

Vehicles In Highway Communication System Using ZigBee And Bluetooth Network

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Abstract: Globally, many vehicle types operate on the highway system. And highway infrastructure stakeholders have developed a number of products intended to facilitate the identification of critical assets and provide guidance for conducting security planning. Many of these products are conducted as joint efforts between the state highway agencies. The main aim of the system is to have a network between Roadside Unit (RSU) and On-Board Unit (OBU) and between On-Board Unit (OBU) and another On-Board Unit (OBU). ZigBee is a consortium of software, hardware and services companies having improved a common standard for wireless networking of sensors and microcontrollers. Bluetooth is a technology of wireless standard for exchanging data for short distances. In this article, we point out sending data to the drivers via not only ZigBee module but also Bluetooth module.

Keywords: ZigBee, Bluetooth, PIC 16F877A, Temperature and Humidity Sensor, LCD, Personal Computer

I. Introduction

Vehicles belonging to highway services can announce themselves, automatically informing drivers about overcoming road work areas. Moreover, vehicles change quickly from a mechanical device into a mobile device because these days, our world is becoming increasingly digital and consumers want to remain connected all the time. Vehicles' drivers should be able to individually set up in their cars the things they want to share. Therefore, Vehicle-to-Roadside Unit communication would revolutionize tomorrow's driving with the help of intelligent mobility. Moreover, radio-based exchange of information between Vehicles (car to car) will also be needed in future.

Router module, USB to UART IC and Personal Computer having been Bluetooth module, the second OBU having Bluetooth module. Two sensing data from DHT11 are in analog wave form. It is the input data of PIC 16F877A and calibrated digital output waveform is fed into the Transmit ZigBee module. These waveforms are received from the Receive ZigBee module which are displayed on the On-Board Unit's computer monitor-screen. In addition Receive ZigBee module, the PC also has Bluetooth module for re-transmitting the waveforms to other OBU which has Bluetooth module as shown in figure 2.



Figure 1. System Configuration of Vehicles in Highway Security System using ZigBee Network

II. SYSTEM DESIGN

There are three communication parts in the system design; namely, Roadside Unit (RSU), On-Board Unit (OBU) in which one vehicle is built up with ZigBee module and Bluetooth module, and another On-Board Unit (OBU) in which one vehicle with Bluetooth module. The RSU is comprised of DHT11 sensor, PIC microcontroller, and ZigBee Coordinator module. The first OBU consists of ZigBee

