Department of Electrical and Computer Engineering
North South University

Senior Design Project

I AM HERE: A SECURITY SERVICE PRESERVING PRIVACY

Mohammad Kaosain Akbar **ID # 1420515042**

Faculty Advisor:

Dr. Nova Ahmed

Associate Professor

Department of Electrical and Computer Engineering

Fall, 2018

DECLARATION

This is to certify that this Project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. Any material reproduced in this project has been properly acknowledged.

Students' names & Signatures

1. **Mohammad Kaosain Akbar**

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2. **Dibya Prokash Sarkar**

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3. **Emrul Kaisar**

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4. **Soufia Neli Roshni**

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APPROVAL

We, **Mohammad Kaosain Akbar (ID-1420515042)**, **Dibya Prokash Sarkar (ID-1430727042), Emrul Kaisar (ID-1430333042)** and **Soufia Neli Roshni (ID- 1512868642)**, members of **CSE**/EEE/ETE: **499** (Senior Design) from the Electrical and Computer Engineering department of **North South University**; have worked on the project titled **"**I AM HERE : A SECURITY SERVICE PRESERVING PRIVACY**"** under the supervision of Dr. Nova Ahmed as a partial fulfillment of the requirement for the degree of Bachelors of Science in Engineering and has been accepted as satisfactory.

Supervisor's Signature

…….

Dr. Nova Ahmed
Associate Professor
Department of Electrical Engineering & Computer Science
North South University
Dhaka, Bangladesh.

Chairman's Signature

…….

Dr. Shazzad Hossain
Associate Professor & Chair
Department of Electrical Engineering & Computer Science
North South University
Dhaka, Bangladesh.

ACKNOWLEDGEMENT

By mercy of the Almighty we have completed our senior design capstone project entitled **"**I AM HERE: A SECURITY SERVICE PRESERVING PRIVACY**"**.

Foremost, we would like to express our sincere gratitude to our advisor Dr. Nova Ahmed for her continuous support in our capstone project progress throughout the whole 499A and 499B, for her patience, motivation, enthusiasm, and immense knowledge. Her guidance helped us in all the time of research, writing and completing of this project.

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Last but not the least, we would like to thank our family as their inspiration and guidance kept us focused and motivated.

Abstract

Rise of personal security is a major concern in Bangladesh. It covers possibility of kidnap, sexual abuse and even murder where the law enforcement system shows weak performance to ensure support for general people. There are efforts to enable ways to help people seeking support in the presence of eminent danger or anticipated danger. Application level support in critical situation can be implemented using current location based services. However, revealing location can impact one's privacy and even place on in vulnerable position if such information is breached. We have developed an application that provides provisions where user can abstract use-location while user seeks for emergency help. The application is developed considering user-centric design principles. We have evaluated the application on more than 100 users. This application development process shows the continuous effort to ensure social justice.

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CHAPTER 1

INTRODUCTION

1. Introduction

Ongoing cases of sexual harassment and increased awareness level has initiated community support along with technology based support systems. Number of murders, kidnapping has increased in Bangladesh over recent years. A father's last call before he was killed followed by his daughter's desperate voice calling "baba, baba are you crying?" was recorded on a phone which was revealed by the media later. It opened up necessity to be able to leave trails in case of anticipated danger. We have worked on an application that balances security calls preserving privacy of users in the context of Bangladesh.

There have been solution approaches designed to support victims of harassment designed to engage a community to achieve social justice. The role of technology in these support systems were on creating a platform of trusted community building or developing ways to seek support. Social cultural barriers, limited access to technology required a solution that remains in a closed community in the context of Bangladesh. Our current work considers such requirements for women.

A solution that is able to seek help along with keeping trails of a person in danger can be helpful to support the person. We have added ways to abstract user's exact location in a way that is preferable to the user giving the application user full control to abstract the user. Location information can introduce vulnerabilities if it is revealed to undesirable people. The weak law enforcement system that is often influenced by use of power and or money requires ways to abstract information.

We have initiated our design through user centric design principles. We have conducted qualitative study on 84 people that we contacted through snowball sampling. The design considered multiple alternatives where we worked carefully on ways to support users along with preserving user's privacy which was a major concern among participants. There was a country wide student protest going on right after our development process. The protest was based on requirements for safer road conditions and better law enforcement system when two students were run over the bus. Some protesting students were attacked and later some were locked up in prison prior to facing trials. The uncertainty, fear and eagerness to seek help placed our work in proper context during the time. We were able to ask more than 100 participants to try our solution approach. These participants included students, parents, family members and many others from known connections.

Our work is an effort to support general people facing suppression, harassment which may help them to seek social justice using technology as a medium.

CHAPTER 2

RELATED WORKS

2. RELATED WORKS

2.1 Context of Bangladesh

In 2016, a 19-year-old female college student was gang raped and then murdered inside the Cumilla Cantonment, while she was returning back to her residence. It was one of the major talk of the town at that particular period of time. This investigation is still going on and victim's family is still waiting to get justice [22].

Fig 1: Headlines in various national Daily [18, 19, 20, 21]

Another controversial killing that took place recently in Cox's Bazar, where security force was directly involved, famously known as "Ekram killing" [24]. Security force brought drug trafficking allegations against Mr. Ekram during anti- narcotic drive. As a result, law enforcers kidnapped him from his own residence and then shot him to death. But an audio-clip was recorded when security forces shot Mr. Ekram, raised questions and criticisms against the government.

All these murders sparked the social media and created nationwide protests against the alleged persons in Bangladesh, but it did not change the condition. Yet everyday new rape incidents are taking place in different parts of the country, abduction and murder like events are coming to the news headlines on a regular basis. We analyzed past 8 years crime statistics from Bangladesh Police database (figure 2), where we found that woman and child repression like occurrences are increasing years after years and it gives the real picture that how much insecure woman and child are in our society. From all these incidents, we decided to utilize cellular device for personal safety, because in recent years number of smartphone users have increased. Moreover, it can help to raise public awareness to fight against these crime incidents and reduce the crime rate.

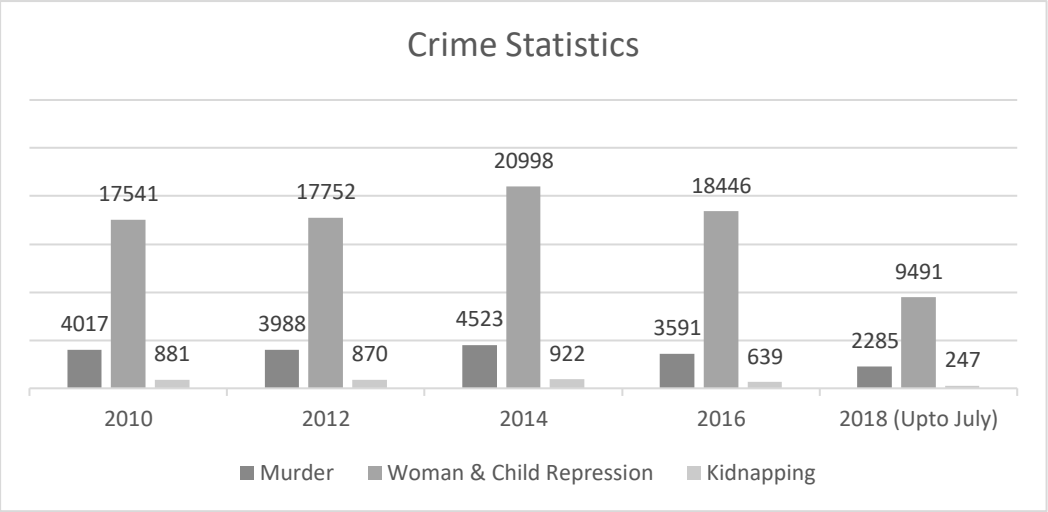


Fig 2: Crime Statistics in Bangladesh [25, 26, 27, 28, 29]

2.2 Mobile Apps and Community Platforms

In recent times, harassment in streets and job spaces are increasing across the globe and most of the victims are women. To tackle such occurrences, researchers and mobile app developers have made several efforts to fight against these crimes. With the advancement of information technology and cellular devices, nowadays people can easily gather information of any event from anywhere within a very short time. Moreover, number of smartphone users are rising up, because people can afford it easily. As a result, most of the researchers are now trying to develop mobile apps what can help not only to reduce street harassments and crime rates, but also to raise awareness against them.

There are lots of community-based platforms and mobile apps, which you can find in Google play store or iTunes. Whenever discussing about community-based platforms, “Hollaback!” is one of them, which is developed by Metropolitan Action Committee on Violence, a Canadian organization. It is especially developed for women to raise awareness against street harassments. It is a social platform like Facebook, where users can share their harassment experiences. The main benefit of such type of social platforms are it helps people to know about different types of harassments across the world. Recently this organization have developed smartphone application as well. This application allow users to share nearby street harassment incidents along with location. Moreover through this application, user can also do documenting and mapping [30].

Another mobile app where user can share real time location along with the harassment experience that user has faced, is “Not your Baby”. It is launched by METRAC, a community that is working on to fight against gender-based violence [31, 32]. Another notable community-based platform is “HarassMap”. It is developed in Egypt. The main feature of this web portal is it helps user to give an overview of different types of street harassments through a map.

Besides that, it has reporting option where user can report any harassment incidents through web or cell phone [38].

“Circle of 6” is another mobile app developed for female users, where user can send an alert message to her friends and trusted contacts whenever she is feeling threatened. This is very famous among female users. In this application, user can set her preferred contacts and specialty of this app is if user taps screen twice, app will send three text messages to the trusted contacts [39]. “bSafe” is another mobile app that works exactly same like Circle of 6, but here whenever user allows to send emergency message to the preferred person at that time it will send otherwise not [40].

There are more noteworthy works, which are mainly developed to fights against street harassments. Among them “SafeStreet”, “HearMe”, “IPROB”, “MehfoozAurat” are notable [37, 42, 43, 41]. SafeStreet is a mobile application that is developed by group of Bangladeshi researchers. In this app, there is a reporting option through what user can report any nearby harassment incidents. Moreover it has real time location sharing option to the trusted persons whenever user feels trouble. Besides that, there is a map where user chooses preferred destination and the app automatically suggests a safe route to reach the destination. Such facility is really helpful especially for women [37].

Apart from them, another noteworthy initiative that has been developed by Bangladeshi developers is *“Protibadi”*. It is a combination of community-based social platform and mobile app, which offers on spot emergency report option [34]. Moreover, it has options like sharing any experience of harassment and raise awareness. Another app named *“Hello CT”*, which is developed to fight against terrorism or any sort of mishap. It is a government approved app, where you can share any incident to Bangladesh Police without sharing your identity. Moreover, there is real time location sharing option, which has added more usability for the users [35]. “Bangladesh Emergency Service (BES)”, it is an application where people will get all the emergency phone numbers as well as emergency report option which will go to the nearby police stations. It made unique because it is developed in Bengali [36].

Moreover, there is a watch named “OnWatch” which leads to provide real time location to the registered trusted people if it senses an unwanted situation [33].

Above mentioned all these mentioned applications main and mutual mechanism is to allow users to report or share the nearby harassment incidents through cell phones or web portals. Besides that, to send emergency text messages or call to the preferred contacts whenever the user feels threatened while walking on the streets. According to ActionAid Bangladesh, most of the women remain silent after facing such crimes because of social disgrace [44]. In this paper, we have developed a mobile application named “I AM HERE”, where we have introduced masking system by which user can share real time location into some segments according to user’s preference. Besides that, whenever user feels threatened at that user can either call to trusted contacts or police. Moreover, this application can be used in Bengali as well.

CHAPTER 3

METHODOLOGIES

3. Methodology

The inquiry that we needed for our project was focused on understanding the security issues of Bangladesh, the vulnerability of those issues and acquiring help using mobile phone application on sensing or being in danger. First, we took interviews of individuals and then gave them a survey containing 10 set of questions. The questionnaire was distributed to 84 people of whom 43 were men and 51 were women. The survey was conducted from 8th June to 3rd July of 2018. The field work was conducted which consist of interviewing faculties and students from university campus and senior citizens at retirement home and residences. Interview sessions and completing the survey for individuals took about 15 minutes on average. Each and every interviews were concluded by asking the participants how they want to use the phone efficiently when they are in any kind of danger, giving them a chance to present their views. Survey questions are provided at the end of this section.

In the following sections we describe the Participant Recruitment, Moderation and Incentive, Analysis and Research Ethics in reporting this research.

3.1 Participant Recruitment

Participants were enlisted through personal contact using snowball sampling, retirement home and relatives at Residence. Before survey and interview sessions, we stated the purpose of interviews and surveys. We provided the floor of rejecting the participation at any moment.

Table 1. Information of recruited participants.

Phase I		
Participant	**Average Age**	**Number of Participants(n)**
Elderly Male	63	7
Young Male	23	36
Elderly Female	60	19
Young Female	22	32
Total	**37.06**	**94**

Phase II		
Participant	**Average Age**	**Number of Participants(n)**
Elderly Male	60	18
Young Male	22	37
Elderly Female	60	19
Young Female	22	33
Total	**35.14 ****	**107**

For obtaining a well-balanced outcome of our research participant recruitment was divided into Male and Female and then Male was divided further into youth male and elderly male and Female was also further divided in youth female and elderly female. Participants were all in between 20 to 64 years old and they all used Internet-enabled and GPS-enabled phone.

