Smart Life Tracking and Rescuing Disaster Management System

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ABSTRACT
In this paper we have designed and proposed a Smart Life Tracking and Rescuing (SLTR) disaster management system based on Global Positioning System (GPS) and Global Service for Mobile Communication (GSM) web services. The proposed system is exclusively designed to handle the consequences caused by disaster such as tsunami, flood, earthquake, cyclone etc. The need of such an effective SLTR is important, where the population density is high and the place in which people live in danger situations. The proposed SLTR is intended to provide timely help to the affected victims and tardy response of relief works. To the general public, the system provides the information of getting the medical aid and relief materials to the deceased victim. SLTR incorporates with GPS and GSM web services to identify the affected areas and possible routes to reach the location. The system consists of two important services, rescue and shelter facility. In addition to these services, the proposed SLTR also provides a web site for real time information about the disaster. At present, the proposed SLTR is in its prototype stage. From the experiments it found that, the result obtained is encouraging and the performance of the system can be subsequently improved to a fully fledged system in future.

General Terms
Wireless Communication

Keywords
Automobile Pilot System, disaster, Shortest Distance Algorithm, Heart Beat Sensor, Global Positioning System

1. INTRODUCTION
The primary mission of the SLTR system is keeping track of the current location and movement of people. The key reason for this tracking is to be able to provide a timely help in emergency or unusual situations. The SLTR consists of a basic GPS-based tracking system [1] like Automobile Pilot System that has a map installed. Automobile Pilot System receives signals from a satellite about SLTR kits current location, and can show where the user is on the map. General structure of current person tracking systems is a GPS receiver with a GSM transmitter [2] or only Radio Frequency (RF) receiver and transmitter [3, 4]. SLTR also has a website that provides live information about the affected areas and necessary information of victims to family and friends.

To develop an effective SLTR, the major challenge is to implement a Shortest Distance Algorithm based on rescue team capacity, density of the pick-up points, average time to save each person in pick-up point, and shortest distance between pick-up points so as to guide rescuer to save much more people as possible in a diplomatic way.

SLTR is designed to provide management tools that allow responding agencies to work with the large amounts of data available to them. It allows them to assign individuals to tasks and facilitates management of people, places, and things that are important in disaster relief. SLTR software ensures that responders and recipients have current relevant information which helps them to respond effectively. The proposed SLTR provides the following services to the users.

- Register individuals or families at a shelter, and link requests for aid (e.g., food, water, and blankets) or services (e.g., medical assistance, counseling, and family reunification) at individual or location levels.
- Manage inventories and update the status and capacity of operating shelters and medical facilities. Missing persons registries can be referenced against those registered at shelters.
- By facilitating sharing of relevant information about disaster through website across the diverse set of individuals and organizations that need to communicate with each other.

A major application area of SLTR is keeping track of the current location and movement of people. The key reason for this tracking is to be able to provide a timely help in emergency or unusual situations.

2. LITERATURE SURVEY
Literature shows that there are very few disaster management systems that are publically available. The first part of this section explains different existing disaster management systems and we have also presented a comparative study of various features of existing systems with the proposed SLTR system. The table 1 gives a comparison of proposed system with the existing disaster management systems. This comparison also illustrates the advantages of the proposed SLTR system over other system during disaster management. The second part of this section briefly explains two related works that resembles the proposed SLTR system.

2.1 Existing Disaster Management Systems

2.1.1 National Disaster Management Division
National Disaster Management Division in India has the National Emergency Management Authority that coordinates disaster management activities such as assisting the government in coordinating post disaster relief and

Table 1. Comparison of existing disaster management systems with proposed SLTR system

Features ↓	Existing Disaster Management Systems				Proposed System
	GIT Natural Disaster Management System:	**Disaster Management with mobile positioning terminals**	**A Fuzzy Intelligent Decision Support System for Typhoon Disaster Management**	**Sahana Disaster Management System**	**SLTR Disaster Management System**
Technology	GIT, RS, GIS, GPS, ICT	Mobile terminals.	GIS	No technology	GPS, GSM, RF, Heart Beat Sensor
Location and identity of victim	Not Known	Not Known	Not Known	Not Known	Known using GPS and unique id given to each kit
Victim information	Not Known	Not Known	Not Known	Not Known	Known as data if victim present in database
Detecting criticality	Not present	Not present	Not present	Not present	Criticality of life understood through heart beat sensor
Website	Not present	Not present	Not present	Present	Present
Alternative source of location	Not present	Not present	Not present	Not present	If GPS fails RF is used.
Network Jamming	Present	Present	Present	Present	Not Present

rehabilitation [5]. In this project only the post disaster aspects such as distribution of resources and funds are handled computationally. Relief work is carried out but it is done manually.

