# Smart Disaster Notification System

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*Abstract*—The devastations of natural disasters are the lash of mother nature that every year hit us with a whip. They are inevitable. There are no alternative ways to prevent this incident, but we can take proper steps to reduce its damage. Now-a-days a great deal of attention is given to the potential of mobile communication technology. Short Message System (SMS) has a huge impact on the communication system. This paper propose an android application which will alert people before a natural disaster like Cyclone, Flood and tell them the optimal route to the nearest shelter via SMS, voice call and voice alert. In evacuation process, we use partition based shortest technique to find nearest shelter place.

*Index Terms*—Natural Disaster, Notification System, Android, Location Based, Nearest Shelter

## I. Introduction

Natural disasters are the consequences of natural hazards. It does occur a serious breakdown in the sustainability of human, animals and property. It also occurs economic losses and disruption of economic and social progress. The overwhelming number of dead or seriously injured and homeless people are affected by the occurrence of a natural disaster. The massive amount of money to be spent for reconstruction and rehabilitation equates to a natural disaster. They are nothing else but extreme environmental events that impact human activities. Hurricane, Earthquakes, Tsunamis and volcanic eruptions are the most frequent threats as well as flooding [11], tornadoes and droughts which are also prevalent.

According to the Annual Disaster Statistical Review 2010 [7], 330 natural disasters were registered worldwide in 2003. Within that, there has been a total of 21,610 people who have been killed where the number of people killed by floods was 9,819 and the number of these killed by storms were 8583. And the estimated damage was 118.6 billion dollar. The statistics only got worse. But the worst part really is that there is no way of preventing natural disaster. The only way we can survive these is preparing for what may come.

Researchers had tried to give early warning system to minimize the loss. They came up with some brilliant way to do it [23], [5], [16]. In this modern time mobile have really changed the way of communications [13], [19]. It is the most used communication tools. Some of them tried to use Short Message System (SMS)[17] as an alerting system for the disaster. SMS is used on modern handsets originated from radio telegraphy [21] in radio memos pagers using standardized phone protocols. These are defined as the part of the Global System for Mobile Communications (GSM) series [22] of standards as a means of sending messages up to 160 characters to and from GSM supported devices. But by this method there is no way of evaluating the level of the disaster because no databases are used. This method only sends messages to the subscribers. But subscriber could be blind, so this method would not be helpful for blind people. Again, researchers used android technology [5] to easy the system. They used algorithm to calculate optimal routes to the shelter for evacuation at the time of disaster and showed the data into google map.

Our proposed technique is an android based application which takes weather updates from websites and calculates the disaster level. Subscribers data can be stored in this applications database. It can calculate the optimal route to the shelter from the subscribers current position and send voice call/ SMS with warning and shelter location to them. It sends voice call or voice alarm so blind subscriber can also get the alert. This is GSM type alerting system so subscriber do not need to have an android device in order to receive the service.

The remaining sections of the paper are organized as follows. In section II describes related work on disaster notification systems. Section III introduces our proposed smart disaster notification model. Implementation of our proposed technique has been described in section IV. Result analysis has been shown in section V. Application of the systems and discussion as well as the future researches are shown in section VI.

