Automatic Notification of Automotive Accidents Using Vehicular Networks

-A Survey.

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***Abstract* — The synergy between communication technologies and vehicles offer a priceless opportunity to improve assistance to people injured in automotive accidents, providing information about the incident to reduce the response time of emergency services. The new communication technologies integrated into the automotive sector offer an opportunity for better assistance to people injured in traffic accidents, reducing the response time of emergency services, and increasing the information they have about the incident. Therefore, we need a fast and efficient rescue operation after a traffic accident occurs which can significantly increases the probability of survival of the injured, and reduces the severity of the injury. This paper briefs about the technologies that are useful in detecting a road accident that makes use of a novel intelligent system which is able to automatically detect the road accidents, notify them through vehicular networks, and estimate the severity of the accident with the help of data mining and knowledge inference.**

I. INTRODUCTION

During the last decades, the total number of vehicles around the world has experienced a remarkable growth, increasing traffic density and causing more and more traffic accidents. The immediate effect of this situation is the dramatic increase of traffic accidents on the road, representing a serious problem in most countries. Numerous efforts have been undertaken by automobile manufacturers to reduce road casualties, mainly focused on both active and passive safety systems. These initiatives have managed to increase traffic safety, achieving a reasonable reduction of road deaths. However accidents still occur and determining the accuracy of the required human and material resources for each particular accident could significantly reduce the number of victims as well as the impact of severity of such accidents.

To reduce the number of road fatalities, vehicular networks play an increasing role in the Intelligent Transportation Systems (ITS) area.Much of the research in ITS assume that vehicles will be able to communicate speed and location data to roadway infrastructure and to other vehicles. Two primary architectures have been proposed for these purposes – a vehicle-to-infrastructure (V2I) architecture and a vehicle-to-vehicle (V2V) architecture which is discussed in the second section of this paper.

When a motor vehicle crash occurs with a potential for injuries, a notification of the event and the location of the crash are critical so that rescue can be dispatched to the scene. It is also helpful for emergency dispatch to recognize the severity of the collision and the extent of injuries so that they can adequately assign personnel and specialized equipment as needed. An Automatic Crash Notification (ACN) technology [1] initiates this critical call for help.

For a noticeable reduction in assistance time, two major steps must be taken: (i) fast and accurate accident reporting to an appropriate Public Safety Answering Point (PSAP), and (ii) fast and efficient evacuation of occupants trapped inside a vehicle. The first of these objectives can be accomplished using telecommunication technologies and systems that have been recently incorporated into the automotive world, where mobile communications and GPS systems are the main representatives.

Presently, the process for reporting car accidents is extremely slow. The accident first needs to be physically reported and then announced via a radio broadcast or a portable GPS [2] unit before a driver is alerted. In this paper, we take an advantage of the use of the vehicular networks, to collect precise information about the road accidents which is then used to estimate the severity of the accident. Fig. 2 show how the use of VANETs [3] for this process will allow drivers within a certain range of the accident to immediately receive an alert that could prevent them from crashing as well. Additionally, the driver may choose to take an alternate route; which may result in traffic avoidance.

II. VEHICULAR NETWORKS

A. Basic V2V2I Architecture

The V2I architecture allows vehicles to communicate with some roadway infrastructure to allow the speed and location of the vehicle to be transmitted to a central server.

This server will maintain the speed and location of all vehicles and will aggregate this data for Intelligent Transportation Systems (ITS) applications, such as determining the fastest path from a vehicle's current location to its destination or identifying the location of an incident, among other applications. The V2V architecture, on the other hand, is quite fault-tolerant because of the highly-distributed nature of the network. As vehicles come into the network, they become nodes that communicate with other vehicles that are close in proximity to them.

The new architecture is a hybrid of theV2I and V2V architectures, which is the vehicle-to-vehicle-to infrastructure (V2V2I) architecture showed in Fig. 1. In this architecture, vehicles still communicate with each other, similar to how they communicate in the V2V architecture. However, the road network is broken into zones, in which one vehicle is designated as a Super Vehicle. The size of the zones is configurable and dependent upon the bandwidth and accuracy desired by the application. The Super Vehicle will receive data from all of the other vehicles within its zone, aggregate the data, and then transmit the aggregated data to the central server. In addition, the Super Vehicle will transmit the data to the other Super Vehicles in adjacent zones. Queries for ITS applications can be sent to the central server, but if there is some sort of failure, the V2V architecture consisting of Super Vehicles can be used.

To detect the super vehicle in different zones a super vehicle algorithm [4] is used. By this there may be a fast reciprocation from the emergency services immediately after an accident has taken place.

Using the V2V2I architecture over the V2V and V2I architectures provides many benefits, including reducing the bandwidth requirement for the roadway infrastructure (which includes the central server), and allowing fault tolerance in the event of a hardware failure of one of the centralized components. However, reducing the bandwidth needed by the central server means that less data is being transmitted to it. In fact, instead of every vehicle transmitting its speed and location to the central server (as is the case with the V2Iarchitecture), in the V2V2I architecture, only one vehicle per zone will transmit speed and location data. The data that is been received by the central sever has to be classified and has to be shared among different service providers for post-accident remedies.