Table 2. Cities their respective participants who tested "I Am Here"

Testing Cities	Number of Participants	Percentage of participants
Dhaka	57	53%
Kushtia	21	20%
Kishoreganj	17	16%
Pabna	12	11%
Total	107	

In the after development test, "I Am Here" was provided to participants in various parts of the Dhaka City namely Badda, Bashundhara Residential Area Baridhara DOHS and Mohammadpur. The test was also conducted outside the Dhaka in various districts of the country such as Kishoreganj, Pabna and Kushtia. Table 2 shows the cities and number of participants and their percentages who tested the application. About 53% participants were from Dhaka City where in total of 57 participants tested and reviewed the application. 20% participants were from Kushtia, followed by 17% and 12% from Kishoreganj and Pabna district respectively.

3.2 Survey (n=94)

Before development phase of the project, we surveyed on 94 participants where 43 of the participants were male and 51 participants were female. The participants were asked whether they would really use a cell phone while they are in any case of emergency or sense any danger around them. Then they were asked whether they want their locations to be tracked and even if they do then up to how much extent they would like to share it. They were also asked if they would call a trusted contact in case of an emergency.

3.3 Application Evaluation (n=107)

In the after development phase, we demonstrated and elaborated our application to 57 participants. We explained how the users can sign in to the application using both phone number and email address. We also explained how users can add a trusted contact and set various radius of respective contacts. In second, users were also guided how to check the current location of trustee contact and also the functionality of emergency dial and logout feature. Tests were conducted how different people uses the application and how they might use it in case of any emergency they face.

3.4 Moderation and Incentive

The interviews and surveys were conducted by the group members of the project. Thus, no incentives were given and no monetary was required during this phase. All the participants whom we interviewed and surveyed, participated voluntarily. At the start as well as at end of the interviews and surveys, all the participants were thanked for their donated time.

3.5 Research Ethics

For creating neutral and comfortable environment based on participants' preferences, we surveyed and interviewed youths at the university campus and elderly citizens at their residences. About four-to-five minutes were spent explaining the purpose our interviews and answer the surveys. Participants were also informed that they had the option of terminating the study at any time. Methods of recording were mostly notes. No pictures were taken during the interviews and no interviews were recorded. All the participants were well aware that their interviews and survey results will be used by the project team. All the interviews were conducted decently and participants were greeted properly at the beginning and thanked at the end of their interviews.

CHAPTER 4
FINDINGS

4. FINDINGS

After conducting surveys and interviews of participants of various age, we observed different opinions. As most of our participants were young male and female, they were very much concerned with their privacy issues. For education and part-time jobs, they often remain outside of their homes and feel insecure. They do often feel the need of asking for help if they are passing by an empty street or quite neighborhood. Since youth are very much attached to their phones, they did show large interest in sharing their locations, although there were different opinions regarding the range of their locations to be shared. On the other hand, elderly people who stay at homes did not feel the comfort of sharing their locations but they did feel the need of contacting in case emergency situations which they might face both indoors and outdoors.

4.1 Concerns about Privacy

Among all the participants' majority of them were very much aware of the current security concerns about Bangladesh. Almost 42.5% participants were very much concerned with the privacy and security issues. They stated their cautiousness about their surroundings. Additionally, 32.5 % participants were moderately concerned regarding the privacy and securities.

They know the threats but consider themselves to keep out of it. Moreover, about 17% were slightly concerned and 5% of them were not concerned about it all. We can see that majority of the participants were very much or moderately concerned about the privacy and security issues.

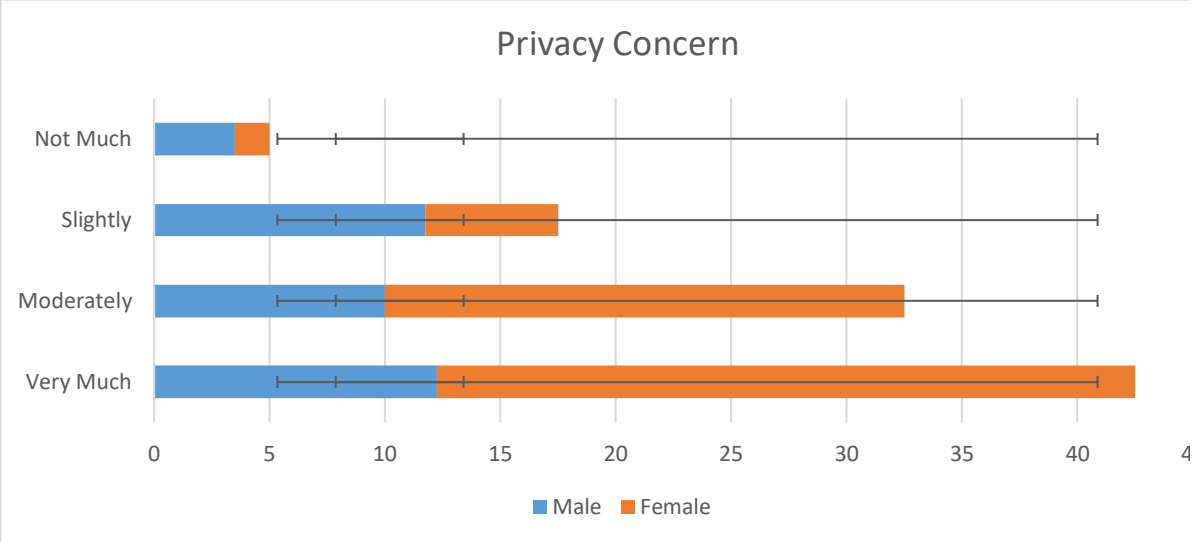


Figure 3 Demographic Chart of Concerns about privacy

4.2 Feelings of Security

The participants stated various opinions regarding their security. 55% of the participants feel totally insecure and addition of 13% feel totally insecure. They stated that constant news on television and newspapers about various crime such as mugging, rape, kidnapping, etc. made them feel very much insecure when moving in streets.

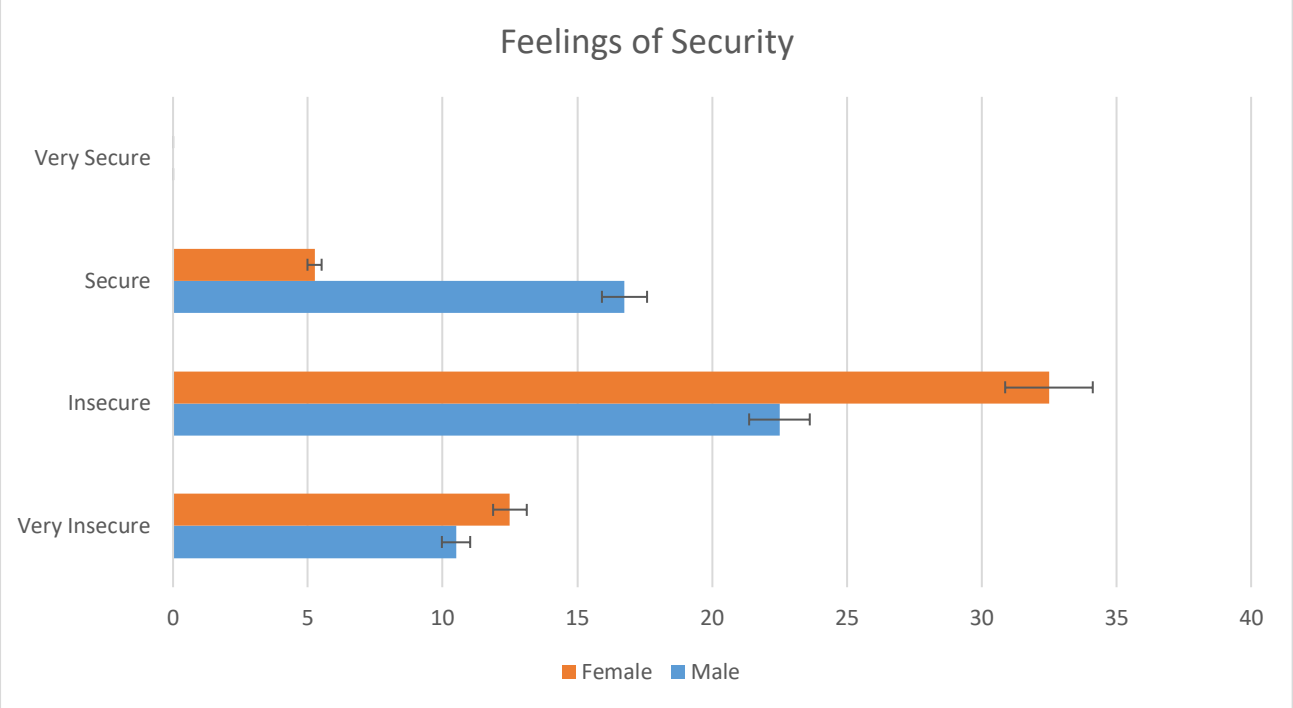


Figure 4 Demographic Chart of Feelings of security

22% of the participants feel secure. These people said that they use personal cars and do not stay out of house during the late hours. Interestingly, 0% people feel very secure, thus stating how insecure people feel.

4.3 Need of Calling Someone While Moving Through the Streets of Dhaka

Our participants were also asked whether they feel the need of calling someone while moving in the Dhaka city. Among them 40% stated that they felt the need of calling someone while roaming around the streets of Dhaka. Other 33% stated that they felt the need but did not make any call. Most of them stated that they were very much nervous to make the call on such situations. Remaining 27% stated that they did not felt the need of calling anyone while moving through the streets of the city. Therefore, we can say that a summation of 73% felt unsecured on the streets.

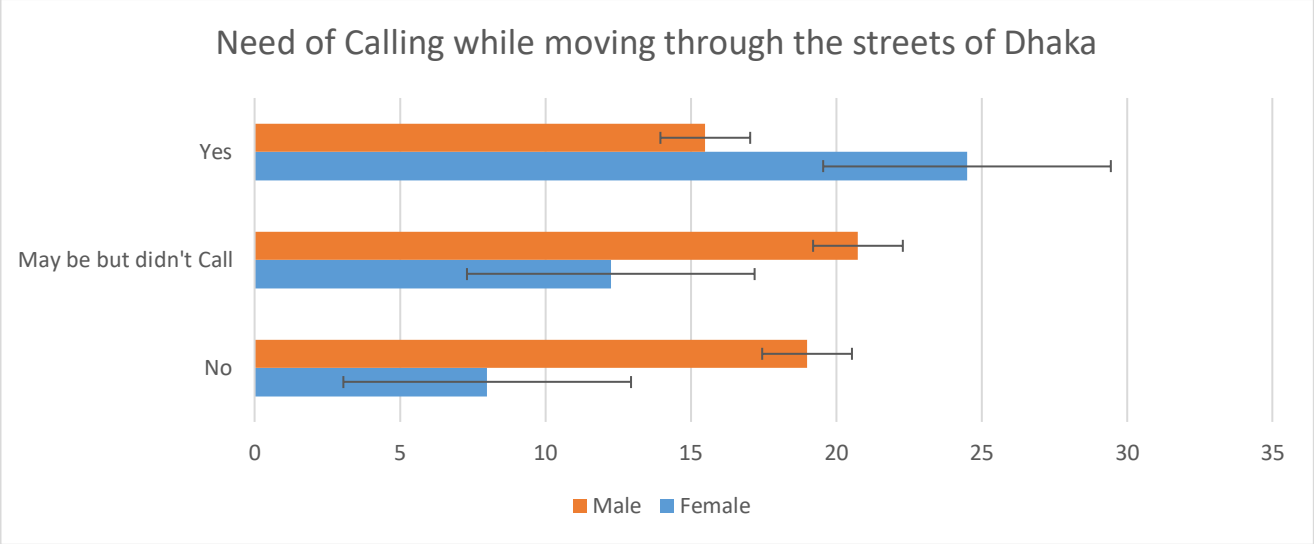


Figure 5 Demographic Chart of Need of calling someone while moving through the streets of Dhaka

4.4 Keeping a Track of Location

When the participants were asked whether they wanted to share their locations to trusted contacts, 87.5% of them showed interest of sharing their locations. Most of them were young female followed by young male Majority of them stated they wanted to share their exact locations while others wanted to share the area of their current locations. Remaining 12.5% were not willing to share any data regarding their locations because they did not want to share their locations because of privacy issues.

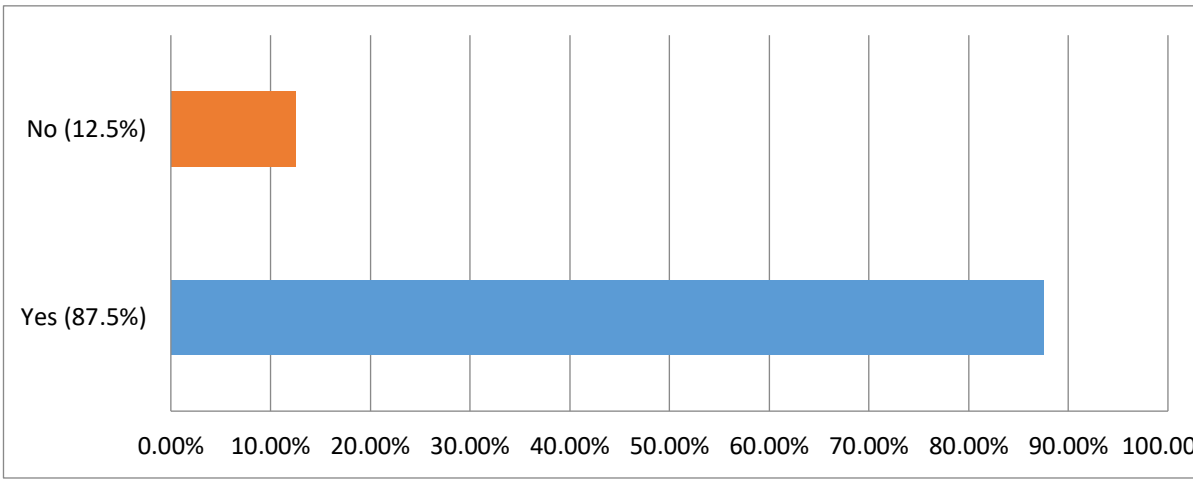


Figure 6 Keeping Track of Location

4.5 Feelings of Emergency Contacts

When participants were asked whether they need an emergency contact or not, then 70% of them expressed the interest in the need of an emergency contact. In case of emergency, they

wanted their location to be uploaded and sent to their emergency contacts so that the contacts can get an alert informing that the user is in trouble. The remaining 30% stated that they do not need any emergency contacts. These participants informed that they do not want to upload their whereabouts or want anyone to see it because they feel that uploading their location would breach their privacy.

