Crowdsourcing Medical Emergency System using Internet of Things in Bangladesh perspective

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Bachelor of Science in Electrical and Electronics Engineering

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This Thesis titled **"Crowdsourcing Emergency Medical System using Internet of things in Bangladesh perspective"** is our own work. This thesis has been accepted as satisfactory by the supervisor as partial fulfillment of the requirement of the Bachelor of Science in Electrical and Electronics Engineering.

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Abstract

Bangladesh is a developing country with huge population in this small territory. In population census 2011, we knew that our 7.48% populations are aged above 60 years of age. Also most of our people are unaware of the system that provide real and practical health care provided by government and non-government care givers at the remote areas, we propose a system that will make easy for them to use and get the medical help everywhere in our country timely. In this modern era many things are going to be model with the latest technologies achieved. By this time most of us have mobile/cell phones under operation. So if we can establish a system that the mobile phone may be the effective tool to rescue people in medical emergencies will be very helpful in countries like ours as well as the under developing countries. The aim of this research work is to design a medical emergency system by leveraging the concept of crowd sourcing that will be able to (1) Monitor and detect a medical emergency situation and (2) Minimize the emergency response time and operational cost. This proposed 'Neighbour Assisted Medical Emergency System (NAMES)' will use the voluntary participation of the neighbours. In this system during an emergency situation, it will connect the cloud and it will search for the nearest neighbour to connect for helps and solutions. Then cloud will give the details to neighbour. After accepting the request, the neighbour will be equipped with

the all necessary documents shortest possible time limit. According to decision of the neighbour, the pharmacy or ambulance will be contacted through neighbour. If ambulance required it will connect to the GPS for transportation and by the ambulance the patient has to reach to the hospital for treatment. This emergency describes by rapid response system should improve the medical emergency needs as a whole. There must be some main components (i) Event detection and response triggering (ii) Crisis response (iii) Process improvement through feedback and (iv) Governance and administration. Based on all these components, it is essential for a neighbour to get the information about the subscribers sooner and be responsible to give the support to the subscribers which will definitely help the human mankind ultimately.

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Chapter 1
Introduction

1 Introduction to our Research

1.1 What is an emergency medical situation

Emergency Medical Situation is a critical health situation when a person is facing medical problems. In this research we are conducting experiments with the medical emergency which occurs on the go. This type of medical emergency is the most critical. Cause the environment is error prone and difficult to handle. Sometimes taking decision on this type of situation becomes more difficult and most tendency to take wrong decision. This is why it is considered as "**Emergency Medical Situation**".

1.2 Introduction to IoT

IoT is widely known as "Internet of Things" means using internet capable devices together for a specified work. For the last few years increase in internet capable devices has given us a chance to use this fairly new technology in our country for the betterment of the people of our country. In [19] author described IoT as "Internet of

Things is the Connections of embedded technologies that contained physical objects and is used to communicate and intellect or interact with the inner states or the external surroundings". So, we can see IoT is intended to work independently and it is a system which performs machine to machine communication. Thus this system is faster and much more error less. As human being we are very error prone. So if we can make device which can take decision on its own.

1.3 Introduction to eHealth

eHealth is a term used widely in the field of medical treatment. People accepted it as neologism[1]. It as the term for describing medical treatment which includes electronic form. According to WHO eHealth is simply using ICT in health industry. They also call it as digital health. Their executive board explain how technology can improve public health in different sector. Essentially this is eHealth[20]. In Bangladesh there are a lot of medical service with many many question marks. People here do not get sufficient medical treatment. Also many has raised a question on equality, quality and utilization of our medical treatment. There is eHealth also mHealth. eHealth means giving health care using ICT. And mHealth refers to public medical health service supported by mobile devices[24]. mHealth is already been used in different case in UK. They used this to do research on HIV infected people. They

got significant result. This technology brings self monitoring system for medical health. Thus improve a lot of condition to improve the situation. This helps to monitor the health so that people don't need to be admit into hospital often[24]. In Bangladesh there are community health care. This also very new things. Govt of Bangladesh is trying hard to implement all of these[21].

1.4   Motivation

Our country is densely populated country with over $166, 926, 854$ people [2]. But unfortunately we have nearly zero medical emergency service. And it becomes more difficult if anyone lives in countryside which is not a city. So, therefore our proposed system has taken the opportunity on solving and minimizing the time it takes to reach medical help to anyone in Bangladesh.

1.5   Introduction to our proposed system

We call our proposed system "**Neighbor Assistant Medical Emergency System**" or simply "**NAMES**" which will include mobile network, smart phone application, database, medic person and many more. Our proposed System will allow us to find the person who is in emergency medical person and find him or her a medic person. This medic person is called "Neighbor" in our system. Neighbor will

go there and provide first hand medical treatment. After giving the treatment the neighbor would take a decision on regarding what to do next. The neighbor can ask for help from a nearest pharmacy on medicine and machine to check patient. Or if the neighbor thinks that the condition of patient is critical neighbor would call for ambulance. All of the work would be governed by the system which would run by Internet of Things. The location data would define where is the neighbor, patient, pharmacy or ambulance is. And using this information our proposed system would run and assign neighbor and other things accordingly and if necessary.