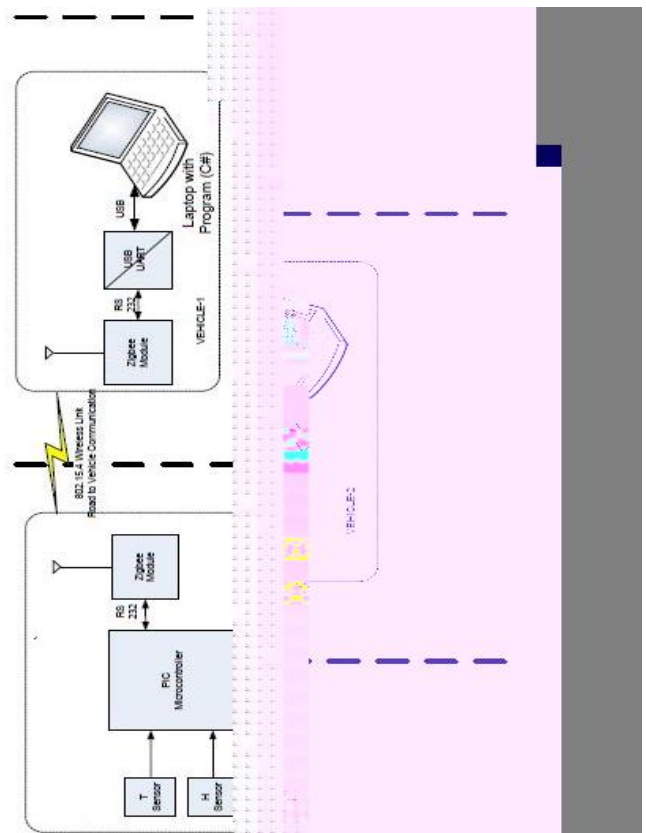


Figure 2. Block diagram of Overall System

III. COMPONENTS OF THE SYSTEM

A. ZigBee

ZigBee, a consortium of software, hardware and services companies developing a common standard, is a wireless network protocol specifically designed for low data rate sensors and control networks. There are three different types of device classes, namely ZigBee routers, ZigBee end devices, and ZigBee coordinator. There are precise steps of how a ZigBee network forms, such as firstly network scanning, then creating a Personal Area Network, discoveries of devices and services, ultimately binding devices. Devices are pre-programmed for their network function. Devices search and discover other devices in the network providing complementary services. Devices can be bound to other devices offering complementary services[2].

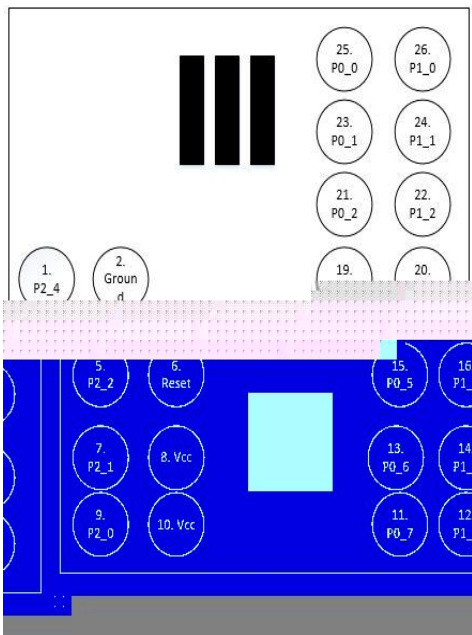


Figure 3. Pin Diagram of ZigBee Module (Xcore 2530)

B. DHT11 sensor

The DHT11 temperature and humidity sensor is a composite sensor contains a calibrated digital signal output of the temperature and humidity. These are the communication steps of reading the DHT11 data. At first, the environmental temperature and humidity data is tested and recorded after powering on the sensor. Then, microprocessor I/O pin set to output at the same time. Data pin is detected to an external signal of the DHT11 low, the output low of 80 microseconds as the Response signal with the output by the DHT11's the Data pin 40. After End signal, the DHT11 internally re-test environmental temperature and humidity data and record the data while waiting for the arrival of External signal. The DHT11 uses a simplified single-bus communication. By this way, data for communication and synchronization between the microprocessor and the DHT11 is transmitted as 40 bit, the high pulse first out. Data 40 bit = 8 bit Temperature integer data + 8 bit Temperature fractional data + 8 bit Humidity integer data + 8 bit Humidity fractional data + 8 it Parity bit

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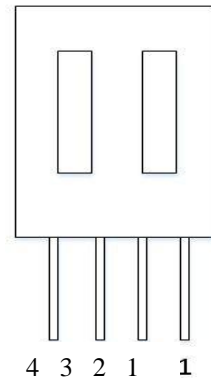


Figure 4. Pin diagram of DHT11 Temperature & Humidity Sensor

- Pin 1 = Vdd power supply 3.5 ~ 5.5 V DC
- Pin 2 = Data serial data, a single bus
- Pin 3 = NC, empty pin
- Pin 4 = Ground pin, negative power