4.6 Application Development

Large number of our participants were youth (36 males and 33 females). All of them stated interest of using an application to send their location to emergency contact or get in touch with the emergency contact in case of sensing any danger. Therefore, it was concluded that an easy, simple user interface was needed instead of a complex and intimidating interface, so that user can choose the correct option in case of any emergency. Moreover, elderly personnel also showed interest in using this application. Thus, a simple, clean User Interface would also increase the efficiency of the application to the elderly.

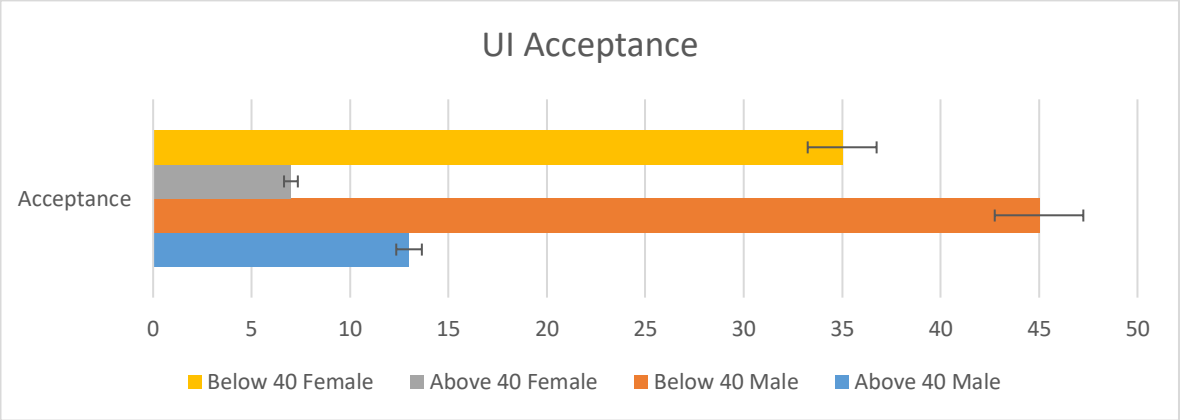


Figure 7 Chart of User Interface Acceptance among different ages

CHAPTER 5
DESIGN

5. DESIGN

5.1 Alternative Design 1

In Figure 6, we have suggested a system which were acquired from the preferences of the participants. Here we have prioritized on user's privacy control, because nowadays users are much concerned about their privacy. Users can seek help in a way that allows them to preserve privacy without disclosing personal details. Only trusted contacts may know further details.

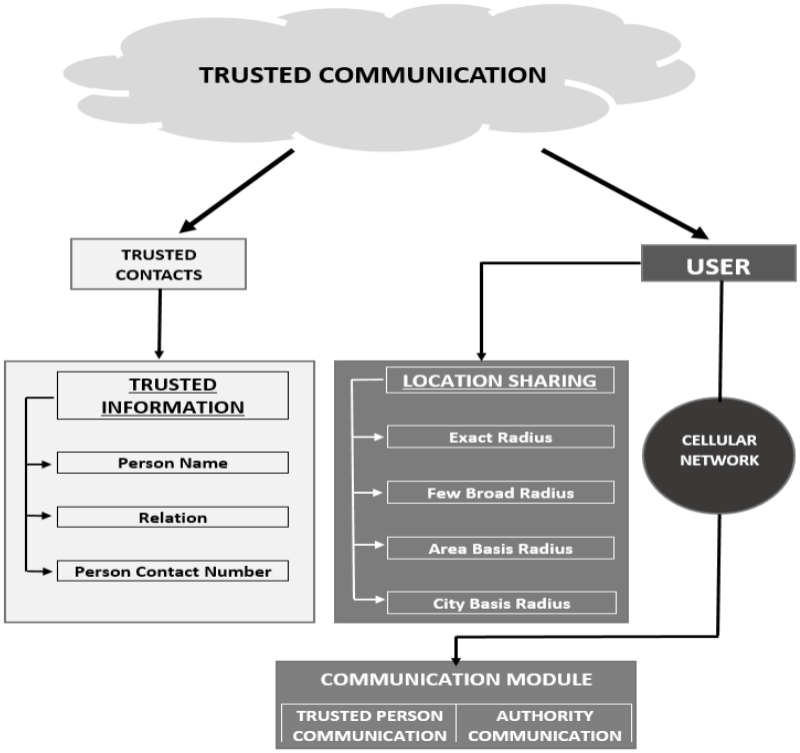


Figure 8 Alternate Design 1

There will be two options, one is for location sharing and another is for communicating the trusted persons. Here user can share his/her updated location into some radius with their trusted contacts. We offered such option, because it gives flexibility to the user. Besides that, user can control the trusted contact list with whom s/he likely to share updated location. Additionally, we have kept a calling option to the police control room.

5.2 Alternative design 2

Using additional GPS hardware to update the location:

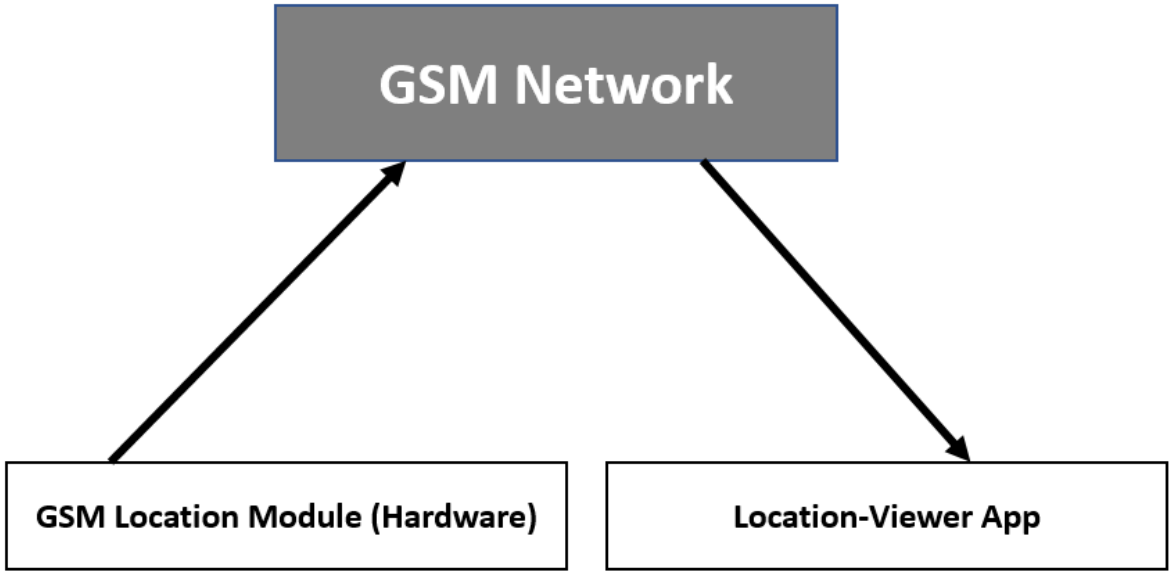


Figure 9 Alternate Design 2

The second alternate design involves implementing and using hardware GPS module for location tracking. Figure 7 shows the hardware implementation of a GPS which required an additional sim card for uploading location coordinates and then a location viewer app is needed to check the location of the user.

5.3 Final Design

Both designs are suitable to provide the services that we intended to provide but looking through the design implications and other important factors, it was observed that alternate design 1 is the appropriate one. Alternate design 1 involved using phone's embedded GPS module to upload location of the user. User do not require to carry any additional piece of hardware and most people never forget to carry their phones, thus, having their security under the tip of their fingers. Moreover, we have seen that design 2 also needed an additional sim to upload the location coordinates and for that the user needed to purchase an extra sim and also required to recharge it as well.

Therefore, using a phone application not only eliminate the burden of carrying an extra device but also increase user's security in much more efficient way.

The above design (figure 8, 9 and 10) shows the various layout of the application that will be developed. Figure 8 shows the menu page where the user would be able to select three options such as trusted contacts, select radius and trustee contacts. Figure 9 focuses on the trusted contacts and the user location that is being shared with them. Figure 10 shows the trustee contact which will be visible to the emergency contact's mobile.

5.4 Block Diagram

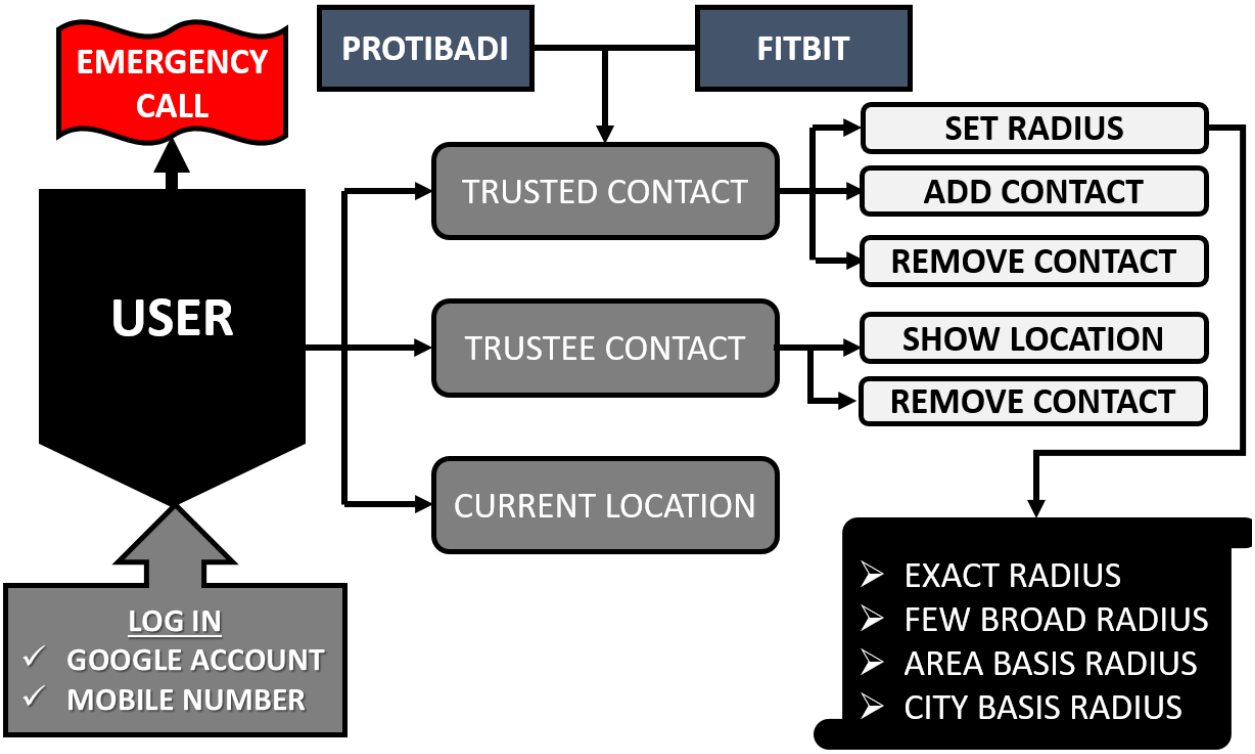


Figure 10 Final Design

CHAPTER 6

IMPLEMENTATION

6. IMPLEMENTATION

6.1 Application Description

"I Am Here" was developed on the latest stable version of android studio 3.0 Canary 1. The application was developed using the API of Android Version 7.0. We did not used the latest android 8.0 version because about according to "Fossbytes", 30% of the user around the world still uses android version 7.0 where-else only 14.6% of the user uses the latest version.