1.6   Objectives of the Thesis

This research paper aims to some specific objectives. The main objective are:

- Build an IoT enable medical emergency system in Bangladesh

- Reduce the response time in medical emergency

- Build an IoT based network in Bangladesh

1.7 Organization of thesis

This paper organized in below manner.

- Chapter 1: Introduction

- Chapter 2: Background

- Chapter 3: System Model

- Chapter 4: System Implementation

- Chapter 5: Proposed Database

- Chapter 6: Mobile Application

- Chapter 7: Big Data Analysis

- Chapter 8: System Evaluation

- Chapter 9: Conclusion and Future Work

Chapter 2
Background of the Thesis

2 Background

2.1 Literature Review

Many work has been done in the field of eHealth and medical emergency system based on IoT. One such example is [3], in this paper the researcher presented an interesting real time health monitoring system which would allow them to constantly monitor the health condition of elderly people.In this research, author proposed recording system for their health data and also in crisis moment it would inform the responsible person immediately[3]. In another research, an IoT architecture has been proposed and analyzed for the health monitoring system [4]. While doing research one of the paper got attention of us is [5], because it shows a work which includes tracking the movements and also detect a possible illness before it triggers. A survey paper that introduced a trustworthy eHealth monitoring system [6]. It also talks about essential service components in eHealth monitoring system. An AI system with humanoid robot is introduced in the paper [7], which would support an emerging multidimensional care approach for the treatment of diabetics through IoT. In this

time the IoT is increasing in use in different sector of engineering, medical and a lot of other sectors. For sustainable use of IoT and medical cases the paper must suggest a reliable and low power machine for under developed country like Bangladesh. In the research paper [8] researcher suggest all the major aspect of IoT and medical care system. This paper also suggest big data analysis for certain medical case for better performance in health care. In [11] the authors have discussed briefly about the total process of IoT based medical system. We can learn about reliability, security, scalability and many more from this paper. Also we learned about a model hat has been proposed in that paper[11]. In this paper also they described about vehicular accident case that might happen also. The paper [12] described a detail report on present condition of IoT in medical service. Also the authors had an extensive work on medical records, personal assistant, automated analyzer and medical devices. They used state-of-art LOD technologies to build a model that transform the local data to LOD compatible model. In their proposed system they retrieve data from various IoT enable devices installed in hospital and doctors chamber. These data would provide the significant information about that particular patient. in the future when another doctor start treatment, with the help of open source information he would have get access to the past records of that patient in a second. This system would help the doctors to track the problem of that patient. Also same time the

patient would not get the hassle to bring and store all small information about their medical history. Another research [13] proposed a different theory. In that research the authors proposed a multilayer architecture. In this multilayer system they analyzed and modeled IoMT system. They connect different sensor to collect information from the patient surroundings. It helps to asses the situation more precisely. In that paper the author experimented the system for outdoor as well as for indoor. The author also divided the research into different category and build the model according to that and examine them. That research opened a new area of IoT in medical technology. In another paper[14] the author describe the problem of management in IoT platform. Now a days IoT capable device is increasing and also many system using IoT to establish their platform. Medical system is in high rise to this. When patient becomes high in number and their records become more and more, it becomes difficult to manage it too. In the paper [14] the researcher proposed another architecture system. That paper tried to solve the problem that is related to management issue. They classified the data in different industry within the medical system. The paper also proposed different detection system using IoT in medical sector. Our target is to come up with a new idea which will allow us to build a system based on IoT in Bangladesh.

2.2 Existing emergency medical service in Bangladesh

In Bangladesh, we rarely have a emergency service which provides a good and all round service. In Bangladesh we have a service "Telemedicine". It is a system where people who is admitted in district and sub-district level hospital can take advice from doctors from specialized hospitals[9]. Beside this in Bangladesh there is another service call "Health Care Centre". In this service people can call 16263 this number and get directed to a doctor who would then give suggestions on the problem[10]. Both of this system allow people of Bangladesh to get a partial medical service which is not nearly an emergency medical service. These two service just help to prevent small injury or just casual help from a doctor. This does not include help from pharmacy and physical meet. Also if anyone need medication it is not possible through this system. In our country there are govt ambulance service also. But to it is very low in number that can not serve the amount of people who need service. Also there is issue with traffic jam. So, we need a better system which is automated and also intelligent enough to take decision.

2.3 Scopes for improving emergency medical service

There are a lot of way to improve emergency medical service in our country. As we discussed earlier there is no service which helps physically. So in our system that

can be done. also in our research we have plan to implement these in our country.

- An IoT based system

- Emergency medical system based on IoT

- IoT network for future development

- Update health care system

- eHealth implementation

- Big data analysis for medical record

Chapter 3
Proposed System Model

3   System Model

System Model describes our work step by step. Here is our system model.