C. PIC 16F877A

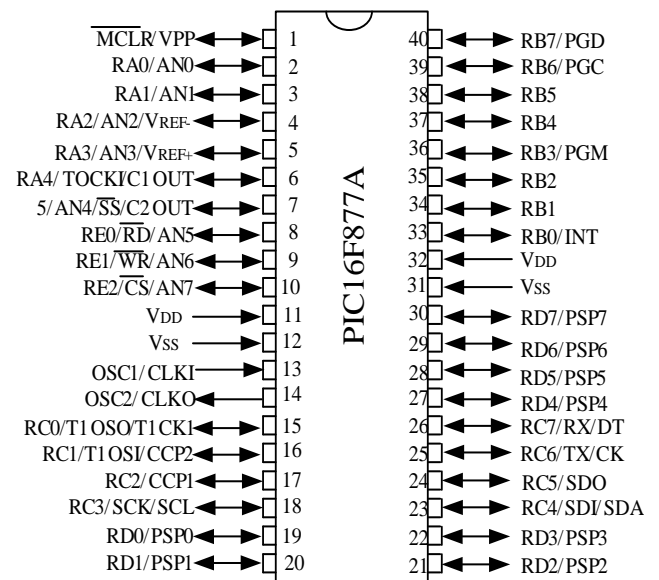


Figure 5. Pin Diagram of PIC 16F877A

The term PIC stood for Peripheral Interface Controller. These devices were originally designed for use in applications with 16-bit microprocessors and computer peripherals, remote control transmitters, domestic products and automotive systems. A simple microcontroller consists of the following modules: an arithmetic logic unit (ALU), one or more working registers for temporary storage during computations, program

memory and data memory, program counter, instruction register, the control unit and a stack[3].

D. Bluetooth

Bluetooth, a wireless technology standard, exchangedata over short distances UHF radio waves in the ISM band from 2.4 GHz to 2.485GHzfrom fixed and mobile devices for the purpose of building Personal Area Networks (PANs). Bluetooth is managed by the Bluetooth Special Interest Group (SIG). The IEEE standardized Bluetooth as IEEE 802.15.1 with no longer maintenance. Bluetooth uses frequency-hopping spread spectrum radio technology. Bluetooth divides transmitted data into packets on one of 79 designated channels which have every 1 MHz bandwidth where an instantaneous data rate of possible 1 M bits per second[1].

E. USB to UART (Universal Asynchronous Receiver/Transmitter)IC(FT232R)

PCs and many microcontrollers have a component called a UART that handles most of the details of sending and receiving serial data. This serial communication has been set up with 9600 baud rate, one stop bit, seven or eight data bits, one start bit and no parity bit. The FT232R is a USB to serial UART interface with several advanced features. FT232R transfer single chip USB to asynchronous serial data transfer interface. The whole USB protocol is handled on the chip which means no USB specific firmware programming required. 128 byte receive buffer and 256 byte transmit buffer are utilizing buffer smoothing technologies to allow for high data throughput. In this IC, UART interface supports for seven or eight data bits, one or two stop bits and odd/ even/ mark/ space/ no parity. This pre-programmed of unique USB serial number device operates from +3.3V (using external oscillator) to +5.25V (internal oscillator) single power supply. The FT232 is compatible with USB 2.0 full speed, having -40 degree Celsius to +85 degree Celsius extended operating temperature range.

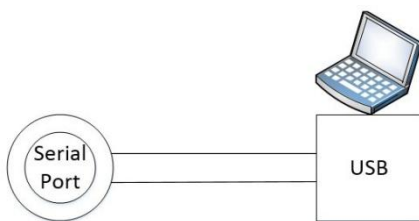


Figure 6. Block Diagram Of FT232

IV. SOFTWARE DESIGN

A. Roadside Unit (RSU)

In the flowchart of RSU, figure 7, the process is started up by initializing the input temperature and humidity data from the sensor. The analog input data from the sensor is fed into the microcontroller and then, the calibrated digital outputs are sent to the transmit ZigBee module (XCore 2530). Since the collection process of sensing data is needed in every second,

there is a yes or no looping for decision making. Ultimately, the results of temperature and humidity data are shown in the LCD display with the unit of Degree Celsius and Percentage.

