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Location based Emergency Response Management System through Satellites in Road Networks

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Abstract

The integration of Wireless technologies, GIS and sensors, has opened new possibilities of developing an Intelligent Transportation System (ITS). The face of ITS are changing with modern applications like Advanced Traveler Information Systems (ATIS), Route Guidance Systems (RGS), Advanced Traffic Management Systems (ATMS), Performance Monitoring and Congestion management etc. An effective Intelligent Transportation System reduces traffic congestion, environmental pollution, trauma related mortality, fuel consumption and driver in-convenience etc. With advancements in Geographical Positioning Systems (GPS), Emergency Management Service are becoming an integral part of many new ITS mobile applications. In this paper, we introduce a new model for Location based Emergency Response Management System through Satellites in road networks. We propose a technique where an automatic voice call is transferred based on the severity of accident to nearest help center in case of emergency on roads. The severity of accident is computed by image comparison algorithm. The paper further suggest shortest path from the help center to reach the accident spot as SMS to the help center. The system also alerts the secondary help line (User Home) by sending the accident details as voice call. At the end, we reflect the benefits of proposed system.

Keywords

Emergency Management System, Intelligent Transportation System, Satellite Phone, Satellite Communication, Image Processing, Spatial Databases, Skyline Queries, GIS, GPS, Location based service, e-call.

I.

I. INTRODUCTION

In depth studies of fatal vehicular accidents provide valuable data for implementing effective emergency services to reduce the trauma related mortality and strengthening legal measures in peak hours of fatal accidents. Traffic accidents take the lives of nearly 1.3 million every year, and injure 20-50 million more in the world. Road traffic injuries account for 2.1% of global mortality. The developing countries bear a large share of burden and account for about 85% of the deaths as a result of road traffic crashes. India accounts for about 10% of road accident fatalities worldwide. According to the latest WHO data published in April 2011 Road Traffic Accidents Deaths in India reached 197,135 or 2.19% of total deaths. This indicates that the surveillance system for vehicular accidents is not well established in India.

Now-a-days road traffic increases significantly. This leads to endanger human life. This is because of no immediate response or emergency service available. Generally Emergency calls are manually done by the people who see the accident and call the help center manually. In European country, a feature called e-call is available in BMW Cars where automatic call is transferred to nearest BMW help center when any accident that damages air-bag happens. This is a vehicle enabled service where common man cannot afford to use this facility. This paper gives a novel idea enabling automatic call to the help center using satellite communication. The system can be used even when no cell tower signals are available as this technique uses satellite communication (GPS) to track user location.

Generally mobile phone has facilities like Emergency call which activates call on demand by the user. This is possible only when user of mobile is in good condition to handle the mobile during accident (hazards). While travelling through bye-pass roads or long roads where people frequency is less, when any hazard happens, people may not be available for immediate rescue. This delays the life saving of the user. Optimum utilization of the time after an accident which is golden hour serves as a measure of effectiveness of any emergency response service provider system. Recovery actions should be taken in time to reduce the loss of life and property. In spite of the reason that the service providers are well equipped, routing problems and traffic congestions breaks their speedy recovery action in real time.

This paper is useful when any accident happens and user is not in position to handle mobile, where the sensor in the mobile automatically activates call to nearest help center by analyzing the severity of the accident. The help center in turn will take necessary steps to rescue the user.

To sum up we make the following contributions:

1. Propose a model for automatic Emergency Response Management System on roads through satellites.
2. An automatic voice call is activated to nearest help center and secondary home alert based on mobile sensor.
3. Discuss sequence of actions for making automatic voice call to the help center basing on the severity of the accident.
4. Designing efficient algorithm to implement the model in mobile applications.
5. Used image comparison algorithm to analyze the severity of accident. Satellite image of accident can be used for further investigation.
6. The model also displays the shortest path to reach accident spot from help center as an SMS service to help center.

The reminder of this paper is organized as follows. In section 2, we review the related work on emergency response management system and image comparison algorithm. In section 3, we formally defined the proposed system model on road Networks. In section 4, we introduce algorithm for automatic voice call to nearest help center and secondary home alert. Finally section 5 concludes the paper highlighting the key benefits of the model.

II. RELATED WORK

A. Emergency Service Systems

Emergency Response System must be supported with Emergency Medical Service Organizations must ensure that the appropriate number of units and trained personnel are assigned at any given time to meet the emergency medical demand within prescribe response time standards. In [2], a unique route finding OCX was programmed and used to plot OD cost matrix from multiple origins to multiple destinations. Route Finder was designed to find shortest, time saving routes and services areas. In [1], Satellite-Assisted LocalIzation and Communication systems for Emergency services (SALICE), developed new designs for integrated communications and localization. In [6], Julie A. Lahausse, D. Psych et al. propose a Automatic Crash Notification (ACN) technology which is typically part of vehicle telematic systems, which involve the transmission of data communications between systems and devices.

