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EFFICIENT ACCIDENT DETECTION AND RESCUE SYSTEM USING ABEONA ALGORITHM

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Abstract

Road safety is an all-time global concern. Everyday a large number of human lives are lost due to accidents and delay in calling the rescue services. Researchers are looking for a solution to reduce the loss of such lives. This delay is caused due to various reasons. The most common one is the lack of proper communication to the emergency services. We propose an efficient system that automatically notifies these services about the accident and also guides them to the spot. When an accident occurs, it is detected by the Crash Sensor of the Air Bag System installed in the vehicle. If these observations are above a preset critical point, a controller triggers a message to notify the Emergency Services. We Employ Vehicular AD-Hoc network (VANET) to deliver this message to the rescue services. VANET also helps these services in finding the optimum route to the accident spot, using ABEONA algorithm and a traffic signal module.

Keywords: VANET, ABEONA, Air-bag System, Accident detection, emergency rescue service.

1. INTRODUCTION

Observing the present day conditions, it is well known that the number of vehicles rolling out on road is rapidly increasing. In accordance to that, the accident rate and pollution levels are also greatly increasing. Apart from this, there are several other factors causing the loss of life. Such factors include carelessness of the driver, delay in reaching the accident spot etc. It is shocking to realise that in most cases causalities occur due to improper or no communication to the rescue team. We are now looking forward to solve these issues by proposing an efficient idea and reduce the loss of human life as much as possible.

2. RELATED WORK

At present, there are several ways to detect an accident. Most detection modules use only the Micro-Electro Mechanical Sensor (MEMS) and the Vibration sensor [1]. The MEMS will detect many factors such as any sudden deceleration/acceleration, roll-over and threshold of the hit. There are ideas that already exist to inform the ambulance using GSM to send alert message [2]. The GSM module is not so reliable since it does not work in places where there is no signal. This means that there could be no access to communication, which makes GSM modules not completely reliable. Lastly, the Dijkstra's Algorithm was proposed by many papers to make the rescue services reach the accident spot. But it is to be noted that this algorithm is used to detect the shortest path only [3], where the traffic factor is not taken into consideration. In many cases the shortest path may have heavy traffic, during which it would result in delay of the ambulance to reach the accident spot.

3. PROPOSED WORK

The Working of the proposed system can be clearly understood by taking up an example. Assume that a car has crashed a bus in the road region R. The vibration sensor and crash sensor which is used to open the airbag inside the car will sense that the car has met with an accident [4]. This module now generates an alert message which consists of several details regarding the accident such as time of accident and the place (region R) of the accident which is given by the GPS module. This is in the form of a packet data. This is now broadcast to all other vehicles around the accident spot. This message is transmitted very quickly and efficiently using Vehicular Ad-Hoc Networks [5]. All the vehicles which receive the alert message will again re-transmit the message around itself. This way the VANET helps the message to reach the police and ambulance services as early as possible. Now the rescue vehicle (say Ambulance) has to come to the accident spot quickly. For this we deploy the ABEONA algorithm [6]. This algorithm will assist the vehicle to find the most efficient path to reach the accident spot. The efficient path here means the route which would have less distance and traffic so that the ambulance reaches the spot without any delay. That way if the ambulance is going in any inefficient route, the ABEONA will also assist the ambulance to re-route to the next most efficient path. We

also propose to use a Traffic module [7], which changes the signals in the route of the ambulance so as to result in smooth movement. Thus the rescue vehicle reaches the accident spot in a short period of time so as to prevent loss of life. The paper's body will have four main sections. The first section describes about the working of Crash Sensor. While the second section deals with VANET, the third section will show how we implement the ABEONA algorithm and the last section deals with traffic signal module.

