

STUDY OF A USER-CENTERED DESIGN APPROACHED TO DEVELOPING A LOCAL POSITIONING SYSTEM FOR SMARTPHONES

Thesis Project

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Table of Contents

Abstract	2
Chapter 1	3
1.1 Introduction	3
Chapter 2	4
2.1 Human-Computer Interaction (HCI).....	4
2.2 Design Principles	4
Chapter 3	6
3.1 Implementation	6
3.2 Use Case	11
3.3 Questionnaire.....	13
3.4 Review	20
3.5 Final Design	20
Chapter 4	22
4.1 Designs Implementation using HTML, JavaScript and Feedbacks	22
4.2 Implementation of the final design using J2ME.....	30
4.3 Implementation of the final design using Android	32
Chapter 5	39
5.1 Backend work.....	39
5.2 Future Plan	42
Chapter 6	39
6.1 Conclusion.....	43
Bibliography.....	44

Abstract

Our application will help users in finding their way around different places inside BRAC University. The user will input the destination and the application will help to find a path from the user's current location. Our application will work for android base smartphones. The target user for this application could be any student of BRAC University, or a visitor who is not familiar with the place. Other Local Positioning System (LPS) applications for smartphones are currently available, but our target is to follow a user-centered interaction design process. Our aim with the end product is to create a system which is accessible to users of all backgrounds. Each stage of the development will be guided by qualitative and quantitative user evaluations/feedback.

CHAPTER 1

1.1 Introduction

A Local Positioning System (LPS) is a centralized version of the popular Global Positioning System (GPS). This navigation system will provide location information in all weather, anywhere within the coverage of the network to locate objects or people inside a building. Due to the signal attenuation caused by construction materials, the Global Positioning System (GPS) loses significant accuracy indoors. Instead of satellites, an LPS relies on nearby anchors (nodes with a known position), which either actively locate tags or provide environmental context for devices to sense.

Not everyone who comes in BRAC University territory is familiar with all the places or knows about the path which leads them to their destination. So this LPS will help the users to find their path to different places inside BRAC University.

The application we are trying to build up will work for android base smartphones. There are other Local Positioning System (LPS) applications for smartphones currently available in market. Those Local Positioning System (LPS) are already structured with different types of structure. Some of the applications look very simple and few are very lucrative but sometimes it gets very hard for the users to understand the system and how to use it although the company builds these applications keeping the matter ahead about user accessibility.

Our aim is to build a Local Positioning System (LPS) which will have a user-centered interaction design. Our objective behind this thesis is to create this user-centered design where in every step we will take review from the user and confirm it that is it actually accessible for the user from every background or not. All these stages of development will be guided by qualitative and quantitative user feedback.

In chapter 2 we discussed about the HCI method and its principal. In chapter 3 it will be discussed what we have done till now and how we did it. All steps of our work. In chapter 4 it will be discussed what will be our future plan. How we will do and what will be our steps. Then in chapter 5 it will be discussed about the conclusion where we will talk about the purpose and usefulness of our thesis.

CHAPTER 2

2.1 Human–computer interaction (HCI)

Human computer interaction is the study, planning and design of the interaction between users and computers. Interaction between users and computer occurs at the user interface which includes both software and hardware. A basic goal of HCI is to improve the interactions between users and computers by making computers more usable and receptive to the user's needs. Specifically, HCI is concerned with:

- methodologies and processes for designing interfaces (i.e., given a task and a class of users, design the best possible interface within given constraints, optimizing for a desired property such as learnability or efficiency of use)
- methods for implementing interfaces (e.g. software toolkits and libraries; efficient algorithms)
- techniques for evaluating and comparing interfaces
- developing new interfaces and interaction techniques
- developing descriptive and predictive models and theories of interaction

A long term goal of HCI is to design systems that minimize the barrier between the human's cognitive model of what they want to accomplish and the computer's understanding of the user's task. Researchers in HCI are interested in developing new design methodologies, experimenting with new hardware devices, prototyping new software systems, exploring new paradigms for interaction, and developing models and theories of interaction.

2.2 Design principles

When evaluating a current user interface or designing a new user interface, it is important to keep in minds the following experimental design principles:

- Early focus on user(s) and task(s): Establish how many users are needed to perform the task(s) and determine who the appropriate users should be; someone who has never used the interface, and will not use the interface in the future, is most likely not a valid user. In addition, define the task(s) the users will be performing and how often the task(s) need to be performed.
- Empirical measurement: Test the interface early on with real users who come in contact with the interface on an everyday basis. Keep in mind that results may be altered if the performance level of the user is not an accurate depiction of the real human-computer interaction. Establish quantitative usability specifics such as: the number of users performing the task(s), the time to complete the task(s), and the number of errors made during the task(s).
- Iterative design: After determining the users, tasks, and empirical measurements to include, perform the following iterative design steps:

1. Design the user interface
2. Test
3. Analyze results
4. Repeat

Repeat the iterative design process until a sensible, user-friendly interface is created.

Chapter 3

3.1 Implementation

As the topic says we are trying to make a user centered application. For our application we studied the HCI method which is a very effective way of designing an application which is usable by the users. For that, each stage of the development will be guided by user's evaluations or feedback. At the first stage of the development we are taking surveys of different user to find out about the necessity, usefulness of the application. We are including some basic questions to query about the application and also providing different options to choose from. We are also providing a sample of each of our designed interfaces to see what part user can understand what part we need to change and what additional feature we should add.

Design 1:



Screen 1



Screen 2



Screen 3



Screen 4



Screen 5



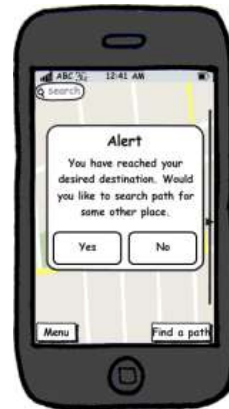
Screen 6



Screen 7



Screen 8



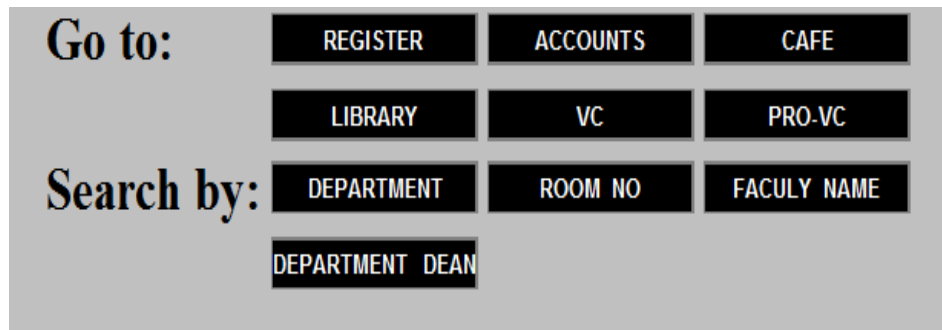
Screen 9

Design 2:

Screen1



Screen 2



Screen 3

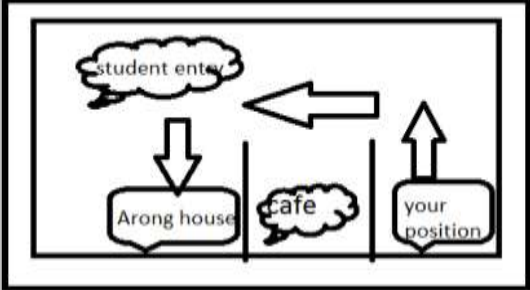


Screen 4

Dr.Mumit khan

12th floor,room no:1111[ARONG HOUSE]

First we need to go Arong house,so follow the image bellow.



The diagram shows a path starting from a box labeled 'your position' on the right. An upward arrow leads to a cloud labeled 'safe'. From the 'safe' cloud, a leftward arrow leads to a cloud labeled 'student entry'. From the 'student entry' cloud, a downward arrow leads to a box labeled 'Arong house'.

Hit the next button as you enter arong house.

NEXT!!! **Back!!!**

Screen 5

Dr.Mumit khan

12th floor,room no:1111[ARONG HOUSE]

Now follow the image bellow



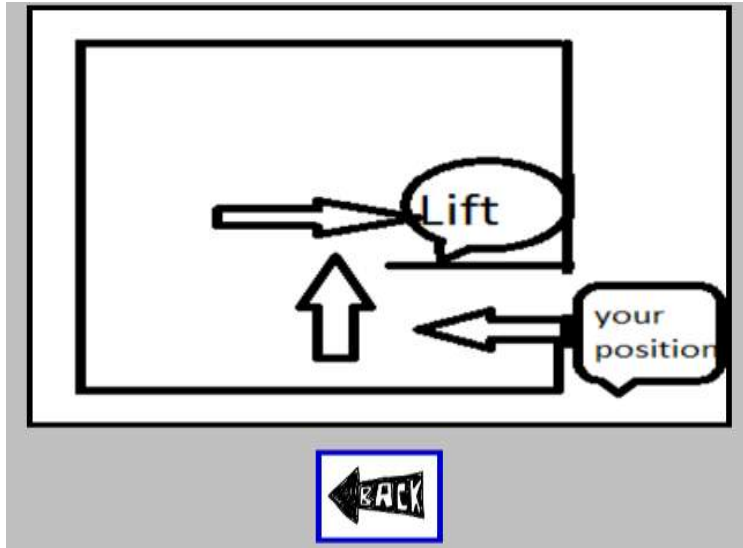
The diagram shows a path starting from a box labeled 'your position' on the right. A leftward arrow leads to a cloud labeled 'Lift'. From the 'Lift' cloud, an upward arrow leads to a box labeled '12th floor'.