B. Proposed Architecture

This approach collects information available when a traffic accident occurs, which is captured by sensors installed on-board the vehicles. The data collected are structured in a packet, and forwarded to a remote Control Unit through a combination of V2V and V2I wireless communication. Based on this information, our system directly estimates the accident severity by comparing the obtained data with information coming from previous accidents stored in a database. This information is of utmost importance, for example, to determine the most suitable set of resources in a rescue operation.

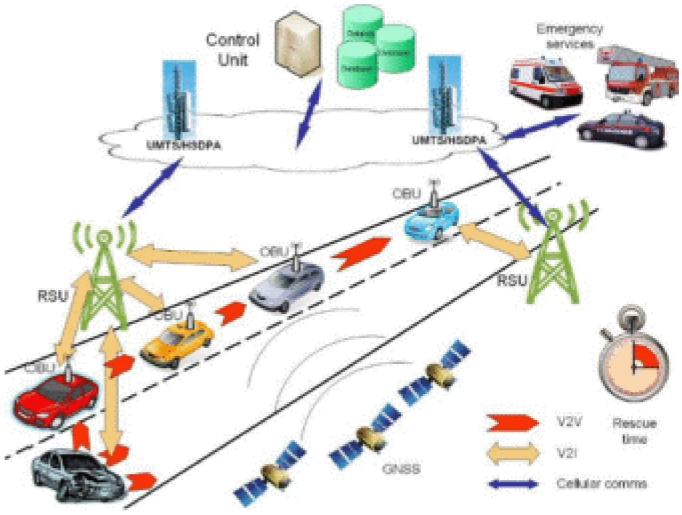

Fig. 1 - Architecture of proposed system for automatic accident notification and assistance using vehicular networks.

This system shown in Fig. 1, consists of several components with different functions. Firstly, vehicles should incorporate an On-Board unit (OBU) responsible for: (i) detecting when there has been a potentially dangerous impact for the occupants, (ii) collecting available information coming from sensors in the vehicle, and (iii) communicating the situation to a Control Unit (CU) that will accordingly address the handling of the warning notification. Next, the notification of the detected accidents is made through a combination of both V2V and V2I communications. Finally, the destination of all the collected information is the Control Unit; it will handle the warning notification, estimating the severity of the accident, and communicating the incident to the appropriate emergency services [5].

The proposed architecture provides: (i) direct communication between the vehicles involved in the accident, (ii) automatic sending of a data file containing important information about the accident to the Control Unit, and (iii) a preliminary and automatic assessment of the damage of the vehicle and its occupants, based on the information coming from the involved vehicles, and a database of accident reports. According to the reported information and the preliminary accident estimation, the system will alert the required rescue resources to optimize the accident assistance.

C. On-Board Unit structure

The main objective of the proposed OBU lies in obtaining the available information from sensors inside the vehicle to determine when a dangerous situation occurs, and reporting that situation to the nearest Control Unit, as well as to other nearby vehicles that may be affected. Fig. 2 shows the OBU system, which relies on the interaction between sensors, the data acquisition unit, the processing unit, and wireless interfaces:

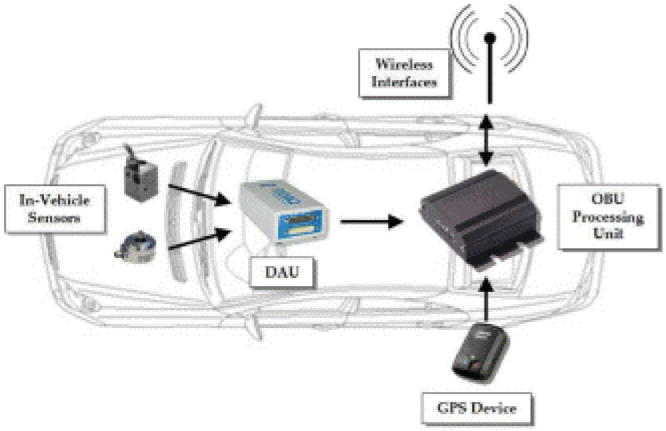

Fig. 2 - On-Board Unit structure diagram.

- In-vehicle sensors. They are required to detect accidents and provide information about its causes. Accessing the data from in-vehicle sensors is possible nowadays using the On-Board Diagnostics (OBD) standard interface [7], which serves as the entry point to the vehicle's internal bus. This standard is mandatory in Europe and USA since 2001. This encompasses the majority of the vehicles of the current automotive park, since the percentage of compatible vehicles will keep growing as very old vehicles are replaced by new ones.
- Data Acquisition Unit (DAU). This device is responsible for periodically collecting data from the sensors available in the vehicle (airbag triggers, speed, fuel levels, etc.), converting them toa common format, and providing the collected data set to the OBU Processing Unit.
- OBU Processing Unit. It is in charge of processing the data coming from sensors, determining whether an accident occurred, and notifying dangerous situations to nearby vehicles, or directly to the Control Unit. The information from the DAU is gathered, interpreted and used to determine the vehicle's current status. This unit must also have access to a positioning device (such as a GPS receiver) and to different wireless interfaces, thereby enabling communication between the vehicle and the remote control centre.

