

WVaMode: A Wi-Fi Vehicular ad hoc Mode for the unmanned vehicle

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Abstract— In recent years, eco-friendly transportation is becoming more and more important. Unmanned vehicle has attracted many researchers' attention from both the academia and industry of, notably, US, EU and Korea. Unmanned vehicle is widely accepted in many public places due to its reliability, security, pollution-free and low-speed. Under these circumstances, inter-vehicle communications has become an important topic in research for its potential advantages in enhancing traffic security and efficiency. Vehicular ad hoc network are emerging as a new class of wireless network, spontaneously formed between moving vehicles equipped with wireless interfaces, employing short-range to medium-range communication systems. As a complement of high-speed wired access technology, Wi-Fi is extensively used in the field of wireless communication (e.g. Intelligent Transportation System), which has many advantages such as mobility and cheapness. In this paper, we present adaptability using the Wi-Fi vehicular ad hoc Mode (WVaMode) for unmanned vehicle.

Keywords— Unmanned vehicle, Vehicular ad hoc network, IVC, Wi-Fi, OSI

I. INTRODUCTION

Unmanned vehicle is a kind of movable robot relied on the inside smart pilot controlled by computer system [6]. It uses the vehicle-mounted sensors to gather knowledge of the surrounding environment, and controls vehicle steering and speed according to the collected information such as vehicle and barrier position to make it more secure to drive on the road. The unmanned vehicle we consider in this paper is mainly used in many public places such as park, campus, industrial zone and airport.

Ad-hoc network is a wireless communication technology that has been widely studied. One of the typical researches is vehicular ad hoc network [7]. The following describes its basic concept. Vehicles equipped with wireless device compose a mobile wireless Ad-hoc network in a certain range. Vehicle can communicate with others as long as they are in the transmission range of each other. If they are out of range, the communication connection can still be established indirectly by using a third vehicle as an intermediate node to build a connection with source and destination respectively [3]. And because the vehicle carries enough energy, the power constraint in Ad-hoc network communication is ignorable and

thus it has a much wider transmission range than a regular node.

In this context, this paper puts forward a prototype mode of WVaMode (Wi-Fi vehicular ad hoc Mode) for unmanned vehicle. In WVaMode, vehicles equipped with wireless communication module are moving sensors on road, which can collect traffic information and transmit to nearby automatic vehicles. Paper proposed a method of estimating traffic status (including traffic speed, weather, and barrier position) based on WVaMode. The paper is organized as follows. In section2, we present a prototype of WVaMode system. In section3, we introduce the communication subsystem and conclusions are drawn in section4.

II. WVA MODE SYSTEM DESIGN

Before getting into the details of our new mode, we briefly review the preliminaries of 802.11 Wi-Fi and the Vehicular Ad-hoc Network.

A. Wi-Fi Operating Mode

802.11Wi-Fi, Wi-Fi has two modes of operation: infrastructure mode and Ad-hoc mode. In infrastructure mode, devices need to connect to an access point and all communications happen through the access point. The access point and the devices associated with it form a basic service set (BSS), identified by an SSID. In Ad-hoc mode, devices within one another's communication range communicate directly without going through access points. The devices thus form an independent basic service set (IBSS), which is identified by an SSID as well. Moreover, due to the increasing availability of Wi-Fi connectivity in mobile devices as well as its large transmission range and high capacity compared to Bluetooth.

B. Vehicular Ad-hoc Network Mode

Vehicular ad hoc Network is an emerging new technology integrating Ad-hoc network, wireless LAN and cellular technology to achieve intelligent inter-vehicle communications and improve road traffic safety and efficiency. Generally, a vehicular Ad-hoc network can be classified into two kinds. One is Road-Vehicle Communication (RVC) network, where a vehicle talks with a