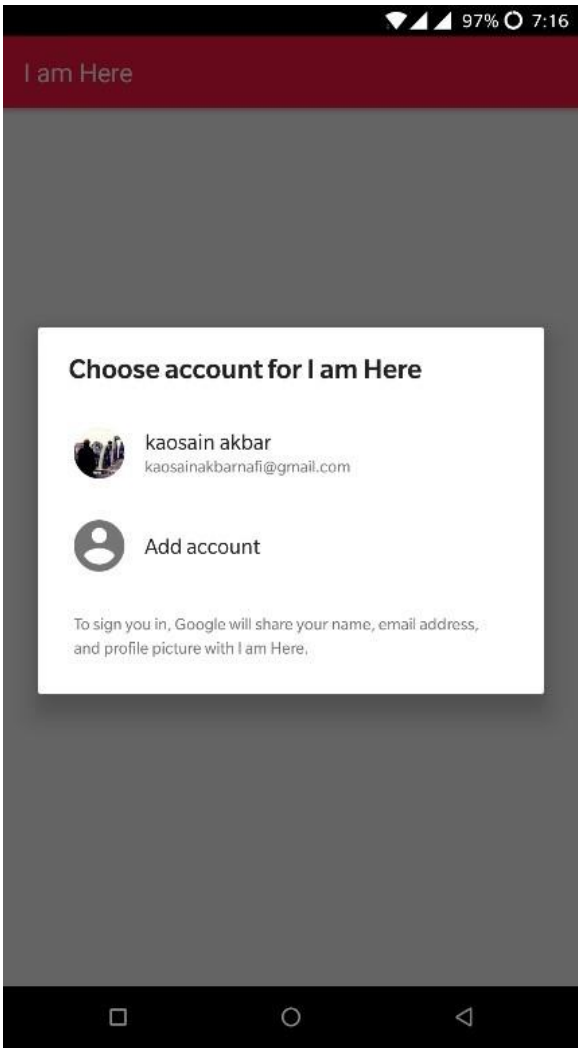


Figure 11 Sign up page of "I Am Here"

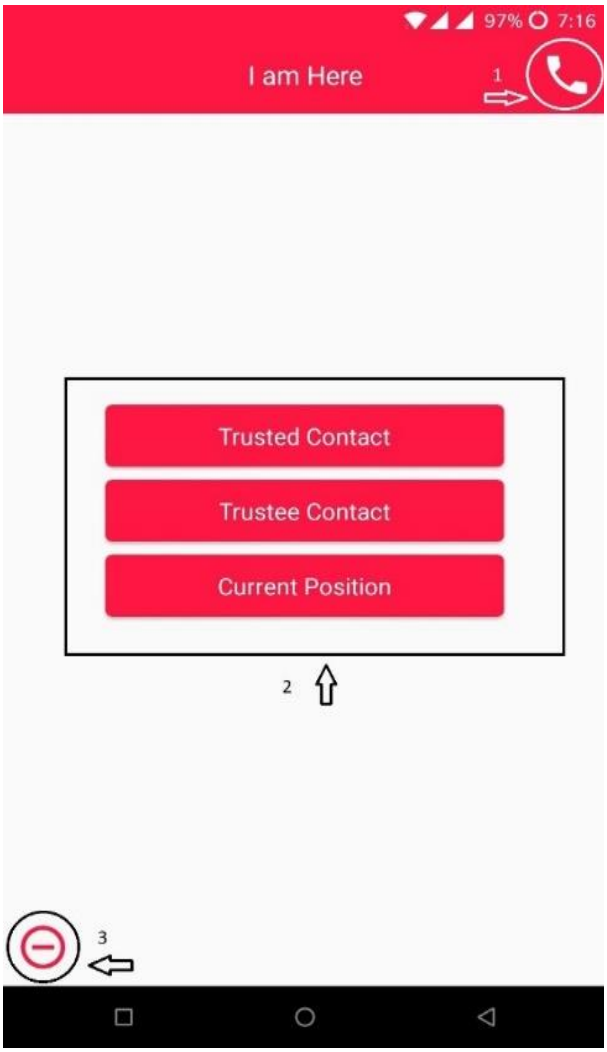


Figure 12 The Main Menu Screen

After developing the application in the android studio, we ran the application on the android emulator on our personal computer. There were minor bugs that needed attention and some UI changes were made. Then, the android package kit (apk) file was generated and was copied to the android phone. The application was installed. After installing, all the necessary permissions such as access to location, contact and SMS, were granted from the settings option and the application was accessed. Initially, the user is required to register to the application by using either the contact number or the email id.

Figure 10 shows the sign-up/ sign-in window of "I Am Here" where the application

automatically suggests the user to sign-up using the account already being used by the phone and also keeps an option of signing with a completely different account.

After the user registration, the application takes the user to the homepage. In the homepage, the user will find few options. In figure 11, we can see that there are 3 marked regions. Region number 1 indicates the option of calling to Emergency Helpline in Bangladesh (999). Region number 2 indicates the main feature of the application and region number 3 shows the logout option. If the user press the dial icon from the main menu of the application, the user will be taken to the dial-up section of the phone where the application would automatically place a call at the Emergency Helpline for assistance. Figure 4 shows the dial-up section of the phone calling the emergency helpline.

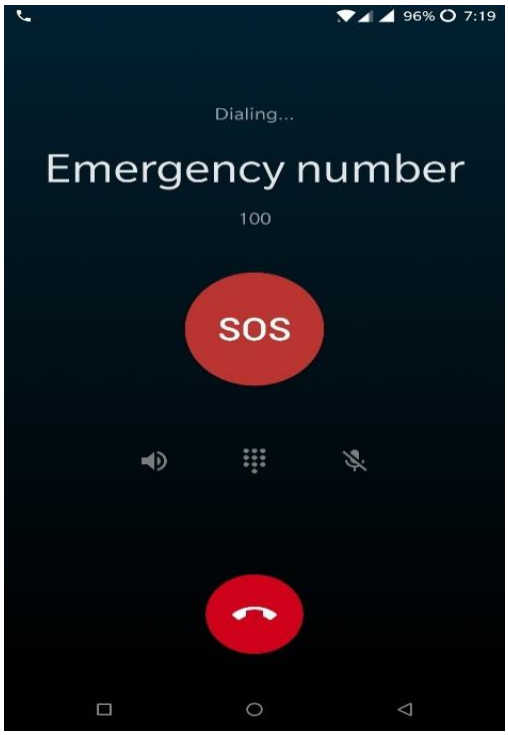


Figure 13 Directly Calling the Emergency Helpline

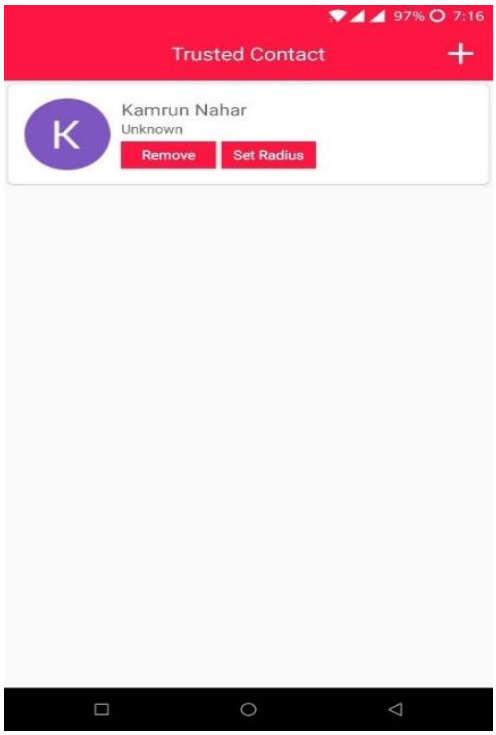


Figure 14 Trusted Contact Section

When the user enters the trusted contact section, user will see the names of the contacts who can see the current location of the user. In figure 12, we can see the name of a trusted contact of the user who can see user's current location. User can also add other trusted contacts in the list by tapping the plus icon on top right corner and searching a contact is done using google id.

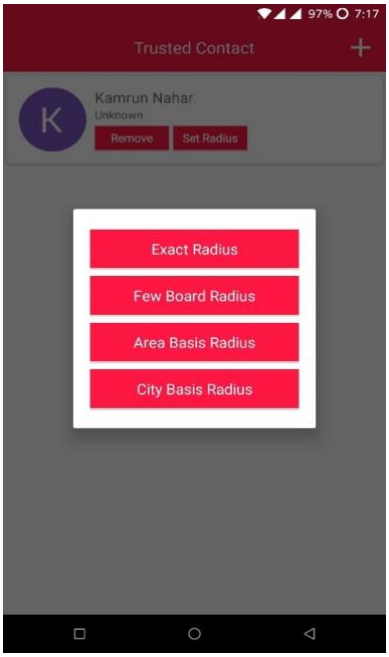
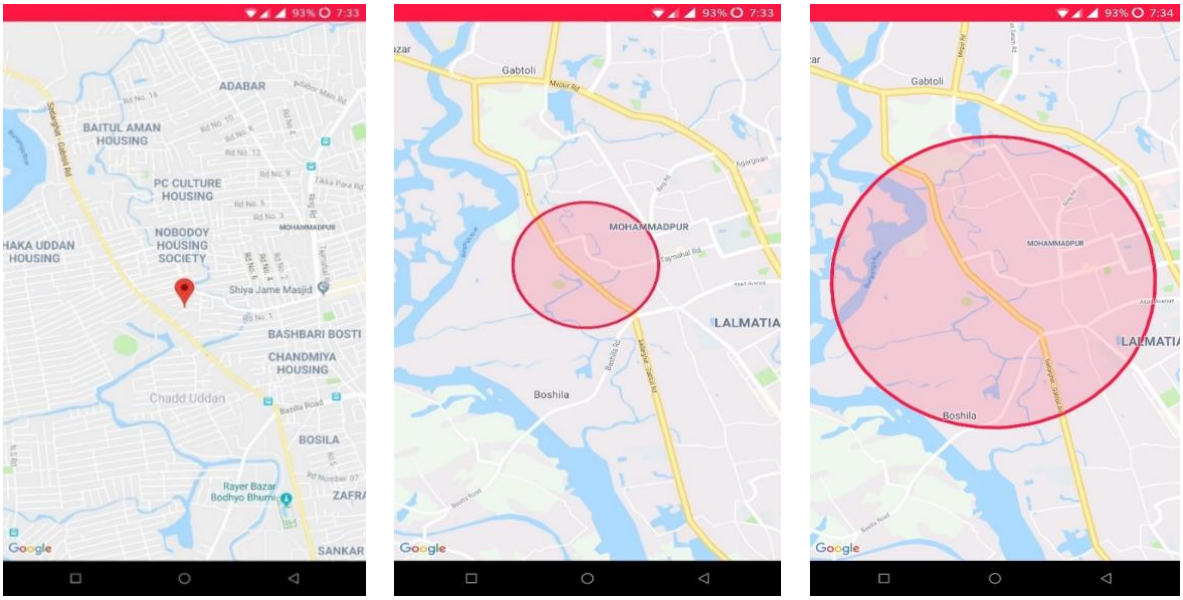


Figure 15 Setting up Desired Radius for Individual Trusted Contact

"I Am Here" provide the user with the flexibility of deciding how much of the user's location will be seen by his/her trusted contact. From figure 13, we can see that the application provides with four options of user's location sharing with the trusted contact such as exact radius, few broad radius, area basis radius and city basis radius. Now for each individual contact user can choose how much of his/her location the trusted contact and see.



Exact Radius **Few Broad Radius** **Area Basis Radius**

Figure 16 The Snippets of Map that the trusted contact would see after the user selecting proper option

Figure 14 shows the location seen by the trusted contact according to the option selected by the user. Figure 14(a) shows the exact location of the user which the trusted contact would be

seeing. Figure 14(b) shows not the exact but the few broad radius of the user that contact sees after user selecting that particular option. Figure 14(c) and (d) shows the Area and City basis radius of the user where he/she is receding in.

If the user selects the Trustee Contact option, then the user would see the name of the contact who is sharing his/her location with the user. Figure 15(a) shows the list of trustee contact of the users and figure 15(b) shows the location that the trustee contact is willing to share with the user.

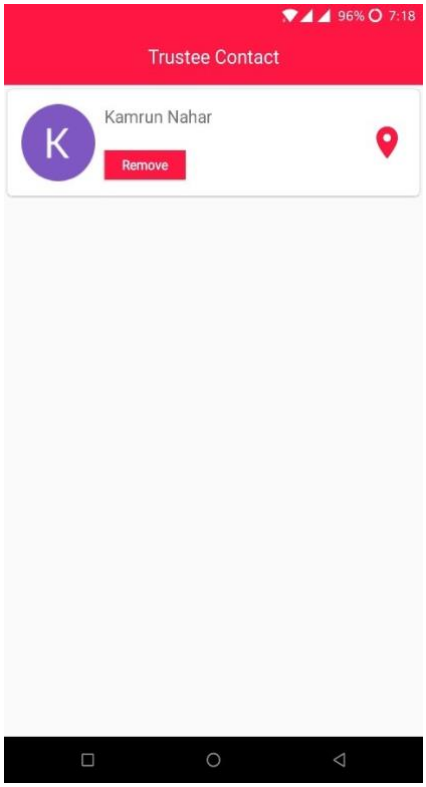


Figure 17 The Trustee Contact Menu of "I Am Here"

Figure 18 Current Position

If the user selects the current position option then the user would be able to see his/her current location. From figure 10, if the user selects the option from region 3, then the user would be logged out and would be taken to the sign in page of the application.

CHAPTER 7

EVALUATION

7. EVALUATION

7.1 System Evaluation

7.1.1 Graph showing consumption and usage of different features of the phone by "I AM HERE"

Consumption of CPU, Memory, Network and Energy of the test device by "I Am Here" is shown below.