Get in to the lift and press 12

Hit the next button if you reach 12th floor.

NEXT!!! **Back!!!** **new search!!!**

Screen 6



Screen 7

Dr.Mumit khan

12th floor,room no:1111[ARONG HOUSE]

Open the door and enter the cse department

Now follow the image bellow



Hit the next button if you reach 1111.

NEXT!!! **Back!!!** **new search!!!**

Screen 8

Dr.Mumit khan

12th floor,room no:1111[ARONG HOUSE]

You reach your destination !!!!



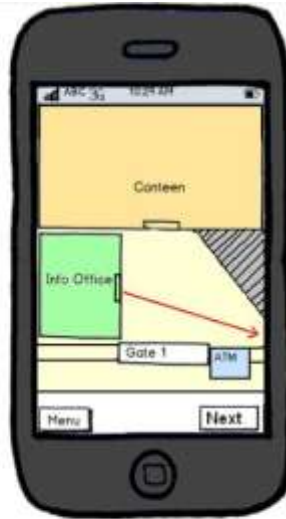
Hit the finish button to end this session.

Finish!!! **Back!!!** **new search!!!**

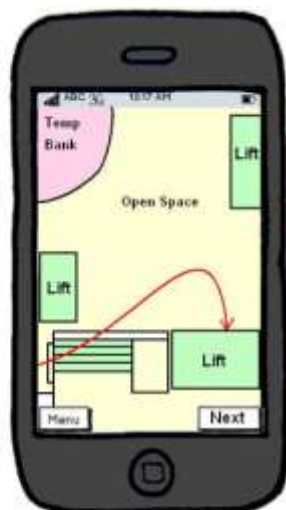
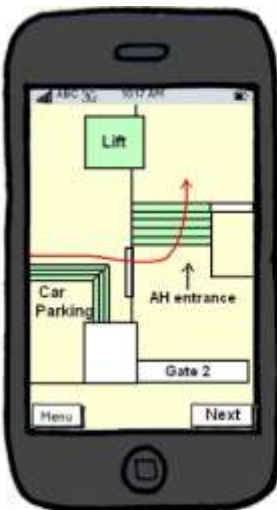
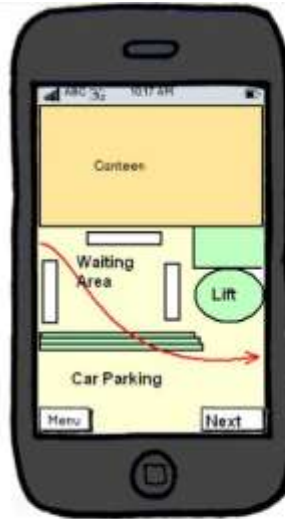
Design 3



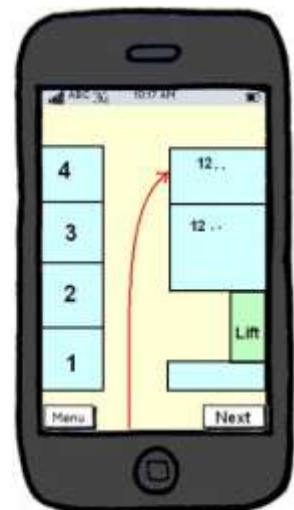
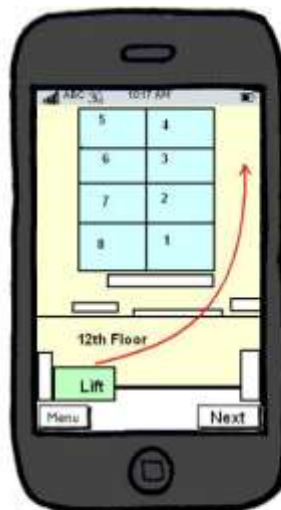
Select your position and your destination



Follow the arrow and click ext to view next path



Select 12 from the buttons



Ta Da!!!

3.2 Use Case

Fresher Student

Assume a fresher student came to get admit in the software will be provided from the information desk.

1. He might need to know his position in the campus and then he need to go to his advisor office for advising.
2. He might need to go to accounts office.
3. On his 1st week in the campus he might need to find the library.
4. For attending class he might need to know how to reach his class from where he is standing so he will input his room no.
5. May be he/she need to talk with the advisor.

Visiting Faculty

Use case 1:

Assume Razib Imran sir came first time in university (FOR INTERVIEW)!!!

He's in front of the gate and he wants to go to the CSE department to meet MUMIT sir.

Use case 2:

Assume Razib Imran sir came first time in university (FOR TAKING CLASS)!!!

He only has the room number for his first class he wants to know how to reach the room.

Use case 3:

Assume Razib Imran sir wants to submit grade!!!

Use case 4:

Assume Razib Imran sir wants to go to Accounts!!!

Parents

Case 1: A parent is of a student wanting to admit in to the university need to find the location of information desk.

Case 2: To know the study supporting facilities they need to find the location of library/ labs.

Case 3: Parents tend to find information about the university from current students. They may want the location of cafeteria

Case 4: To know the result of their child they need to know the location of corresponding Departments

Case 5: To clear the payment of semester fee they need to find bank booth

3.3 Questionnaire

QUESTION:

1. What you do when you have to go any place in BRAC University that you are not familiar.
 - a. You have to ask the security guard.
 - b. You have to go to the info desk.
 - c. You have to ask anyone whom you find in front of you.
2. What problem you face finding the specific place?
 - a. You get lost after someone directed you the path.
 - b. You get confuse about the path direction.
 - c. Sometimes you get confuse even you have been to that place before.
3. How frequent you have to ask for your destination
 - a. 1 b. 2 c. 3 d. 4
4. Does every time you get to know the right path for the place you want to go?
 - a. Yes. b. No. c. Sometimes.
5. Do you want to process the moment you select the present position and destination?
 - a. Yes. b. No. c. May be there should be a button to start the process.
6. What type of option menu you prefer?
 - a. Option icon menu. b. Option extended menu. c. Drop down menu.
7. What type of context menu you prefer?
 - a. List view. b. Icon view.
8. What type of layout you want?
 - a. Simple without any option on the screen.
 - b. Screen full of menus and option.
 - c. When touch on the screen the menu arises.
9. How do you want to give input of your position and destination?
 - a. Drop down menu. b. Written text c. Voice command
10. What type of user interface should be used
 - a. Simple. b. Gorgeous. c. Stylish.
11. Do you want to have records for the last few positions user have used?
 - a. Yes. b. No.
12. Do you want have a visual look of the place you want to go, like picture or something?
 - a. Yes. b. No.
13. Do you want to show your location on the screen?
 - a. Yes. b. No.

Here is a sample of the outlook of the Local Positioning System.

Design 1:



1. Having any problems understanding what to do?
2. Any changes required any suggestion?



1. Are you ok with the front end.
2. Do you want to add/remove any more button or option on the screen?



1. Having any problem learning the what menu button do
2. Do you want to add/remove any more option on the menu?



1. Are you ok with the search option.
2. Do you want it to be more detailed when you use the search option?



1. Do you have any problem to set the present location or destination?
2. Are you ok with the combo box when you want to select these?



- The map will be colorful. Picture will be attached with every point such as when you select information desk a picture will arrive how information desk look.
1. Do you find any problem understanding the direction.



A small note will display on the screen which will say to click on lift icon when you boarded on the lift.

1. Do you find any problem understanding the direction?



A small note will display on the screen which will say to click on destination icon when you reached.

1. Do you find any problem understanding the direction?



This alert box will arrive when you will reach to your destination.

1. Do you find any problem understanding the direction?

Design 2:



screen1

A screen will display when you open the program. You have to press Start button to start the program.

1. Are you finding any difficulty to guess that you have to press the start button to continue?
2. Or you want this button to move?
3. What you want to see in welcome page?

Go to:

REGISTER	ACCOUNTS	CAFE
LIBRARY	VC	PRO-VC

Search by:

DEPARTMENT	ROOM NO	FACULY NAME
DEPARTMENT DEAN		

A screen will display narrow down your search.

screen2

4. Do you want any hint button, like press your desired destination?

DR. MUMIT KHAN!!!	ZIA UDDIN!!!	MRS ABED!!!	?????!!!
CSE	MNS	CFL	CSE
?????!!!		?????!!!	
CSE		CSE	
?????!!!	?????!!!	?????!!!	?????!!!
CSE	CSE	CSE	CSE

← BACK

Here all deans name with their department 'name, you simply have to choose one.

screen3

5. You have to select your destination by simply clicking the name of department dean name.
6. Any difficulty understanding the use of back button??

Dr.Mumit khan

12th floor,room no:1111[ARONG HOUSE]

First we need to go Arong house,so follow the image bellow.

Hit the next button as you enter arong house.