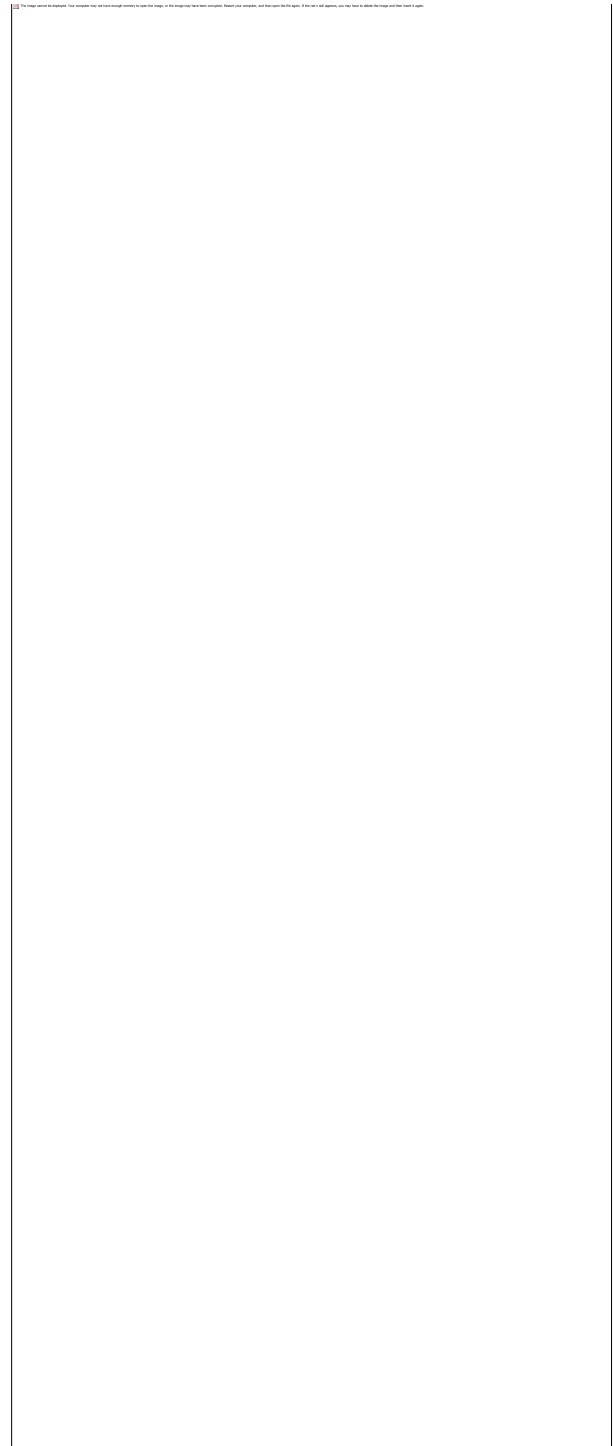


Figure 7. Flowchart Process Of Roadside Unit (RSU) for Vehicles In Highway System Using ZigBee And Bluetooth Network

B. On-Board Unit (OBU)

The Vehicle's OBU accept the data from the RSU via ZigBee module, and display on the OBU's monitor-screen,at the first portion. In the second portion, this OBU re-transmit these data to the another OBU using Bluetooth. The process of Temperature and Humidity are displayed in Monitor icon which is illustrated in figure 8. Figure 8 also expresses the connection of Bluetooth and Zigbee modules of the Vehicle's OBU.

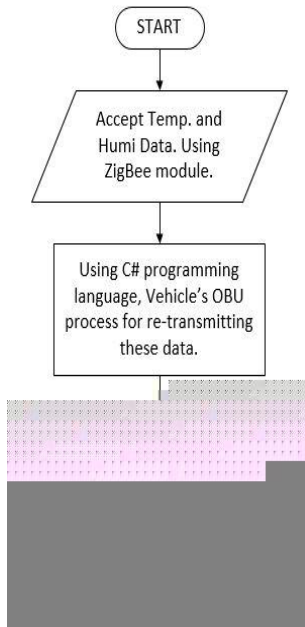


Figure 8. Flowchart Process Of On-Board Unit (OBU) For Vehicles In Highway System Using ZigBee And Bluetooth Network