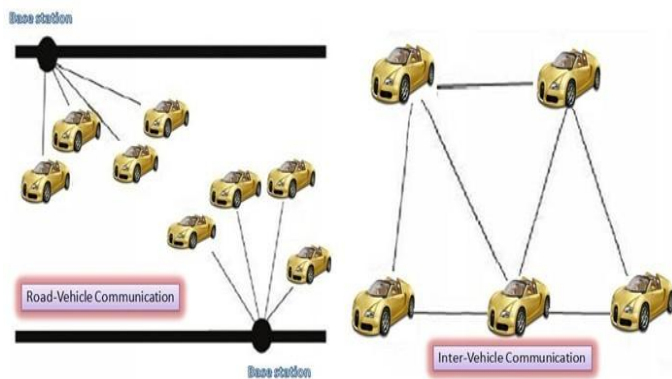


Figure 1. Two kinds of network in Vehicular Ad-hoc Network: RVC and IVC

base station on the curb. The other is Inter-Vehicle Communication (IVC) network, in which vehicle talks with vehicle directly (e.g. Figure 1) [2]. The RVC network is more reliable due to that its communication is taking place between a mobile vehicle and a non-mobile base station. But it is very expensive and takes much time to construct. By contrast, the IVC network is easier to build when there are more than two vehicles, and it prevents from constructing large-scale network by only placing a small wireless communication device on the vehicle. Our proposal uses Wi-Fi as communication method that makes the IVC network more reliable.

C. Wi-Fi vehicular ad hoc Mode

WVaMode is an infrastructure of traffic information based on RVC network model. It is composed by Vehicles equipped with WI-FI module, each unmanned vehicle is connected as a whole by wireless communication, and so traffic information can be transmitted and shared between vehicles.

In WVaMode, equipped vehicles can collect traffic information distributed in real time, and send it to other vehicles by multi-hop communication or to the Traffic Management Centre directly, which can help Traffic Management Centre to get traffic status accurately. Vehicles can communicate with other vehicles directly through Wi-Fi module, where vehicles can cooperate and forward information on behalf of each other. If the city's core road network is in the coverage of wireless inter-vehicle communication, traffic information management system can obtain the traffic condition of urban road network. This is the foundation of traffic control and traffic guidance, which can ease traffic pressure and improve road capacity in rush hours.

In WVaMode, vehicles acquire related information via lots of vehicle-mounted sensors. Every equipped vehicle is also a moving sensor in IVC network model. These equipped vehicles and Traffic Management Centre constitute a large scale wireless sensor network. Thus, WVaMode can get more extensive information. The collected information is managed by the Traffic Management Centre, and efficiently used for analysing the whole transportation system. As the wireless

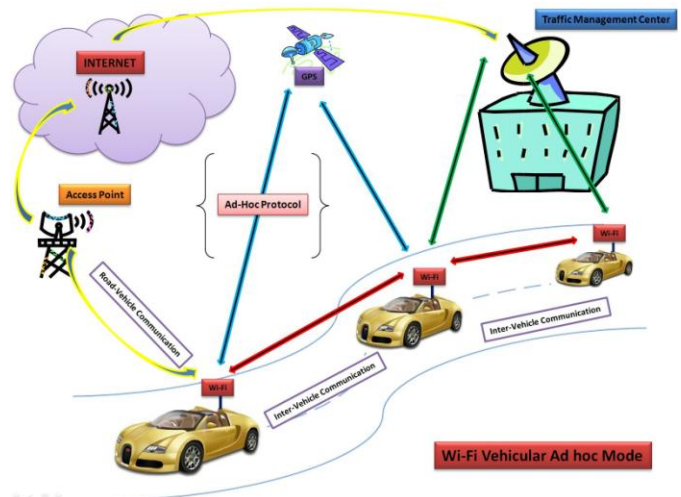


Figure 2. Wi-Fi vehicular Ad-hoc Mode System

mobile IPv6 (MIPv6) technology, assign unique IP address for transmission range is getting wider and wider, we can use each equipped vehicle. Then, unmanned vehicle can get not only road condition and dynamic guidance message, but also internet service, including text message and multimedia data, displayed on its inside monitor.