2.1.2 Indonesia Disaster Management Information System

Indonesia Disaster Management Information System (SIPBI) is aimed at providing up to date information on various disaster events and related disaster management measures [6].

2.1.3 SAHANA Disaster Management System

SAHANA Disaster Victim Registry is a central online repository, where information on all the internally displaced disaster victims can be stored [7]. But it provides only online information about the people affected during disasters.

Sahana- A Free and Open Source Disaster Management System is a web based system to manage disaster related problem with different sub applications portals. These sub-applications are built to address the common disaster coordination and collaboration problems in disasters between civil society, Government, private sector, volunteers and the victims themselves.

2.1.4 *GIT Disaster Management System*

Emerging geo-information technologies (GIT)[8] is focused on the potential uses of GIT for natural disaster management with particular examples in Pakistan. The GIT includes Remote Sensing (RS), Geographical Information Systems (GIS), GPS, Information and Communication Technology (ICT) etc.

2.1.5 Disaster Management System with mobile positioning terminals

Collection and remote management of disaster information with mobile positioning terminals [9] is another existing system, which provides data support for emergency response and scientific decision-making to commanders by uploading accurate, reliable and instant information on disaster-occurred spot. It does some research on instant disaster information upload and remote disaster management using mobile terminals.

2.1.6 Disaster Management System with a Fuzzy Intelligent Decision Support

A Fuzzy Intelligent Decision Support System for Typhoon Disaster Management [10] is intended to build a decision support system for typhoon mitigation. It can support the operations as decision making or disaster recovery. The system has to integrate with the function of geographical information system to incorporate the typhoon forecasting and analysis model.

2.2 Related Work

The proposed SLTR working principle is somewhat related to the following two systems that are used for different purposes.

2.2.1 A Multipurpose Child Tracking System Design and Implementation

The system consists of two modules; parent module and child module [11]. When a violation of the child's safety is detected, a specific sensor in child module will produce a signal. This signal will be sent from these sensors to controller then through transmitter to parent module which will take the required decision and start the violation handling procedure.

2.2.2 The Integration of GPS Navigator Device with Vehicles Tracking System for Rental Cars Firm

The aim of this research is to integrate the GPS tracking system with GPS navigator or rental cars, allowing the user to use various applications to monitor and manage the cars [12]. This enables the firms and customers to communicate with each other via the GPS navigator.

3. TECHNOLOGIES USED IN THE PROPOSED SLTR

The proposed SLTR utilizes various existing technologies. Brief overviews of these technologies are follows:

3.1 GPS

The GPS [13] tracking principle uses 24 satellites and 12 ground stations. The system can determine the position of a user having a GPS receiver by the reception of three signals from three or four satellites using a method called trilateration.

3.2 Trilateration

Each satellite transmits signal including the transmission time. Knowing the speed of signals we can deduce the distance from the satellite [14]. Knowing this distance is not enough because there is on earth around the center point with all the locations within the same distance from the satellite. So let's take a second satellite, which end up with a two intersecting circles, but which cannot be determined which of the two intersections where one is. So this requires a third satellite and the intersection of the three circles is the desried point.. The figure 1 shows the trilateration.

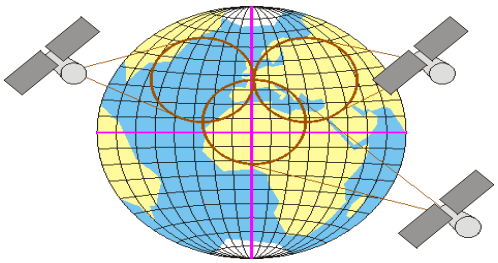

Fig 1: Trilateration

3.3 GSM

GSM is a digital cellular communications system [15]. GSM is designed to provide a comprehensive range of services and features to the users not available on analogue cellular networks. The figure 2 shows a GSM modem.