D. Control Unit Structure.

The Control Unit (CU) is associated to the response centre in charge of receiving notifications of accidents from the OBUs installed in vehicles. In particular, the Control Unit is responsible for dealing with warning messages, retrieving information from them, and notifying the emergency services about the conditions under which the accident occurred. Fig 3, shows the modules included in the Control Unit to achieve all its objectives within our proposed system:

- Reception/interpretation module. The first step for the CU is to receive a warning message from a collided vehicle, and so there must be a module waiting for the arrival of messages and retrieving the values from the different fields.
- Accident severity estimation module. When a new accident notification is received, this module will determine how serious the collision was, and the severity of the passengers' injuries.
- Resource assignment module. After deciding the severity of the accident, an additional module is used to define resource sets adapted to the specific situation.

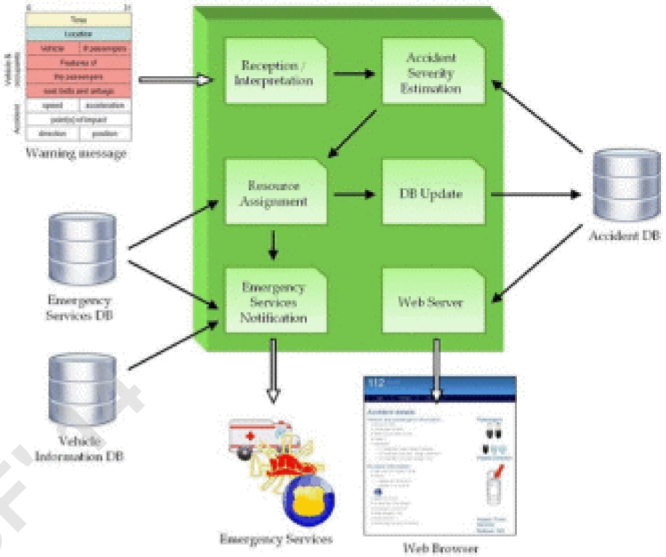

Fig. 3- Control Unit modular structure.

- Database update module. The data collected from the notified accident are stored into the existing database of previous accidents, increasing the knowledge about the accident domain.
- Web Server module. The Control Unit incorporates a Web Server to allow easy visualization of the historical information recorded and the current accident situations requiring assistance. A web interface was chosen in order to increase user friendliness and interoperability.
- Emergency services notification module. When the information has been correctly managed, the notification module sends messages to the emergency services including all the information collected, the estimated severity, the recommended set of resources, as well as additional information about the vehicles involved in the collision (for preliminary planning of the rescue operation). The information about vehicles consists of standard rescue sheets, which highlight the important or dangerous parts of a specific vehicle that should be taken into account during a rescue operation: batteries, fuel tanks, etc.

III. SEVERITY ESTIMATION

The currently available technology within motor vehicles combined with satellite communication systems allows for timely notification of emergency medical services (EMS)[6]to crash events. An automated system of crash notification would inundate the EMS systems within minutes. Vehicles are also equipped with event data recording systems similar to those found in airplanes which provide detailed information of the vehicle's engine, restraint, airbag deployment, and braking status seconds before the crash event. These two features provide the necessary elements for an automatic crash notification system (ACNS) that could provide timely notification of the crash event as well as information regarding crash severity and injury likelihood. Data for this cross-sectional study were obtained from the Crashworthiness Data System (CDS), a part of the National Automotive Sampling System (National Highway Traffic Safety Administration, 2003) Injury severity is reported in the CDS database using the Abbreviated Injury Scale (AIS).

For the purposes of this analysis a victim with a severe head injury was defined as one with a head AIS of 2 or greater.

The severity estimation is done through data mining and knowledge inference using Knowledge Discovery in Database (KDD) [7]. The system will benefit from additional knowledge to improve its accuracy, grouping accidents according to their degree of similarity.

Several approaches can be found in the existing literature with the objective of increasing traffic safety through the use of telecommunication technologies, and also in the field of accident severity estimation using historical data

IV. CONCLUSION.

The new communication technologies integrated into the automotive sector offer an opportunity for better assistance to people injured in traffic accidents, reducing the response time of emergency services, and increasing the information they have about the incident just before starting the rescue process. To this end, we have been providing particular information on automatic accident notification and assistance based on V2V and V2I communications, as we called these as vehicular networks.

Vehicular networks are nothing but the subgroup of MANET, which uses moving vehicles as nodes to communicate the information between the vehicles using V2V and V2I architectures as shown in the above section. There are several algorithms that are been developed to implement these kind of real-time systems.

The survey was done to show that these systems can better notify the emergency services as the vehicle population these days are drastically increasing. Thus can save lives of people injured in automotive accidents by estimating the severity of the accident.

Most of the existing work focused on data mining in traffic accidents is based on data sets where a very limited pre-processing and transformation are performed. The above systems are validated at the Passive Security Department of Applus+ IDIADA Corporation and showed how it can successfully detect traffic accidents, reporting all the detailed information to emergency services on time.

V. REFERENCES.

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