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IoT applications of vehicle to vehicle communication for autonomous driving

Nguyen Thu Hang*

**Faculty of Information Technology, East Asia University of Technology*
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Abstract: *The trend of vehicle applications have increased with the development of connected autonomous vehicles (CAVs), which requires network communication topology to exchange information between vehicles and with vehicle to infrastructure. In real-time, this paper tests the Vehicle to Vehicle (V2V) communications equipment for autonomous smart car with ESP8266 module on laboratory, by Mega Arduino calculates the distance to the obstacle in front of the leader through the distance sensor. Immediately, distance data from this Mega Arduino which is forwarded to ESP8266 (Transmitter) and sends it to the two followers through its respective ESP8266 (Receiver). The results obtained by V2V channel experiment with a low cost, which show that the effectiveness and practicability transmitter/ receiver the data between smart cars in a platoon.*

Keywords: *Device communication, connected autonomous vehicles, V2V platform, V2I platform, real time.*

1. Introduction

A platoon is a group of Connected Autonomous Vehicles that apply network communication topology to exchange information between vehicles and with Vehicle to infrastructure. Namely, it can perform automatic movements [1] and performed the function tasks such as platooning [2], intersection crossing [3], and lane changing [4]. A platoon has the advantage of being able to perform various tasks automatically and efficiently, increasing overall traffic quality, growing traffic congestion and enhancing road safety.

V2V channel are crucial in the platoon to assist vehicles in acquiring information [5], which are one of the most important factors influencing platoon performance. The communication links between cars, such as how they transmit/receive or exchange information, are illustrated by information flow topology. These channels promote vehicle mobility and multi-step forwarding between cars to extend communication range.

The most prominent problem with V2V channel are its ability to do it in real time with the influence of several factors such as unpredictable transmission delays, the intermittent connections and speed and ability to transmit and receive data.

In this paper, we tried to cover all essential aspects so that some helpful information can be gained throw this review paper. This paper presents the development of the data communication systems between smart cars in a robot platoon using ESP8266 module through WiFi communication. ESP8266 module as data receiver/transmitter on the robots. For V2V, each ESP8266 module is connected through it emitting wifi. Communication system using a wireless used with a standard IEEE 802.11b with a frequency 2.4 GHz. The distance data of leader smart car is processed on ArduinoMega2650 based on distance sensor and forwarded to its ESP8266 module (transmitter). Then these data wil send to two followers through ESP8266 module (receiver).

2. System description

The electric vehicle is a new direction of interest for the development of autonomous smart car. The smart car components were introducted in the development of the electric vehicle as in Fig.1, which includes the Arduino MEGA 2560 microcontroller, the L9110S driver, distance sensor, the ESP8266 module... etc.

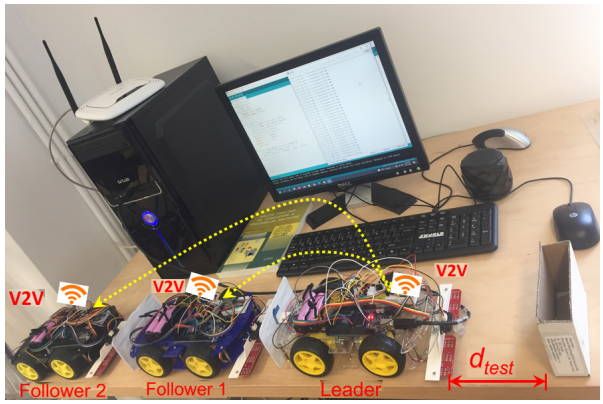

Fig 2.1. Testing communication V2V for smart car platooning

In this section, we focus on the aspect of transmitting/receiving data from other smart cars. Wireless communication is a transmission method that uses radio wave as the transmission medium. The information is modulated into the electromagnetic wave and transferred between points that not connected physically. Wireless communication has the broadcast characteristics, in which the electromagnetic wave is radiating to all direction and allows receiver to collect the information regardless of its position to the source as long as it is within effective radiation range.

ESP8266 module can easily transfer data and receiver data on the robots based on the router utilizing integrated WiFi technology and built-in stack. Communication system utilizing a wireless used with a standard IEEE 802.11b with a frequency 2.4 GHz. By the application of wireless based IP it would be help a man to control as well as on the monitoring.

Further, utilizing ESP8266 module, we may touch to any available network or make a P2P net mesh. It allows us to access a page and make web server by writting in HTML or any other supported language.

ESP8266 modules could even act like access points. we may communicate directly using P2P communication, or access it by a computer, smartphone or any device that may touch to the ESP8266 directly without the need for an external network.

The Wemos D1 Mini ESP8266 module in autonomous smart car area includes two functions: a transmitter device and a receiver device. This device is available on the market and one can easily buy it with the cost is approximately 7.

The C code blocks are implemented in Arduino platform, can be summarized as follows:

Step 1: Make sure the connection between Transmitter/Receivers devices is successful.

Step 2:

- Mega Arduino calculates the distance to the obstacle in front of the leader at time instant k (sample, respectively).
- Saved distance data in Micro SD card
- Forwarded distance data to Transmitter

Step 3: Communication: Transmits the data to Receiver 1, Receiver 2 through Transmitter.

Step 4: Forwarded the data from Receiver 1, Receiver 2 to Mega Arduino of two followers, respectively.

Step 5: Save the data of two followers in Micro SD card, respectively, Increment k and and return to Step 1.

3. Testing results

To confirm the proposed approach is feasible for real platoon control systems through car to car and car to infrastructure channels. We will test the ESP8266 modules for their suitability to be employed in Internet of Things (IoT) implementation.