3.1   Flowchart of the System Model
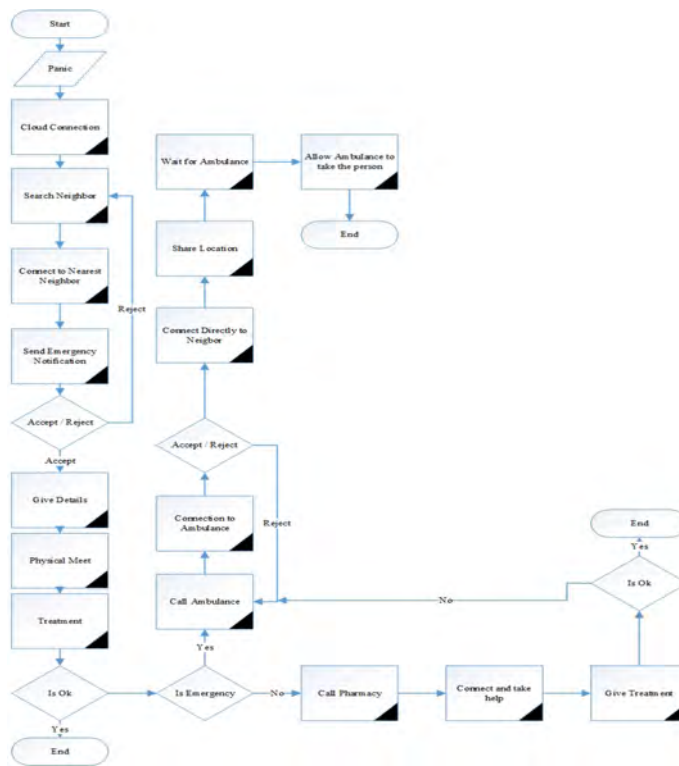
Figure 1: Flow_chart_thesis.jpg

3.2 Description of System Model

As we can all see our System vividly picture the step by step work of our system. We also can see we can divide our work into main four parts. Here is the explanation of all part one by one.
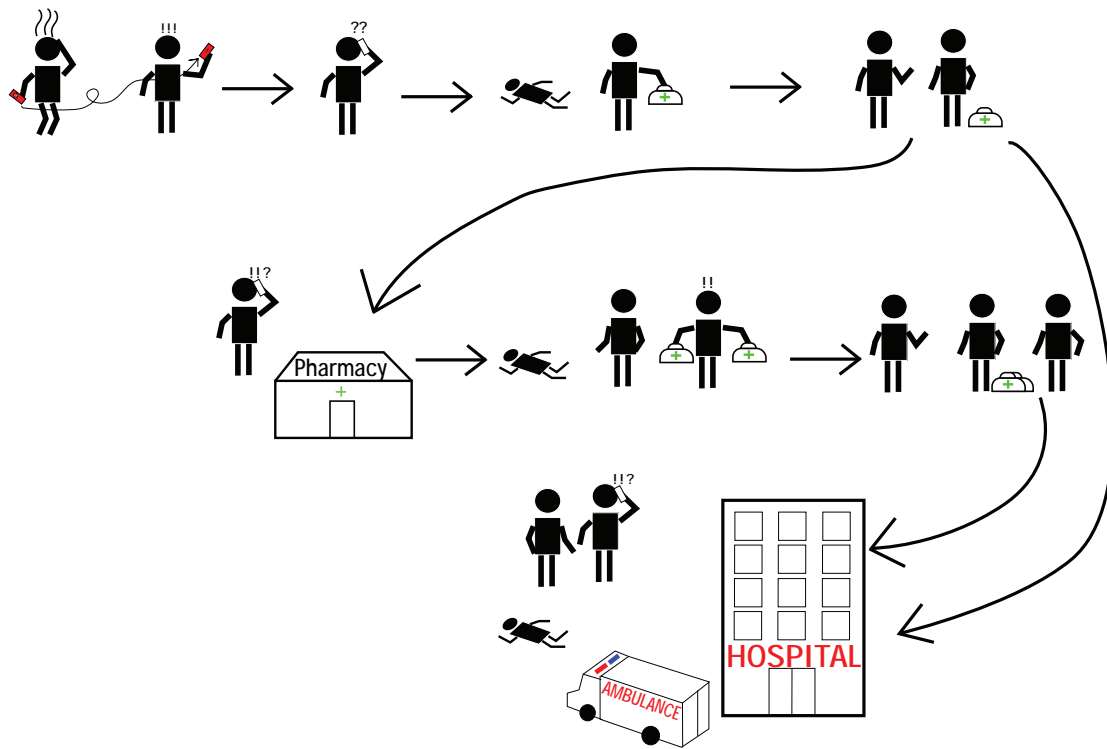
Figure 2: IoT Enabled Medical Service

3.2.1 Emergency initiate

This is the first stage of our system. Our system detect the emergency by the activity of the patient. The patient sends the emergency signal through his or her phone. When our system detects that a emergency notification is served it acts very quickly and take all the work by its own. When a emergency is issued our system start to follow checklist and do one by one all the task.

