Automatic Accident Notification System using GSM and GPS

D.G. Shashidhar, Dr.B.K. Sujatha and Dr.B.P. Vijayakumar

Abstract--- *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. Determining more accurately the human and material resources required for each particular accident could significantly reduce the number of victims. The proposed system requires each vehicle to be endowed with an On-Board Unit (Piezo Electric Crystal, GSM, GPS, ARM) responsible for detecting and reporting accident situations to an external Control unit that estimates its severity, allocating the necessary resources for its assistance. The development of a prototype based on off-the-shelf devices shows that this system could reduce notably the time needed to deploy the emergency services after an accident takes place.*

Index --- *Piezo Electric Crystal, GSM, GPS, ARM*

I. INTRODUCTION

During 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. This scenario represents a serious problem in most countries, as an example, 2,714 people died on Spanish roads in 2009, which means one death for every 16,949 inhabitants. A close look at the accidents shows that many of the deaths occurred during the time between the accident and the arrival of medical assistance. In a traffic accident, completing the assistance of the seriously injured passengers during the hour immediately following the incident is crucial to minimize the negative effects on the health of the occupants. Therefore, a fast and efficient rescue operation after a traffic accident occurs significantly increases the probability of survival of the injured, and reduces the injury severity.

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 notification of the place of accident. These objectives can be accomplished using telecommunication technologies and systems that have been recently incorporated into the automotive world, where GSM and GPS systems are the main representatives.

In this paper we prototype the Accident Notification System, designed for automated detection, reporting, and assistance of road accidents using the capabilities offered by GSM and GPS communication technologies. This proposal does not focus on reducing the number of accidents, but on improving post collision care with a fast and efficient management of the available emergency resources, which increases the chances of recovery and survival for those injured in traffic accidents.

II. ACCIDENT NOTIFICATION ARCHITECTURE

Figure 1 presents the basic structure used to develop the Accident notification system. The goal of our proposal is to provide an architecture that allows: (i) direct communication between the Vehicles involved in the accident, (ii) automatic sending of a data files containing important information about the incident to the Emergencies Coordination center.

The Accident notification system has V2I communications to efficiently notify an accident situation to the Control Center. Different 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 from sensors in the car, and (iii) communicating the situation to a Control Unit (CU) that will address the treatment of the warning notification and its subsequent sending.

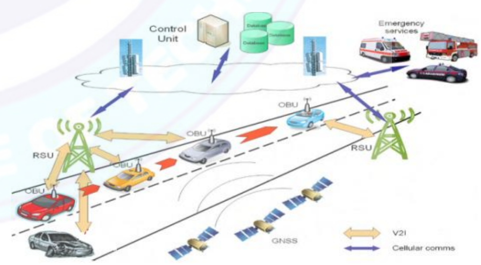

Fig. 1: Accident Notification Architecture Based on V2I Communications

III. ACCIDENT NOTIFICATION SYSTEM PROTOTYPE DESIGN

Using the architecture in Figure 1 as a framework, we have developed a prototype using general-purpose devices that can be used to carry out preliminary tests until the required technology (that is, the IEEE 802.11p standard) and the infrastructure (RSUs) are available for its deployment in a

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real environment. The configuration of each system component is detailed in the following paragraphs.

A. *On-Board Unit (OBU) Design*

The main objective of the OBU lies in obtaining the available information from piezo electric crystal sensors coming inside the vehicle to determine when there has been a impact or dangerous situation that must be reported to the nearest answering point. The structure of the developed prototype is shown in Figure 2, in which the main unit is a ARM Processor and the piezo electric crystal. The vehicle position and speed are obtained using a GPS device *Qstarz BT-Q818XT*. When developing an On-Board Unit prototype, the connection to the vehicle sensors can be complicated as each manufacturer differs in how the data is represented. In addition, most of these sensors are analog, and hence a prior transformation into digital format is necessary in order to properly handle the provided data. These problems have been solved by using an ARM *embed NXP LPC 2148*microcontroller that can be used for rapid prototyping because, among other features, it includes a built-in compiler for the C++ language, it can read directly from an analog input, and it can communicate with a GSM and GPS through different interfaces, including USB and Ethernet ports.