NEXT!!!	Back!!!
---------	---------

A screen is helping you to reach your destination.

screen4

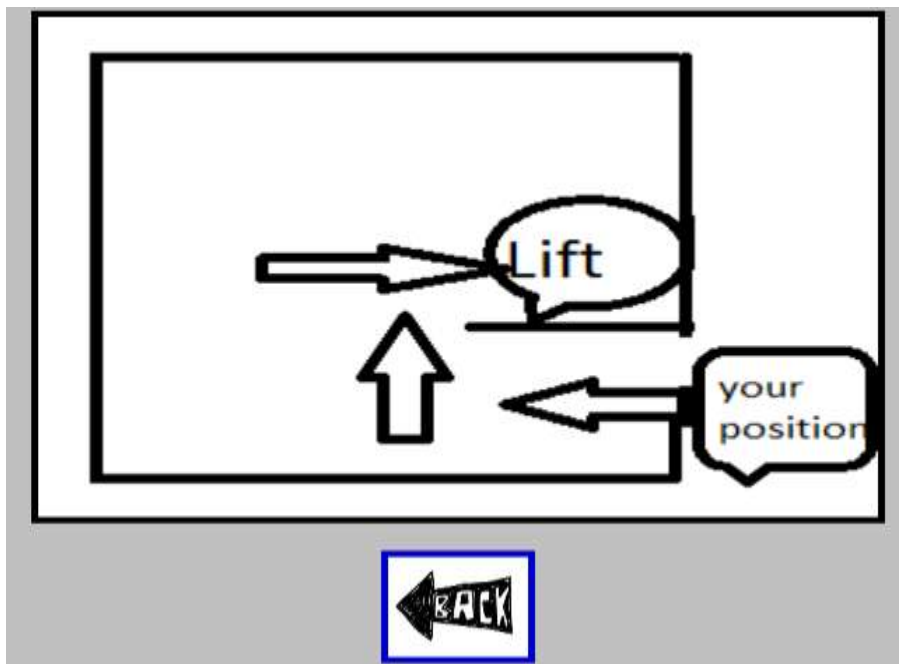
7. Your destination always top of your screen, do you find it unnecessary?



A screen is helping you to reach your destination.

screen5

8. If you find difficulty to understand the image you click on it and make it larger, any difficulties?
9. Back button used for last session, in case you missed some part.
10. New search means in case you want to start a new search.



Zoom in image.

screen6

11. You have to use the back button to continue.



A screen is helping you to reach your destination.

screen6



A screen will display when you reach your destination.

screen7

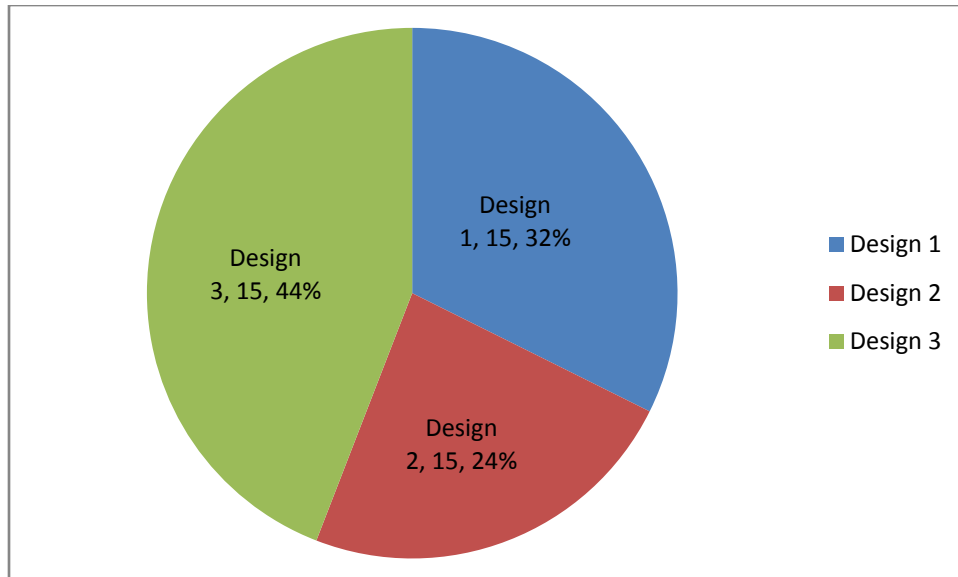
12. Do you like image I use to let you know that you reach your destination??

Design 3:



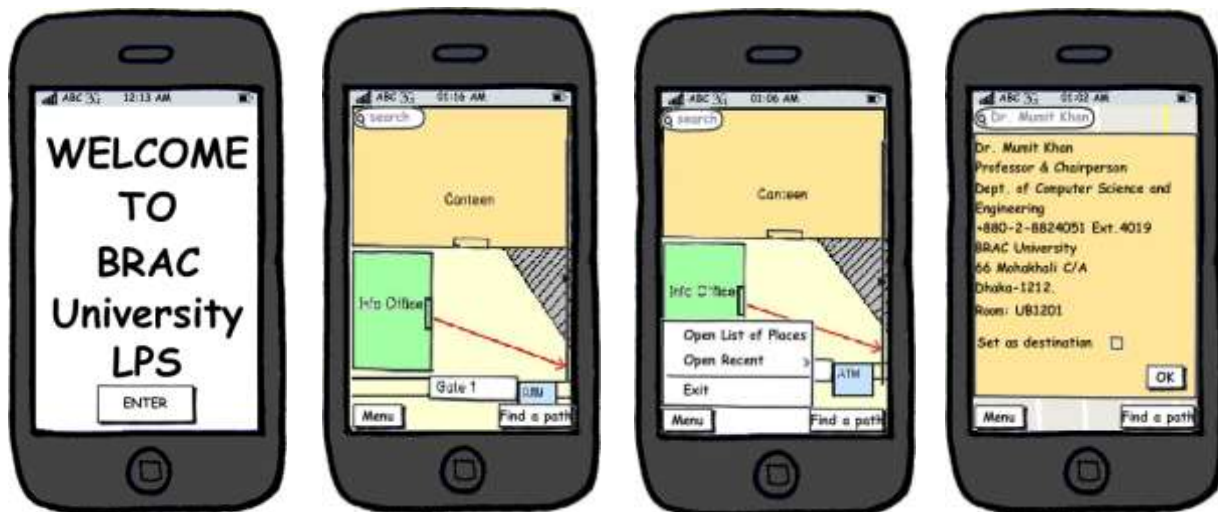
1. Do you understand the map view?
 - a. yes b. no
2. Can you follow the directions clearly?
 - a. Yes. b. No.
3. What kind of map do you want to see?
 - a. Yes b. No
4. Do you want to store information of your visited path?
 - a. Simple maze view b. Colorful graphics c. Text output
5. Do you want alert tone/ message after reaching destination?
 - a. Yes b. No
13. Any suggestion/feature do you think we need to add.

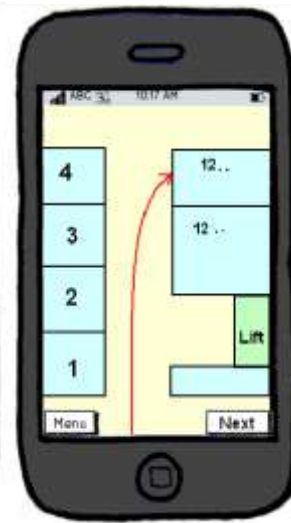
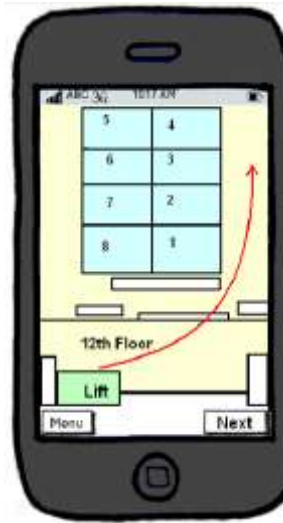
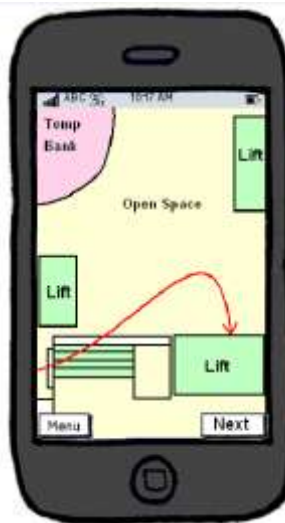
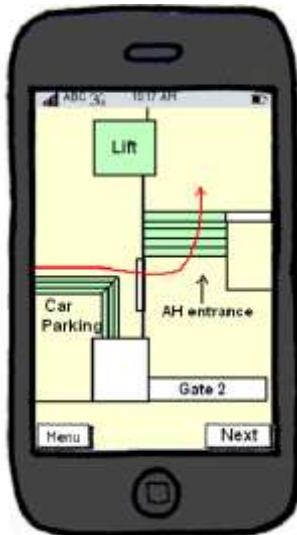
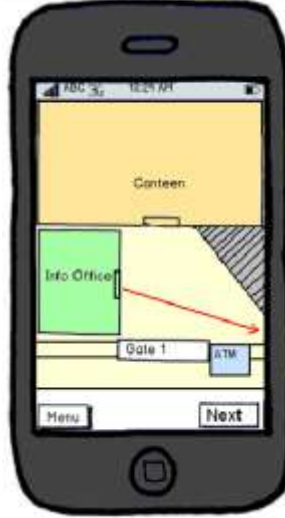
3.4 Review



After took the review from different users the result we got was set on as a percentage pie chart.

3.5 Final design





Chapter 4

4.1 Designs Implemented using HTML and their feedbacks

Previously in the pre-thesis we only designed few front interfaces that we thought for the Local Positioning System (LPS). Now in this part we implemented all those design using HTML. So that the user can actually experience how effectively it works and the all the changes required to make it more usable to users. We implemented all the three designs and from that we reviewed and took opinion from the user and designed a final where we tried to make an error free design. We took review for every design so that after the final design anyone can easily and comfortably use it.