## II. Related Work

Early disaster warning and evacuation approach are very general disaster management system in disaster-prone areas. Now-a-days mobile phones play an essential role in disaster management system in several ways: monitoring, communication, warning dissemination, evacuation and rescue and relief aid. A number of notification system has been proposed in our real world. In research paper [3], [9], Short Message Service (SMS) is sent to all citizens from the server about the awareness of upcoming flood warning. A huge number of SMS transfer from the server cause network congestion and can break the voice communication system in same network. To avoid this kind of congestion cell broadcasting service is
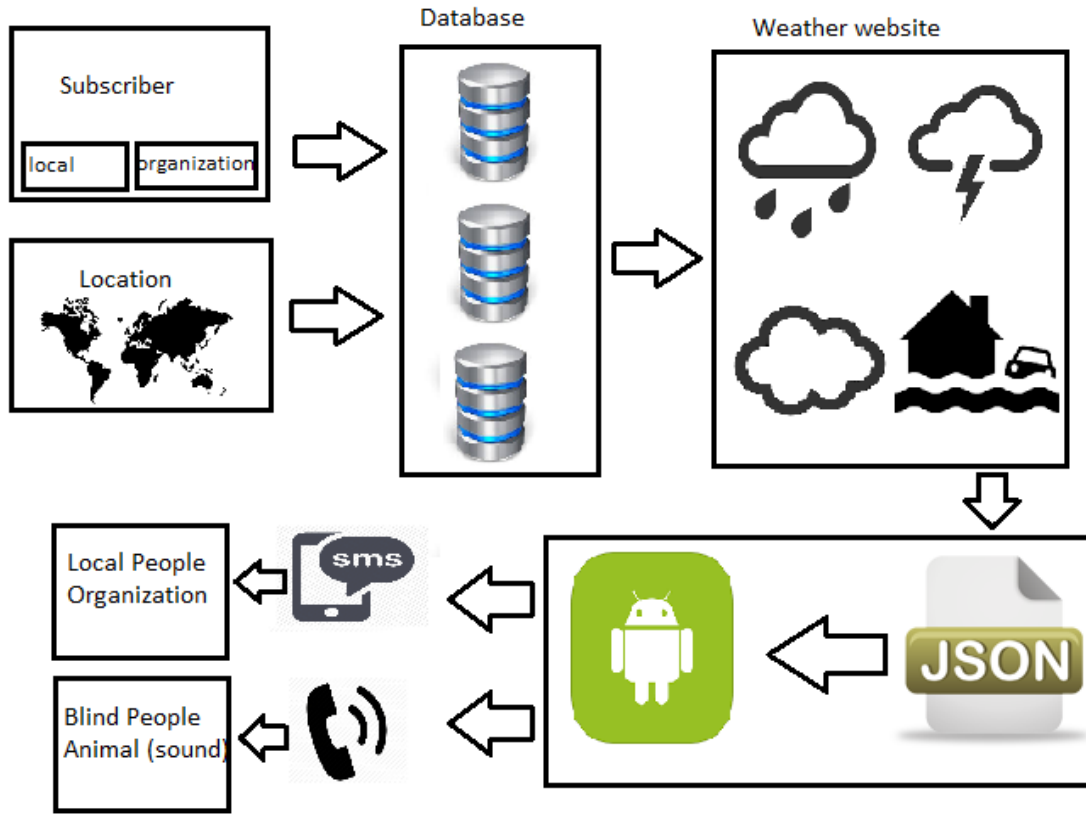
Fig. 1. System Overview

used to directly send messages to the subscribers in a specific area [20]. But this process fails to help in evacuation process which provides information about safe region. GSM alarm device is used for evacuation process in which three kinds of warning are sent to the police station or fire brigade station [8]. Although it can avoid network congestion, the GSM alarm is not a faster way for evacuation process.

Satellite communication systems will be very fast, reliable and robust. As a result well developed countries like Australia and South Korea are planning to use satellite communication for disaster management [18], [1], [9]. This satellite service maintenance is expensive and developing countries cannot afford this. Very few researchers propose location based services for disaster management on mobile phones. Previous works on location based services for disaster management did not distinguish normal people and blind people. Considering this, Amit Gosavi et. al. [6] presented a location based early warning and evacuation system by visual and audio warnings useful to both normal and blind people.

Natural Disasters such as cyclone, storm, earthquake, Tsunami and flood have shown the harmful, damaging mode of nature which has taken millions of lives including people and animals. Above all techniques are concern about people warning. Most of them did not discuss about evacuation processes by which people get shelter place. Dijkstra's algorithm based shortest path calculation is used to find the nearest shelter place[6]. This process is time consuming because it search all paths from the source to destination. For this, we propose a location based smart disaster management system that can warn all subscribers (people, blind people and animals). In the evacuation process we used partition based trajectory to find nearest shelter place. It is very faster than the previous proposed methods.

## III. PROPOSED SOLUTION

The main purpose of Smart Disaster Notification System is to alert people before the time of disaster and tell them the optimal route to the nearest shelter. In our system we divide the whole application in some module. First one is database building that consists of subscriber information and locations whose probability of disaster is measured. Second one is based on locations in which our proposed methods take information from weather website. After that these information will be converted to JSON (JavaScript Object Notation) [2] format. Then, according to JSON information the system will be able to understand the probability of disaster and then the system will send nearest shelter information to the subscribers. The architecture of our proposed technique depicts in figure 1. Each part of our system will be explained details in the next few sections.