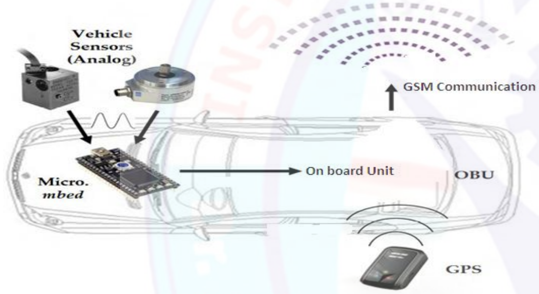


Fig. 2: On-Board Unit Prototype Structure

B. *Warning Message Structure*

The messages exchanged between the vehicles and the Control Unit should be concise, avoiding irrelevant information, but they should not ignore any possible information that might be useful for emergency services to determine the necessary resources. Thus, the information the delivered to the response point should include data about the conditions under which the accident occurred, the occupants of the vehicle and the different security systems included. These data are sent to the emergency services to provide a more detailed view of the conditions of the accident before they arrive to the affected area. For the designed system, we implemented a message containing the following fields, accessible via the sensors included in the vehicle

Time

1. To inform exactly when the accident occurred.

Location

1. Geographical position of the vehicle, to determine the exact location of the injured.

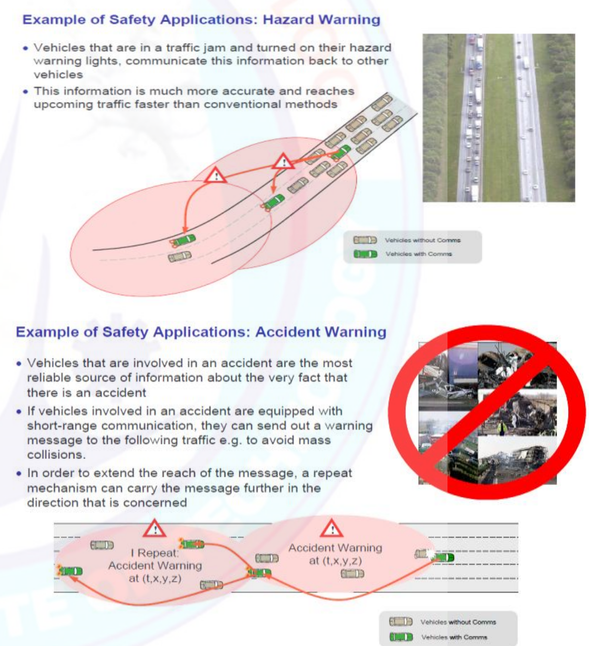
Accident

1. point of impact, i.e. exactly where the impact has been produced.
2. direction of impact force. This is a mechanical concept. If we consider the top of the car as a clock, we can describe the direction of impact force as an hour. (12 for front side, 3 for right side, 6 for rear side, etc.).
3. position of the vehicle after the crash to estimate the severity of the accident and to warn the emergency team about the level of complexity of the rescue.

C. *Control Unit (CU) Design*

The Control Unit (CU) is associated to the response center in charge of receiving notifications of accidents from the OBUs installed in vehicles. The Control Unit is responsible for dealing with warning messages, obtaining information from them, and notifying the emergency services about the conditions under which the accident occurred. The Control Unit prototype has been structured as shown in Figure 5. After receiving the message, the CU must store the crash data in a database to record that the accident information has been successfully delivered. The CU should have an available database providing information on different manufacturers.

IV. APPLICATIONS



The test system included an external computer receiving regular information from the sled (via a wireless network) of the measurements recorded by the OBU to ensure the proper behavior of the sensor reading module, along with another computer that simulated a Control Unit in charge of receiving alert messages. The test helped to show that the OBU was able to correctly detect both the magnitude and direction of the impact, and to generate an appropriate warning message from the sensor data and send it using GSM technology to the Control Unit in all the tests.