Design 1:



Screen 1

Screen 2

Screen 3

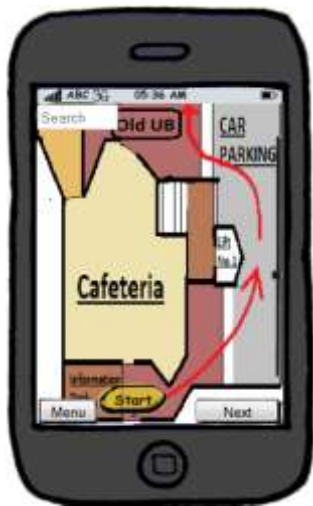
Screen 4

In this screen press ENTER to start the program.

Here it shows the full view of the map. To find a path either write in the search tag or press Find Path.

Here we have drop down lists to select the present location and the destination of user.

Here the information about any faculty is shown and there is an option to set as a destination.



Screen 5



Screen 6



Screen 7



Screen 8

In this screen it will show the map along with the path direction towards the destination.

This screen also shows the map with direction. When the next button is clicked it will move to next screen.

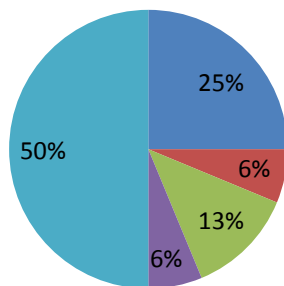
This screen shows the map with direction. When finish button is clicked an alert box will appear.

This alert box will ask about either to exit the program or to start for a new search.

Deficiency of this design:

1. All walls in the map should have the same color.
2. Search out is not needed, there should be a button for search.
3. Search area is not very much visible.
4. Cancel button should be implemented in the Alert box.
5. Text area in screen 6 should be removed as it covers a portion of the map.
6. In screen 4 find OK and FIND PATH button is confusing which one to click.

Design 1



- Do you understand all the elements of the map
- Do you understand all the functionality of the map
- Are you satisfied with every position of all the buttons
- Do you understand the feedbacks after the action took place
- Error Free

Design 2:



Screen 1

This is the welcome page to start press start button.



Screen 2

Here we have different type of search option for the destination.



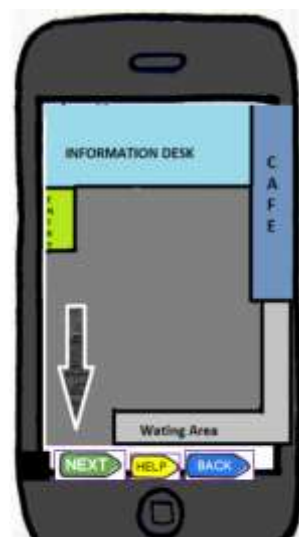
Screen 3

Here we can get the list of all deans of all departments.



Screen 4

Here we can select our present position.



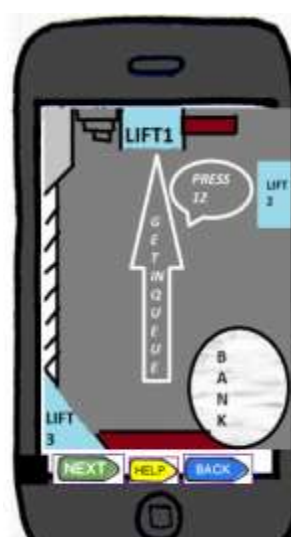
Screen 5

Here the map is shown along with the path direction. Press next button for the next map.



Screen 6

Here also the map is shown along with the path direction. Press next button for the next view.

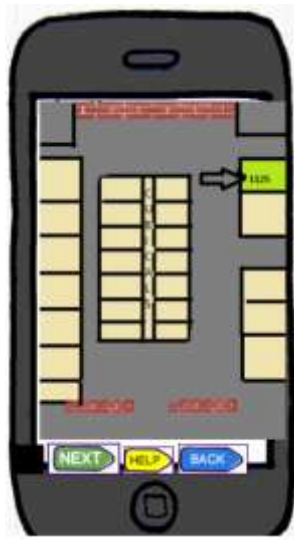


Screen 7



Screen 8

Here also the map is shown along with the path direction. Press next button for the next view



Screen 9

Here also the map is shown along with the path direction. Press next button for the next view.



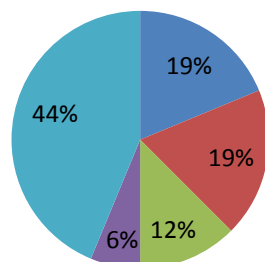
Screen 10

This page shows a message that the user has reached to destination.

Deficiency of this design:

1. The map is not so clear and understanding.
2. The path should define either bottom to up or left to right.
3. The position of the back button and the next button is not comfortable.
4. Search button position is not right.
5. The button position should be fixed.
6. Texture of the button.
7. There should be a search option.
8. Position of the present location in the map cannot be identify.

Design 2



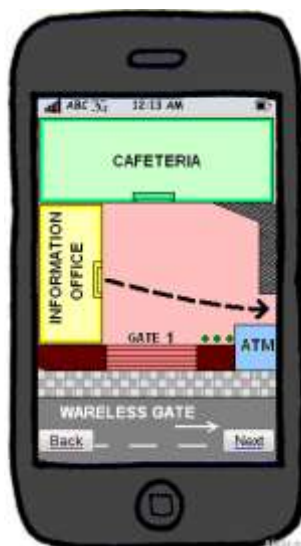
- Do you understand all the elements of the map
- Do you understand all the functionality of the map
- Are you satisfied with every position of all the buttons
- Do you understand the feedbacks after the action took place
- Error Free

Design 3:



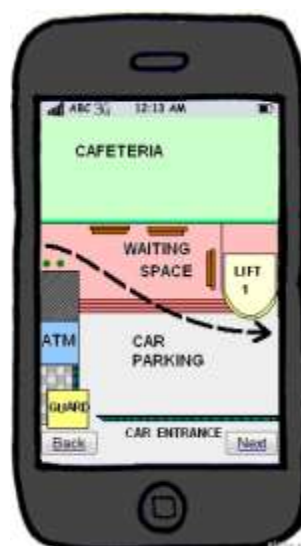
Screen 1

This is the welcome screen and also here user can select his present position and destination.



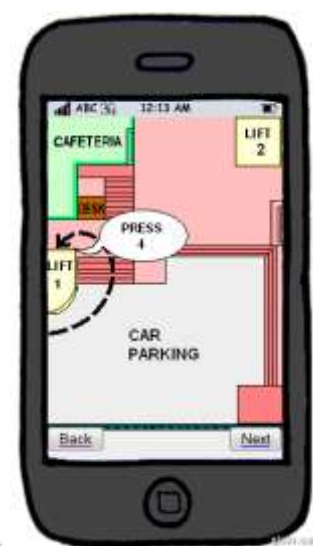
Screen 2

This page shows the map of the partial map of the ground floor along with the direction.



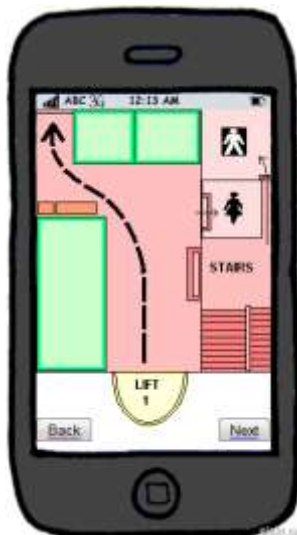
Screen 3

This page shows the map of the partial map of the ground floor along with the direction.



Screen 4

This page shows the map of the partial map of the ground floor along with the direction.



Screen 5

This page shows the map of the partial map of the 4th floor of UB1 along with the direction.

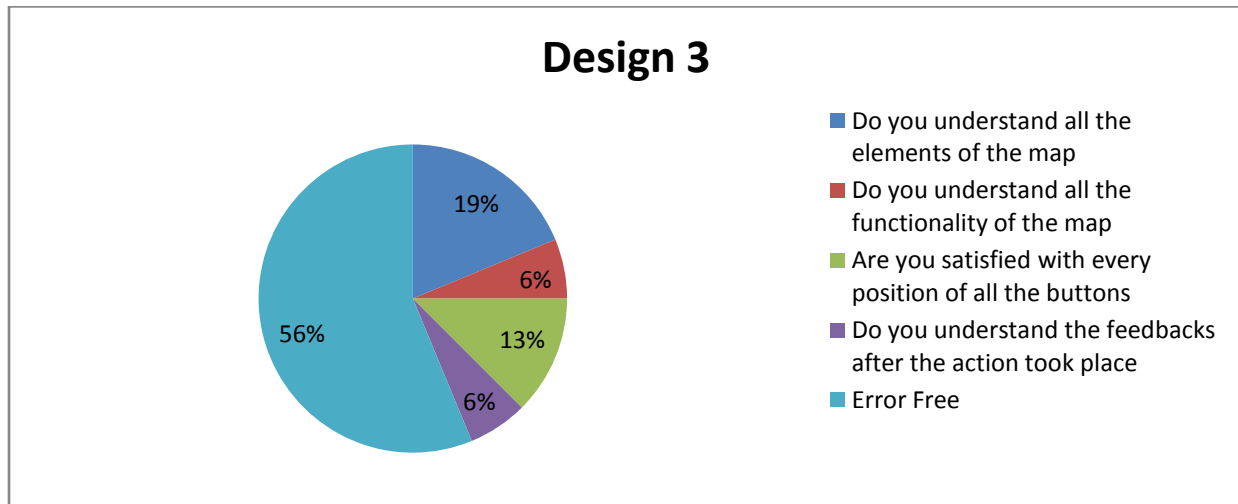


Screen 6

Here it shows we reached to account office. If done button is pressed it will go to the welcome screen.