V. RESULTS

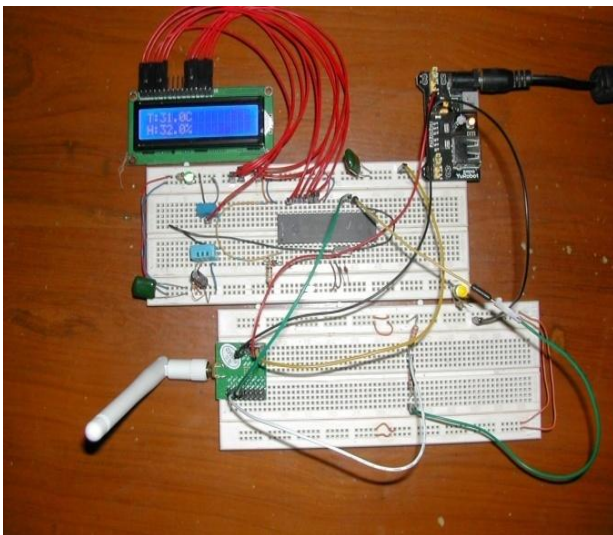


Figure 9. Constructed Circuit of The Roadside Unit (RSU with ZigBee module)

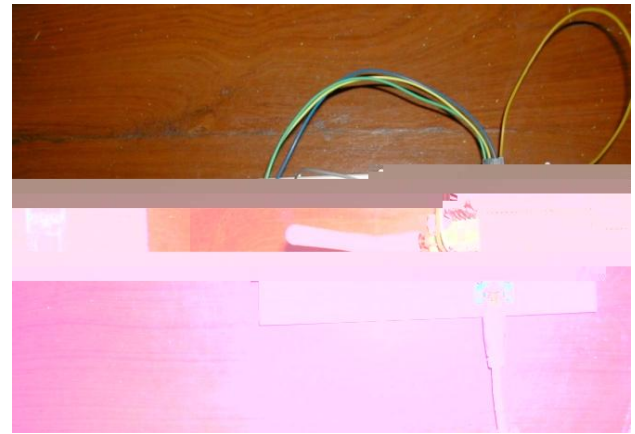


Figure 10. Constructed Circuit Of On-Board Unit(Vehicle with ZigBee module And Bluetooth module)

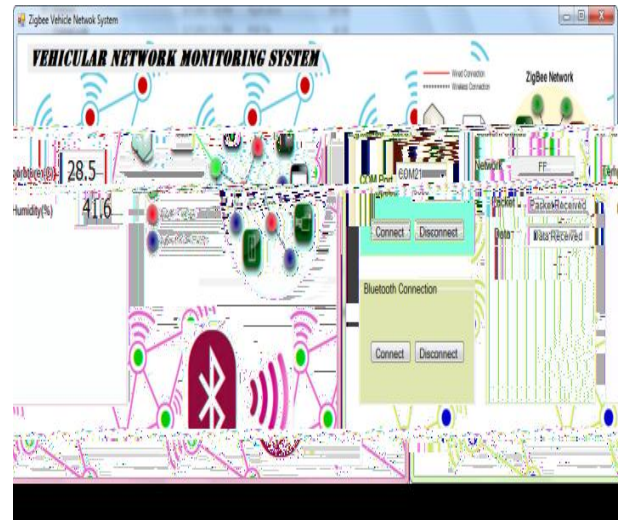


Figure 11. Graphical User Interface Of Roadside Unit (RSU) Using mikroC Programming Language

The practical construction and graphical user interface of the Roadside Unit (RSU) of Vehicles In Highway Security System Using ZigBee and Bluetooth Networks has been shown in figure 10 and figure 11. An GUI is an important part of software application programming in the area of human-computer interaction. Its goal is to enhance the efficiency and ease of use for the purpose of underlying logical design and a stored program. There are four main icons, namely ZigBee Connection, Bluetooth Connection, Network Status, and Monitor. When ZigBee Connection's Connect button is clicked, the operation is started. We can choose Computer Port number and Speed. In Bluetooth Connection icon, Connect and Disconnect buttons can be chosen. When Data and Packet Frame is received, the address of ZigBee module is shown, address range is from 0 to FFFF, default address FF, and numbers of connected devices via Bluetooth. The value of Temperature and Humidity are displayed in Monitor icon which is illustrated in figure 11.