### A. Preliminaries

The consequence of natural hazards is called the natural disaster. There are different kinds of natural disaster such as cyclone, storm, earthquake, Tsunami and flood etc. Different kinds of natural disaster occurs at the different time in different geographical area. Some recent examples of violent natural disasters are the 2011 Japan earthquake and Tsunami, the 2010 Haiti earthquake, the 2007 cyclone SIDR, the 2004 Indian Ocean Tsunami, the 1991 Bangladesh cyclone. Geographically few South Asian countries are situated in between the Himalayas and the ocean, on the delta of wide rivers, means that the countries are very exposed to flooding [14]. The people live in coastal areas have to face several storms each year and cultivable lands disappear in the river due to river erosion. Such countries are mostly affected by the planets climate changes and number of cyclones. Hence, there is also the risk of Tsunami in these countries. Our disaster preparedness system protects the people from upcoming disaster. For this it uses SMS, voice call or voice alert. Our proposed work can be implemented on android mobile phones. Android [4] is an operating system for mobile devices such as smart phones and tablet computers developed by Open Handset Alliance led by Google. As android is more open and comprehensive than other mobile operating system, this is the best selling product worldwide. It also allows building of new applications at lower cost. Consequently, this is more interactive for users. Hence, an android mobile platform has been used in our proposed disaster awareness system.

### B. Input into database

We will keep the record of subscribers in the database. In there we will store the subscriber name, location and mobile number. Based on the subscriber locations we can give them the proper warning about the disaster. Smart disaster notification system will fetch the information from it and sends notification to the subscribers. Sending notification will depend on update from the websites.

### C. Update from website

This application will take update from website and evaluate the level of disaster. Then it will convert the data into JSON format. The following figure 2 shows the update process.



Fig. 2.   update from website

### D. Minimum distance calculation

We determine the optimal route to the nearest shelter and show it to the application and in case of the non-android user we just give them the placement of the nearest shelter. If figure 3 subscriber gets a disaster awareness message form the system. The system will send nearest shelter information. Here if we calculate Euclidean Distance [12] we find nearest shelter point is B. But that existing path is so far than path A. For that reason we use trajectory partitioning method[15] to calculate distance between two places. Trajectory partitioning means path partitioning, which is very important because propose algorithm has used sub-trajectories.
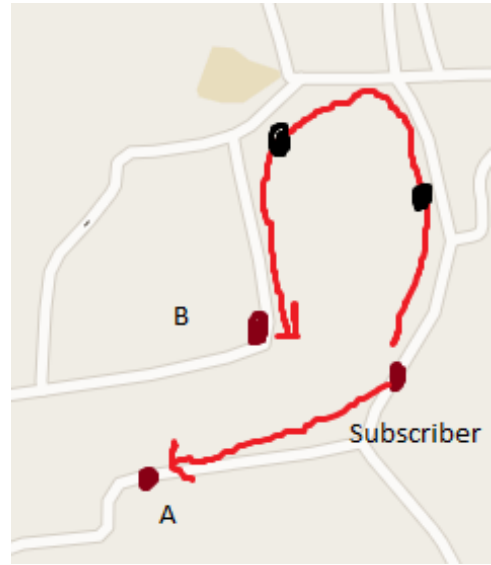


Fig. 3.   Calculation of nearest shelter place.

For partitioning, we first took the starting and ending point of the route. Then from the starting point we move towards using the trajectory points. In the first trajectory point we measured the perpendicular distance with respect to the line which was drawn from the starting and ending point of the route. We used equation 1 to measure the perpendicular distance where $(m, n)$ is the coordinate of the trajectory point, $d$ is the perpendicular distance, and $Ax + By + c = 0$ is the equation of the line. Then we check the perpendicular distance to the given limit to check whether it would need to partition the trajectory. If the distance is greater than the given limit, we would partition the trajectory into two parts. Figure 4(a) shows the approximate solution structure. The other partition will replace the existing line which was used to measure the perpendicular distance. Then from every point we follow these steps and determine the trajectory path and store them in the array and finally shows the result. In figure 4(b) $P3$ trajectory partitioned into two parts.Then we measure the perpendicular distance for the partitions. For left partition the distance is lower than the given limit, so we can take the partition as an approximate solution and store the result in an array.
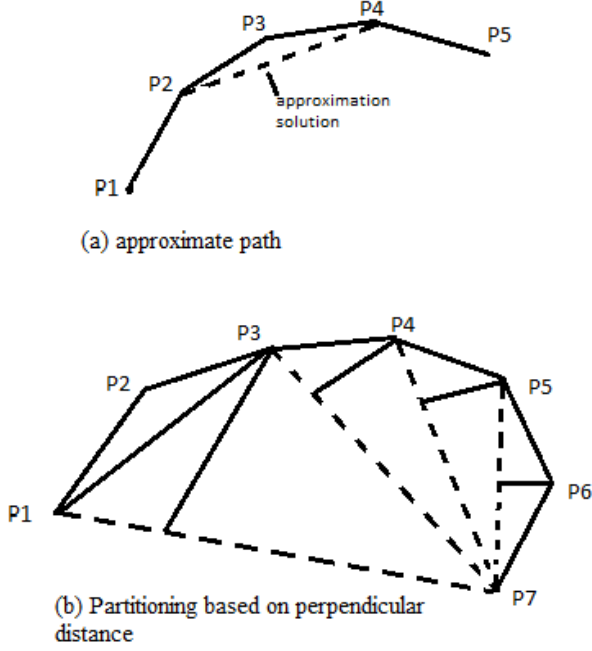
Fig. 4. Calculate Minimum distance function for path shelter