Deficiency of this design:

1. The color combination of the map is not proper.
2. No exit button.
3. In screen 2 the ATM booth seems to be inside university.
4. No search option.
5. Animation should be static.



Final Design:



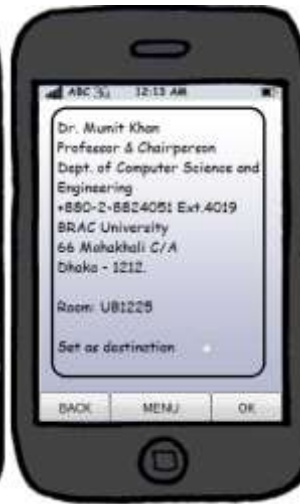
Screen 1

This is the welcome screen the logo is animated.



Screen 2

Here we have different buttons for different option and also a search area.



Screen 3

Here the information about any faculty is shown and there is an option to set as a destination



Screen 4

In this screen the deans of every department is listed so that anyone can click to whom he/she want to meet



Screen 5

This page shows to set the present location of the user



Screen 6

This is the map along with the animated directional map to find the path.



Screen 7

This map also shows the whole map of the floor along with the animated path direction.

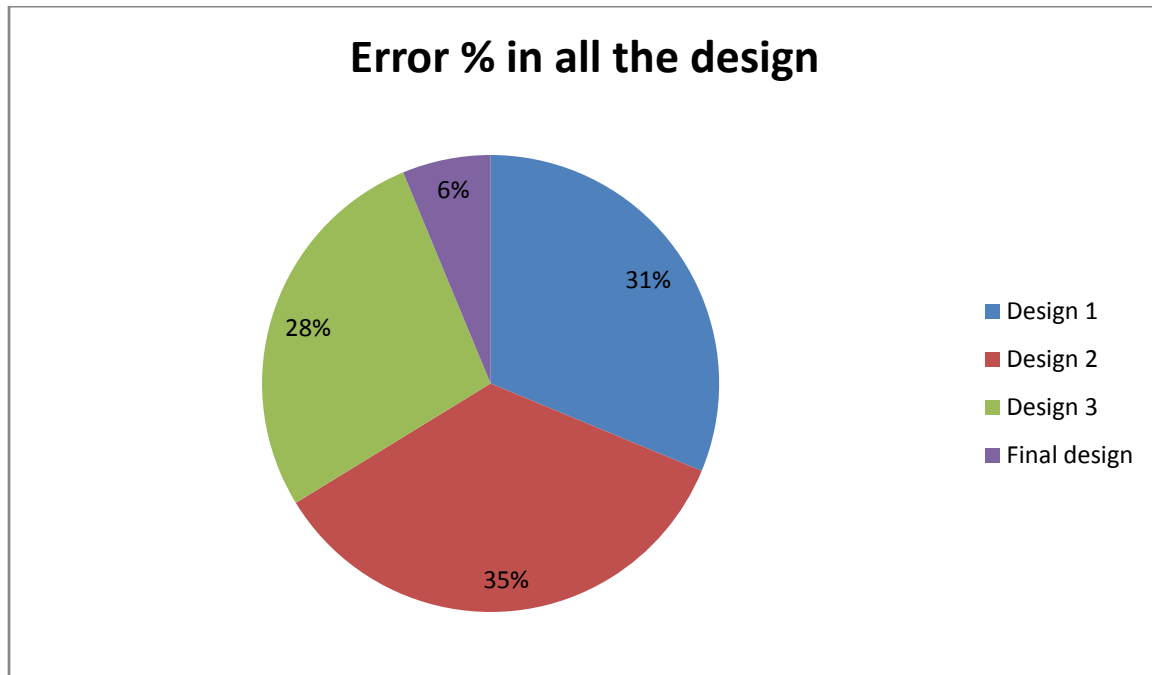


Screen 8

This alert message will appear after the user reaches to his destination.

Deficiency of this design:

1. Portion of the image cannot be zoomed in this design.
2. Few extra buttons and options could have

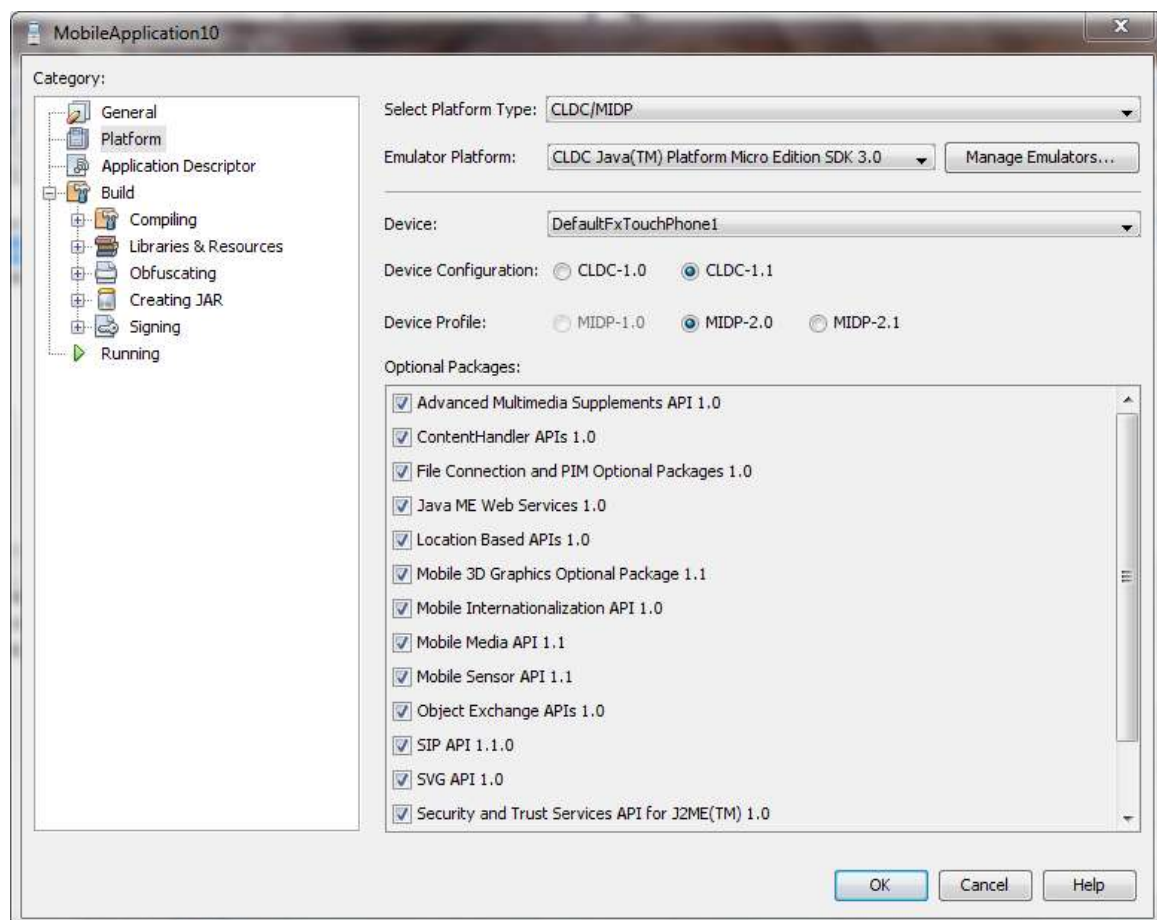


4.2 Implementation of the final design using J2ME

After evaluating the survey result we implemented a demo in j2ME.

Configurations:

- ➔ MIDLET version 2.0
- ➔ CLDC 1.1
- ➔ SDK 3.0
- ➔ Device : Default Touch Phone 1



Our topic is about studying a user centered design approached to develop a local positioning system for Smart phones. We used the HCI method to make the interface as much user friendly as possible.

At first it shows the logo for the Local Positioning System (LPS). Then it takes the user to the first menu page, where there are some options shown. The options under the “Go To”

caption, is showing some destination names. By clicking them user will be asked to give his/ her position. We only designed from information office as user's position.

The options under the "Search By" caption, is giving the user some choices to specifically search something, such as, Department Head, Department etc.

At the end of a search user is given to search a new. So that user does not need to cut the program and reload again.

Changes from final design :

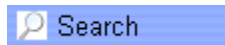
While implementing the interface we had to make some changes to the interface view. These changes did not change any of the contents but only the look of it. These happened because of some built in properties of J2ME.

1 .The first change is the menu page. When we designed the menu in our html final design, it had a grid view. But in J2me it was shown in list view.



In J2ME library there is no tool to design menus in grid view. But we would not decline the fact that grid view is possible to make. Such examples are, *Lightweight UI Toolkit (LWUIT)* is released recently specially for cell phones. Also with Blackberry and Android program we can build the grid view.

2. The second change is the search option in the menu page. Since canvas is a low level component and list is a high level component, it is not possible to mix them together.