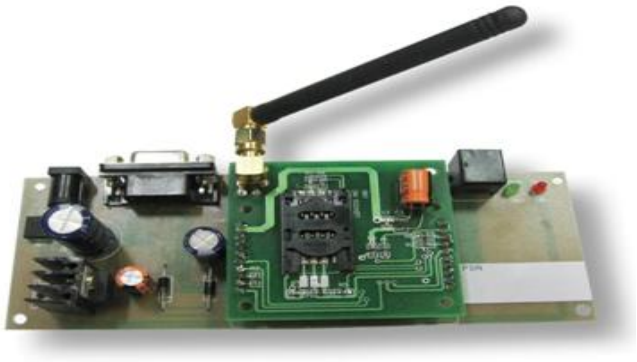

Fig 2: GSM modem

3.4 Radio Frequency

Radio Frequency (RF) transmitters/receivers [16] are electronic devices that can be used to control or automate nearly any product that receives/transmits video, voice or data information.

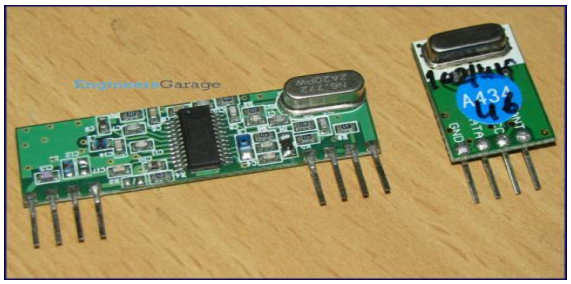

Fig 3: RF Transmitter & Receivers

3.5 Heart Beat Sensor

Heart beat sensor [17] is designed to give digital output of heart beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

Fig 4: Heart Beat Sensor

3.6 Google Map

Google provides a web mapping service application and technology called Google Maps [18]. Normally, Google Maps is used to get high-resolution satellite images along with hybrid view which combines the illustrated map and satellite view.

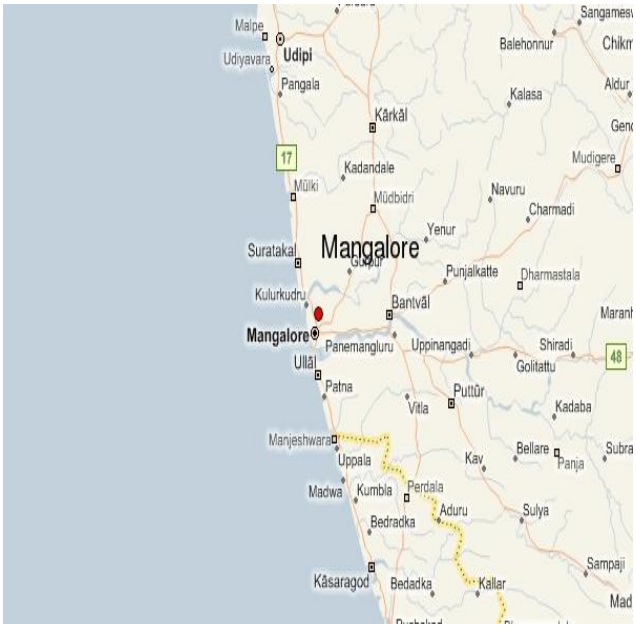

Fig 5: Google Map Image.

4. PROPOSED SLTR ARCHITECTURE AND WORKING PRINCIPLE

The proposed SLTR architecture is as shown in figure 6. Whenever a user Trigger's the SLTR, the Relay Switch enables the serial communication of GPS module. The GPS Module then sends a signal to the GPS Satellite. While receiving the signal, the GPS Satellite sends the location and time data to SLTR KIT. As a result, the SLTR KIT sends the current location of the user to the Control Station via GSM Module so that the nearest rescuer can be assigned to the user. The working principle of the proposed SLTR is as shown in figure 7.