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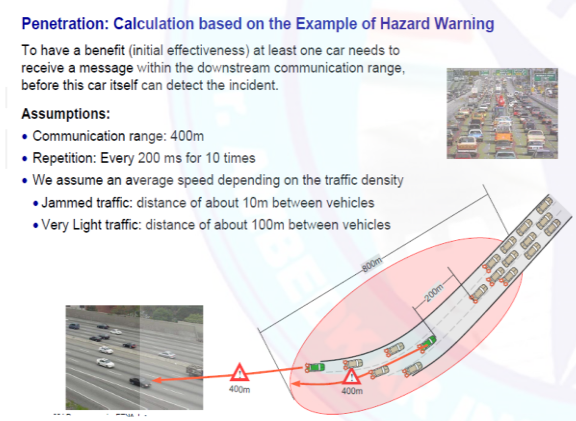
V. CONCLUSIONS AND FUTURE WORK

In this paper we presented the Accident notification system, which allows fast detection of traffic accidents, improving the assistance of injured passengers by reducing the response time of emergency services and the submission of relevant information on the conditions of the accident using V2I communications. This architecture replaces the usual mechanisms for notification of accidents, based on witnesses who may provide incomplete or incorrect information in an inappropriate time. The development of a low-cost prototype shows that it is feasible to massively incorporate this system in existing vehicles.



Future work in this area includes deploying the system in a real environment with the OBUs installed in real vehicles to check the system behavior when moving at high speeds.

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REFERENCES

[1] Direcci´on General de Tr´afico (DGT), "The main statistics of road accidents. Spain 2009," 2009, available at http://www.dgt.es/portal/es/seguridadvial/estadistica.
[2] H. Oh, C. Yae, D. Ahn, and H. Cho, "5.8 GHz DSRC packet communication system for ITS services," in *Vehicular Technology Conference, 1999. VTC 1999 - Fall. IEEE VTS 50th*, vol. 4, 1999, pp. 2223 –2227 vol.4.
[3] "Google Maps API Family," 2011, available at http://code.google.com/apis/maps.
[4] Qstarz International Co., "Qstarz BT-Q818XT Bluetooth GPS: Features and Specification,"2011, available at http://www.qstarz.com/Products/GPS%20Products/BT-Q818XT-F.html
[5] H. Hartenstein and K. Laberteaux, "A tutorial survey on vehicular ad hoc networks," *Communications Magazine, IEEE*, vol. 46, no. 6, pp. 164 –171, june 2008.
[6] Task Group p, "IEEE P802.11p: Wireless access in vehicular environments (WAVE)," IEEE Computer Society, 2006.
[7] M. Chong, A. Abraham, and M. Paprzycki, "Traffic Accident Analysis Using Machine Learning Paradigms," *Informatica*, vol. 29, pp. 89–98, 2005.
[8] "MBED NXP LPC1768: Reference information," 2011, available at http://mbed.org/nxp/lpc1768.
[9] K. B. Hornfeck, "A Customizable Socially Interactive Robot with Wireless Health Monitoring Capability," Master's thesis, Case Western Reserve University, Cleveland, OH, USA, 2011
[10] Applus+ IDIADA: Instituto de Investigaci´onAvanzadadelAutom´ovil, "Information and resources," 2011, available at http://www.idiada.es.
[11] F. Martinez, C.-K. Toh, J.-C. Cano, C. Calafate, and P. Manzoni, "Emergency services in future intelligent transportation systems based on vehicular communication networks," *Intelligent Transportation Systems Magazine, IEEE*, vol. 2, no. 2, pp. 6 –20, summer 2010.
[12] EuroNCAP (European New Car Assessment Programme),"Evaluation procedures and test results," 2011, available at http://www.euroncap.com/testprocedures.aspx.
[13] RCAR, the Research Council for Automobile Repairs, "Design guides and information for manufacturers," 2011, available at http://www.rcar.org.