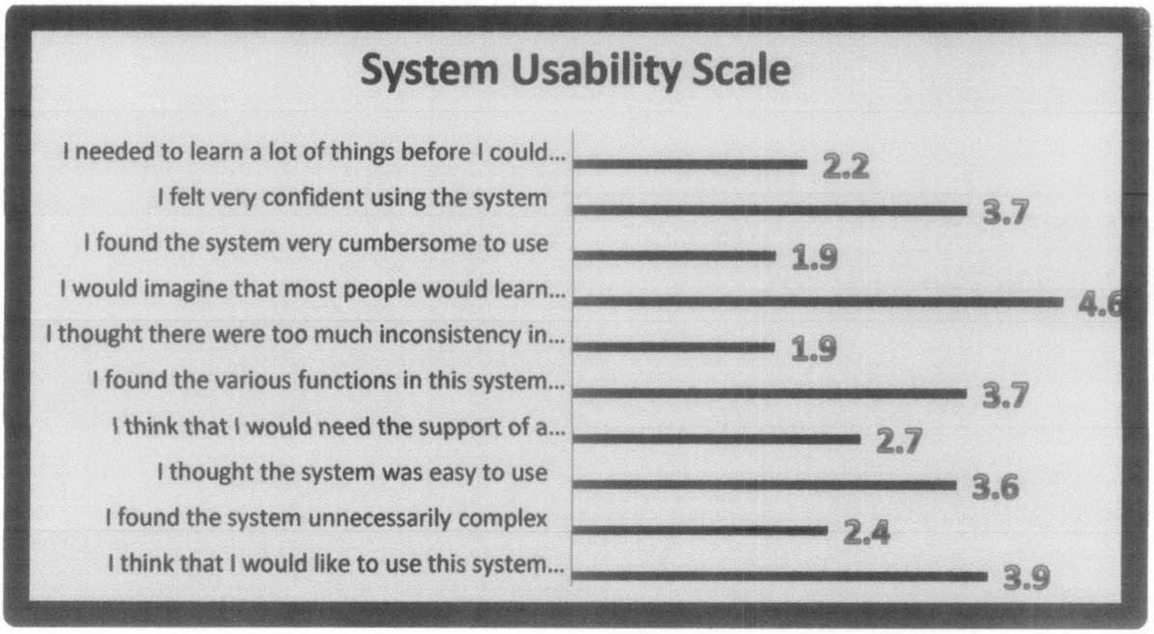

Figure 4.4: SUS

4.3.1 Generic User Interface Questionnaire (QUIS)

This questionnaire mainly focuses on the interface representation of the system to the user. There are four main sections which rates the system:

- Overall reactions of the system
- Screen
- Learning
- System capabilities

The overall reactions to the software show a fair value for all the criterias which include terrible/wonderful, inadequate/adequate power, difficult/easy, dull/stimulating, frustrating/satisfying and rigid/flexible.

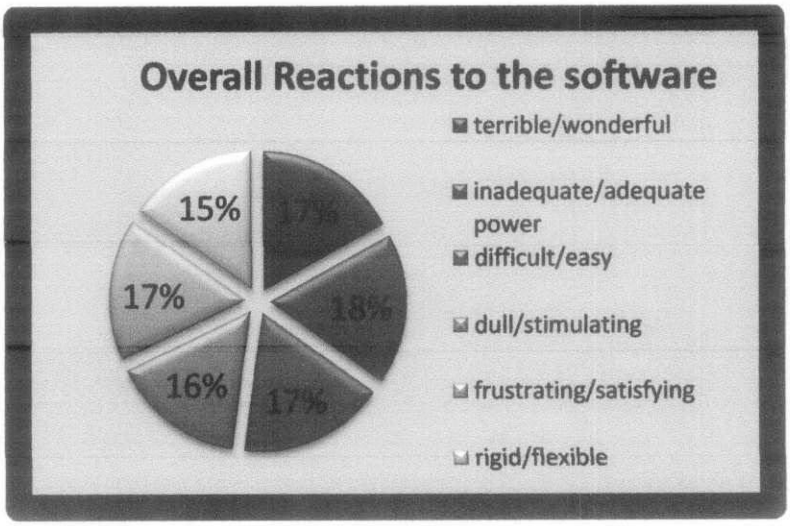

Figure 4.5: Overall reaction of the software

The screen testing shows that the character display on the screen is good followed by the sequence of the screen and the highlights on the screen simplifies tasks. All the elements have a fair weightage in the pie chart shown below.