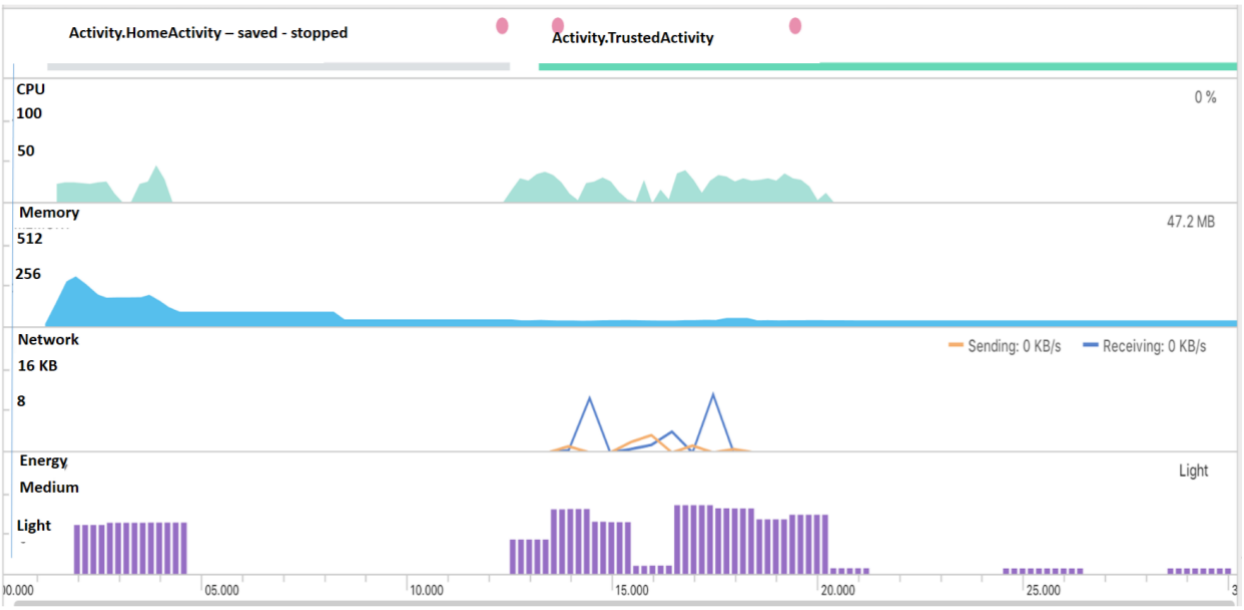


Figure 19 An overview of the CPU, MEMORY, NETWORK and ENERGY consumption of the cellular device by "I AM HERE"

The graph of figure 17 was generated by testing "I Am Here" on Google Nexus 5x. The device runs on a Qualcomm Snapdragon 808 chip which is Hexa-core CPU with 2 gigabyte ram and 2700 mAh battery. The version of android used on the device was Android 8.1 Oreo. It can be observed from figure 1 that various feature consumption of phone by the application is small. Under the network section, it is seen that the receiving bytes per second by the application is higher than that of sending bytes per second. It can be concluded that the user will be needing less data to operate the application than the data needed by the trusted contact. Therefore, location can be shared seamlessly in areas having slow data connectivity.

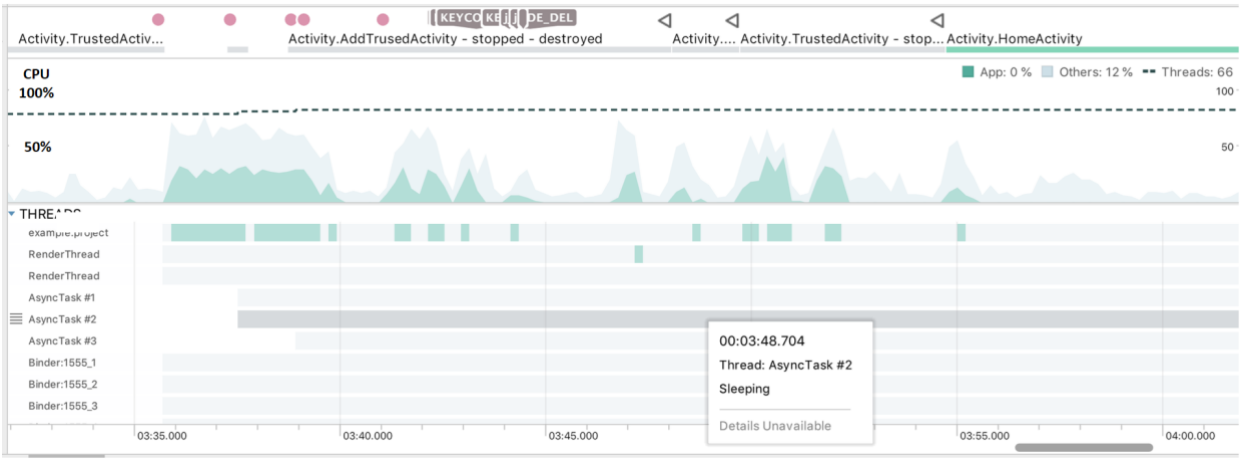


Figure 20 CPU Consumption by "I AM HERE"

Figure 18 shows the CPU consumption of Nexus 5x device by the application. It is seen that core application process uses less than 50% of the CPU on its operation. All over about 66% of the CPU is seemed to be consumed by the application while it is running. "I Am Here" seemed to be consuming less amount of CPU than other applications even though threading was used. Thus, it can be concluded that "I Am Here" runs smoothly on any android devices, even with low configuration.

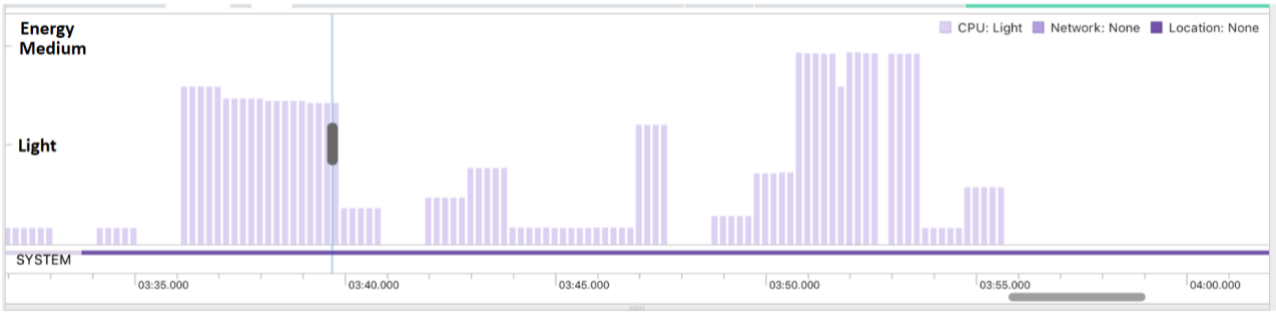


Figure 21 Phone's Energy Consumption By "I AM HERE"

Figure 19 shows how much energy the application consumes from the phone. From the graph, it is seen that most of the energy consumption is done by the CPU and not by the network or location services. The rate of energy consumption was mostly light but in some cases such as changing location frequently, the energy consumption raised to a medium level. The application never reached the status of heavy energy usage. Therefore, running "I Am Here" in the background of the phone will not produce much strain on the device's battery.

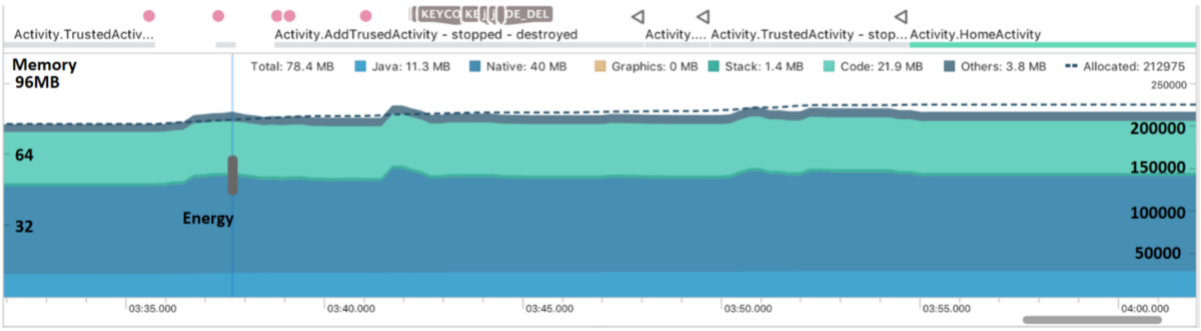
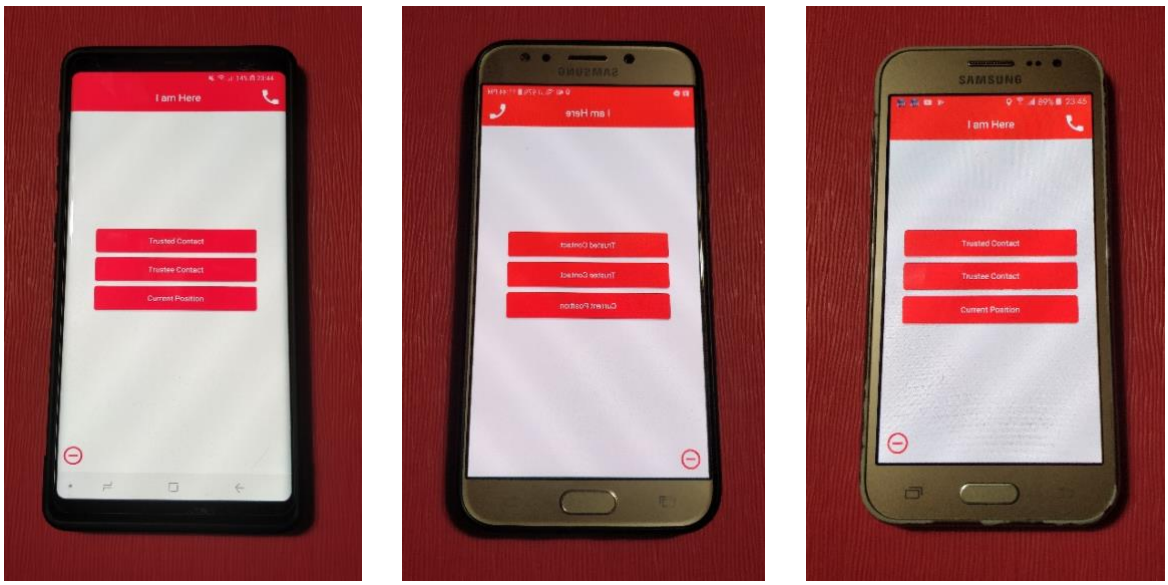


Figure 22 Memory (RAM) consumption by "I AM HERE"

Figure 20 shows the how much memory is consumed by the application while operating properly. A careful observation of the graph informs us that a total of 78.4 MB is used by "I Am Here" where Java processing takes up 11.3 MB, native application itself occupies 40 MB of the RAM and Stack, code and others need about 1.4 MB, 21.9 MB and 3.8 MB of the memory. The low end cellular devices of 2018 come packed with minimum of 1000 MB of memory of which 79 MB is very negligible portion. Therefore, not only in high end mobiles but "I Am Here" can run smoothly on low end mobiles with less RAM.

7.1.2 Operating "I AM HERE" on High-End, Mid-Range and Low-End Devices

In order to check whether "I Am Here" is suitable for all range of devices, the application was tested on three devices.



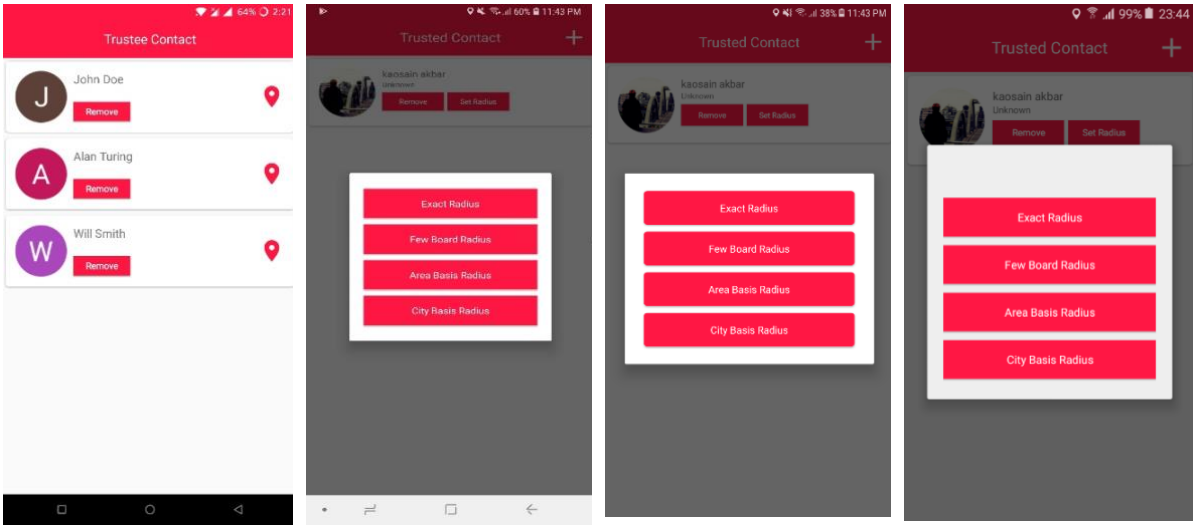
Samsung Galaxy Note 9 **Samsung Galaxy J7 2017** **Samsung Galaxy J2 2016**

Figure 23 Various Range of Devices where test of "I Am Here" was performed

Table 4. Specifications of different phones on which "I Am Here" was tested

Specification	Samsung Galaxy Note 9	Samsung Galaxy J7 2017	Samsung Galaxy J2
Network	GSM / HSPA / LTE 2G Bands, 3G Bands and 4G Bands.	GSM / HSPA / LTE 2G Bands, 3G Bands and 4G Bands.	GSM / HSPA / LTE 2G Bands and 3G Bands
Network Speed	HSPA 42.2/5.76 Mbps	HSPA 42.2/5.76 Mbps	HSPA 42.2/5.76 Mbps
Chipset	Qualcomm Snapdragon 845	Exynos 7870	Exynos 3475
Number of Cores	Octa-core 2.8 GHz (kyro)	Octa-core 6.1 GHz (Cortex)	Quad-core 1.3 GHz (Cortex)
Platform	Android 8.1 Oreo	Android 7.0 Nougat	Android 5.1.1 Lollipop
Ram and Internal Space	8 GB and 512 GB	3 GB and 16 GB	1 GB and 8 GB
GPS	A-GPS, GLONASS, BDS, GALILEO	A-GPS, GLONASS, BDS	A-GPS, GLONASS
Year Released	2018	2017	2015

The devices were Samsung Galaxy Note 9, Samsung Galaxy J7 2017 and Samsung J2 2016. Galaxy Note 9 is powered by Qualcomm Snapdragon 845 which an Octa-core chip, being the latest processor on any mobile devices of 2018 and having about 8 GB of ram and runs on latest android version 8.1 Oreo. It is embedded with latest dual layered GPS module along with GLONASS, BDS and GALILEO. Galaxy J7 2017 is a mid-range device powered by Cortex-A53 Octa-core chip having 3 GB of ram runs on previous generation android 7.1 Nougat. It has the same GPS of Note 9 but of single layer. Galaxy J2 on the other hand is powered by Quad-core Cortex A-7 chip with 1 GB of ram and embedded with a single layer, old generation GPS with only GLONASS. The phone runs on three-generation old android 5.1.1 Lollipop.