3.2.2 Neighbor Assist

The next major step is neighbor assist. When anybody initiate emergency, first the system search for the nearest neighbor. When found it provides necessary guideline to reach the patient. And neighbor use the Google map to reach there. And after reaching the point neighbor starts doing what is necessary.

3.2.3 Pharmacy

In the system it is allowed to take help from a pharmacy if needed. Neighbor will take decision on this. If neighbor thinks it is needed to take help or medication from a pharmacy then he can ask nearest pharmacy to help. In the system the neighbor will have an option to call a pharmacy. Upon calling nearest pharmacy all the nearest pharmacy would get notification through web. And they would contact the neighbor

and would go to the location with the equipment that neighbor ask for.

3.2.4 Ambulance

If neighbor thinks that a pharmacy would not be able to help. In such situation he can call for an ambulance. He can call it after taking help from pharmacy or even at first also. When neighbor sends the emergency signal to ask for ambulance, all of the nearest ambulance would get a notification. This emergency notification would request them to help. upon accepting the request ambulance would get the direction for the patient. And the operator of the Ambulance would go there as soon as e could. He would be responsible for the patient to drop in the nearest hospital.

Chapter 4
Full Implementation of Our System

4   System Implementation

TO implement the system we have used embedded system. We have used internet, database, website, App and many more. We have built a device with Ardiuno and Gsm module. This device helped us to collect the data that we require for this research.

4.1   Device Description

our device is made by us and used many components. The major components are describes here. Here is our device.

Figure 3: Device

4.1.1 Arduino

Arduino is the brain of this machine. All the other components are connected with this and control by this. For the project there is a code for arduino which allows us to collect data and store it into our database.
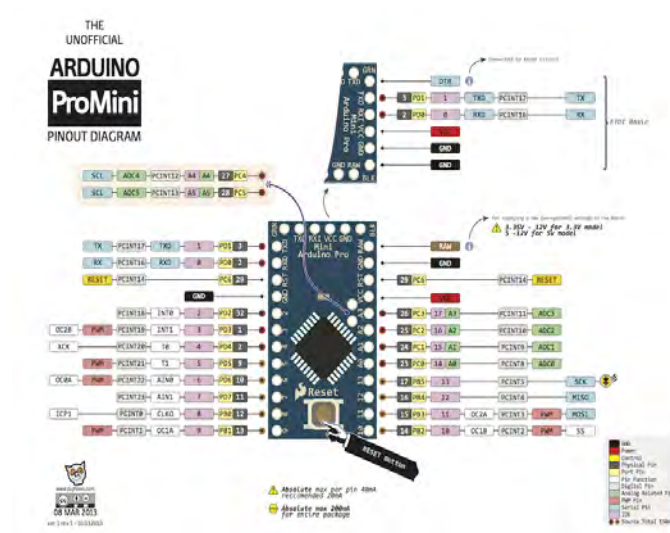
Figure 4: Arduino Pro Mini[15]

4.1.2 SIM808

SIM808 is a quad band GPS+GSM+GPRS module, which is a GPRS multi slot class 12/10 [16]. It is controlled by AT commands which are distinct for every model. The module also requires a cellphone Subscriber Identity Module (SIM). In this research we have used a 4G enabled SIM from the mobile network operator Grameenphone. It uses coding schemes (e.g., CS 1, 2, 3, 4) [16]. This is another reason to make this a perfect choice for our work. SIM808 supports SMS broadcast, can connect with the database with FTP or HTTP and uses TCP/UDP protocol [16]. We have also attached two antennas GPS and GSM. These are the reasons to choose this module.

These antennas help to connect and get the data from the servers [17].

Figure 5: SIM808 and GPS Antenna

4.1.3 GPS Antenna

GPS Antenna is connected with the SIM808 module for collecting the location data in the form of latitude and longitude. We receive the latitude and longitude in the mathematical floating point value. This data gets sent to the server created beforehand and gets stored there. Afterwards said data gets collected and sorted into an excel sheet [18].

4.2 Data

For this research project we have collected a range of location data from Dhaka, Bangladesh. The data is longitude and latitude. This data allows us to locate the

position of any place. This helps us to model our system in Matlab platform so that we can simulate it.

4.2.1 Data Collection

We have used our machine to collect data. The machine is connected with gsm and used the gsm network to receive and sent data. To do this research we have used a 4G Grameenphone sim. Here is our data table.

Figure 6: Data Table

We can see in our table we have these values as well as time and date.This helps us to do lot more.

4.2.2 Data sharing and collaboration

After getting the data, our model used these data to plot and mapped it so we can visualize the situation. We have collaborate our data with google map and google earth. Here is few of them.

Figure 7: Google Plot

4.3 Algorithm Flowchart

Algorithm is the procedure which is followed to solve a problem. When we describe the step by step procedure to solve the problem it is called algorithm[25]. Algorithm is sequence of certain input which would bring the desired output. Here is the algorithm of our research work.

First of all we introduce following notations: Emergency button (B) and Emergency initiate (E_i).