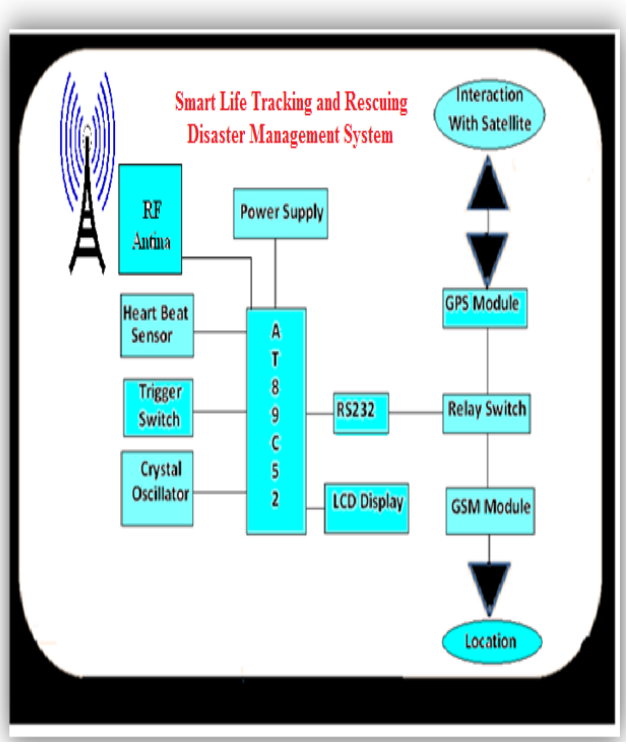

Fig 6: SLTR KIT Architecture

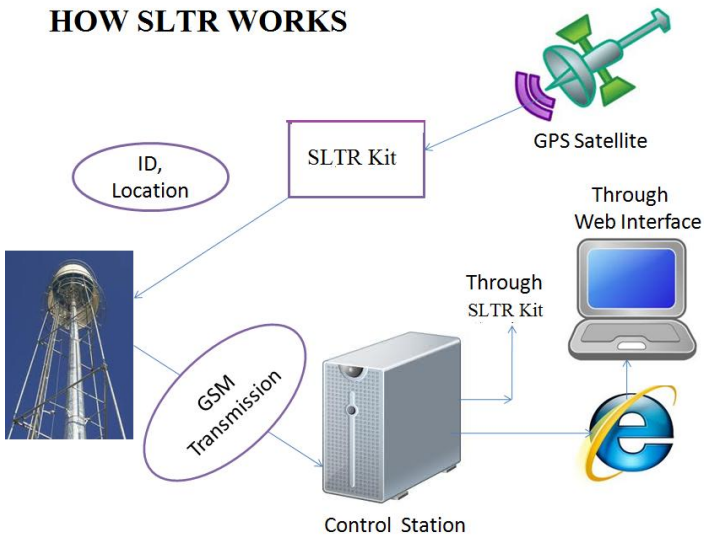

Fig 7: SLTR Working Principle

The control station consists of different databases, contains various information such as Rescue teams and about the shelters for the given area etc. On receiving the signal from the SLTR Kit, the Control Station loads the information about the person to be rescued into the People Database. As a result, the SLTR checks the density of the people to be rescued in a particular area and decides Pick-up Point's. Then, based on a Shortest Distance Algorithm as shown in figure 8, the SLTR assigns different rescue teams to different Pick-up Points depending upon their capacity. The direction to reach the nearest pick-up points and shelter homes in that area are displayed on a LCD Display. Thus the user can use this information to save him and also help other people in need. The SLTR Kit also displays the information about the saved lives to the user.

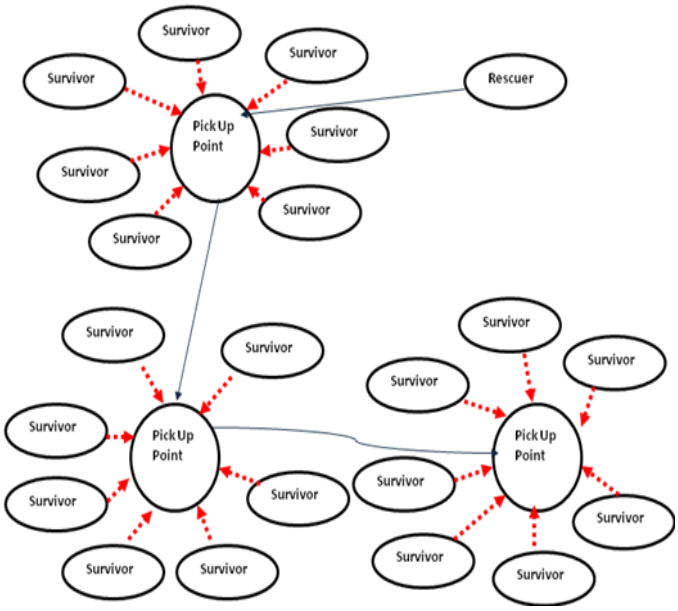

Fig 8: Application of Shortest Distance Algorithm

Based upon different factors like rescue team capacity, density of pick up points, average time to save each person in a pick-up point and shortest distance between pick-up points, shortest distance algorithm is applied. The shortest distance between each pick-up points and rescue team is calculated first. Then the rescue teams are assigned to pick-up points