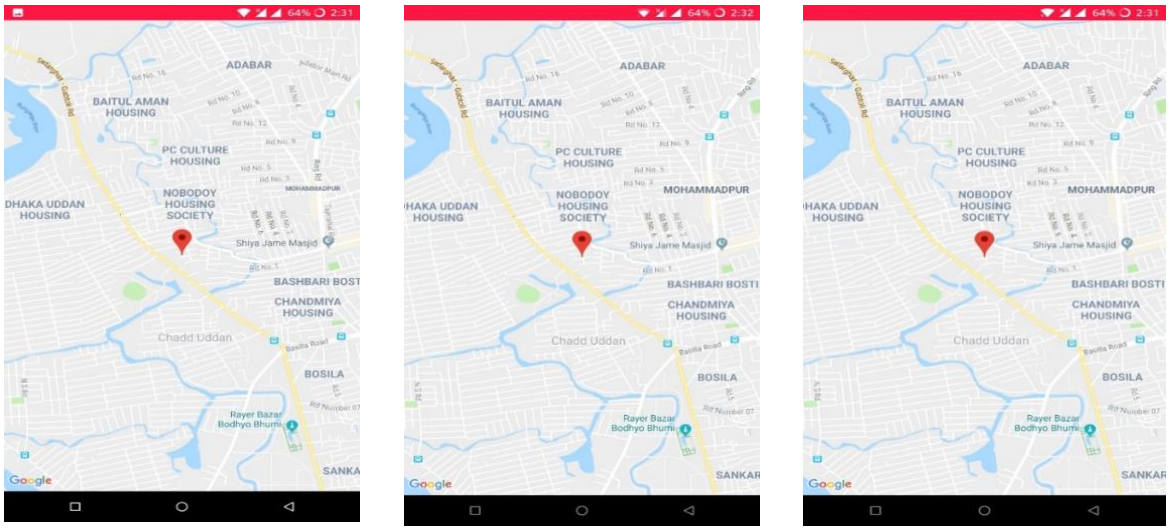


Trustee contact screen of the observer | **Location sharing window of USER 1 (Note 9)** | **Location sharing window of USER 2 (Galaxy j7)** | **Location sharing window of USER 3 (Galaxy j2)**

Figure 24 Initial window of the observer and users of three different phones

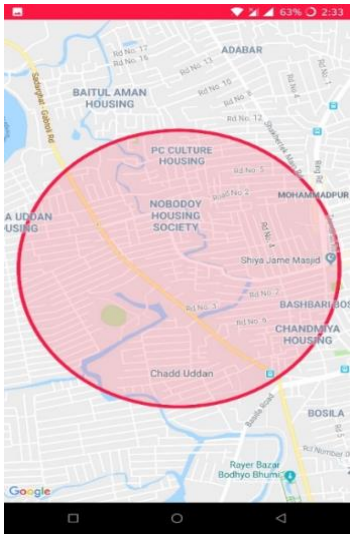
Initially all the three devices were assigned to a same single trusted contact who can see their location. The trusted contact will receive the requests from the devices and can see the names of his/her trustee contact in the trustee contact section, once the requests are accepted. USER 1 is using Galaxy Note 9, USER 2 Using Galaxy J7 and USER 3 using J2.

Initially all the three devices were assigned to a same single trusted contact who can see their location. The trusted contact will receive the requests from the devices and can see the names of his/her trustee contact in the trustee contact section, once the requests are accepted. USER 1 is using Galaxy Note 9, USER 2 Using Galaxy J7 and USER 3 using J2.

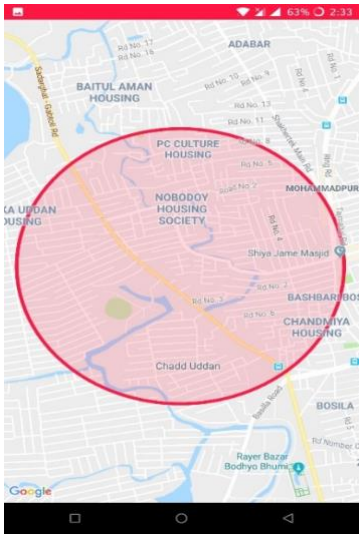


USER 1 (Note 9) | **USER 2 (Galaxy j7)** | **USER 3 (Galaxy j2)**

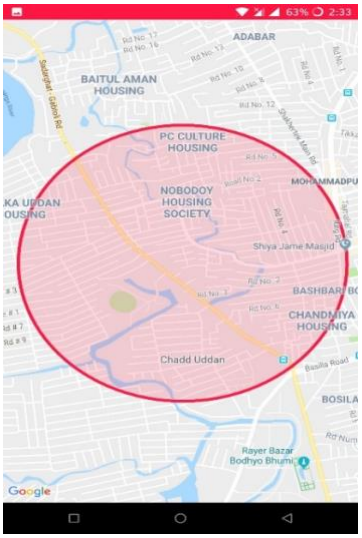
(a) Exact Location by all three devices



USER 1 (Note 9)



USER 2 (Galaxy j7)

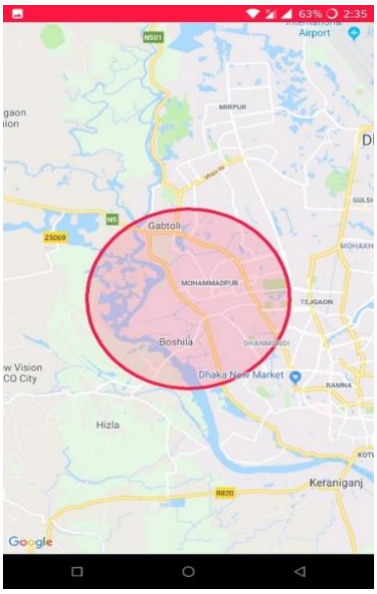


USER 3 (Galaxy j2)

(b)Few Broad Radius by all three devices

USER 1 (Note 9)

USER 2 (Galaxy j7)



USER 3 (Galaxy j2)

(d) City Basis Radius by all three devices

Figure 25 Comparison between various location sharing options of Galaxy Note 9, Galaxy J7 2017 and Galaxy J2

First, the exact radius option of all the devices for the trusted contact was selected. The location of the three devices were found from trustee contact option of the observing user. For both the high-end Note 9 and mid-range Galaxy J7, exact location was shown similar where-else for j2 there was a slight change in placement of location indicator but it was quite acceptable as shown by figure 23(a).

If the location setting for trusted contact is changed to Few Broad Radius, the observing user would see no change in the map for both Note 9 and Galaxy J7 but for Galaxy J2 (low-end

device), it is seen in figure 23(b), the area covered is seemed to be bit more than that of those two devices. Additionally, for Area Based Radius and for City Based Radius settings, the observing-contact would see similar results respectively as of figure 23(c) and 23(d) for all three of devices of various range. Although, for "exact location" and "few broad radius" option, the location shown by the low-end device was slightly different from the high-end and the mid-range device but that is negligible and can be easily overlooked. For the remaining two options, all three of the devices showed similar output on the observing-user's window. It is well understood that "I Am Here" functions properly on any android devices and it is not necessary for that device to be a high-end or mid-range.

7.1.3 Comparison of "I AM HERE" against Google Map

For checking the efficiency of "I Am Here", the application was put to a test alongside with "Google Maps". The comparison test was conducted from the Kuril Flyover to Zia Colony, Cantonment Area of Dhaka Metropolitan. The test was conducted on Oneplus 5, powered by Snapdragon 835 which is an Octa-core chip with 8 GB of RAM, having 3G connectivity and a dual layer GPS with A-GPS, Glonass, Bds and Galileo features. During the test was conducted from within a car, having an approximate speed of around 60km/h and the roads having normal traffic.

The testing began from figure 24(a) from top of the Kuril Flyover, where both of the maps showed similar location. Figure 24(b) and x(c) also showed similar gps location on both the application and Google maps. Near Army Golf Club, although in figure 24(c) both the locations were shown inside the Golf club. In figure 24(d), it was seen that Google maps showing the location inside the Army Golf Club whereas the location provided by the application was on the road. So there were delay of updating location in the Google maps in contrast to that of "I Am Here". Again figure 24(e) and 24(f) showed similar locations for both of the application. In figure 24(g), it was again observed that Google maps is showing location off-road whereas the location provided by "I Am Here" was pointed on the road.

Again it was an update delay by Google map in compare that of "I Am here". In figure 24(h) and 24(i), we reached the desired destination and again both of the application showed similar location of the user. The update delays of Google maps were due to the heavy usage of device resources in compared to the usage of "I Am Here".

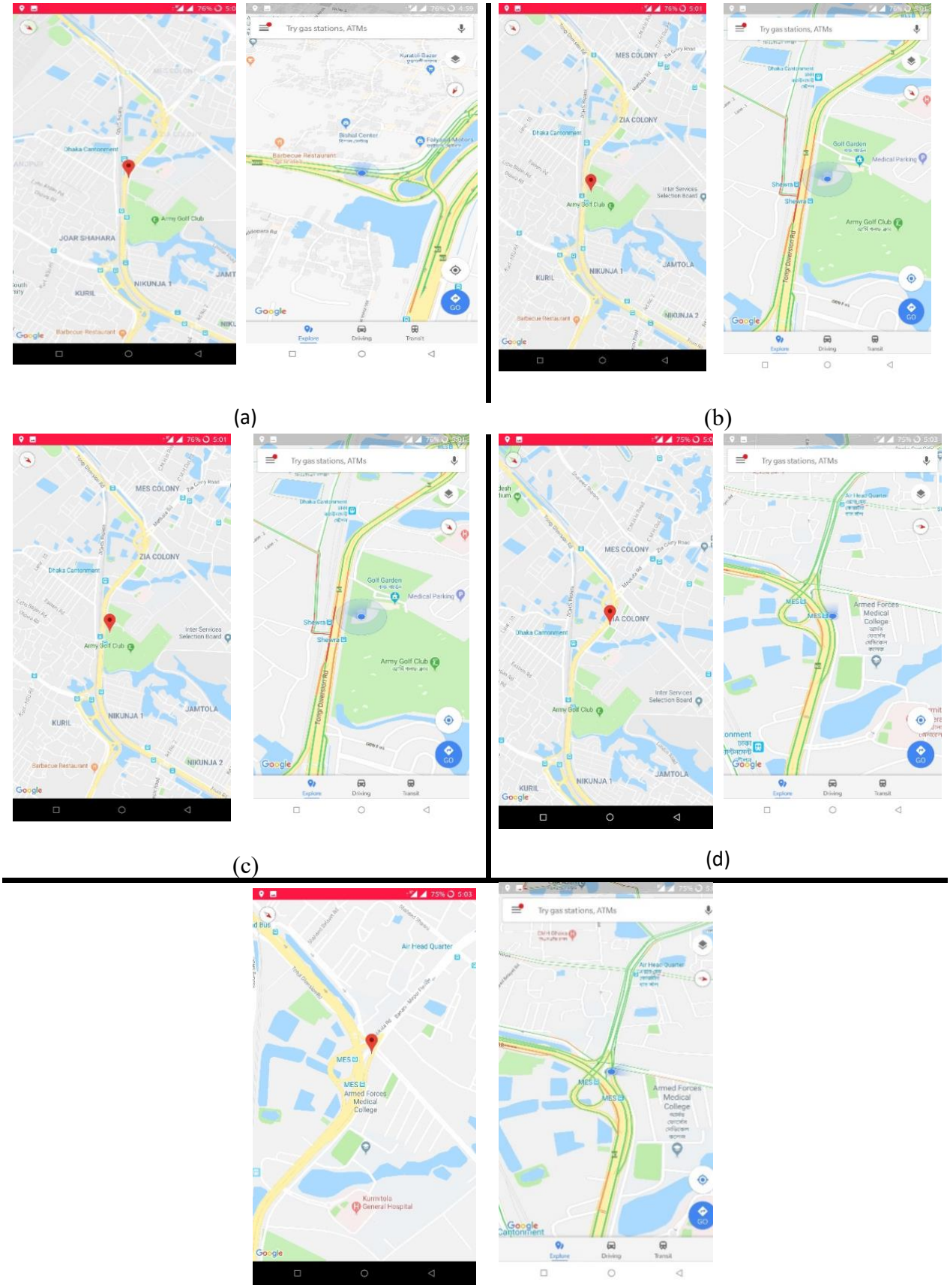


Fig 26: Snippets of comparison between "I am Here" and "Google Maps" in between Kuril Flyover and Zia Colony

7.1.4 Accuracy testing of "I AM HERE"

Accuracy testing of "I Am Here" is done inside the Dhaka Cantonment Area in between CMH and Shaheed Bashar Road. The traffic was normal and no traffic stops were faced. The testing mainly involved tracing accuracy of location by "I Am Here". The test was conducted on Oneplus 5, powered by Snapdragon 835 which is an Octa-core chip with 8 GB of RAM, having 3G connectivity and a dual layer GPS with A-GPS, Glonass, Bds and Galileo features.