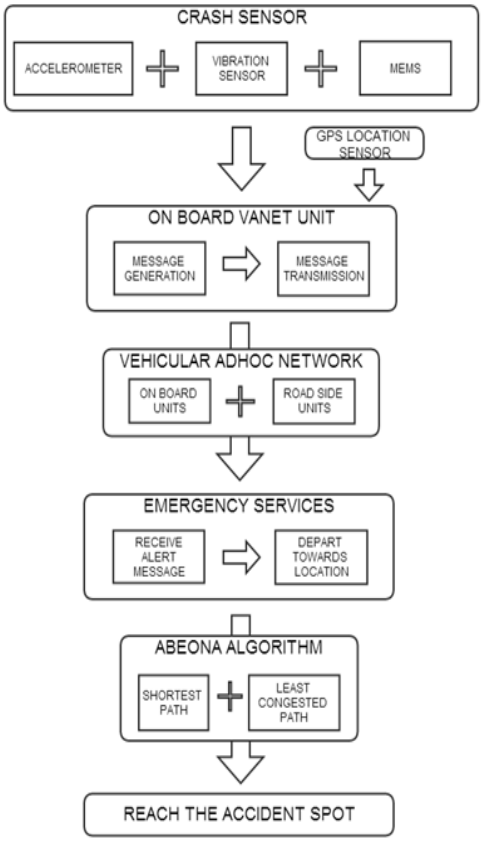

Figure 1 Flow diagram

4. SECTION I: ACCIDENT DETECTION

The Accident detection module is the crash sensor of the Air Bag System (ABS) that is already installed in all the vehicles by default. The crash sensor comprises of four main hardware parts: the Micro-Electro Mechanical sensor (MEMS), the Accelerometer, the Vibration sensor and a Central assembly that acts as a processor for the whole module. The input from the vibration sensor is also an additional factor that plays a significant role in detecting sudden impulses.

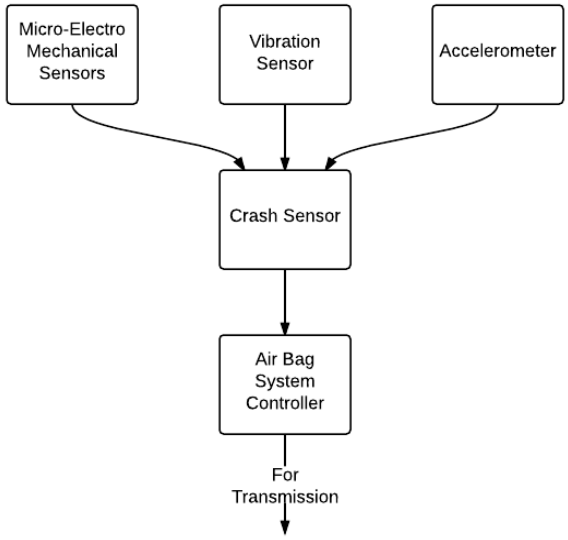

Figure 2 Detection Module

Let us assume that all the cars in our network are equipped with an ABS which prevents the loss of life of passengers. An ABS employs an integrated Acceleration sensor equipped with Micro-Electro Mechanical Sensor (MEMS) system. This whole detection module is placed in an ultimate location where the crash level is exactly determined by the system and also takes care that the module itself is not affected during the mishap. When this sensor detects the crash, the output from this sensor is sent to the ABS. This setup works conjointly to detect accidents almost instantaneously and broadcasts information like geographical coordinates and the time within a few seconds. As soon as an accident occurs the alert message is automatically sent by the Crash sensor to the rescue team and the road safety patrol. A GPS module is used to locate the accident spot. In order to intimate the rescue team when a crash/ accident is detected, the sensors trigger the processing unit to generate a message and transmit it through the VANET.

