

Automotive Industry Safety using Virtual Light Communication

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Abstract- Starting from the first ever car invented until now in the automotive industry, safety is the main issues highlighted especially involving consumer driving activities. Therefore, this study is an attempt in investigating and designing a new concept of technology for future car based on the Virtual Light Communication (VLC) technology that involves the developing technology for driveless car. The objective for this project is to design and develop new model in transmitting signal from a car to another car inters vehicle communication using the approach of virtual light conception. Moreover, there are three stage available in carrying out the systems element; sensing, controlling and notifying stages. The receiver sensing elements will wait until system receives the transmitting signal from the sensing stage. In the meantime, for the controlling part it will supervise the motor performance based on the transmitting and receiver signal. Hence, an indicator is us for notification stage will notify the current condition of vehicle. At the end of this project, the system has been successfully being designed, developed and tested at the prototype level for three stage of the system. More to the point, the system will starts to trigger the IR sensor whenever the digital input becoming HIGH which will respond to the mechanical output. Nevertheless, the IR transceiver required a 38 kHz modulated frequency to match the operating system of the transmitter and receiver.

Keywords: *virtual light, IR transmitter, receiver*

I.INTRODUCTION

This paper present the application of VLC in Automotive industry safety that can reduce the road accident by transmitting the speed data for driver to be alert and be prepared when the front car is slowing down the speed. Hence, it examines the necessary elements for the realization of the development for the driveless future technology in automotive industry. This study will benefit users in increasing their safety especially during driving environment.

Virtual Light Communication system is one of the wireless communication systems that are still at the very early stage of usage. The VLC for application car to car break communication using IR transceiver expected to revolutionize the technology for the new feature that is driveless car. Apart of giving advantages to the user it also environmental friendly as it do not produce any harmful gasses or wasted raw material. Furthermore, it is practical to make with the simple design and minimal cost. Compare to what has been achieved in the area of infrared (free optic space) the application of VLC taken the idea from what are commonly applied at television and remote control. A way to connect with other device it is just a low cost needed. The angle of the VLC receiver and transmitter must be in the range of 90° for infrared receiver to receive the data transmit by transmitter. Data is not received or it will receive a non existing data (random data) if the angle is not parallel or out of sight.

From the former research on Visible Light Communication for Advance Driver Assistance System it shows that this project is an outdoor application that used the application of traffic light system for traffic information transmission[1]. Another research is Enabling Vehicular Vehicle Light Communication (V²LC) Network [2]. It examines the feasibility on realizing the VLC network influenced by noise and interference sources and the capability of the V²LC network for the requirement of the vehicle application. How the LED could send data and receives data using image sensor that actually consists and array of photodiodes is shown in the research. These two researches used different indication on applying VLC concept with different method.

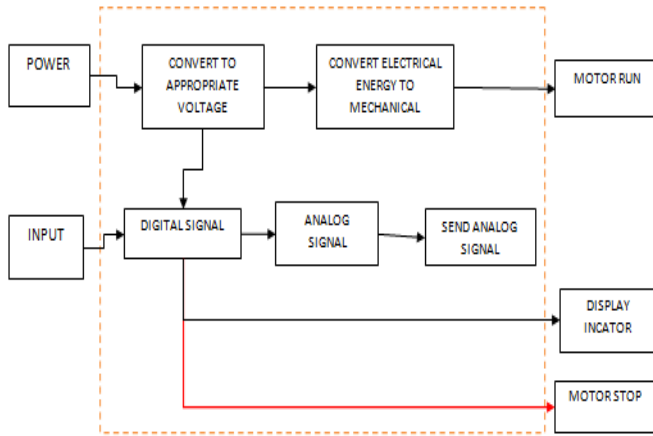


Figure 1: Block Diagram for VLC Transmitter

Figure 1 shows the block diagram of VLC transmitter. The VLC transmitter used IR transmitter to transmit the signal when input is detected. This system is power up 6V voltage that gives sufficient power in converting electrical to mechanical energy to run the motor. The digital input is either HIGH (1) or LOW (0) signal will be converting into analogue signal and transmitting the signal to the receiver.