depending upon their capacity, shortest distance, density of pick-up points and average time taken to save each person. Once rescue team finishes rescuing, they are reassigned applying the same shortest distance algorithm.

The SLTR maintain a database as shown in figure 9. After rescuing the person the administrator updates the Shelter Assign Database. When the Rescued People are sent to the Shelter's, SLTR updates Shelter Assign database, so that any relative of the rescued person can easily locate him using the web site of SLTR. If in any circumstance the user of the kit dies then the kit senses it using the pulse sensor and then notifies the rescue station that the person is dead so that the rescuer can rescue other people who are alive.

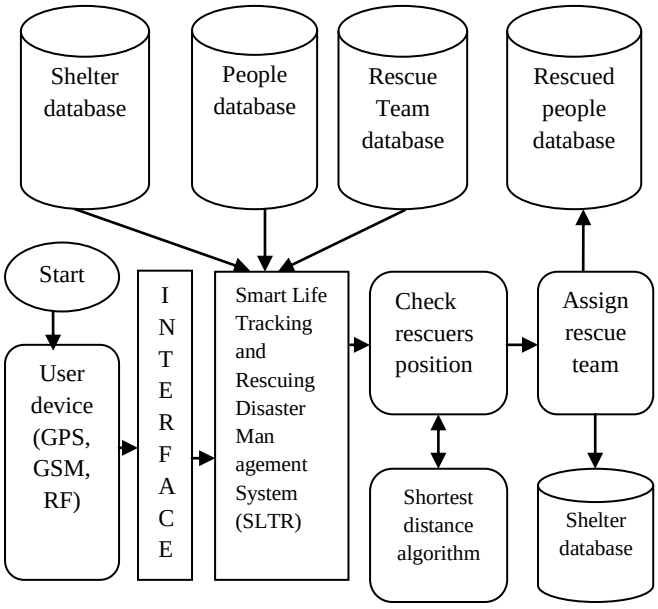

Fig 9: SLTR Database Architecture

5. DEVELOPED SLTR SOFTWARE MODULES

The SLTR is divided into three different modules as follows: The first software module includes Registering, Monitoring and Assigning rescuers to pick-up points and people to shelters. The second module is intended for sending acknowledgements and receiving requests via SLTR kit. Finally, the third module is a website used to provide information to the general public.

5.1 Module 1

The various sub modules and their associated function of the first software module is as follows:

5.1.1 Login Module

It is responsible for the authentication of the administrator.

5.1.2 Menu Module

This form guides the administrators to different modules.

5.1.3 Register Module

This module is divided into Person registry and Rescue Person registry. The Person Registry Module is used to register the person when he buys the device. Rescue Person Registry module is used to register the rescuer and assign to Rescue Teams.

5.1.4 Area Registry Module

This module is used to register areas depending upon the latitude and longitude within a given diameter.

5.1.5 Shelter Registry Module

This module is used to register shelter homes after disaster.

5.1.6 Monitor Module

It displays the position of the rescuer and the person in need in Google Maps. The Monitor module can also display position of all the people who have asked for help and rescuers in a loop as shown in figure 10.The point A points to the position of the person.

5.1.7 Shelter Assign Module

This module is used to assign rescued people to particular shelter homes.

5.1.8 Rescue Team Assign Module

Rescuers can be assigned based on shortest distance algorithm or they can be assigned manually as well. Manual assigning of rescuers is used in situations where shortest distance cannot analyze the criticality. In such cases administrator manually assigns the rescuer to severely affected areas that need immediate help. Shortest distance algorithm assigns rescuers based on their current position. A message is sent to the rescuer which contains the area name as well as the latitude and longitude to which he is assigned. The path taken by the rescuer is displayed on the map as seen in figure 11. Points A and B indicate the source point and the destination point of the rescuer.