We have divided the algorithm part into 3 main parts, which are: Neighbor, Pharmacy and Hospital.

Algorithm 1: Neighbor in the emergency

---

1. **for** B = ON,

2. E_i = ACTIVE,

3. **for** $i = 0$ to N, **do**

4. **if** (S(i) = RESPONSE)

5. The nearby neighbor gets notification on the emergency medical help.

6. Upon acceptance by a neighbor he or she would go to the patient for further investigation.

7. Neighbor would try to give first hand medical treatment.

8. After giving treatment neighbor would take decision on whether the patient is okay or not.

9. **If** The patient feels okay then the emergency situation is over.

10. **else** The patient is not okay then neighbor would take decision.

11. **Case 1:** The patient needs help of some medication or neighbor needs some equipment for check up, then neighbor calls for pharmacy and nearby pharmacy would be informed.

12. **Case 2:** Neighbor thinks that the condition is critical then he would ask help from ambulance to drop the patient to the nearest hospital.

13. **end if**

14. **end if**

15. **end for**

16. **end for**

Algorithm 2: Pharmacy in the emergency

---

1.   **for** B = ON,

2. E_i = ACTIVE,

3.   **for** $i = 0$ to N, **do**

4.   **if** (S(i) = RESPONSE)

5.   The nearby pharmacy would get notification on the emergency medical help and all the details.

6.   Upon accepted by a pharmacy, a person from the pharmacy would be connected directly with the neighbor.

7.   Neighbor would ask him to provide necessary medication and equipment.

8.   With all of those neighbor would give treatment to the patient.

9.   **if** The patient feels okay then the emergency would over.

10.   **else** Neighbor thinks that the condition is critical then he would ask help from ambulance to drop the patient to the nearest hospital.

11.   Neighbor would wait until the ambulance take the patient

12.   **end if**

13.   **end if**

14.   **end for**

15.   **end for**

Table 2: Algorithm 2

Algorithm 3: Ambulance in the emergency

---

1. **for** B = ON,

2. E_i = ACTIVE,

3. **for** $i = 0$ to N, **do**

4. **if** (S(i) = RESPONSE)

5. All nearby ambulances would get notification on the emergency medical help and would receive all the details.

6. Upon acceptance by an ambulance, it would be connected directly with the neighbor.

7. Neighbor would give the operator all the information regarding their location.

8. After receiving location details the ambulance would go to the spot.

9. Ambulance would take the patient to the nearest hospital.

10. When the ambulance accepts the patient, neighbor's task is completed.

11. The operator of the ambulance takes responsibility of the patient.

12. The operator admits the patient to the hospital.

13. The authority of the hospital can contact police for assistance.

14. Emergency ends now.

15. **end if**

16. **end for**

17. **end for**

Table 3: Algorithm 3

Chapter 5

Proposed Database to use in this Research

5 Database

Database is the space in the internet where we can put data and save it. To do collect data and save automatically we need to have a database. One of the best databases is ThingSpeak. This is a website who provides free space for IoT research and save data[26]. This actually helps as a student researcher our research have low sponsorship.

5.1 Thingspeak

Thingspeak is a great platform to do data research. We could do a lot of things with the data. Let us discuss about the features of thingspeak.

5.1.1 Collect data in private channel

This a cool feature that thingspeak offer. We can make channel with our account in thingspeak. The channel can be private or public. Private channel is the best to keep private data for the research of our own. And public channel is the best way to share your data with the world if you want. So, in this we can make a private

channel of our research and start our work. In any IoT research we have a lot of sensors and machine that handles data in and out. In our research we have collected a lot of location data. So, in our research we made a channel and collected the data.

5.1.2   RESTful and MQTT APIs

This is the most important features of all. This allows us to send and retrive data from our channel. As we know thing speak helps us to store data in online. We make channel and start sending data from our sensor and device to the channel using API's. Each channel has different and unique API. And using this API we can update a channel feed. This means we can update the data. In the settings we can find the API number for each channel. There are several API for a single channel and also an account can have multiple channel. And each channel can have unlimited number of fields to store different types of data.

5.1.3   MATLAB analytics and visualizations

Use the MATLAB Analysis app to prepare, filter, and analyze data such as calculating average humidity, calculating dew point, and eliminating data outliers from a ThingSpeak^{TM} channel. ThingSpeak allows you to use MATLAB to analyze and visualize your data. The analysis and visualization apps provide template code to assist you with basic operations on historic or live data. These tutorials take you

step by step through each code template. Use code template tutorials to get started with ThingSpeak. Use the apps to convert from one unit to another, compare different or similar data on the same plot, or visualize the statistical distribution of your data[27].

5.1.4 Alert

In every project we tend to do something when a certain thing happen. We can set it up with this alert system. Like when a smoke sensor reaches a certain limit the alert start to play the alarm. This system is so helpful and we can easily intregated this with the project of our and start doing what we can do.