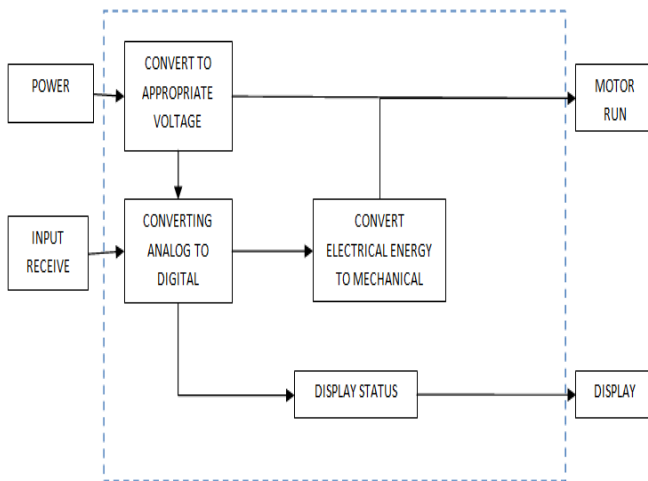


Figure 2: Block Diagram for VLC Receiver

The block diagram of VLC receiver is showed in figure 2. The receiver will respond when receiving signal from transmitter to produce desired output when the digital input of transmitter is HIGH (1). There are many different kinds of infrared receivers. IR communication module has both transmitter and receiver design with modulated frequency of 38 kHz.

II. METHODOLOGY

A. Flow Chart

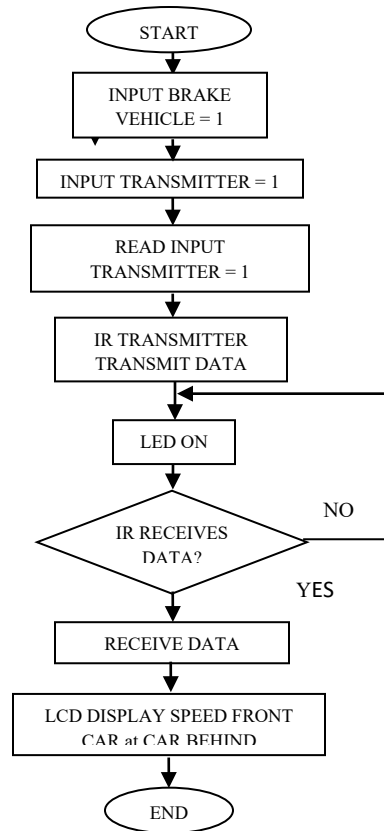


Figure 3: Operation of the project

Figure 3 shows the flow chart of Automotive Industry Safety using Virtual Light Communication. When the driver of front car pushes the vehicle brake, it will send digital signal to the controller and transform into analog signal and the transmitter will transmit the signal to the receiver. For the DC motor speed, the value being set at the Pulse Width Modulation (PWM) input is the transmitting input. When the data is transmitting, there is an IR Receiver waiting to identify the receiving data from IR transmitter. The receiver will waited until it receives the matching data from the IR transmitter and display the data through the LCD display. In addition, when IR receiver receive the signal from the IR transmitter the system will automatically reduce the speed of DC motor for about 50% of duty cycle. Else, it will loop again or wait until the transmitter send signals again if the sensor cannot detect the transmitter signal.

B. Circuit Design

For the project to successfully operated, connection of circuit and pin location is important in circuit designing. In identifying whether the circuit is complete routing and well-designed for the model to operate, experimenting process for the circuit is another step to be done. To check whether it has error and synchronous with the coding being programmed, the circuit was tested on the breadboard. The circuit then will undergo the testing and troubleshooting process again.

In this project, there are two circuit had been used. One is connected with Arduino Uno microcontroller and another one with Arduino MEGA microcontroller. However both of the microcontrollers being set with different task, one for transmitter and another is receiver. Both of microcontrollers are using the same ATMEL integrated circuit. The output for both circuits is the DC motor and indicator.