B. GPS Location Track and Satellite phones

GPS technology has been used in a variety of applications to measure time complexity. GPS technology has greatly expanded the scope of space-time analyses by allowing the local people information on trip plans and routes travelled. GPS technology has been used for business and leisure applications: e.g. guiding agricultural machinery for planting and pesticide application [3], coaching for high performance athletes [7], and deploying hunters for the U.S. Forest Service [9]. More recently, GPS technology has shown promise in studying human behavior: e.g. the Lexington Area Travel Study [24] and Oklahoma Urban Air Toxics study [19]. GPS integrated with GIS opens new applications for Street view, road network study [11]. With improved technology resulting in smaller GPS devices, researchers are exploring diverse applications including studying physical activity in children [23] and pesticide exposure in migrant farm workers [23]. Recently GPS applications include nearest neighbour [15],[20],[21] which are location based applications in mobiles.

Satellite and cellular phones are wireless devices. They almost look alike but the way they work is totally different. A cellular phone functions on the basis of cells, and hence are called cell phones. When a satellite phone is turned on, a signal goes up to any number of satellites of a group the phone is registered with. When a person makes a call from the handset, a signal goes to the nearest orbiting satellite. The satellite connects to the gateway or ground station. Then the gateway takes the call to the destination. Some of the Satellite phone service providers are. Iridium, Inmarsat, Thuraya, Globalstar.

C. Satellite Image and Comparison Techniques

In paper [12], Minwoo Park and Jiebo Luo et al produced more precise location information, i.e. the viewing direction for geo-tagged photos, with both Google Street View and Google Earth satellite images. Their system performs 1) visual matching between a user photo and any available street views in the vicinity determine the viewing direction, and 2) when only an overhead satellite view is available, near-orthogonal view matching between the user photo and satellite imagery computes the viewing direction. In paper [17], a new approach for standing- and walking-pedestrian detection, in urban traffic conditions, using grayscale stereo cameras mounted on board a vehicle. Paper [14] focuses on classification of the satellite image of a particular land cover using the theory of Biogeography based Optimization (BBO). The original BBO algorithm does not have the inbuilt property of clustering which is required during image classification. Hence modifications have been proposed to the original algorithm and the modified algorithm is used to classify the satellite image of a given region. Paper[8] proposed an automatic approach consisting of a segmentation step followed by two stages of object classification. In the process we utilize the multispectral image, the panchromatic image and a road network. Paper[4], presents an automated video analysis system that can: detect and track road users in a traffic scene, and classify them as pedestrian and motorized road users; identify important events that may lead to collisions; calculate several severity conflict indicators. Based on the geometric consistency of the satellite images with as-is local terrain, in paper[4], a Computational Mechanism is introduced for generation and adaptation of a roadway model transferable through the network. In this work, we use a new swarm data clustering method based upon flower pollination by artificial bees to cluster the satellite image pixels. The aim of clustering is to separate a set of data points into self-similar groups. Those clusters will be further classified using Biogeography Based Optimization.

III. SYSTEM MODEL

In this section, we describe the road network and system model; define the EmerSat emergency response management system in spatial networks. We assume a spatial network [California Road Network], containing set of static data objects as well as help center database. We assume all road maps are maintained by cloud server.

A. Road Network

We model the underlying road network as a weighted undirected graph G = (V,E) where E is an Edge set of road segments in the road network, V is the Vertex set of intersection points of the road segment and each edge is given travel time of its corresponding road segment as weights. In this model (Figure 1), we consider our system with a mobile environment in which mobile user is able to communicate with the service provider through wireless communication infrastructure e.g.: Wi-Fi.