5. SECTION II: VANET

For the purpose of broadcasting the message from the Crash sensor, we use Vehicular Ad-Hoc Networks (VANETs). VANETs are special Mobile Ad-Hoc Networks (MANETs), in which networked nodes are vehicles equipped with wireless communication capability. They coordinate within themselves to deliver data without the help of a centralized administration. In general VANET consists a set of onboard units (OBUs) fixed inside vehicles and road-side units (RSUs) setup along roads. The OBU and RSU can interact among themselves using dedicated short-range communications or the European Standard for

ITS operating in the 5-GHz frequency band (ETSI ITS-G5), both based on the IEEE 802.11 standard on the 5.9-GHz band. The communications between vehicles can be classified into two main methods: vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I).The alert signals are sent in the form of beacons. A beacon contains the following information: 1) the Vehicle ID, 2) the vehicle's position, 3) the Road ID, 4) the current Epoch ID, 5) the density estimation for the current Epoch ID, 6) the VIL table (containing the Vehicle ID of a random set of cars that have traversed the VIL reference line during current Epoch ID), and 7) historical data(i.e., containing the estimated flow, density pairs for the past recent epochs).

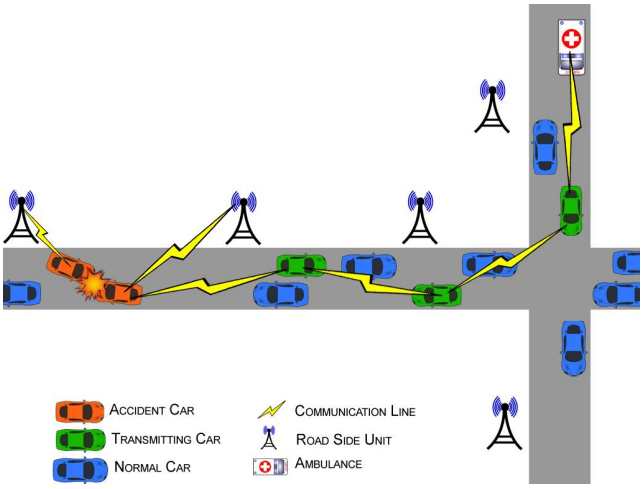

Figure 3 Message Delivery

A broadcast in a network begins with transmission of the emergent information from a source node to all approaching vehicles. Usually, all receivers relay the message upon its reception and ignore the subsequent copies of the same message. We propose to use the fast on time warning delivery scheme Receiver Consensus (ReC) [8]. We have chosen ReC as it works in nearly all conditions, and is applicable to 1D, 2D and 3D scenarios. According to this, a data packet containing some information about the geographical location is broadcasted periodically by every vehicle, following DSRC/WAVE standard [9]. ReC consists of two components: location-based ranking and acknowledgement-based neighbor elimination. The former enables fast propagation without unnecessary waiting time, latency at every hop, and the latter guarantees reliability while reducing the number of retransmissions considerably. In both components, receivers utilize local knowledge to achieve consensus on forwarding strategies. Neighbors' geographic positions, local topology and CDS are updated by information sharing. The topology may get modified dynamically in between. Data packets also include acknowledgement of warning messages. Each warning message has its duration. Upon expiration of the message, the corresponding acknowledgment will not be attached in future packets. After broadcasting the message, it is also necessary to bring the rescue team to the accident spot as soon as possible. This can be done by the ABEONA algorithm.

6. SECTION III: ABEONA

In VANETs, we can use each vehicle as a sensor to measure crucial congestion factors such as flow, density, and speed of the traffic that determine the time required to reach the spot. This paves way for a new world of opportunities. ABEONA's algorithm enables rescue services to forecast traffic congestion events and re-plan their route accordingly so as to reach the location soon. The ABEONA algorithm will implement V2V type wireless communication to transmit and receive messages among vehicles. In order to achieve efficient communication we assume that all vehicles have V2V capabilities. Apart from ABEONA we need a Global-positioning system (GPS) device with an accuracy of 1 s. Each Onboard Unit (OBU) collects the observed data in 1-min sets, determined by an epoch value (i.e., the current minute) called Epoch ID. The roads are divided into different regions, each of which is identified by a unique Road ID, and including this information in a GPS navigation system. Each vehicle periodically broadcasts the observed data within its region (identified by the Road ID), not only about the current epoch and about the historical data. This makes sure that the data required at each region to predict the future traffic conditions are readily available at the region. All vehicles bounded by a region cooperatively assimilate and distribute this information. For example, when a vehicle comes out of Road ID 1 and goes into another region say Road ID 2, the vehicle cease to broadcast Road ID 1-related information and awaits the receipt of information about Road ID 2.