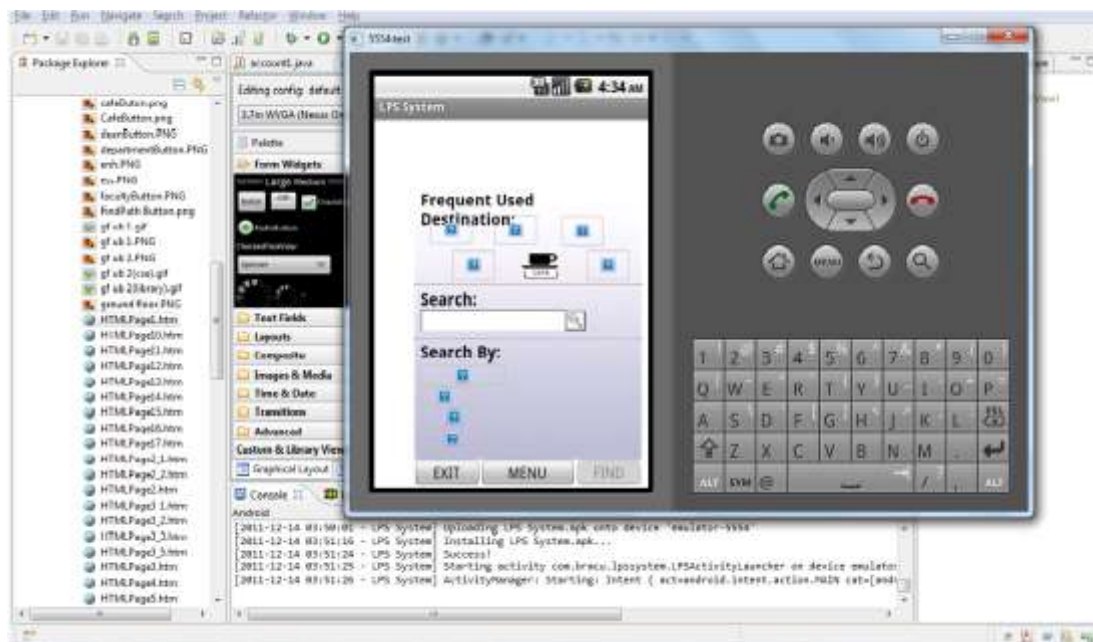
That is why we have given an option named “Search”. This will take the user to the search page where they can search through writing the destination.

These are the basic changes we made throughout making the program.

4.3 Implementation of the final design using Android

At first we tried to implement the final design using HTML and JavaScript. Then we tried to implement it as an actual mobile application using J2me. But there we had to make some changes in our design. So then we tried it with android, to make an application for all android devices.

While using android firstly we tried to make a web view of our user interface, but if we use that then the animated logo and some other things get static. The image of the button sometimes doesn't show up. The window size of our browser and mobile is not same so we had to resize all those screens.



Then we tried to implement it as an android application. It was better in a sense that in j2me not all functionality supports so for that we had to bring few changes in our reviewed design. But here it is possible to implement the exact same design of the final design that we reviewed.

The configuration we used for our project.

Configurations:

- Android 2.2
- API Level 8
- Skin HVGA

Among the three use case we randomly select one case and made design for that one. As it is possible to build the interface for one use case we believe the other use case can also be implemented using this Android SDK.