5.1.5 Event scheduling

This is also an important feature of thingspeak. We can schedule an event to happen according to the sensor data changes. As we have attached a lot of sensor with our project and all the data is going to the thingspeak so we can easily integrated this to the main system so that we can allow something to happen when a certain data changes.

5.1.6 App integration

This feature allow us to integrated an app with the project. As we can use mobile network and project module simultaneously so we might use an app to drive it all. It is very easy to add an app with the thing speak database. We just need to integrated the app with the channel and allow it to pass data in and out so that it can work easily with all other peripherals.

Chapter 6
Mobile Application

6   Mobile Application

A mobile application, most commonly referred to as an app, is a type of application software designed to run on a mobile device, such as a smartphone or tablet computer. Mobile applications frequently serve to provide users with similar services to those accessed on PCs. Apps are generally small, individual software units with limited function. This use of app software was originally popularized by Apple Inc. and its App Store, which offers thousands of applications for the iPhone, iPad and iPod Touch.

A mobile application also may be known as an app, web app, online app, iPhone app or smartphone app [28].

6.1 Flow Chart of App

Here is the fow chart that describes how the app will work.
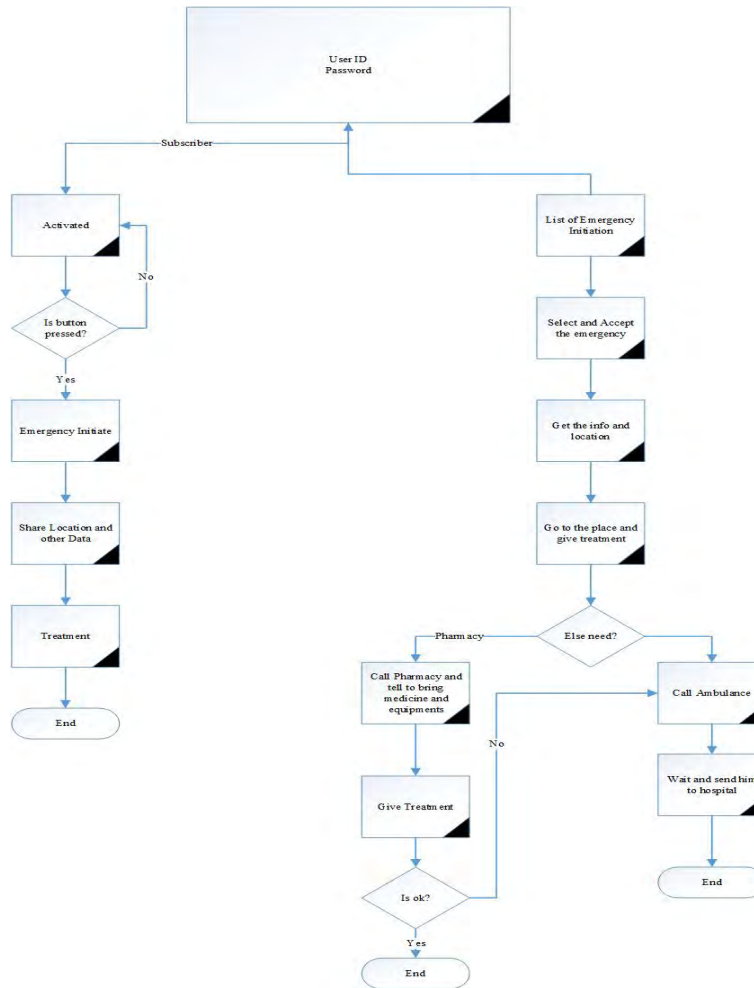
Figure 8: Working Flow of Mobile Application

6.2 Description of Mobile App

Our Mobile App design is very simple but workable. As this app would be upgradable so it is okay to build this app with minimum requirement now. We are planning to build the app so that it can run on every operating system platform possible. Also we would try to introduce both English and Bengali language so people can understand it better.

Also this app is and would be used in Bangladesh so Bengali language is an important part of this app. We also have plans to add more features to do this app.

As from the Fig 8 we can see the full diagram of the app that we would make to work with this. First the app would take and ID and Password to identify weather the person is user or neighbor. After detecting that the app would do as instructed.

6.2.1 If User

If the ID and Password resemble that this is a user account then the app would go online and ready to trigger. In this process the app would take charge and monitor the button (Designed by the App) to be pressed. This press would indicate the medical emergency. If the app detect the pressed button then it would start the emergency procedure.

First the app would take the location of the user from the mobile network and

GPS. This location information would then transfer to the database to distribute it to the nearest located neighbor.

When a neighbor accept the request then the app would stop sending emergency request. And also if within 5 min the neighbor does not come then it would start sending emergency signal again.

The app would work as the sender of location and previous medical records.

This documents would be an advisory for the medic person to do his job more efficiently.

6.2.2 If Neighbor

In this part after getting the password and other data the neighbor will see the nearest emergency points in his app. And he would accept one of those emergency calling. And after accepting he would go there by following Google map. After getting there he would start the medical treatment to save the person. To get further assistant he may call pharmacy or a Ambulance. Which is also there in the app. Only neighbor after reaching the User can have this option. Before reaching there neighbor would not have that option in their app.

