A Framework for Vehicular Accident Management using Wireless Networks

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Abstract

In this paper, a new framework for vehicular accident management using wireless networks is proposed and discussed. We present integrated wireless network architecture for next generation all IP wireless networks which supports our framework. In this architecture we show that different wireless Networks can provide Internet access for moving vehicles. A new distributed system is developed to manage vehicle accidents (anywhere, anytime) such that it communicates accident information with traffic police department, hospital, and Insurance Company. The proposed system is implemented using a test bed. Then the results are discussed.

Keywords: Wireless Networks; Accident Management, Vehicular Ad hoc Networks.

1. Introduction

Every year many accidents happen causing injuries and fatalities. For example, the road injury statistics in Yemen from 2001 to 2010 indicate that around 129,946 vehicle accidents was occurred, 166,744 person incurred serious injuries, and 25,441 people die [1]. Traffic statistics are worse in modern countries and it is in increase. The delay associated with these accidents increase the number of deaths. These statistics raise the query to have better accident management especially in countries with no infrastructure and in remote areas. As a result of the advances in wireless communications technologies and the availability of Internet access anywhere and in anytime, automobile manufacturers continue to incorporate more and more technological features such as wireless access with in automobiles, and new applications can be developed to achieve better accident management.

Due to the increase in the number of vehicular accidents in every country and due to the rapid growth and usage of wireless mobile communication technology and wireless networks, a demand for vehicle accident management services become increasingly important. Wireless networks can be utilized for a broad range of applications, which could allow the addition of valuable services [2]. All applications proposed are concerned with vehicle driving and road safety but none is concerned with accident management, so that new applications and services are needed in the near future.

2. The proposed framework

The proposed framework consists of three components, as depicted in Figure 1. The first component is the vehicle, which includes a computer system connected to different intelligent sensors. The second component is the heterogeneous wireless communication networks, which provide internet access and short message system between the vehicle computer system and Internet. The third component is a distributed system which includes different applications and database servers for managing vehicle accident.

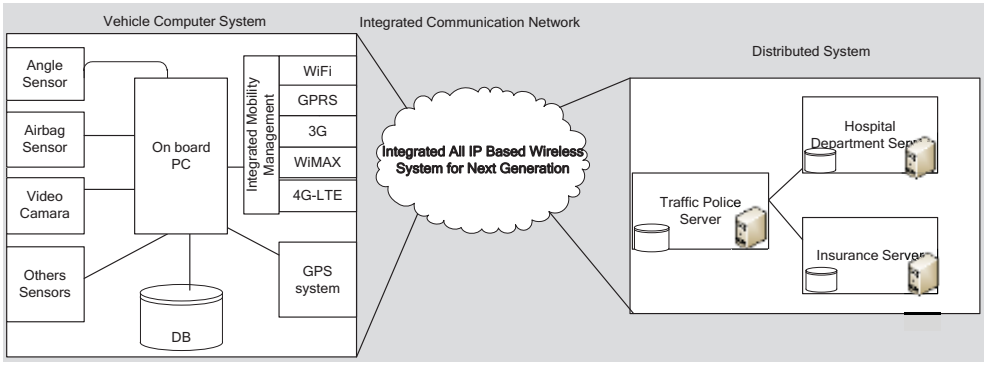

Figure 1: The proposed framework architecture

2.1. The vehicle computer system

It is a computer system connected to different intelligent sensors and control units, which are implemented by micro-controllers. Many research works

define the vehicle computer system requirement such in [3].

2.2. The heterogeneous wireless communication networks

The motivation for heterogeneous wireless networks arises from the fact that no one technology or service can provide ubiquitous coverage and continuous high QoS levels anywhere and anytime, so that seamless handoff across heterogeneous wireless access networks is one of the main features in the mobility management architecture of future generation wireless mobile networks[4]. The proposed framework is defined such that it utilizes the architecture of future generation wireless mobile networks. Figure 2 depicts the proposed framework network architecture.

2.3. Distributed system

The proposed distributed system is a software system running on one computer system as a client and three servers connected using the suggested heterogeneous wireless communication networks. The proposed distributed system is divided into four main modules, namely, vehicle computer system, traffic police system, hospital system, insurance system; together, these modules will cover the functions covered under the proposed distributed system. For example: vehicle computer system has many functions such as video recording, location coordinate detecting, communicating with mobile phone using SMS (auto or manually), and communicating with traffic police system.

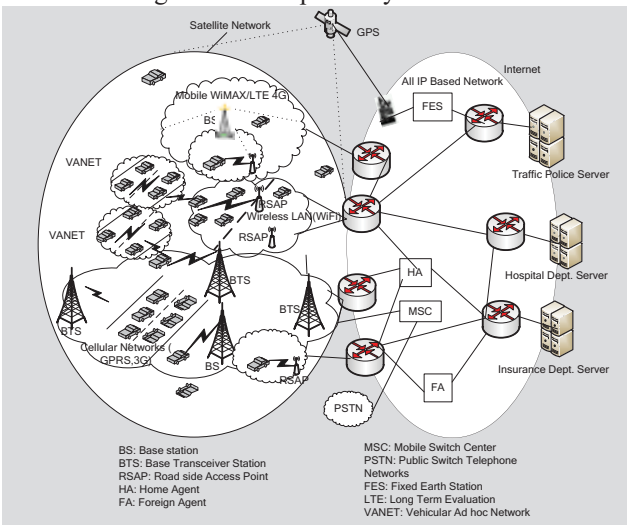

Figure 2: The proposed framework network architecture

2.4. System Design

The network infrastructure required for the proposed framework includes different types of wireless Networks. Next generation all IP wireless Networks is the most candidate for our framework. The mobile node performs seamless handoff between different networks. Mobile node senses different signal from different wireless network and select the strong signal according to some handoff algorithms [5, 6].