Figure 1



Figure 2

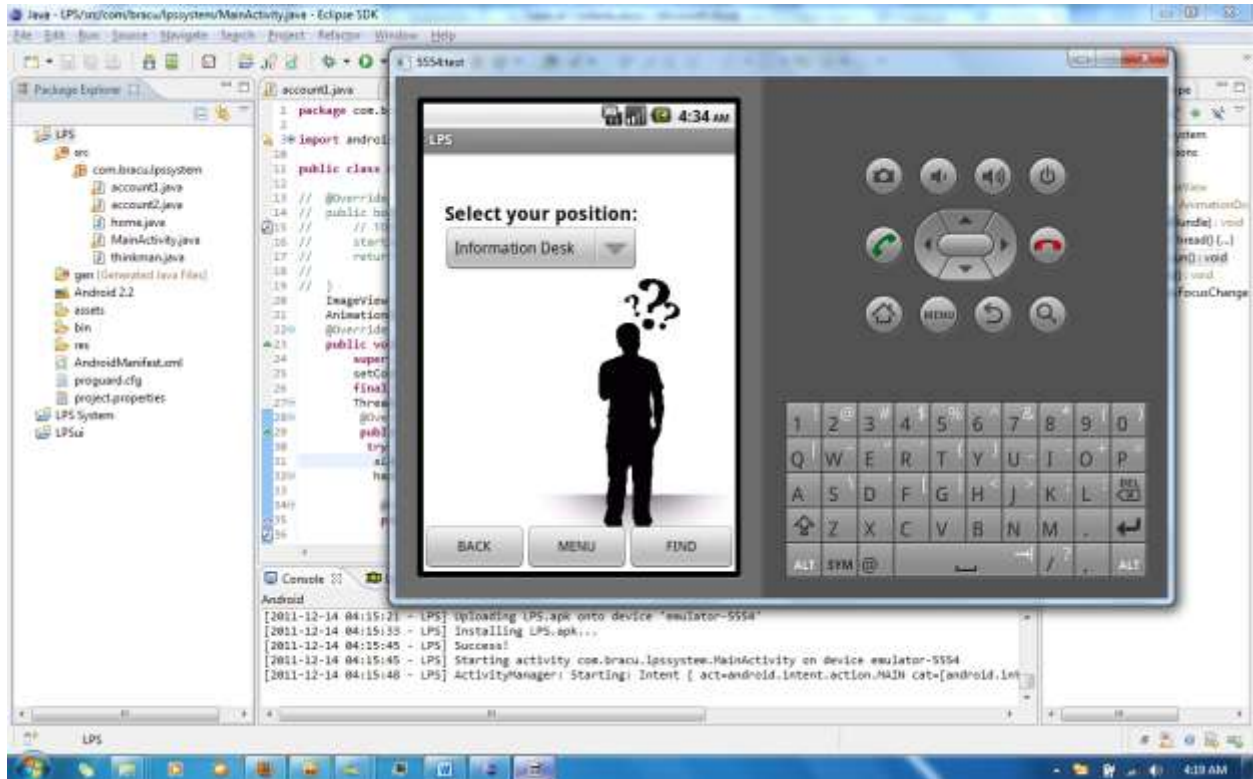


Figure 3



Figure 4

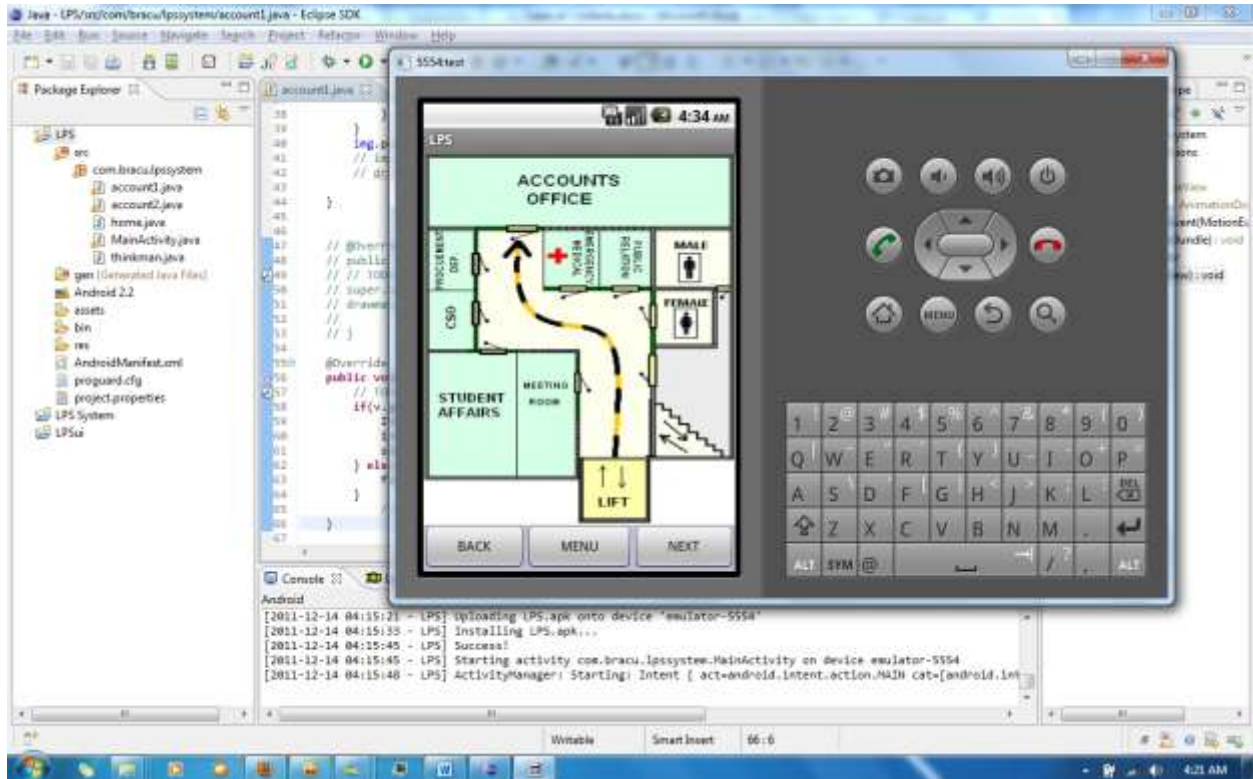


Figure 5

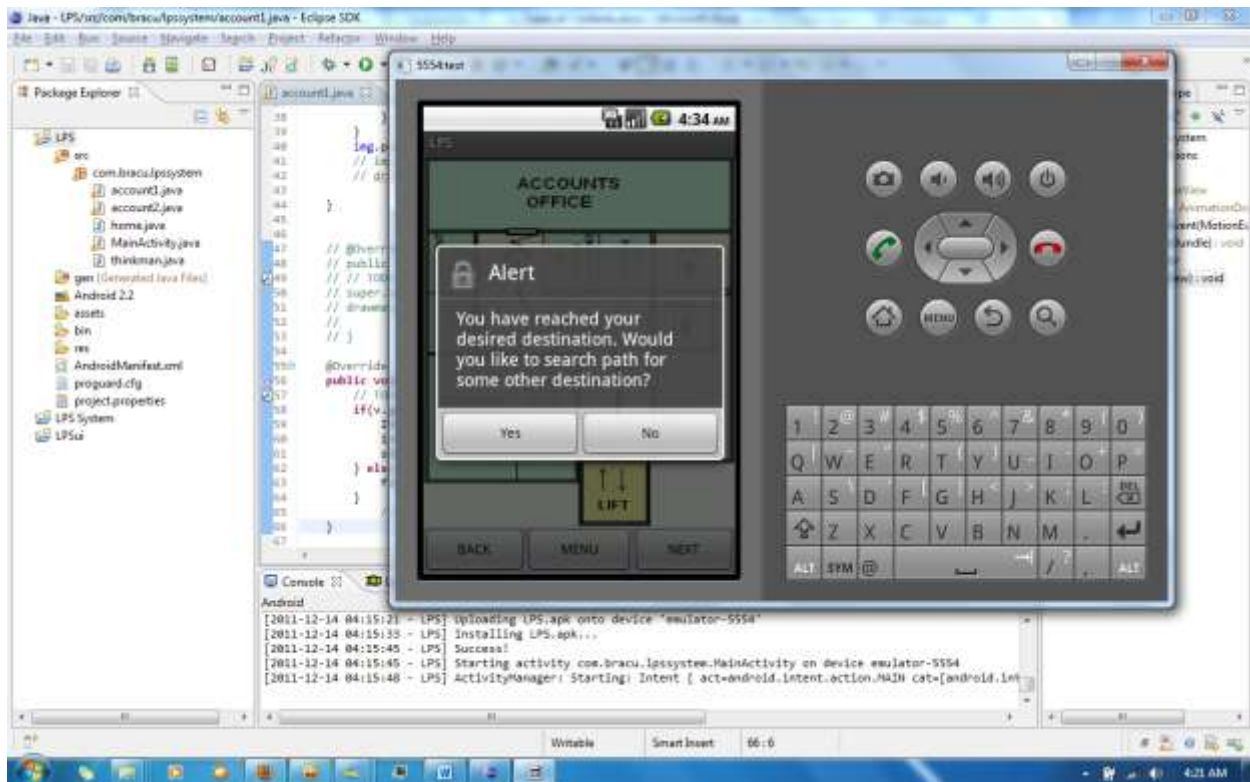
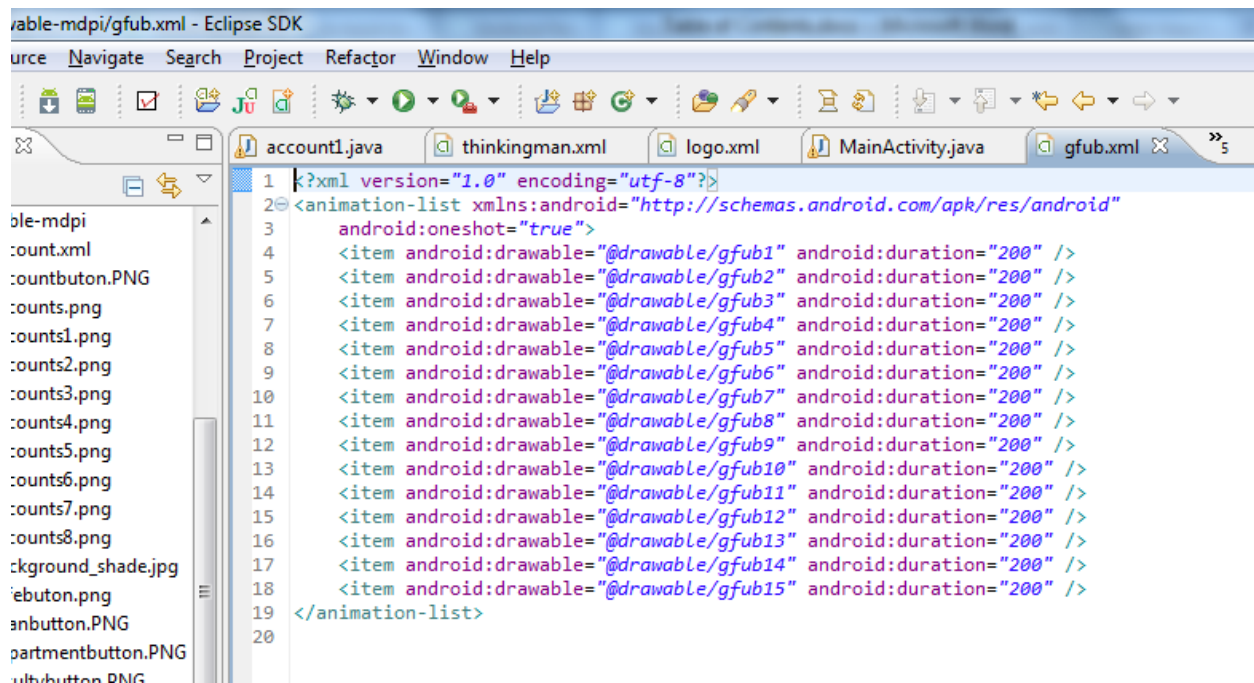


Figure 6

While implementing this we faced few problems as we were using android for the 1st time. We had big issue about the logo of our project as android doesn't support gif file. So we had to use animate method. Where the images of the animation are arranged according to playing order



We faced another problem that after we implemented the application when we click find after selecting the present location of the user to find the path of his/her destination the program crashes showing an error called “/AndroidRuntime(521): java.lang.RuntimeException: Unable to start activity ComponentInfo{com.bracu.lpssystem/com.bracu.lpssystem.account1}: java.lang.NullPointerException”. This error occurred because of somewhere we didn’t link up the account class to the activity. In figure 7 we marked it out. After all these trouble we manage to implement the design in android.