5.2 Module 2

The second module consists of the following two sub modules used for different purposes as follow:

5.2.1 Receiving Module

This module enables serial communication between the input/output ports to receive requests from people in need via SLTR kit. The module uses GPS receivers and GSM transmitters to receive location and Person ID. The receiving module also receives status of each person by a continuously sensed Heart Beat sensor. As a result, the system identifies whether the person is alive or not.

5.2.2 Sending Module

This module is used to acknowledge back to the people who asked for help and gives direction to nearest pick up points or shelter homes in the LCD display. If location is not received via GSM transmitter then a message is sent to SLTR kit to switch on the Radio Frequency transmitter.

5.3 Module 3

The third system consists of the following Web Application modules used to provide information to the general public as shown in figure 12. The *Home Page* gives an introduction about SLTR and also displays a slide show of appropriate images uploaded by the people. *Search Page* is used by the relative of the victim to get details about them if they were present in the affected area. *Upload Image Page* is used to upload images of disasters by the people. *Volunteer Page* is used so that interested people can register themselves as volunteers. Public can provide funds to the affected people through the *Funds Page*. Finally, *Contacts Page* provides information about the founders of this website.

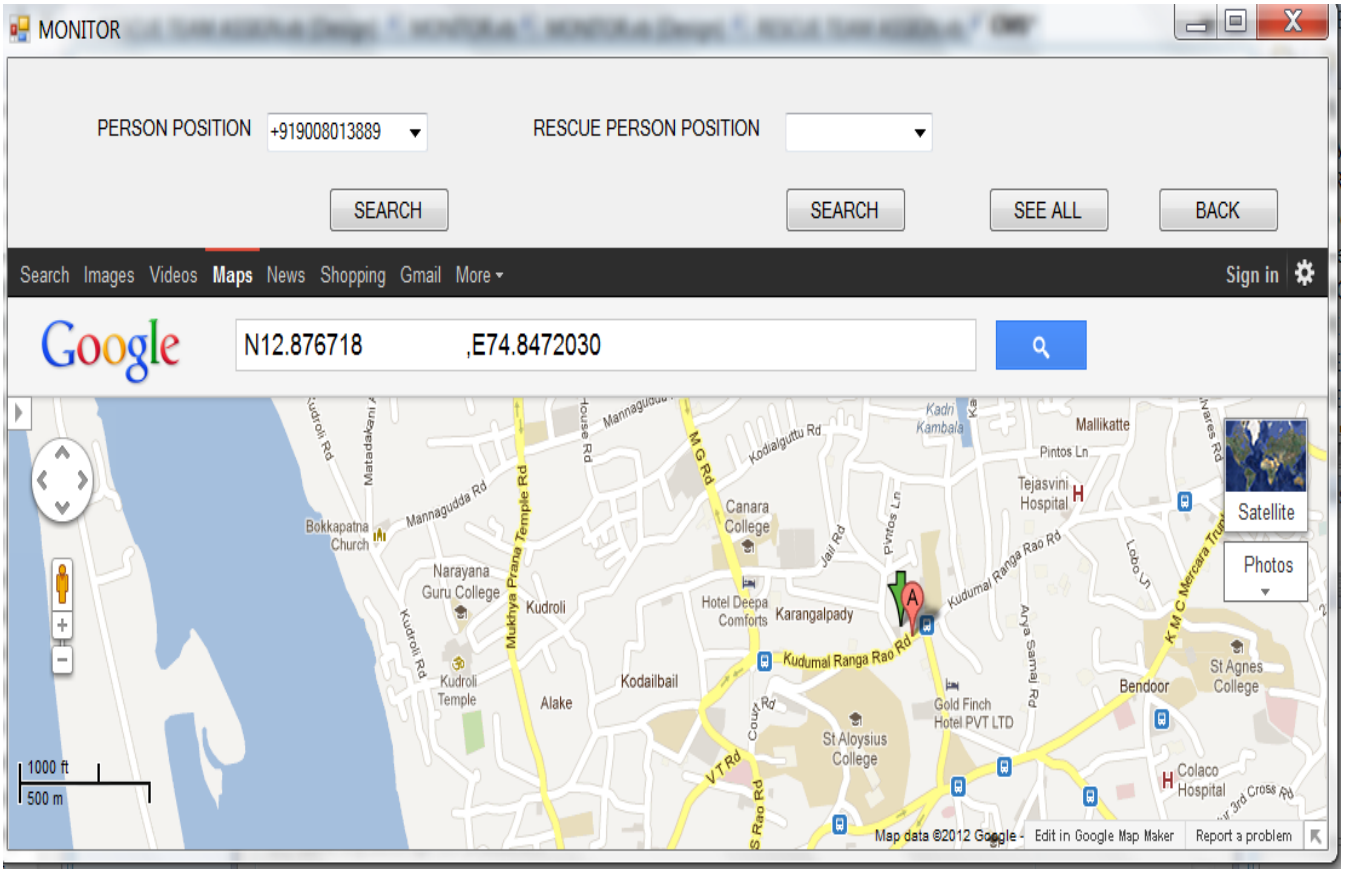

Fig 10: Monitor Module

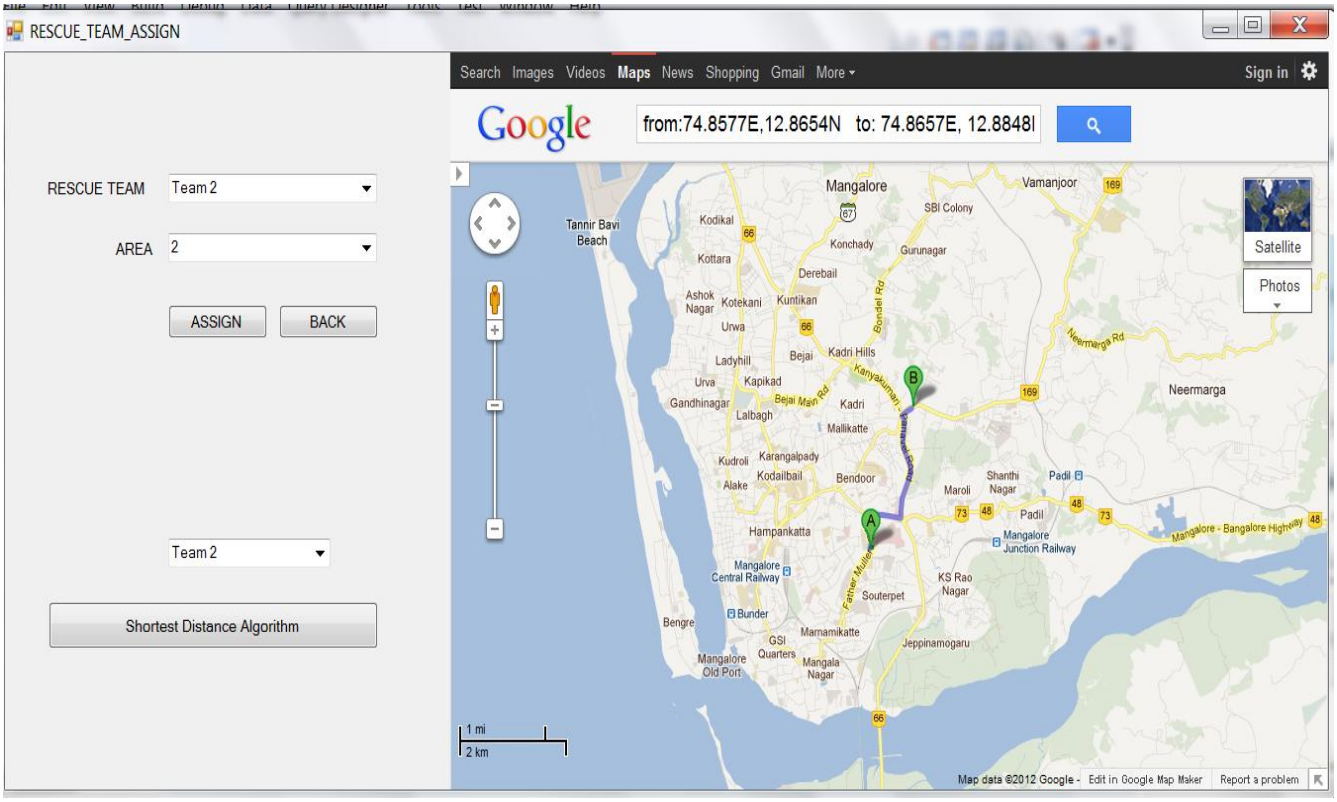

Fig 11: Rescue Team Assign Module

Fig 12: Home Page of SLTR Website

6. PERFORMANCE AND FURTHER APPLICATIONS OF PROPOSED SLTR

Performance: The system shall take as less time as possible to provide service to the people who requested for help and also by providing timely help. The number of requests received depends on the speed of the processor. Any number of people can ask for help since it uses GSM messaging services. The system is developed in such a way that it can be enhanced to handle many people and any number of areas. Even though very few disaster management systems are developed, no one is publically available to compare the performance of the proposed system.