A prototype system of wireless traffic information service system is illustrated in Figure 2.

III.COMMUNICATION SUBSYSTEM

Inter-vehicle communication is based on WI-FI wireless network model, and all of the network mode have followed OSI (Open Systems Interconnection) network model [7], like OSI model, the communication subsystem of WVaMode has also hierarchical structure. Here, the WVaMode is composed by five layers:

1) Physical Layer: The task of physical layer is establishment and termination of a connection to a communications medium to transmit bit-stream. These are bit-streams operating over the radio link.

2) Data Link Layer: Data link layer is used to packet data from network layer into frames, and achieve error-free transmission on the link between two nodes. This layer manages the interaction of devices with a shared medium, which is the function of a Media Access Control sub layer, and IEEE 802.11 wireless LAN protocol, obsolescent MAC layers include Token Ring and FDDI.

3) Network Layer: Network layer is responsible for selecting suitable routing, this layer performs network routing functions, and might also perform fragmentation and reassembly, and report delivery errors. so that the packet from the host transport layer can be delivered to the right destination. The Network Layer provides the functional and procedural means of transferring variable length data sequences from a source to a destination via one or more networks, while maintaining the quality of service requested by the Transport Layer.

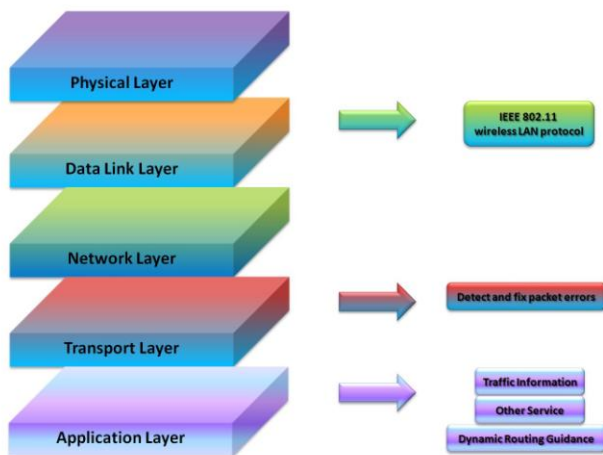


Figure 3. Structure of communication subsystem

4) Transport Layer: The most important layer, which plays a role as buffer when two Wi-Fi devices build a data connection network. Transport layer is used to control the information flow, detect and fix packet errors to ensure smooth communication.

5) Application Layer: It is the interface between inter-vehicle networks. In WVaMode, there are many types of applications. Equipped vehicle can send traffic information to the nearby vehicle or road-side station and download dynamic routing guidance as well. Besides, vehicles will share text, multimedia and other services in the network.

The structure of communication subsystem in WVaMode is shown in Figure 3.

Data to be exchanged may have different forms and the diversity of the protocols. In general, there are 3 data units for communication: Signals, data and information. We choose IEEE 802.11 as MAC layer protocol, and 2.4GHz as radio frequency. The signals can be carried with electromagnetic waves as in wireless communications, the physical protocols deals conversion between physical signals and bits, while the data link protocols in receiver side turn the raw bit flow into error-free data unit in proper format.

IV. CONCLUSIONS

In recent years, unmanned vehicle technology is developing rapidly. Automatic vehicle technology leads the future development of vehicles. In the near future, such smart vehicle Based on vehicular Ad-hoc network will be available for human being. This paper puts forward the prototype mode of WVaMode. WVaMode provides a new method of estimating traffic status via Wi-Fi device, every unmanned vehicle on road is also a moving sensor which can collect traffic parameters can send them to road-side station and vehicle nearby by multi-hop communication. All the equipped unmanned vehicles and road-side stations make up a huge wireless sensor network. Next work will focus on the simulation of inter-vehicle communication and optimization of system performance, which will be our future interest.

With the newest version of Wi-Fi Direct [9] [10] being released at the end of this year, to build a large Wide Area Network (WAN) will be the highlight of wireless communication research in the next few years.

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