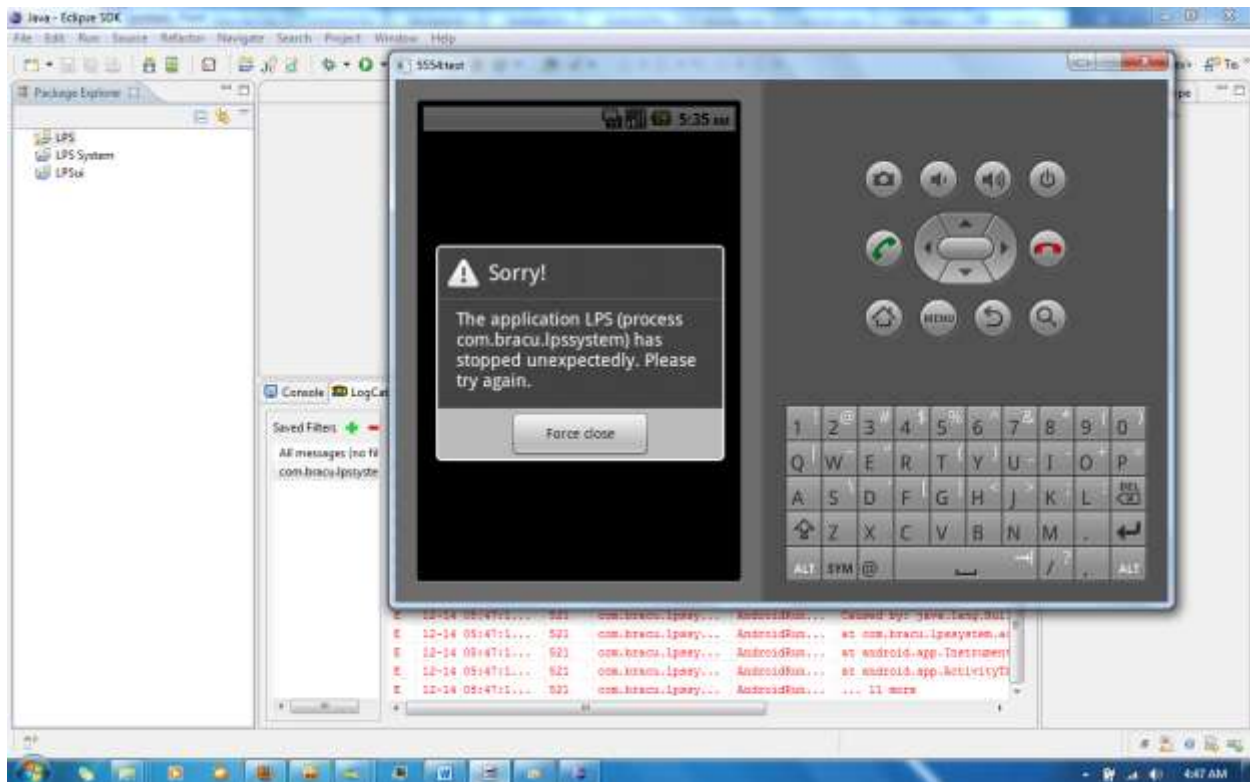


Figure 7

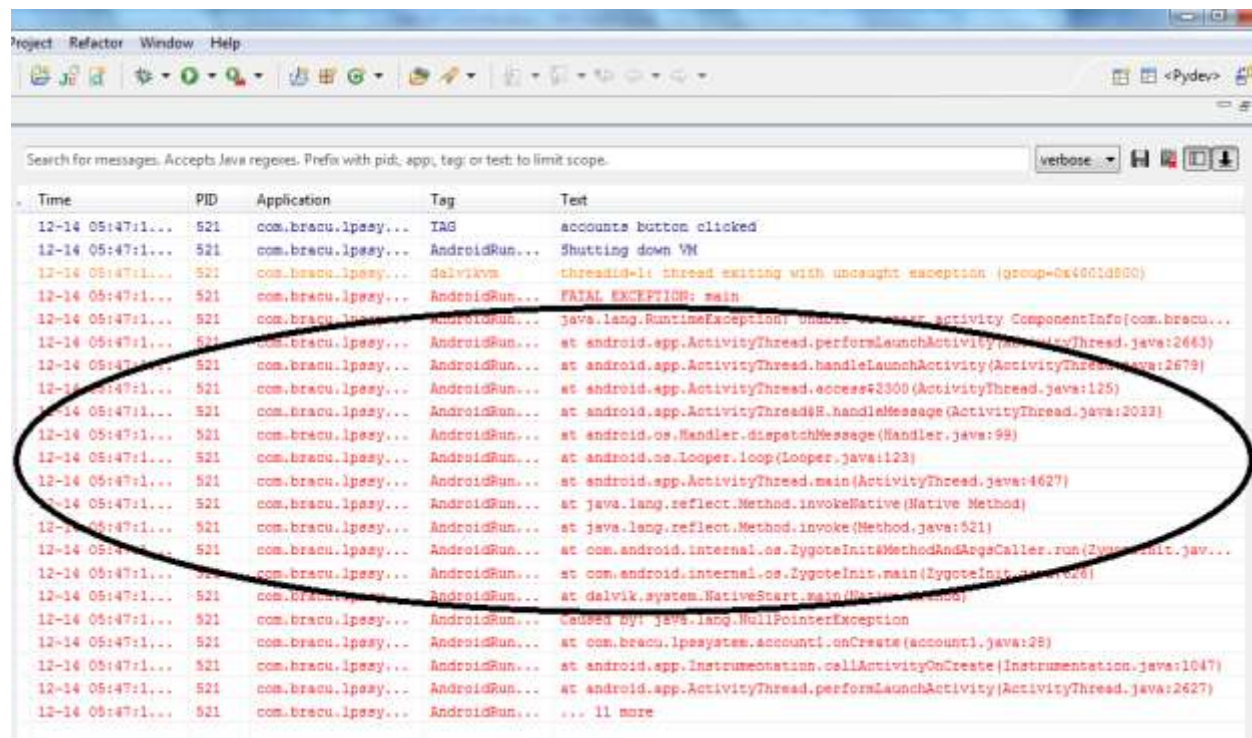


Figure 8

Chapter 5

5.1 Backend work

For Our back-end work in our pre-thesis we said that we might use technology like

- **Infrared (IR)**
- **Wi-Fi**
- **Ultra-Wideband (UWB)**
- **Radio Frequency Identification (RFID).**

We need this technology for two major reasons and they are:

1. To get user's present Location.
2. For Checking users are taking the correct path or not.

Infrared (IR)

Infrared could be a very good device to work as an emitter. But the problem with infrared is it needs to be directly pointed towards the receiver so the user have to look around for the infrared device to know his present location and the second problem is now a day's maximum high tech mobile doesn't support infrared. So this system will not work fine for our application.

Wi-Fi

We could use Wi-Fi, it's the technology we having in every recent mobile device. It can also cover a larger radius than infrared or Bluetooth but it's not an advantage for our project. Its large covering radius is working as disadvantage for our application because if we set Wi-Fi router in any floor it will definitely cover the whole floor. Then we would not be able to locate any specific room on that certain floor. And if we set Wi-Fi router to each and every room still it will not work as it will conflict with other routers then the application will get confuse which router to select and it will create confusion to the user. So it won't be a very good decision to select Wi-Fi router.

Ultra-Wideband (UWB)

Ultra-Wideband (UWB) technology, based on the WiMedia standard, brings the convenience and mobility of wireless communications to high-speed interconnects in devices throughout the digital home and office. Designed for low-power, short-range, wireless personal area networks (WPANs), UWB is the leading technology for freeing people from wires, enabling wireless connection of multiple devices for transmission of video, audio and other high-bandwidth data.

UWB communications transmit in a way that doesn't interfere largely with other more traditional narrowband and continuous carrier wave uses in the same frequency band. However first studies show that the rise of noise level by a number of UWB transmitters puts a burden on existing communications services. This may be hard to bear for traditional systems designs and may affect the stability of such existing systems.

Radio Frequency Identification (RFID)

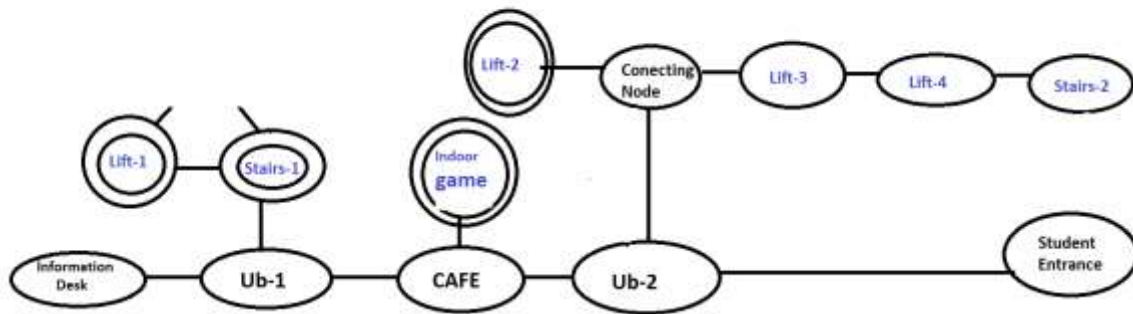
Radio-frequency identification (RFID) is a technology that uses radio waves to transfer data from an electronic tag, called RFID tag or label, attached to an object through a reader for the purpose of identifying and tracking the object. Some RFID tags can be read from several meters away and beyond the line of sight of the reader. The application of bulk reading enables an almost-parallel reading of tags. But it is too expensive.

As we can see every one of these has some issue so we not able to work with any of these technology.

So we stop working for the back end, but after some time we realize for the First problem if the user can give us their present location or give us some clue about their position we can still manage to finish the back end work. Let's say user is in front of Information desk so user choose information desk as his location which is known spot so the user easily able to give user's location some other known area is Café, Student entrance. But if the user is in front of 11th floor labs where he hardly knows anything, then we suggest the user to go in front of any room and select the room number as user's location.

And for the 2nd problem is we will not be able to find user is taking the right path or not. Assume a case where a user told to go to 12th floor and then straight to CSE Department. The users mistakenly get down in 10th floor and after that user will not be able to find out CSE Department in 10th. With out Radio Frequency Identification (RFID) we cannot solve this problem. So there is only one solution left which assuming the user is taking the correct path. Therefore our back-end work will always assume users are taking the correct path!!!!

After this assumption we started our work and we chooses Node or link list to solve the problem for us. Our first step is to make an architecture where every element of BRAC University is present and connected to each other. But it's impossible to make the full architecture in this short time, so we took only the ground floor for our testing actually our code is working or not. And the architecture is look like the figure below:



And the Node class needs to contain some information like:

Attributes	Function	Example(CAFÉ NODE)
public String id;	Need an id to find out what is this, Which is unique.	id is =ub0003
public Node next;	Which is the next element?	Ub-2 building
public Node child;	Is there any way to go somewhere else	Indoor games
public double x;	Position on x axis	0.0
public double y;	Position on y axis	0.0
public String name;	Name of the place	Cafe

When we started Coding for back end at first I have to create some methods to add this architecture in our database like insert, add child and many more, and with some methods like getid, findpath, traverseuser will able to find the paths from one destination to another. But when we went deep to find how strong our coding is we found when both the destination and current position is in a child node my code is not giving the correct path then we have to change node class by adding an extra attribute call parent which helps me to check previous node. After adding this node my attributes look like:

Attributes	Function	Example(CAFÉ NODE)
public String id;	Need an id to find out what is this, Which is unique.	id is =ub0003
public Node next;	Which is the next element?	Ub-2 building
public Node child;	Is there any way to go somewhere else	Indoor games
public double x;	Position on x axis	0.0
public double y;	Position on y axis	0.0
public String name;	Name of the place	Cafe
public Node parent;	What was the previous element	Ub_1 building

It's not so difficult to implement the rest or the architecture, anyone has java knowledge can implement rest of this. The position on axis x and y will be needed when we connect this with our frontend design. In future we would like to connect this back-end work with our front-end design to make it complete software which can be use as BRAC University LPS System.

5.2 Future Plan

Our future plan is to implement this Local Positioning System for smartphones using our reviewed design from user. We just have to do a little coding for the backend and interface the front end and the back end work.

CHAPTER 6

6.1 Conclusion

The purpose of our application is to create something which can be used by the user of every background. This system got a very huge usage. Although it's not very popular in Bangladesh but university and other places in different countries use this system to find the position and path. It can be used in any university campus like especially like Dhaka University campus it would be a great help for the students as it got a very large area. Not only for university, it could even use in factory or in dockyards any kind of indoor.

The major consumer benefit of indoor positioning is the expansion of location-aware mobile computing indoors. As mobile devices become ever-present, appropriate awareness for applications has become a priority for developers. Most applications currently rely on GPS, however, and function poorly indoors. Applications benefiting from indoor location include:

- Guided tours of museums
- Mall and airport maps
- Store navigation

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