In this proposed system we have made use of GPS, GSM and RF technologies. Heart Beat sensor is used to detect the pulse of the victim which enables us to understand if the victim is alive or dead. This proves to be useful during times of disasters so the preference is given to people who are still alive and they will be reached first and rescued. The rescue operations are based on shortest distance algorithm which ensures that rescuers are assigned to areas that have more number of affected people and also the rescuer is assigned the area nearest to him. Another important aspect of SLTR is the SLTR website. This website provides real time information about the disaster to the general public. The search page in the website allows the people to get information about their friends or relatives who have triggered the kit and asked to be rescued. There are several more features in the website.

These are some of the aspects that make SLTR stand apart from the other existing systems.

6.1 Other Applications

Even though, the main objective of the SLTR is to computationally handle any natural disasters, it can also be used in the following applications.

6.1.1 Women Protection System

Stalking is a form of criminal activity and it is a term commonly used to refer to unwanted and obsessive attention by an individual or group to another person. When stalking is coupled with intent to instill fear or injury, however, they may constitute a pattern of behavior that is illegal. Stalking first attracted widespread public concern when a young actress named Rebecca Schaeffer, who was living in California, was shot to death by an obsessed fan who had stalked her for two years.

Fig 12: SLTR Women Protection Application

If a girl is being stalked most of the time the girl tends to ignore the stalker, but in some cases the stalker turns out to be violent and may cause harm to the victim as seen in the above case. In such cases if the girl registers her complaint in the help website, police personnel will provide her with a kit. When the girl is being attacked by the stalker she can trigger the device and be provided help.

6.1.2 Patient Monitoring System

The proposed SLTR system can also be used to the following patient monitoring system.

Amnesia: The SLTR kit can also be used and very useful to monitor patients who suffer from amnesia. Amnesia is a condition in which one's memory is lost. There are some cases