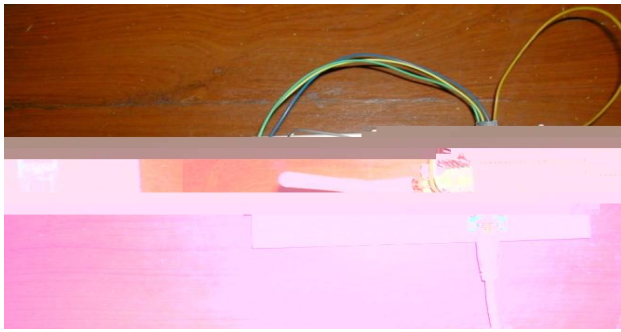


Figure 12. Constructed Circuit Of On-Board Unit(Vehicle with ZigBee module)

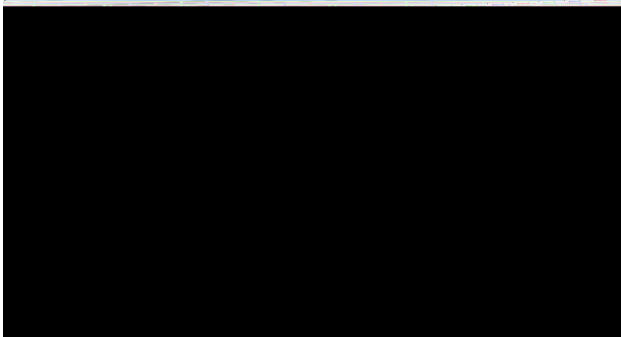


Figure 13. Graphical User Interface Of On-Board Unit (OBU) Using C# Programming Language



Figure 14. Constructed Circuit Of On-Board Unit (Vehicle with Bluetooth)

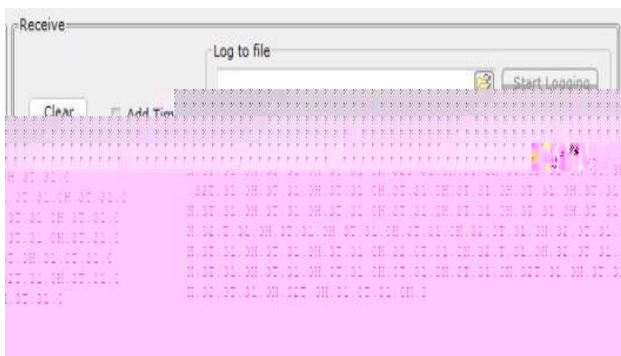


Figure 15. Output Result Of UART Terminal Using MikroC Programming Language of On-Board Unit

The practical construction of On-Board Unit (OBU) of Vehicles In Highway Security System Using ZigBee Network and Bluetooth Network and On-Board Unit (OBU) of Vehicles Using Bluetooth Network have been shown in figure 13, figure 14 and figure 15. The numeric value of output Temperature and Humidity data are illustrated in figure 15.

VI. CONCLUSION

The main aim of this Vehicles in Highways System is to have communication links along the highway lane. In future, vehicles (cars) will become connected, enabling the exchange of information between OBU and OBU (Vehicles-to-Vehicles) and their environment through Internet connection. With the help of RSU, the new era of mobility will lead to a highway for companies and countries in dealing with different challenges, such as security aspects, data privacy, and consistent connection line. According to market analysis, one in every five cars will be connected through the Internet until 2020 for the purpose of cooperation.

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