$$d = \frac{|Am + Bn + c|}{\sqrt{A^2 + B^2}} \quad (1)$$

Algorithm 1 and 2 shows the procedure to determine the distance of the trajectory path from the starting point to ending point. In algorithm 1 for every trajectory $tr_i$, we found the minimum distance of the subscriber $u$. Then we select the start point $tr_i[pos]$. And call the *distance* function explained in the algorithm 2. Then we recommend a shelter point to the subscriber $u$. In algorithm 2 for each *position* and for each starting point $SP_i$ we check the perpendicular distance with the given limit. If the distance is greater than the given limit, then we can call the *distance* function twice for the left and right partition. If the perpendicular distance is lower than the limit we took the approximate solution and store the result. Lastly it calculates the total distance from the two partition or with the approximate distance for each trajectory and return the result in the algorithm 2.

TABLE I
ALERT CLASSIFICATION

| Disaster | SMS | Voice Alert |
|---|---|---|
| Rainfall | Yes | Yes |
| Heavy Rainfall | Yes | Yes |
| Cyclone | Yes | Yes |
| Wildfire | Yes | Yes |
| Flood | Yes | Yes |

*E. Sending notification*

After getting updates from websites minimum distance is calculated and then a notification is sent to the subscriber who already registered in the database. This notification is both audio and text message because subscriber can be blind.
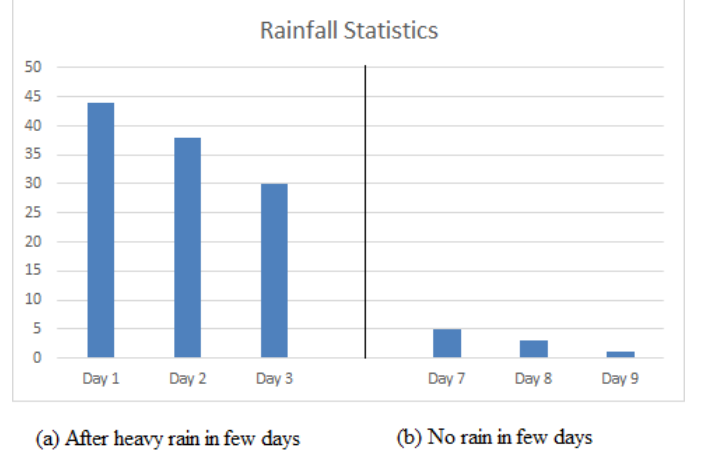


Fig. 5. Weather Update statistics view.

*F. Location tracking of victim*

At the time of disaster, subscribers are in the middle of it. Then for rescue, this application determines the victims location by using GPS for android or triangulate location using mobile network for non-android phone and send back the data to the rescue center.

## IV. IMPLEMENTATION

In our implementation, we have used android based smart technology. For alerting people we first insert their data into the applications database. In database, subscriber locations are also saved. Then the application communicates with the server. Determining the kind of situation server responses with a JSON file containing the weather information. This application reads the JSON file and convert the data into a message which would be sent to the people whose data are in the database. If JSON file gets some disaster like as Cyclone, Flood, Wildfire it sends SMS or voice call to the subscribers.

