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Distance Measurement Implementation for VLC-Based V2V Communication on Motorbike Platooning

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Abstract

Vehicle-to-vehicle communication (V2V communication) is the wireless transmission of data between motor vehicles. The goal of V2V communication is to prevent accidents by allowing vehicles in transit to send position and speed data to one another over an ad hoc mesh network. Depending upon how the technology is implemented, the vehicle's driver may simply receive a warning should there be a risk of an accident or the vehicle itself may take preemptive actions such as braking to slow down.

In this article we used Visible Light Communication technology to provide communication system between motorbikes when platooning. The motorbike headlamp were used as transmitter and a photodetector placed near the tail-light used as its receiver. The implementation of distance measurement systems between motorbikes where implemented using ultrasonic sensing system where data transmitted to the leading motorbike can be used to keep safe distance over subsequent members of platoon with a maximum measurable distance of 3 m. The systems are more effective at a distance of 2 m. If the distance between motorbikes are less than 50 cm then an LED indicator, a Buzzer and LCD will light up as an early warning before the driver slow down its speed.

Keywords; *motorbikes platooning, V2V Communication, Visible Light Communication, ultrasonic distance measurement.*

I. INTRODUCTION

Technological developments in this era have increased significantly, especially in the field of communication. Transmission media can be divided into various types, from using cables to without using cables. Many innovations in transmission media, for example, use visible light to send information. Visible light communication (VLC) is data communication that uses visible light as an information medium [1].

In this research, visible light was used as a medium in the communication system between motorcycle. The workings of this system are using the front lights of a motorcycle to send information through visible light media in the transmitter side, while on the receiving side there is a photodiode that functions to detect information received, this component is installed on the back of a motorcycle which the function is to convert light signals into electrical signals, then electrical signal is converted back into digital information by the demodulator after it was amplified, then the ultrasonic sensor will work measuring the distance from the transmitter device to the receiver device. After that, the information in the form of distance will be processed first on the transmitter VLC device and forwarded to the receiver device, and the information will be shown in LCD. An ultrasonic distance sensor in communication between motorcycle has a range of 50 cm to 100 cm, if the range of the transmitter and receiver is out of the range, then the communication will be disconnected automatically.

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This research will be discussed about the design and implementation of distance measurements for communication between motorcycles using an ultrasonic sensor with visible light as a medium transmission, so that fellow motorcycles can communicate by measure the distances and adjusting the distance between motorcycles.

II. DESIGN

2.1 Designing a Distance Measurement System

The following is the process of designing the distance measurements.

In figure 1 shows the flow of the system design which is numbered with the following description:

1. Electrical power source for the system

For the simulation, the power supply is using several batteries arranged in series and produces a 12-volt. While for the implementation process the power supply is using accumulator with produces 12-volt.

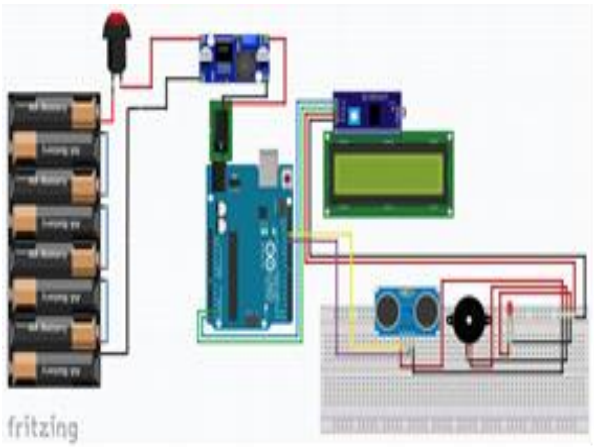

Figure 1 : Designing system in in fritzing software

2. Switch

In this circuit, a switch is used to turn on the source to make efficient the battery using, which will be used when conditions are really needed.

3. DC-DC regulator 12 to 5 volts

Regulator is used to convert the voltage of a battery that has a 12 volts to the required input of Arduinopower which is 5 volts.

4. DC Power Jack

the function of this component is to connect the regulator output circuit to Arduino so the voltage can be channeled.

5. Arduino UNO

This component is used as a microcontroller which functions to run and control a circuit through the configuration of codes on Arduino UNO.