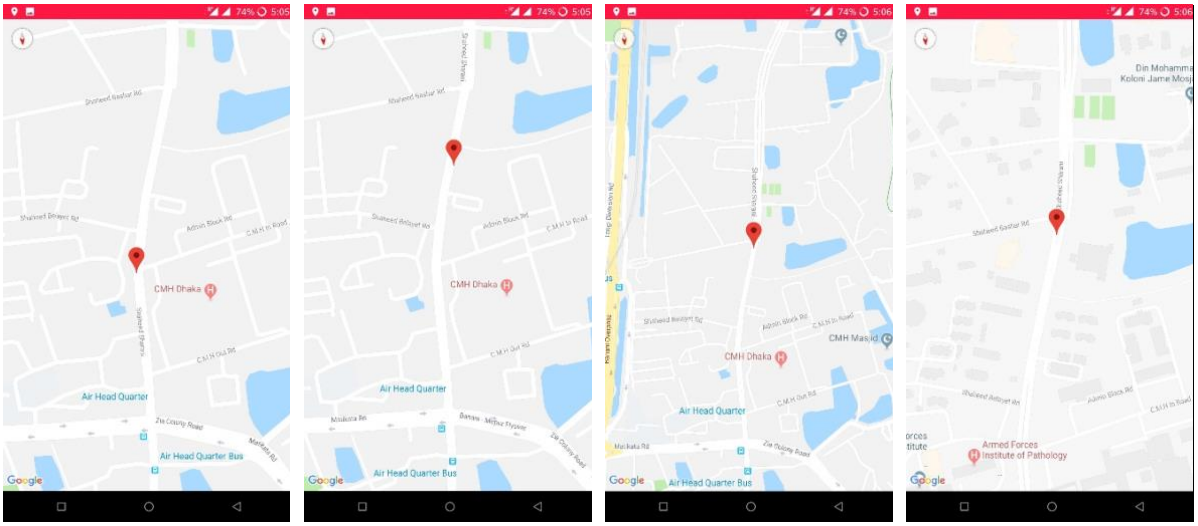


Figure 27 sharing location while travelling from CMH to Shaheed Bashar

Figure 25 shows the sharing up of location of a user while travelling. Throughout this journey the location sent from the application was on road and was accurate. The updating of every new location was done in 2 second interval so the application gets enough time to send the exact one.

7.2 User Evaluation

We have presented the methods of user data collection in the Methodology section, showing our application usage study on 107 users. We have conducted usability study in Dhaka mainly and some outside Dhaka city.

Most of the users (95%) mentioned positively about the application. However, some were concerned about the accuracy of the given locations (8%). Only 8% of the participants wanted to reveal exact location while 67% preferred a broader radius and the rest wanted it to be obscure (e.g. city specific information).

Table 5. Percentage of Participants choosing their desired location sharing options

Location Sharing Option	Percentage Of Participants Showed Interest
Exact Location	8%
Few Broad Location	67%
Area Based Location	22%
City Based Location	3%

Current UI seemed complex to some users (17%) and a large number asked to provide the similar support in Bengali (43%). We hope to improve our application based on these user inputs. The detailed survey questions and responses are attached in the appendix.

After testing the application, many participants expressed their benefits and appreciativeness of using it. One of the participants said:

"I am a student and I am stay in a hostel. When I go home during semester break, it takes 9 to 10 hours in bus or train journey. Mostly, I travel alone and feel insecure. So, using this app, my family can see my exact location and can sigh breathe of relief." – (Student, Age 20, Chottogram)

Another female student stated:

"*I agree with sharing my location with my parents. I think this can help me with my security. I am a student and I go home alone so I feel that the app can help me being safe. Additionally, my parents also feel secure.*"
- *(Student, Age 22, Sylhet)*

A female student with a part time job told:

"Currently I am studying at a Private University. In order to support my family I do a part-time job at a customer call-center of a reputed mobile phone operator of Bangladesh. During day, I attend lectures and four days of each week I work during the night shift at the customer helpline. Because of my duties, sometimes I fail to receive my parent's call. Although, after my duties I reach home using the office transport, my parents still remain tensed about my safety on my way back. With help of 'I Am Here', now my parents can easily check on my location

even without the need of calling me during my work, as well as when I am returning home."
– (Student and a part-time employee, Age 23, Dhaka)

Not only women, but many men also expressed their gratefulness about the application providing their security as well as maintaining privacy. A teenage student mentioned:

"I stay in Banani and every three days in a week I go Farmgate for admission coaching. During my coaching days, my mother feels very in secure so for that reason I will be using the app. The application would help my mother to stay calm."

- (University Coaching Student, Age 19, Dhaka)

Another male student said:

"While I was returning home after teaching my new student from Mohammadpur, I was mugged and my beloved cellphone was forcefully taken. I went to the nearby police station and on informing them, the officers wanted to know the location. Since I was new to that area, at that moment I could not recall the name of the place where I was mugged and the officers did not want to waste their time for me. By using this application, my trusted contact can not only trace me but also will know the last location. Back then, if I had the app, I could retrieve the last location where my phone got turned off and could have informed the police right away so that they might would have taken immediate actions" -
(University Student, Age 22, Pabna)

A housewife mother mentioned:

"I feel worried for my daughter as she goes for coaching after school. It is not too far from our house but I have another baby. So, it is not possible for me to go with my daughter. This app will be very useful for me because with this app, I can track my daughter's exact location."
–
(Housewife, Age 35, Dhaka)

The General Manager of a private Bank also stated that how the application was helpful in order to keep track of his 74 years old father's location:

"My father is 78 years old and he still refuses to take any sort of assistance while going out for a walk or for Praying. I shifted to a new apartment one month back and the whole area is new to my father because at this old age, he is not able to remember the directions properly. One day, he went out to Pray and was lost on his way back home. Me and my wife had to rush back and had to search the roads and blocks of the area along with some neighbors when we heard from our maid that my father did not returned home for 3 hours. After an hour of searching we found my father. Upon using 'I Am Here', I discovered that the tracking feature of the app would help me to trace my father easily even if he forgets his directions."
– (A Bank Employee, Age 42, Dhaka)

A working mother informed that:

"I stay at work from 9am to 5pm on every working day. My son will be appearing for O-Level exam on the upcoming session. Every day, he attends multiple coaching classes. Each

coaching is quite a distance from the other. Sometimes he might be at class for which I remain confused whether to call him and ask him where is he is currently attending his class for which as a mother I remain worried. This application helps to drive me off that confusion. Now I can keep an eye on where my son is currently attending a class without the need of calling him." – (Government Officer, Age 38, Dhaka)

Many other teenagers and elderly people have also stated their thoughts about using "I Am Here."

7.3 Field Test Experiment

For this test, we visited near to Balu River in Purbachal from North South University. The main goal of this testing was to observe whether the app is capable to provide real time location or not and to check how fast it can update user's location on map. While we were in North South University, at that time we installed our app on some participants (n=5) smartphone and then manually gave permission to share location. All our selected participants were male.

After installation, we added our names as trusted contact in their app. Enabled their mobile data and location from settings, so that we can trace down their location. Then we started from North South University.

While we were heading towards to Balu River from NSU, we observed the current location of each participant. Besides that, we saw that our app updated current location in just 2 seconds delay which was really impressive. After reaching to our destination then we concluded our app testing and then asked for feedback to the participants.

Recruited Participants (n=5)	**Comments**
P1 (male)	App is running well and really impressed to see how fast it can update my current location in the map. But I suggest to implement it with some wearable device, so that in emergency situation I can take quick actions.
P2 (male)	Well everything is fine, but I think UI need to be more user friendly.
P3 (male)	It is fine for us, but not for many. I think Bengali should be introduced in the app and try to include a wearable device to make it more feasible.
P4 (male)	I think in the app try to implement sending notification to the nearest trusted contact in emergency situation. It will be better one.
P5 (male)	Great app!

7.4 External Connectors

We have conducted wide numbers of surveys and have performed several user studies along with taking one-to-one interviews of many users who used our application for a given period of time. All these helped us to find any sort of flaws or incompleteness there could have been in our developed application. From various interviews that we have conducted in different places one important feedback that we obtained from the users was that our application would be more helpful and efficient if we can pair it up with some external connectors via Bluetooth. These days' people are very much into using smart watches or fitness band. Therefore, what those users said was connecting our application to any wearable devices so that in case of any emergencies their closed ones can be informed immediately with little or no delay without having to use the phone at all.

7.3.1 Connection with FITBIT

The first choice of our wearable device was fitbit wearable devices. Fitbit is a famous company for making wearable devices for a very long time. It makes both smart watches as well as smart band. Therefore, it is famous among majority of the people since the data provided by the fitbit is said to be very accurate. Both youth and health conscious people use fitbit.

First we went through all the available APIs that is open to the user. It was discovered that in order to use their API, we must register our application at the fitbit community. After getting the access to the APIs, we started using and implementing the Fitbit features to our application. We used Fitbit Charge 2 for our development.

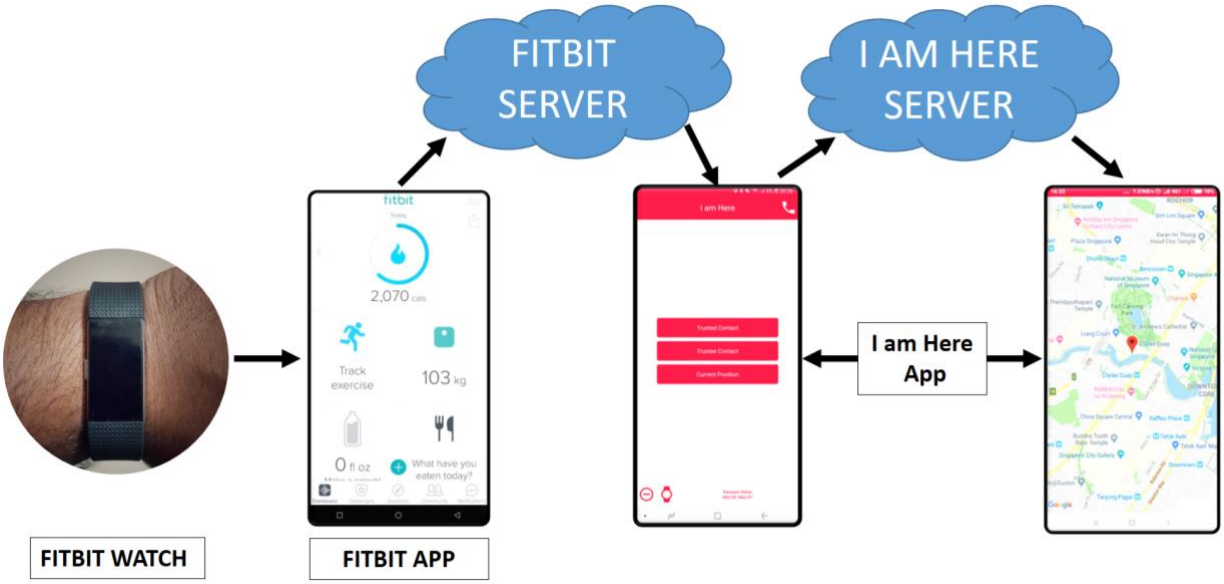


Fig 28: Connecting FITBIT with "I AM HERE"

Initially, we thought that it would be a part of our application similar to the all other features but we discovered that it can only be embedded as web API. It was alright for us but then

another issue raised that fitbit do not allow customized use of its button. Therefore, triggering immediately by the press of a button is not possible by using not only fitbit charge 2 but also with other models of fitbit also.

Then we come up with a solution that emergency message can be triggered by reading the abnormal pulse rate of the user wearing it. We assumed that an emergency alert will be triggered by an abnormal pulse of the user. We were on the verge of embedding this feature into our application when we encountered a large problem.

The fitbit web API do not send the real time data to our application. Therefore, in case of any emergency even though the abnormal pulse can be read from the fitbit, still the data would reach our application after sometime and thus no emergency alert is triggered. Therefore, development using fitbit came to a halt and no further developments were tried.

7.3.2 Connection with PROTIBADI

Another way of triggering emergency alert was using a device called Protibadi. It was built to ensure women safety and for quick response. The hardware is designed and developed as a low cost wearable system that costing only $5 to $6.