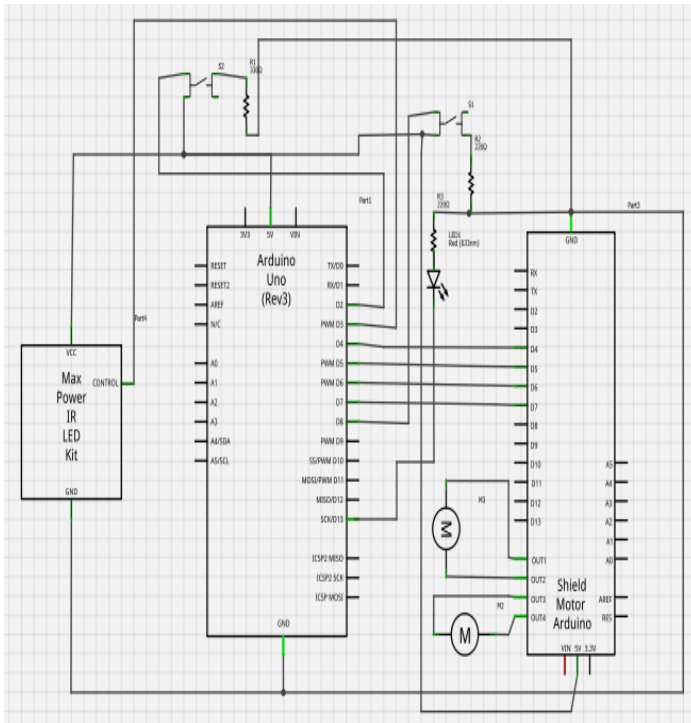


Figure 4: IR Transmitter with arduino UNO schematic for Brake system

The schematic diagram of the transmitter part of the VLC for Brake system is shown in figure 4. It consists of Arduino Uno microcontroller as the control Unit, Arduino Motor Shield, IR Transmitter as mean of communication.

Arduino Motor Shield used to drive current that needed to operate the motor and its system that connected at digital pin. To control the speed of motor, the duty cycle need to being set at the digital pin of arduino using Pulse Width Modulation (PWM) technique. IR LED transmitter that used in transmitting signal or data is the important component for this project. IR LED will start transmitting when receiving digital input and thus will send the signal to the receiver to read the data.

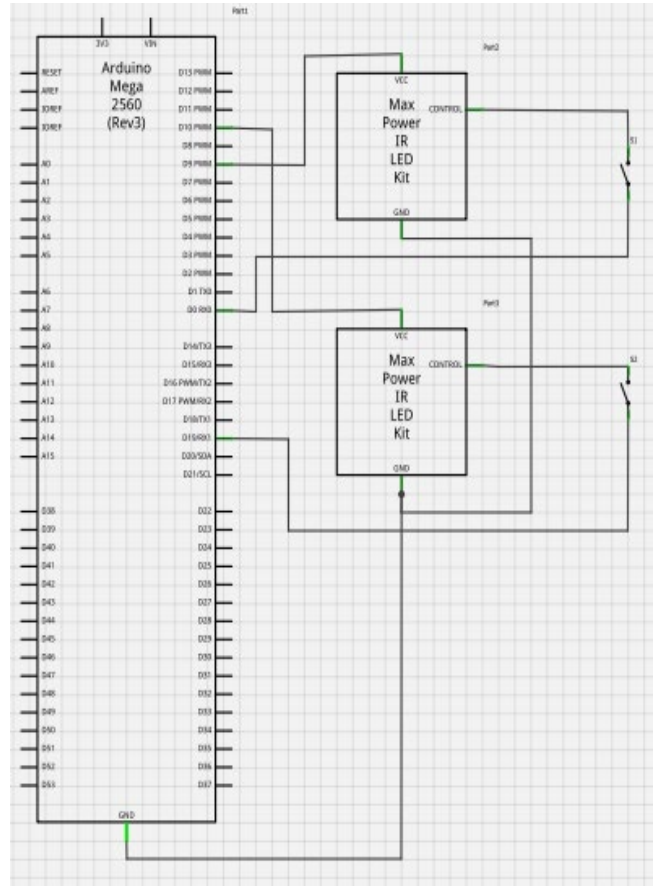


Figure 5: Schematic diagram of Transmitter part of VLC for Vehicle Signal

Figure 5 is the schematic diagram of transmitter part of the VLC for Right and Left Vehicle Signal. This circuit consists of two IR transmitter, Arduino MEGA and push button use as to give the input either Right or Left IR Transmitter will transmit the signal when user of vehicle want to turn Right or Left.