The leader utilized infrared sensors made by Sharp gp2y0a21yk0f for distance measurement, Mega Arduino calculates the distance to the obstacle in front of the leader through the distance sensor and the data is forwarded to ESP8266. The ESP8266 module tasks data receiver/transmitter to other smart cars. The ESP8266 module used a wireless with a standard IEEE 802.11b, a frequency 2.4 GHz. By the application of wireless based IP it would be help a man to control as well as on the monitoring.

Data from the leader of Mega Arduino is transmitted to the ESP8266 module through TX1 and RX1 pins, it is called “Sever”, the transmission rate of Mega Arduino is 11500 baud. The ESP8266 module on each follower smart car is called the Client 1, Client 2, respectively. Data is transmitted from Server to Client 1, Client 2 through V2V channel or V2I channel and data transfer rate of Sever is 11500 baud.

The smart car platooning is tested the ESP8266 modules for their suitability to be employed in the smart car with V2V communication.

The Wemos D1 Mini ESP8266 module in autonomous smart car area includes two functions: a transmitter device and a receiver device. The diagram of ESP8266 module is as in Fig.2.

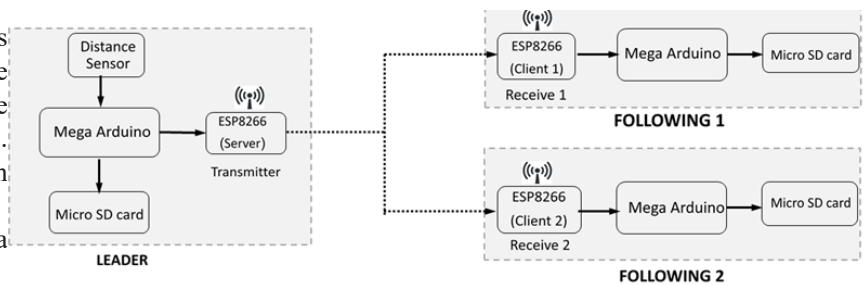

Fig. 2.2. Functional diagram for application

For the leader of smart cars, after the micro-controller has the distance data from the distance sensor, this data transmits the distance to each following car through WiFi communication module ESP8266 as in Fig 2.3. Communication between the smart cars are through a wireless from the ESP8266 of leader. The ESP8266 have a function as emits wifi.

Distance data transmitted from Server to the two respective Clients of the two following smart cars as in Fig 2.4, Mega Arduino calculate the distance through the sensor distance in time interval [0, 50s], at same time forwarded it to Server. Then, the data is transmitted from Server to two Clients, and then forwarded it to Mega Arduino of each follower through the TX1 and RX1 pins. Testing results can show in Fig 2.4.

For V2V channel, it is clearly seen from testing results, the errors between samples satisfied in the experimental results. The ESP8266 modules is a suitable application to employ for transmitting, receiving data between Mega Arduino and ESP8266 modules, Server and Clients for CAVs in the smart car platooning.

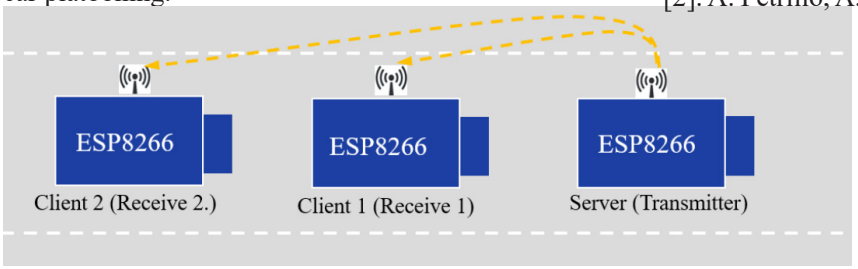

Fig 2.3. Diagram block processes of V2V channel data using multiple clients

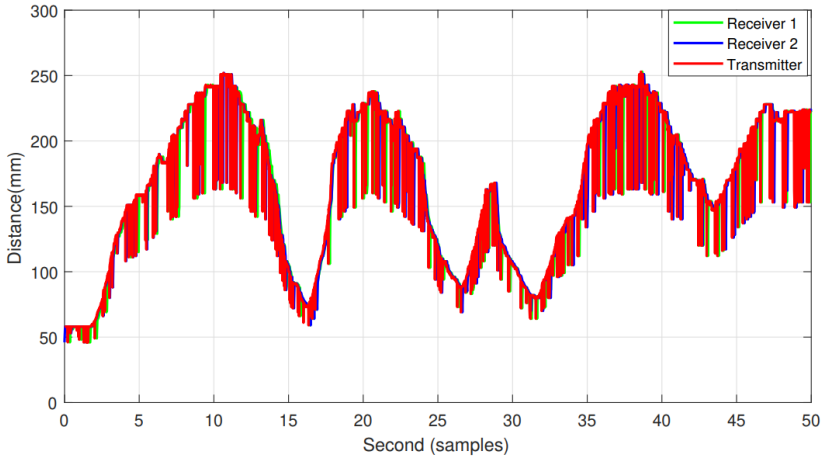

Fig 2.4. Data receiver and data Transmitter using multiple clients through V2V

4. Conclusion

In this paper, we have implemented a real test on laboratory with V2V channel using the ESP8266 module for smart car in a platoon. Mega Arduino calculates the distance to the obstacle in front of the leader through the distance sensor, and the data is forwarded to Server. Clients as data transmitter to two followers. According to the results, it is shown that the error between samples is satisfactory in the test results. The ESP8266 module is a suitable application to solve the problem of transmitting and receiving data between the micro-controller and the ESP8266 module for CAVs in the smart car platooning. Through V2V communication data exchange between smart cars forming a platoon can easily used in real-time application.

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