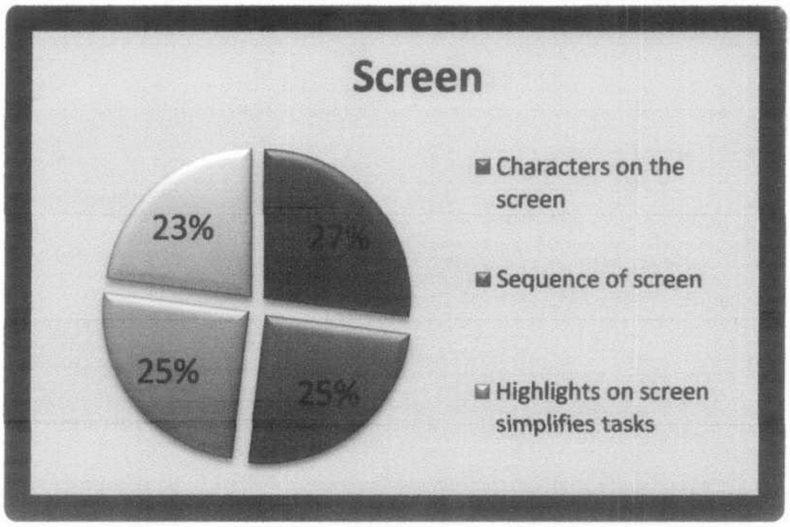

Figure 4.6: Screen

The learning testing results also shows the similar results as the screen testing where all the elements share almost the same weightage. The illustration of the results is shown below.

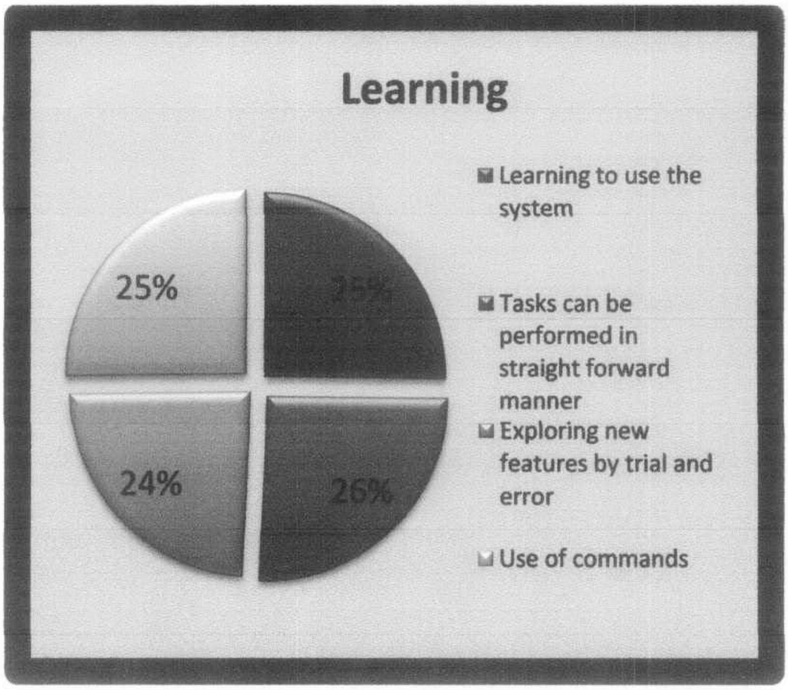

Figure 4.7: Learning

The system capabilities show a positive value for all the elements which includes speed, correcting the mistakes, reliability and consideration of user needs.

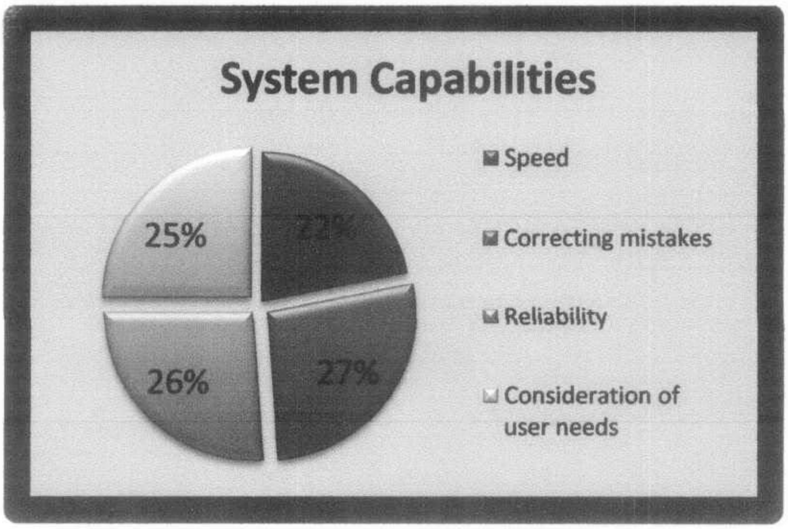

Figure 4.8: System Capabilities

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

To conclude, the development of channel using Junaio AR browser was a new experience and adventure to develop a context awareness AR tour application. The development of the channel comprises of 10 POI which includes the places around the campus.

The wireless connection enables the channel to be accessed from anywhere by the user. The wireless connection need to be provided for free in all places to encourage the development and implementation new technology. The project has a good prospect to further expand its scope outside the campus in future. There is an opportunity to create a channel for a specific region in Perak itself to promote tourism in the country. Nevertheless, to develop our own AR browser for the country is highly achievable provided that the Augmented Reality (AR) field has experts and well accepted by the nations.

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