6.1. Traffic Forecasting

Each vehicle has the ability to individually forecast the expected values of density and flow, with the help of the current and historical epoch information. The vehicles can also relate them with a set of reference values. These reference values are usually substantial for a given road. In order to predict the future density and flow values, ABEONA adopts a linear prediction algorithm [10] or, the linear least squares. When a vehicle detects that forecast-density value is greater than reference value and forecast-flow value is greater than reference flow, a traffic state change is forecast, triggering a need for the vehicle to change route. The vehicle keeps track of the warning messages received from a given road region which is expected to become congested. This would be evident if more number of vehicles send the warning message. The vehicle then changes its route into a lesser congested road so as to reach the accident spot earlier. This way the ABEONA algorithm is efficient in re-routing the vehicles based on the anticipated traffic in any road.

7. SECTION IV: TRAFFIC MODULE

When an ambulance is using the ABEONA algorithm, it automatically knows the route it is going to travel. Thus all the Road Side Unit (RSUs) will store the data about the accident and also about the ambulances. This also means that even the signals in that route will know when an ambulance is approaching it using the ABEONA algorithm. Whenever a traffic signal module receives the information about the accident, the VANET signal receiver is turned ON to search for ambulance nearing the traffic signal. Whenever the emergency vehicle reaches near to the traffic signal (approximately 100m), the traffic signal will be made green. Thereby the ambulance is allowed to reach the accident spot without having to wait in traffic or for signals.

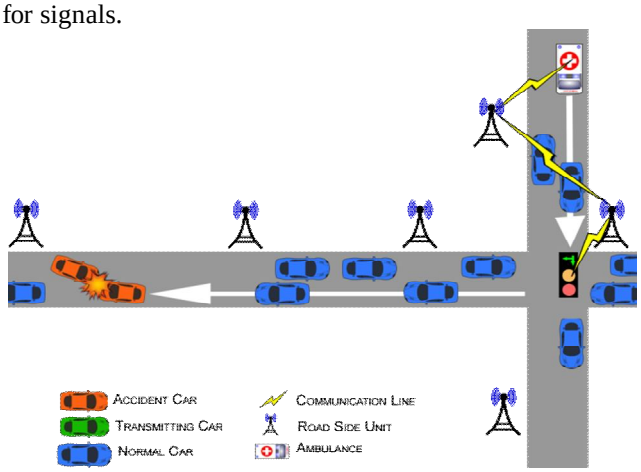

Figure 4 Path Figuring & Signal Optimization

8. FUTURE IMPROVEMENTS

In the future, this system can be extended to more applications. We can facilitate connectivity to the nearest hospital and provide medical assistance through live streaming from the ambulance and also through video conferencing.

9. CONCLUSION

The proposed idea is an all-round system for it not only detects an accident but also informs the emergency services and also lets them to reach the accident spot early. In the proposed idea we are using the crash sensor which is used to detect crash and open the airbags in the vehicles. It is well known that nowadays almost all vehicles are already having the Air Bag System (ABS). Thus, it is a feasible option to use this detection module. Also, we use the Vehicular Ad-Hoc Networks, which automatically communicates the accident case to the surrounding vehicles. As this is based on wireless network, there is no need of any human effort to inform the rescue team. The news is automatically passed to the nearest rescue service.
Our system is more reliable for the fact that it not only detects an accident and informs the rescue services but it also assists the services to reach the accident spot quickly. The ABEONA algorithm analyses several factors such as traffic, distance etc, and figures out the most efficient path to reach the accident spot. It also helps in changing the route to another if needed. Most importantly, even the traffic signal is modified so as to allow the ambulance to reach the victim at the earliest. Thus, our proposed idea is a complete system for accident detection, alerting the rescue services and also assists them to reach the accident spot. This idea is believed to be of great usage for the general public in the near future.

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