Chapter 7
Data System and Big Data management

7 Big Data Analysis

When we would start our work a lot of data flow will start to happen. And after few months of operation we would have a lot of data to store. And thus it would allow us to bring AI and start working on big data analysis.

7.1 What is AI

AI or simply Artificial Intelligence is a program that runs by its own and does not need instructions immediately. Anything that can work and take decision by its own we call them artificially intelligent. This is very new and modern topic. In engineering and IoT topic big data comes very often. As IoT can collect a lot of data so it also works for the big data generates. And this big data leads to a special condition where we must apply AI to rebuild everything.

7.2 Why calling Big Data

Big data or massive data refers to that a system which is collecting various range of data from a lots of sensors and nodes. These data are generally reviews by human to

work further. But if the data range becomes so great that it becomes quite impossible for any human to interact with it. The problem is that when the system becomes large enough it would produce more and more data which in turns produce more data and this process continues. Despite the size of the data is not matter to this fact but the data range matters.

7.3 Our work and Big Data

In our project we have developed a system which would allow us to monitor and give treatment using IoT. In this process we collects various data including location, health parameter, past medical records and e.t.c. So, when the networks becomes large enough then big data comes in. In our project we are planning to implement big data algorithm so analyze our network more perfectly.

Chapter 8
Remarks of Our System

8   System Evaluation

Evaluating our system to know more about it. This is a random network system. So we need to understand the wireless network effect on this system. All the IoT capable devices are IP enabled and sends random signal to everywhere around them. Performance of the total system depends on the reliability of the IoT wireless system. Wireless IoT network can be little hazy as the system depends on internet and also the power of the devices it is connected to. Device power is the power which is used to generate network more stable is used to connect that device with the wireless network surroundings. So a lot of things are there to consider for this network to work very efficiently. Also device that run this system also need to be modified for this system as it runs. An wireless network burst its energy to the environment and as it goes further the power gets lower. So, the receiving device is also needs to be powerful and should have a great performance. And in our system receiving and generating signals both of this work has to be done by every device. As we have seen earlier all the device must both receive and generate the signals in order to make this network run. Also this network must be consistent, that means if network jumps

up and down then problem will pursue again. Network consistency is important. If network is not stable then help would not come in time as because people would receive the message late and thus it would collapse the system. That is why we need to evaluate this system to identify its performance in all way round.

8.1   Random Signal

NAMES is the random signal as described in [29, 30]. A random signal is a signal which is in nature random. It means it would behave that we would not possibly tell where it would go as it is random. Random signals are the one which we would deal. Random signal would go about everywhere and do its task. We would analyze the signal's interference, outage probability and SIR threshold to know the behaviour of the network.

8.2   Interference

We took our device outside and store location data into the database. In our system there are pharmacy, neighbor, subscriber and also Ambulance. So, everybody gets interference with each other network system. Lets see the plot of location data in MATLAB.
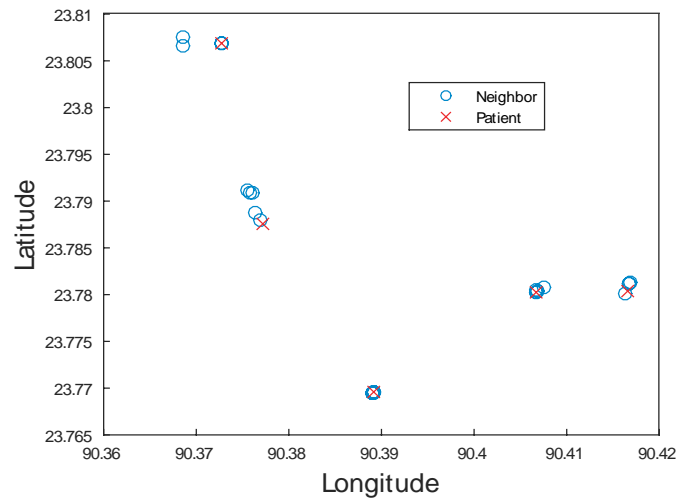

Figure 9: Locations of neighbor and patient

From the Fig. 9 we can see that there are multiple neighbor around a single subscriber or patient. So, patient device must get interference signal from neighbor devices. The interference signal is given by[31]:

$$I_o = \sum_{d_i \in \Phi \backslash d_o} p_i h_i \, \|d_i\|^{-a} \tag{1}$$

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where p_i is the transmission power from neighbor's device and h_i is the channel interference gain from neighbor's device to intended patient's device. The distance between intended neighbor's device and patient's device is denoted by d_i. And lastly a denotes pathloss exponent in wireless environment. For simulation, we consider that all channels are Rayleigh fading, which is exponential random variables with unit mean and variance.

8.3 Outage Probability

In information theory, Outage probability of a channel is the probability that a given information is not supported because of variable channel capacity. The information rate is less than the required threshold.