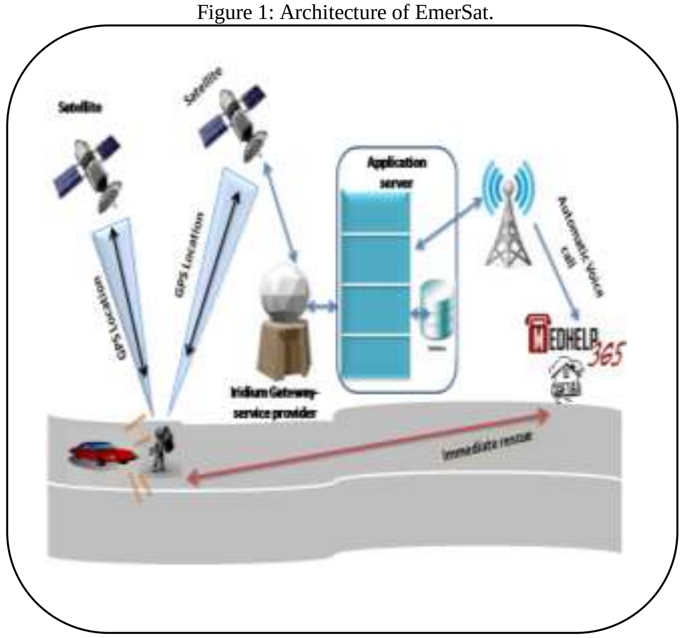
IV. ALGORITHM

As a pre-computation, the road network is partitioned into grids (Figure 2) to reduce the search space in finding out the nearest neighbor vertex of the user location. We apply a road network clustering approach to efficiently compute the nearest vertex of the user origin. The database of help centers is maintained. The model works in either of two phases namely Normal flow or Alternate flow.

A. Normal Flow

When an accident happens, the sensor in the user mobile is activated. The EmerSat service is initiated from the user mobile to the service provider based on sensor data.

Figure 1: Architecture of EmerSat.



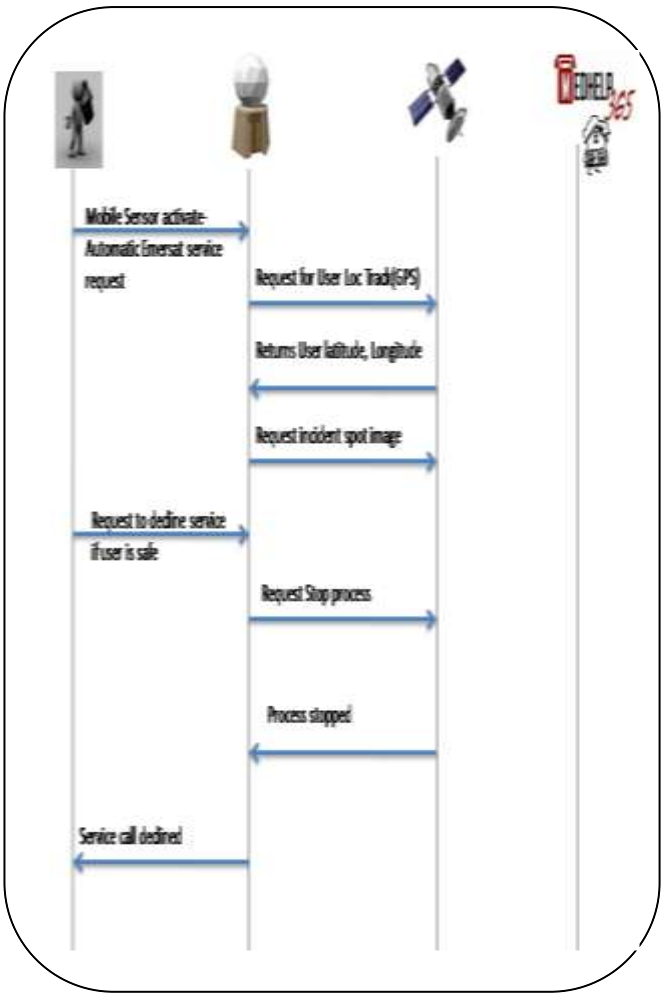
The function InitiateSensor() does the function of activating the Satellite service provider for EmerSat service. Satellite service provider sends the signal to orbiting satellites to locate user and capture the accident image. The two or more Orbiting Satellites finds the current user location by GPS technology. The function getCurrentLocation() returns the user current latitude, longitude coordinates. The CaptureaccidentImage() function returns the image of accident spot taken by the satellite to the Service Provider. The function takes four parameters namely top left and bottom right of spatial region(latitude, longitude). The photograph area is considered as fixed size for the given user latitude, longitude coordinates. The user current location and accident spot image is returned to the Satellite Service Provider. The service provider then process the satellite image of accident spot by image comparison algorithm. The paper uses Biogeography based Optimization (BBO) technique proposed by Line Eikvil, Lars Aurdal et al. for comparing the image distortion and prepares the severity of the accident. The function RankSeverity() function returns severity status of the accident spot by image comparison technique. Basing on the severity of the accident, if status is high then the service provider immediately transfers automated voice call to nearest help center. The function AutomateEmergencycall() based on the severity status prepares a automatic voice call which contains the accident area, time of accident, objects collided. The function NearestHelpCenter() function helps in finding the nearest help center to the user current location.

The NearestHelpCenter() function uses road network data which consists of roads(edges), intersection of roads(vertex) and database of help center with their latitude and longitude positions. The EmerSatCall() function finally sends the automatic voice call to nearest help center. It also alerts a secondary helpline to the user home. The sequence of actions under normal flow is depicted in figure 2.