*A. Database Design*

This is an Android application so we used Sqlite database[10]. This database contains three attributes which are subscriber name, mobile number and region. The attribute mobile number acts as a primary key because mobile number is unique for subscribers. In the weather server, we create database tables for storing the weather status and to store the shelters position.
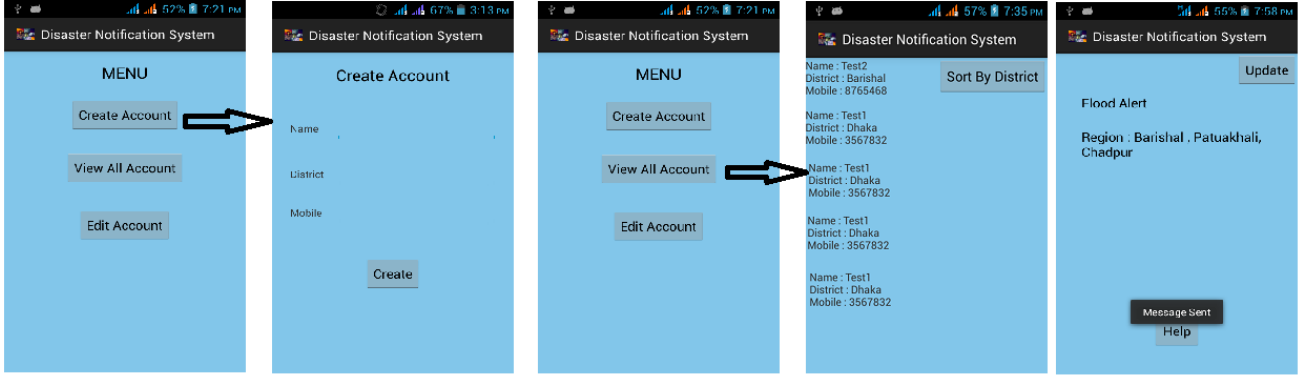
Fig. 6. Application Demonstration.

## B. Application Testing

Figure 5(a) shows that statistics of rain in 5 days. The heavy rainfall may cause flooding and it affects some areas so the JSON file pointed to those possible affected areas. If the statistics show no promising situation of disaster system, it will point to no warning in figure 5(b). The system will search if there is anyone exist in affected regions, it will send them the alert. By this only the affected people get alerts, not all the people in the database. Table I shows the overview of the alert classification.

Figure 6 shows inner looking of the application. For inserting data into the database users need to press the create account button and give the information. After completing registration, data of the people are saved in the database. User also can edit or delete account information by choosing Edit Account Menu. After pressing the Edit Account button there are two options edit account or delete accounts. If user wants to edit account, then user has to provide the mobile number which is unique (primary key) and then edit the information. For deleting account user have to again give the mobile number. Then systems will search the database corresponding that mobile number and will delete that information. When apps requests for weather updates, website calculates the situation of the disaster and make JSON report according to the condition of the weather.

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**Algorithm 1** MinDistance (TR, U)
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1: **for** each $u \in U$ **do**
2:     **for** each $tr(i) \in TR$ **do**
3:         Find minDistance $u$ to $tr(i)$
4:         Select startPoint = $tr(i)[pos]$
5:         minDistance = Distance $(tr(i) , SP)$
6:     **end for**
7: **end for**
8: Recommand minDistance up to $u$

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**Algorithm 2** Distance ($tr_i[pos]$, SP)
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1: **for** each $psoition \in tr_i[pos]$ **do**
2:     **for** each $SP_i \in SP$ **do**
3:         Check PD with the given limit/* PD = Perpendicular Distance */
4:         Distance $(tr_i[pos], i)$
5:         Distance $(i, SP_i)$
6:     **end for**
7:     Calculate total distance
8: **end for**

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## V. RESULT

From table II we can see that for every test case the Euclidean distance is smaller than the trajectory distance. Because Euclidean distance only calculates through the direct path using co-ordinate of two places. But there may not be direct paths from those two places. In this case, the distance is more accurate than the Euclidean distance. Hence, we can calculate the nearest shelter and recommend the subscriber.

TABLE II
TRAJECTORY PATH RESULT

| Test Case | Euclidean Distance | Calculated Trajectory Distance |
|---|---|---|
| 1 | 1.95 Km | 5.1 Km |
| 2 | 0.18 Km | 0.19 Km |
| 3 | 1.07 Km | 1.39 Km |
| 4 | 3.46 Km | 3.96 Km |

## VI. DISCUSSION AND CONCLUSIONS

Disaster do not consider any geographical boundary. To minimize the losses in these natural phenomena we should prepare ourselves. Android technology allows us to get information from websites easily. And disaster alert should be a solution to help and give necessary instruction to people that will save lots of human life. This application gives alert before disaster like heavy rain, flood, cyclone, wildfire and so on. This also calculates the optimal route to the nearest shelter.

In future work we will solve this kind of challenges. We will try to create awareness of other unexpected disaster that happen very quickly like Tsunami and Earthquake.

## ACKNOWLEDGMENT

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