6. Modul I2C

This device is used to simplify the wiring on the LCD, there are 4 pins including SCL, SDA, GND, VCC.

7. LCD

This device has a function for display the distance indicator in the form of a visual display, so the real distance can be seen directly.

8. Sensor Ultasonik

This sensor has a function for measure the distance between vehicles in real-time, then the distance data will be sent between vehicles, so that motorcycle users can know the distance between vehicles, and minimize the occurrence of accidents.

9. Buzzer

This component is used as a sound indicator, so that vehicle users can find out the distance being measured is nearing the distance of another the vehicle.

10. LED

This component is used as a visual indicator in the form of visible light, which the function to determine the distance that is being measured is nearing the distance limit of another the vehicle.

11. Project Board

This section is used to place the components that

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will be used to create the prototype of the system.

a. System Diagram

The block diagram of the system is designed to clearly show the flow of work on making this system, this part is made to simplify the process of making the circuit so that components can be identified as inputs and components that function for output. The following is a block diagram from the design of the proximity sensor system.

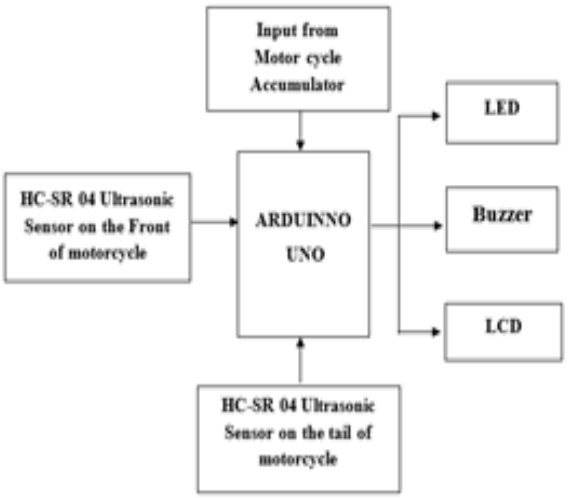

Figure 2 : Block diagram from the design of the proximity sensor system

The block diagram in Figure 2 makes it clear that the power for Arduino comes from a 12 volt accumulator, then after that the ultrasonic sensor HC-SR04 will measure the distance between vehicles, after measuring the data obtained from the proximity sensor will be processed by Arduino microcontrollers and the results will be displayed on indicators, including displayed visually through LCD and LED and displayed audio through the buzzer.

b. Flow Chart Distance Measuring System

In Figure 3, it explains how the measurement system using proximity sensor on a convoy motorcycle starts from turning on the vehicle's engine, after that there will be two choices, is the motorcycle will be allowed to join the convoy or not? If so, the switch will be turned on to drain the power to Arduino, thenthe proximity sensor will be active and start measuring the distance between the convoy vehicles.

Next, there will appear on the 16x2 LCD in the form of distance data that has been measured, if the measured distance is <50 cm then the buzzer indicator and LED will light up, but if the measured distance is> 50 cm, the indicator will turn off and the distance sensor again measures. Here is a figure of the flow chart of the HC-SR04 distance sensor measurement system:

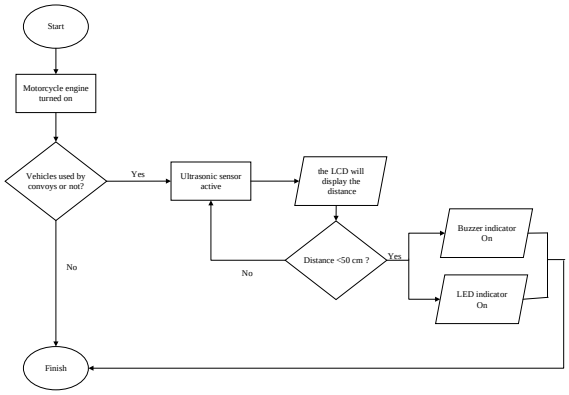

Figure 3 Flow Chart Distance Measuring System

c. Implementation of Distance Measuring Systems on Vehicles

In the implementation of the proximity sensor on a vehicle, a mechanical design is needed which is intended to protect components from outside the system, such as rain, heat, etc., and to place the components in the appropriate place. The following is the installation of a sensor device on a motorcycle:

Figure 4 : Implementation of the entire device on a motorcycle

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d. TheTesting Steps

This Tests will be carried out on the prototype and on the implementation results to compare the sensitivity of the ultrasonic sensor installed:

1. Prototype testing is done by placing the object in front of the sensor in some distance experiments, in prototype testing the distance is measured using a ruler, taking into account:

Table 1 : indicators used for testing

No.	Indicator
1.	LED
2.	Buzzer
3.	LCD

under the conditions that the LED will show a bright light and the Buzzer will also be loud if the sensor detects the distance between vehicles <50 cm, both of these indicators will die if the distance between vehicles is detected by an ultrasonic sensor> 50 cm, and the LCD will be as an indicator to display the measured distance.

2. from the implementation testing the sensor implementation on the vehicle is done by testing it on the motor that is on and all supporting components have been installed, the proximity sensor is placed at the front, then after the proximity sensor measures, the distance data will be sent via VLC to the receiver installed on another motorcycle, testing distance on the implementation measured using a meter, taking into account:

Table 2 : indicators used for testing

No.	Indicator
1.	LED
2.	Buzzer
3.	LCD

under the conditions that the LED will show a bright light and the Buzzer will also be loud if the sensor detects the distance between vehicles <50 cm, both of these indicators will die if the distance between vehicles is detected by an ultrasonic sensor> 50 cm, and the LCD will be as an indicator to display the measured distance.

III. TESTING AND RESULTS

3.1 Testing Results of Distance Sensor Implementation

Testing the results of the implementation is done by measuring the distance sensitivity of the proximity sensor.

From the results of testing, it can be concluded that distance sensor can measure up to 300 cm provided that the object in front of it is static, if the object in front of it is dynamic like a vehicle, the distance sensor can measure the maximum a distance of 200 cm, more than that there will be an error in measurement.

The following is a graph that aims to show the difference between measuring distance sensors for static and dynamic objects.

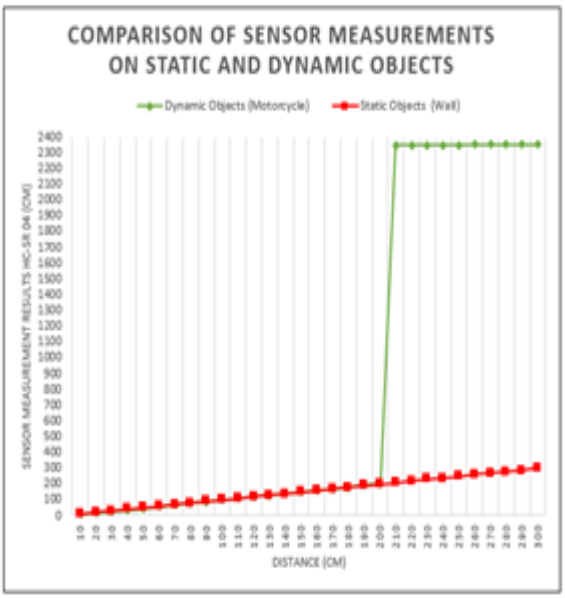

Figure 5 : Graph comparison of distance sensor measurements on static and dynamic objects

The red line graph shows the stability of the HC-SR 04 distance sensor when measuring the distance to a static object namely a wall and can measure distances at a maximum distance of 300 cm well, while a green line graph is the result of measuring distance sensors on dynamic objects namely motorcycle, where measurements above 200 cm become unstable. So if a conclusion is taken, the

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IV. CONCLUSIONS

Based on the explanation that has been explained in the previous sections, that the HC-SR04 ultrasonic sensor works by measuring the distance between vehicles, after measuring the data obtained from the proximity sensor will be processed by an Arduino microcontroller and the results of processing will be displayed on indicators such as flame from LEDs, audio from the buzzer to give warnings between riders that the distance between vehicles is too close.

The measurement results obtained include a distance of <50 cm, then the LED indicator and buzzer will light up, if the distance> 50 cm then the buzzer and LED indicators will be off, and the data sent can be seen visually through the LCD, if more than 200 cm then the measurement an error will occur because it exceeds the HC-SR 04 sensor sensitivity limit.

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