where the patients wander off on their own and they are unable to recall their destination or their whereabouts. If this patient is made to wear the kit which is integrated in a watch or an arm band, then the patient can easily be located.

Tachycardia: For patients suffering from tachycardia the kit can be integrated into arm band which would measure the heart rate continuously. Detection of tachycardia would help the person from a lot of damages like:

- Coronary artery disease (atherosclerosis)
- Heart failure (poor pumping heart)
- Heart attack (myocardial infarction)
- Congenital heart defects (condition you are born with)
- Inflammatory or degenerative heart conditions
- Chronic lung disease
- Septicemia

6.1.3 Personal tracking

Law enforcement: An arrested criminal out on bail may have to wear a GPS tracker, usually on the ankle, as a bail condition.

Race control: In some sports, such as gliding, participants are required to carry a tracker. This allows, among other applications, for race officials to know if the participants are cheating, taking unexpected shortcuts or how far apart they are. This use has been featured in the movie Rat Race.

Espionage/surveillance: When put on a person, or on his personal vehicle, it allows the person monitoring the tracking to know his/her habits. This application is used by private investigators.

These devices are also used by some parents to track their children. The supporters claim that if cleverly used, this actually allows children more independence. GPS personal tracking devices are being used increasingly to assist in the care of the elderly and vulnerable .Devices allows users to call for assistance and it locates the user's position.

7. CONCLUSION

SLTR is a pre planned automatic system that provides on time help to people during disasters via a SLTR kit and information to people about disaster prone areas via a web site. Hence SLTR makes an effort to save much more people during times of disaster by providing timely help. The proposed SLTR is in prototype at present. The system can be easily extended to the real life application for handling natural disasters. The proposed system can be very useful in the current situation, where natural disasters happening frequently.

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