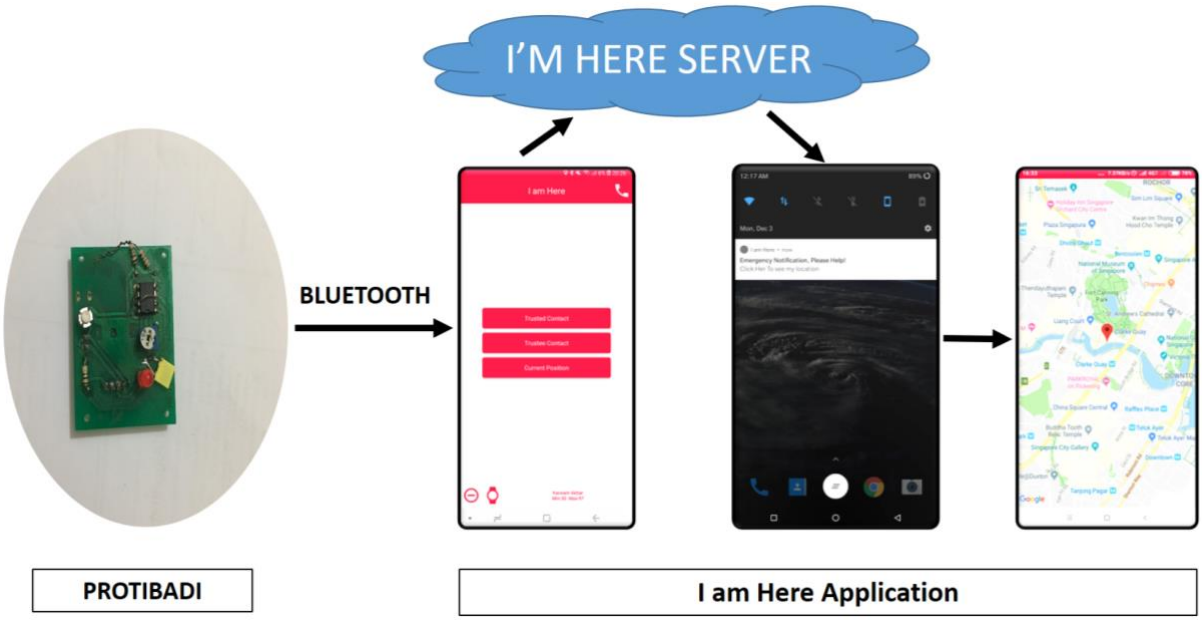


Fig 29: Connecting PROTIBADI with "I AM HERE"

This minimalistic hardware performs with a mobile phone application where hardware helps the app to send the text to the rescuers. The cost was reduced by using pure analog circuit in the system. No microcontroller or GPRS device were used as well as no coding was done.

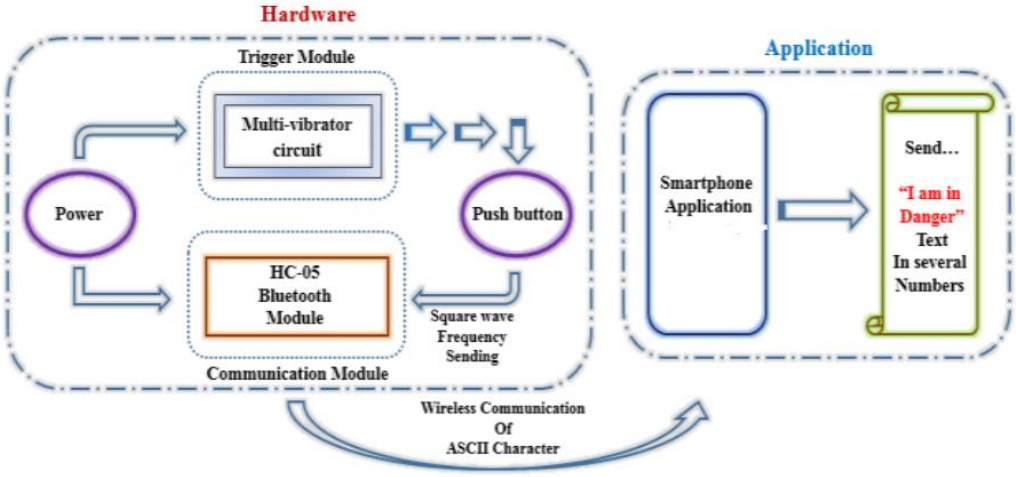


Fig 30: Block diagram of the PROTIBADI

The multi-vibrator circuit is essentially a square wave generator with a push button. Upon pressing the button, the circuit will activate for a specified length of time and generate a continuous square wave of a predetermined frequency that corresponds to an ASCII character, used as trigger for the mobile app. This ASCII combination is transmitted via a communication module (Bluetooth HC-05) to the mobile app.

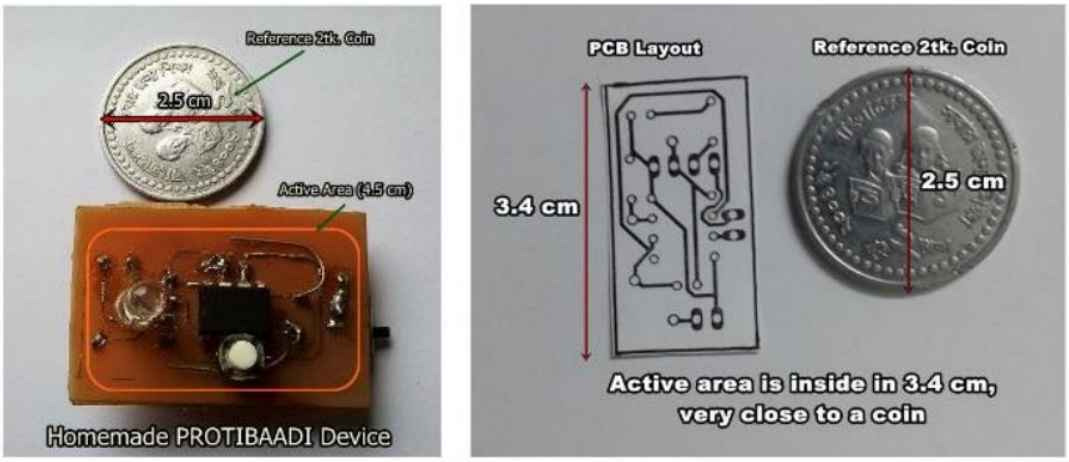


Fig 31: PROTIBADI Device

Therefore, when we will connect this device to our application, by pressing the emergency button, an alert can be triggered and the trusted contact of the user can be immediately informed. Thus, users can get inform their trusted contact in case of any emergency without having to take out the phone from the bag or pocket.

CHAPTER 8
CONCLUSION

CONCLUSION

The software has the capability of reducing the abduction issues of Bangladesh that is occurring frequently. Since, Smart Phones are becoming cheaper every day, making it more available to larger population, these greater number of people can have the opportunity of accessing the service that may help them to tackle many life-threatening situations that they may not only encounter on the streets of capital Dhaka, but as well as the whole Bangladesh. Our goal is not just reducing abduction but also other tackling crimes such as mugging, rape and any other kind of harassing issues. If people from all gender and ages learn to use this application properly and share the benefits of it around then, streets of Bangladesh may become much safer than before.

It can be hoped that after successful launch of the "I am Here" system women will actually be able to move freely without the fear of being victimized. This system not only takes care of women's security but also it acts as a protector for women, from 551 any kind of adversaries faced in road, while she is moving alone. Such adversaries may even be health related issues. The focus of this work is not only helping the women but also automating the help request when the woman is unable to ask for help. Monitoring of the woman's health condition is also done by this system. In this paper, only a prototype of the system is presented and the wearable sensor band is not designed physically. Health monitoring sensor bands are already available in the market but an integrated e-health watch is yet to design. So, the future work on "I am Here" will aim in designing the watch and use real test data to check the working of the application. The decision tree can also be improved in order to reduce false alarms. Some inevitable challenges in designing "I am Here" include the difficulty in putting a woman in a dangerous condition in which her fear will be detected; that also, only for the purpose of testing.

On the other hand, if the woman is previously informed that she will be put into such a danger only for testing of the device, she will not be actually afraid in that situation and the watch will not be able to detect her fear. In future, it is needed to test the correct working of the system in actual dangerous conditions.

We also discussed problems of HCI intervention more generally, including as the field engages deeply contested and unsettled cultural issues of the sort addressed here. Such complexities are likely only to intensify as the feminist and HCI4D projects within HCI grow and mature. More and careful work in this space, of both theoretical and empirical varieties, may cast further light on the dynamics and challenges described here. Such work may also enhance the impact and responsibility of the field.

APPENDICES

APPENDIX A

1. How much concerned you are about the current security condition of Bangladesh?
   a. Very Much b. Moderately c. Slightly d. Not that much

2. How much secured do you feel to move in Dhaka?
   a. Very Secure b. Secure c. Insecure d. Very insecure

3. Did you ever feel so insecure that you called/wanted to call someone while moving in Dhaka?
   a. Yes b. No c. Maybe wanted but didn't call

4. How do you take privacy issues?
   a. Very seriously b. Seriously
   c. Didn't think about it d. Not that much seriously e. Not bothered at all

5. Do you think keeping a track of your location might help in case of emergency (i.e. kidnapping)?
   a. Yes b. No

6. Do you think that sharing your live location data with your trusted people might make your feel more secure?
   a. Yes b. No

7. Would you mind to share your location data with your trusted people of your choice?
   a. Yes b. No

8. Up to which extent would you be comfortable to share your location data with your trusted people?

   a. Exact location b. With a few broad radius (i.e.: NSU)
   c. With more broad radius (i.e.: Bashundhara R/A- B block)
   d. With area based radius (i.e. Gulshan, Banani, Uttara)
   e. With city based radius (i.e. Dhaka, Gazipur, Narayongonj)

9. Would you mind if an app saves your exact location for 24*7 and reveals it to your trusted contact in case of emergency?
   a. Yes b. No

10. Do you think emergency call (999) shortcut might help in emergency case?
   a. Yes b. No c. Maybe

APPENDIX B

EMRUL KAISAR (28%)
✓ Project Proposal ✓ Market Analysis ✓ Requirement Analysis ✓ System Design ✓ Poster Submission (ICTD X) ✓ System Implementation (Front End) ✓ User Testing ✓ After Development Studies ✓ Report Writing ✓ Paper Writing ✓ Poster Presentation (BPW UBICOMP) ✓ Working with Wearable Devices (FITBIT & PROTIBADI)

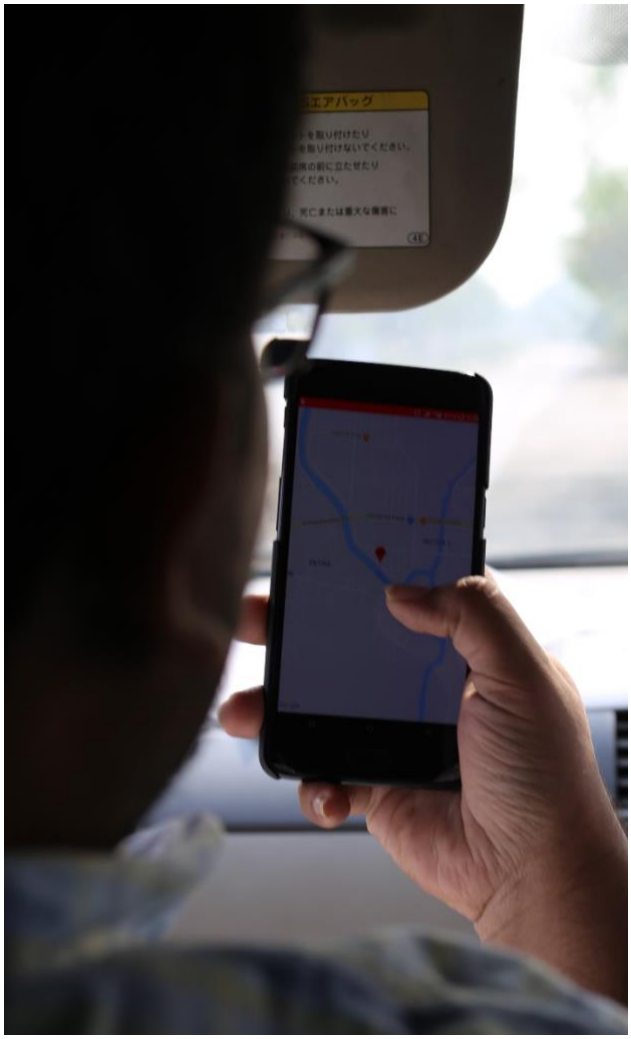
MOHAMMAD KAOSAIN AKBAR (26%)
✓ Project Proposal ✓ Market Analysis ✓ Requirement Analysis ✓ System Design ✓ Poster Submission (ICTD X) ✓ System Implementation (Front End, Firebase, Request Add/Delete) ✓ User Testing ✓ After Development Studies ✓ Report Writing ✓ Paper Writing

DIBYA PROKASH SARKAR (26%)
✓ Project Proposal ✓ Market Analysis ✓ Requirement Analysis ✓ System Design ✓ Poster Submission (ICTD X) ✓ System Implementation (Front End, Map Integration, Emergency Button Integration) ✓ User Testing ✓ After Development Studies ✓ Report Writing ✓ Paper Writing

SOUFIA NELI ROSHNI (20%)
✓ Project Proposal ✓ Before Development Survey ✓ Poster Submission (ICTD X) ✓ User Testing ✓ Report Writing ✓ System Design ✓ After Development Studies

APPENDIX C

PHOTO GALLERY




be different

---THE END---