B. Alternate Flow

When an accident happens, the sensor immediately initiate the EmerSat service to the Service Provider. If user is safe with minor injuries then user can immediately cancel the EmerSat service at the start of service request itself.

Figure2: Sequence of actions under Normal flow



The function QuitEmerSat() stops the call transfer to the service provider to stop the EmerSat service. The user can also cancel the EmerSat request in the middle. The help center can also confirm the accident by calling user mobile if the user is in position to handle the call. If not immediate rescue operation can be started by help center. The sequence of actions under alternate flow is depicted in figure 3.

C. Algorithm

Algorithm 1 : EmerSat

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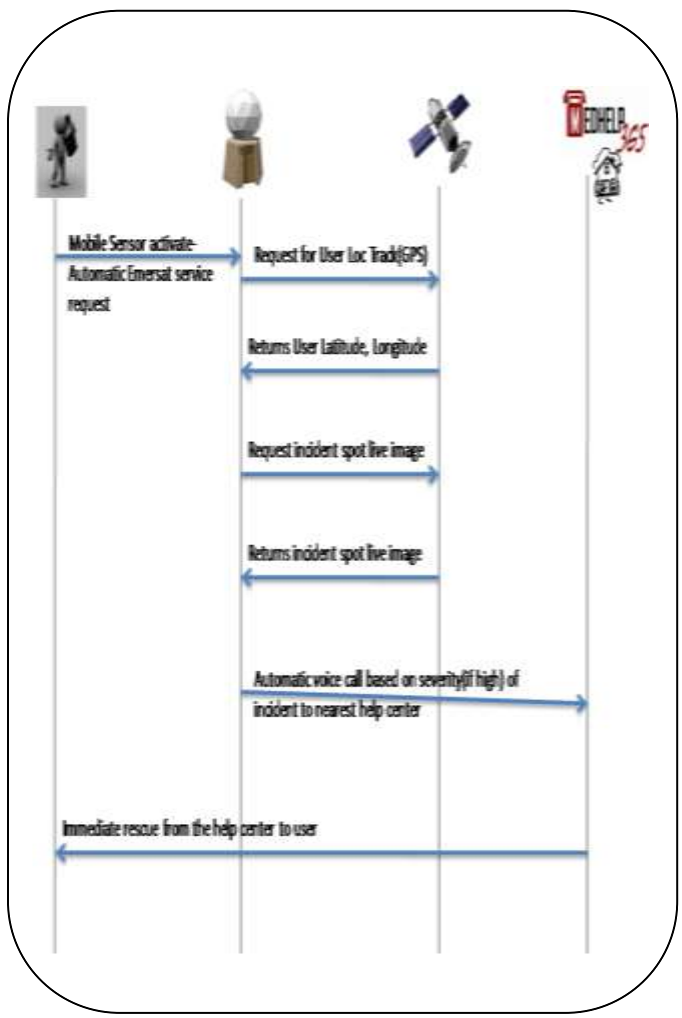
1. sensordata_rep ← InitiateSensor()
2. IF (sensordata_rep) THEN
   BEGIN
   /* When a mishap occurs, the mobile phone sensors are activated to make automatic signal to satellite phone provider. */
3. userloc ← getCurrentLocation()
4. acc_image ← CaptureaccidentImage()
   /* The satellite phone provider receives the signal and sends the geo-coded lat, long co-ordinates to satellite to take an photograph of the specified area. The satellite takes the photograph and sends the image to service provider for further processing. */
5. severity_status ← RankSeverity()
   /* The service provider after receiving the image, performs a relevance mapper/compares to analyze the impact of accident.*/
6. call_rec ← AutomateEmergencycall()
   /* based on the image mapper report, the service provider sends an automatic voice call to nearest helpline and secondary number. */

Figure3: Sequence of actions under Alternate flow



7. helpcenter ← NearestHelpCenter()
/* finds the nearest help center */

Figure 3: sequence of actions in Alternate flow

8. EmerSatCall()
/* In addition to voice call, shortest distance to reach accident spot is also sent as sms to help center. Immediate rescue operation will be started by help center.*/

End

9. Else

10. QuitEmerSat() /* cancels the EmerSat service */

Hence the proposed model provides an immediate rescue to the accident area based on satellite communication. The accident image can be used for further investigation.

V. CONCLUSION

In this paper, we propose a Emergency Response Management System which sends voice call to nearest help center. The sensor in the user mobile is activated when an accident occurs. Immediate call is directed to service provider for help. The service provider in turn communicates with satellites and gets the image of accident spot and user location. Basing on the image comparison report the call to help center is activated. The System also sends an secondary call to user home for alert. It also suggests the shortest path to reach accident spot from the help center by an SMS. This type of Emergency Response Management System reduces the fatality rate to a great extent.

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