2.4.1 Vehicle subsystem requirements: The vehicle should has a computer system (on-board PC) connected to (1) digital camera, (2) wireless interfaces that support either one or all wireless networks, and (3) sensors connected to computer system, and (4) GPS system. The computer system must be kept in strong container which connected to the following:

Digital camera: for recoding the last moments before the accident, vehicles must be fitted with digital camera that continuously recording inside the vehicle. The proposed system records the last minutes before and during the accident. We proposed two schemes for recording accident: The first scheme is to start video recording while vehicle power is on until vehicle stop or accident occurs. The first scheme is simple and reliable because it records everything about the accident. This scheme needs huge amount of storage which is expensive. The second scheme use two video files. It starts recording in one file for ten minutes, after that it records in the second file for another ten minutes. After the ten minutes of recording in the second file is finished, it removes the contents of the first file and starts recording in it. The above steps repeated until accident occurs.

Wireless interfaces: For communication to occur between vehicles and Internet, vehicles must be equipped with some sort of radio interface, such as Wireless LAN, WiMAX, Cellular Network, and Satellite Networks.

Sensors: the vehicle computer system must be connected to sensors such as Air Bag sensor, and vehicle angle sensor. There are two methods for accident detection. The first one is when the vehicle turnover. We call it **vehicle turnover detection (VTD)**. In this case, the computer system continuously senses the vehicle angle. We assume that vehicle angle is 90 degree in normal position. If the angle is decreased or increased around 45 degrees, then this is an indication of accident and the accident process is executed. The second detection method is called **vehicle crash detection (VCD)**. In this method, the computer system continuously senses the air bag status. If it is on, then this is an indication of accident and the accident process is executed.

GPS system: Vehicles must be supported with device that provides detailed position information such as Global Positioning System (GPS) or a Differential Global Positioning System (DGPS) receiver.

2.4.2 System network architecture: the proposed architecture provides communication and Internet access inside the vehicle. The vehicle computer subsystem is connected to the Internet via different connections, such as wireless WAN, wireless LAN, and Satellite Network [4].

The wireless WAN would be one of the wireless Internet connection provided by any appropriate wireless communications carrier for cellular phone. The GPRS (General Packet Radio Service) [7], which it is a packet oriented mobile data service on global system for mobile communications (GSM), can be implemented as the wireless Internet connection and supports short messages system(SMS).

Wireless LAN with several handover schemes have been proposed to provide internet services for moving vehicles such as buses, trucks and high-speed trains [8]. The wide deployment of many WLAN access points reduce the cost of internet access and provide many services and applications for moving vehicle.

Mobile IP enables the mobile node to access Internet and changes its access point without losing the connection.

3. Implementation

Figure 3 shows a logical view of how all the components interact with each other while providing a framework for vehicle accident management. Each node has one interface. Each node gets configured manually as shown in figure 3. The laptop computer of vehicle is configured with the IP address of traffic police server and port number (5151). The traffic police is configured with IP address and port number as a client of the hospital server and insurance server.

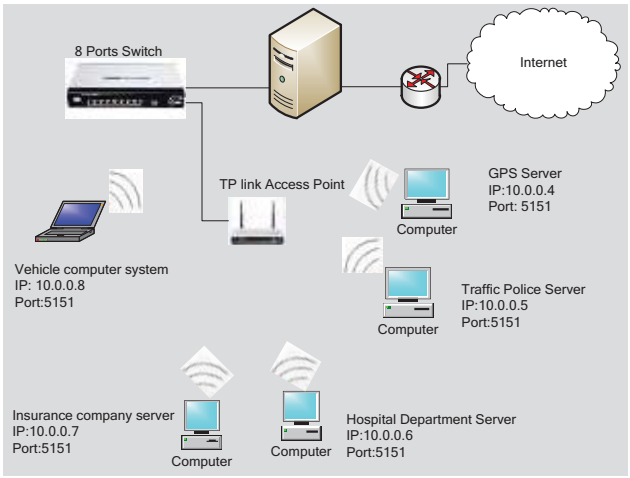

Figure 3: System test bed and components

We used Visual studio .Net 2008 using visual basic to code the system. Microsoft SQL server is used for creating database at every server. There are many scenarios of running.

4. Results and discussion

The system is tested successfully. Through running the proposed system, we found that we can manage the vehicle accident in a very short time anywhere, anytime.

5. Conclusion

This paper illustrates a novel framework for vehicle accident management suitable for next generation wireless networks. It presents discussion about each component of the proposed framework. The contributions of this paper are listed as follows. It enables communicating accident information between different system components efficiently. It presents integrated wireless network architecture for next generation all IP wireless networks which supports the proposed framework. It presents two methods for accident detection which are sufficient for any type of accidents. It records different accidents information which can be used for accident investigation.

6. References

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