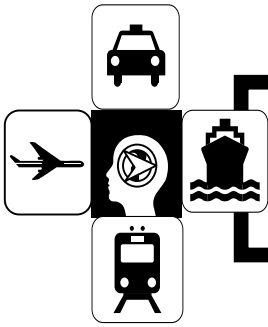


JERSEY DOT'S

"Turning Problems into Solutions"



Need a solution?
Think Jersey DOT

Tech Brief

Development of a Low-Cost Automated Crash Notification System

FHWA-NJ-2001-027

July 31, 2001

Summary

Rowan University has developed a Low-Cost Automated Crash Notification System that has the potential to dramatically reduce traffic fatalities on New Jersey highways. The project was developed in response to national studies which show that nearly half of all traffic crash fatalities occur before the crash victim reaches a trauma center. Many of these deaths can be attributed to the inability of EMS personnel to locate and reach the victim during the so-called "Golden Hour" after the accident when emergency medical treatment is most effective.



The Objective of Automated Crash Notification is to Improve Emergency Response Times.

The goal of this project is to significantly reduce EMS response time by developing and testing an advanced in-vehicle system that automatically transmits the location and severity of a crash to EMS personnel. Specifically, the project has designed, developed, and tested a low cost functional system that combines wireless communications and Global Positioning Systems with a network of inexpensive sensors for crash detection.

Introduction

With the advent of trauma centers, the fatality rate of persons reaching a hospital after a car crash has dropped dramatically over the last twenty years. However in 1999, over 17,000 crash victims died in the U.S. before ever reaching the hospital [1]. Undoubtedly, some fraction of these deaths resulted from catastrophic crashes. However, many of these deaths can be attributed to the failure of Emergency Medical Services (EMS) personnel to reach the victim during the so-called “Golden Hour” after the accident when emergency medical treatment is most effective. National statistics clearly show that despite a growing wireless communications network and the availability of medivac transport, the time to notify emergency personnel of a crash and respond to the crash victims can be quite lengthy. For fatal crashes in the U.S., the average pre-hospital time is approximately 30 minutes in urban areas and 1 hour in rural areas [2].

One solution that has been proposed to this problem is to equip cars with an Automated Crash Notification System (ACN). An Automated Crash Notification System is composed of three components: (1) a crash sensor which can detect that an accident has taken place, (2) onboard GPS to determine crash location, and (3) a wireless modem to automatically notify the emergency medical personnel of the severity and precise location of the accident. Current Automated Crash Notification systems, e.g. OnStar, are expensive and available only on higher-end passenger cars.

Research Approach

Under the sponsorship of the New Jersey Department of Transportation, Rowan University has undertaken a research project to determine the feasibility of a low-cost ACN unit based upon newly released silicon accelerometers, single chip GPS location devices, and Web-enabled CDPD wireless communication to eliminate 911 Base Station phone line contention issues.

The system is composed of two major subsystems: (1) the Mobile Unit which is installed in the occupant compartment of the vehicle, and (2) the Base Station which is responsible for receiving distress calls from the Mobile Units and reporting their location to emergency response dispatch personnel. The Mobile Unit is responsible for detecting

a crash, determining the location of the crash, and communicating crash severity and crash site location to the Base Station.

FINDINGS

Mobile Unit. The Mobile unit, shown below, contains a two-axis silicon accelerometer, embedded 8-channel GPS system, embedded Z-World Z180 microcomputer, and embedded wireless modem. All components are mounted on a custom printed circuit board which was designed at Rowan, and constructed by an outside fabrication facility.

A crash algorithm, a software module in the microprocessor, was developed to detect a crash while avoiding false alarms. The Mobile Unit must be able to distinguish between actual crashes and low-severity crashes or non-crashes such as panic braking or backing into a shopping cart. To detect a crash, the microprocessor samples the accelerometer output at 1000 Hz (1 sample per millisecond). Based upon examination of National Highway Traffic Safety Administration crash tests coupled with crash test modeling, the crash detection algorithm was designed to signal that a crash has occurred if a 10-miles/hour change in velocity occurs in under 50 milliseconds.



Mobile Unit: Research Prototype.

Base Station. In the event of a crash, the Mobile Unit and Base Station will communicate using wireless Cellular Digital Packet Data (CDPD) technology over analog cellular networks. CDPD is a new wireless Web access technology with widespread coverage in the eastern United States. CDPD allows a direct TCP/IP link to be established between the mobile unit and base station. Using CDPD, the base station is designed as a Web Server, and the Mobile Unit reports a crash to the Server via a

wireless Internet connection. This approach allows the base station to monitor multiple vehicles involved in crashes without the requirement for banks of dedicated phone lines. When the Base Station receives a message from a Mobile Unit, the Base Station displays the crash location and severity on a commercially available mapping product.

Performance Testing. To check the communication between the Mobile Unit and the Base Station, the completed prototype was tested in tracking mode. In this test, the Mobile Unit and associated antennas were mounted in a car, and the Mobile Unit was switched to its special diagnostic-tracking mode. When in tracking mode, the Mobile Unit automatically reads the GPS and transmits its location every second. Note that tracking mode is a research diagnostic only: this mode will not be included in the production prototype. During the test, the car with installed Mobile Unit was driven on a 10-mile circuit around Rowan University. From the continuously updated map on the Base Station, we were able to track the student team as they drove from street to street, and even identify which lot they parked in upon their return.

Using a six-meter drop tower constructed for this task, the research team has subjected the Mobile Unit to foam-covered barrier impacts up to 30 km/hr. These test are designed to evaluate the survivability of the electronics to impact as well as testing the ability of the system to detect and report collisions of this magnitude. Impact tests to date have successfully tested the Mobile Unit at severities up to 9 G.

Conclusions

This research project has designed, developed, and tested a low cost Automated Crash Notification system that combines wireless communications and Global Positioning Systems with a network of inexpensive sensors for crash detection. Efforts to date have successfully designed and constructed a working prototype system. Successful operation of the prototype has been demonstrated in establishing a wireless web connection between the Mobile Unit and the Base Station, and in low-severity impacts up to 9 G's.

Recommendations

Future work should include a second research phase that will perform operational field-testing of the ACN system. A fleet test would evaluate the performance of the system in both crash and non-crash modes, and would provide important consumer acceptance feedback from the motorists. A fleet of 1000 ACN-equipped cars could be expected to incur approximately 10 collisions per year for evaluation of the system under crash conditions. The location of the cars should be chosen to produce a fleet mix representative of the New Jersey's mix of urban and rural highways. Captive fleets such

as those maintained by the New Jersey Department of Transportation or the New Jersey State Fleet would be ideal for such a field test.

References

- [1] 1999 Fatality Analysis Reporting System, National Highway Traffic Safety Administration, U.S. Department of Transportation (1999).
- [2] "Traffic Safety Facts 1999", National Highway Traffic Safety Administration, U.S. Department of Transportation (2000).

FOR FURTHER INFORMATION CONTACT:	
NJDOT Research Project Manager:	Ed Kondrath
Phone Number:	609-530-2058
Email:	EdKondrath@dot.state.nj.us
FAX:	609-530-3722
University Principal Investigator:	Dr. H. Clay Gabler
University:	Rowan University
Phone Number:	856-256-5346
Email:	gabler@rowan.edu
Fax:	856-256-5241