The outage probability of patient's device can be expressed as:

$$O_p = P\left[SIR_o < \theta\right] = 1 - P\left[SIR_o > \theta\right] \tag{2}$$

where SIR_o is signal to interference ratio expressed as $SIR_o = S_o/I_o$. S_o represents signal power between intended patient's device and neighbor's device. I_o is the interference power coming from surrounding neighbor's devices, which are not the intended neighbor's device. θ denotes target SIR threshold. If SIR_o is below than target SIR threshold, signal is not properly received. For the simulation of outage probability, we consider that all transmit powers are same (i.e., $p_o = p_1 = p_2 = ... = p$).

8.4 Outage Probability VS SIR Threshold
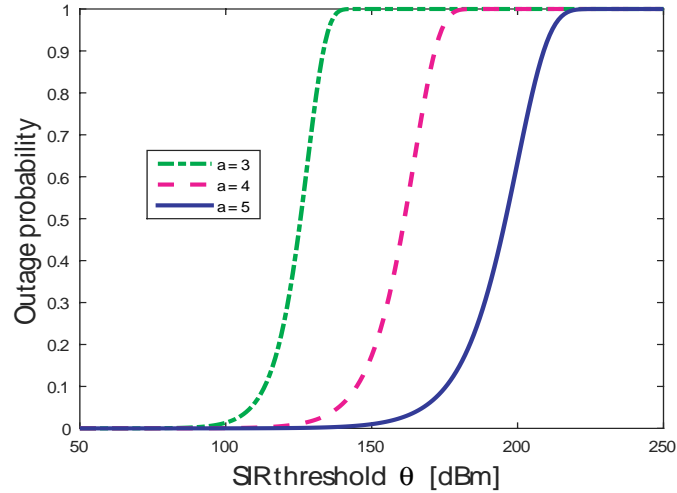
Figure 10: Outage probability vs. SIR threshold.

In Fig. 10, we observe that the outage probability has a remarkable effect on the SIR threshold. As SIR threshold increases, the outage probability increases at the patient's device and this implies low SIR threshold is better. When SIR threshold is below 100 dBm, the outage probability is same for all pathloss exponent (e.g. $a = 3, 4$, and 5). As seen in Fig. 10, outage probability decreases with increasing pathloss exponent after 100 dBm. Hence we can conclude that low SIR threshold is better for e-health monitoring system.

Chapter 9
Conclusion and Future work

9   Conclusion and Future work

9.1   Conclusion

To conclude we would like to state that our project needs a lot more research. Just doing this wold not comply our results. But for now our results are very promising. As this is a new approach in our country so we would find it difficult during some period firstly. Our location data shows us very precise location point. we also have collected and transferred data from sensor to database which is our primary success.

Also we want to take it further. We want to marge our research with mobile company. This collaboration would help us to gain knowledge and experience in the field.

9.2 Future Work

What we have done till now is the initial work for our research. We have a lot of plans further to extend our knowledge in the field of Internet of Things. In our initial research we have just collect some data using gogle map. This is for the location from patient to neighbor. We have only collected a little amount of data. At first, we want to work on collecting more data. Actually we want to do big data analysis. So we want to collect more than 1000 data for our research and then we will come with a conclusion. Big data will give the hidden information about our research, our research aim, our research planning and our long term contribution about our research. As we know that big data analysis helps researchers to modify their work from before. So it is a great opportunity for a researcher to make work more specific to others. By this big data analysis researcher also can extended knowledge about research and this will help a researcher to do more research that would be helpful for researcher as well the human beings. Secondly, we will create a mobile application.There will be some features according to our allocated works for patients and neighbors. This APP is basically work as the communication system between patient and neighbor. Through the app the patient will give notification to the neighbor. After getting the notification the neighbor will take desired steps to help the patients by the help of app. So the app is more important thing if we want to implement our research

practically. Another thing is that if we would not implement our research practically then this research will not be helpful for the human being that is our main target. So, to fulfill our target we have to make an app for the practical implementation of our work. On the other hand, nowadays app is more reliable internet protocol for mobile users. We think that if we will able to make an app for our research then it will definitely create its own stability in the market. So, as a researcher I think that app is more important things that will be happening in our research. Thirdly, if we want to make our research wider and make it reliable to others then we need help of some organization like Robi that is working with different app and spread the app among the people. So, we think that we will make correlation with Robi to take our research in the market so that people can know more about our idea and able to deal with the emergency case from anywhere in Bangladesh. According to our plan we have already sent a proposal to Robi and we are waiting for the confirmation. After getting the confirmation we will start our research to take it out among the people of Bangladesh. Fourthly, as this is new idea in Bangladesh so we have contact with the ICT division of Bangladesh Government. They agree to help us to spread our idea. So we think that, if Robi and ICT division of Bangladesh help us then we will of course come out with the best possible result that will be the save the life of many people in Bangladesh.

Chapter 10
Publication of Our Research

10 Publication

This thesis has been accepted and Published in "**Proc. of the 2018 IEEE 5$^{\text{th}}$ International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA 2018), Songkhala, Thailand**".

11   Reference

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