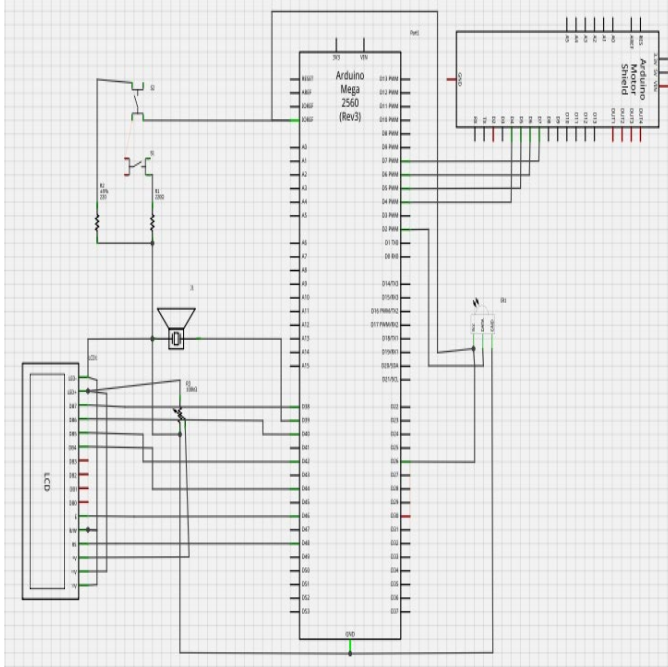


Figure 6: Receiver part Schematic diagram

Figure 6 shows the Receiver part for this system. These parts consist of three main components, Arduino MEGA with more than 12 digital input, IR receiver motor driver and LCD as indicator. LCD will display the current situation of IR receiver for the user read data receive. IR receiver also part of receiver as the receiving sensor that connected to digital pin 2 of Arduino MEGA.

C. Design Specification



Figure 7: IR Transmitter Module

Figure 7 shows IR Transmitter Module. IR Transmitter Module is design for IR communication pairing with the IR Receiver module. Nevertheless, IR Transmitter also has its own limitation that is needed to synchronous with the whole systems. IR transmitter specification is need 5V as power supply, modulate frequency is 38 kHz and interface in digital.



Figure 8: IR Receiver module

IR Receiver module has shown in figure 8. IR is widely used in remote control application. With the IR receiver, project is able to receive command from any IR remote controller if connected with the matching IR module with the IR receiver. The specification of IR Receiver is same with the IR Transmitter Specification. The specification for the IR Receiver is corresponding with the IR transmitter.

To move the motor and its chassis is another important element in this project. Additional power supply is needed to move and support the dc motor so that it could operate in the whole system. DC motor need a motor driver to drive the maximum current 2A to the motor so that it receive sufficient current and both motor used could rotate with the same current and voltage. The specification for the Arduino Motor Shield showed at table below.

TABLE 1: ARDUINO MOTOR SHIELD USES L298P

2A Motor Shield
2 way 7-12V motor drive
Support PWM speed control
Up to 2A current each way
Pin 5,6,7,8 to drive two DC motor

III. RESULT AND DISCUSSION

Technology in using wireless has spreading up. Mostly there has been revolution of the new technology system. Infrared is one of the low cost wireless communications that can be improve more in its application. To reduce the small accident heading for the new technology of driveless car, the design of VLC for vehicle use is one of the ways. It is a low cost way to be used in communication between vehicles. Two cars has been use as the module in this project to describe the application.

The sensor that will modulate signal in the range of the frequency being set for the sensor is IR transmitter. Therefore, IR transmitter will transmit data within the range of 38 kHz frequency as long it is synchronous together with IR receiver. The data will transmit successfully as long as it in the frequency of 38 kHz.



Figure 9: Virtual Light Transmitting data using IR.

Figure 9 shows the transmitter and receiver in the parallel position. As long as it still in 38 kHz frequency IR transmitter will transmit data up to above 200cm. But, IR will only transmit data if parallel condition as shown in figure 8 and in range 90° degree. For this project, two cars are required for modeling. When the brake light or signal light is emitting, the IR transmitter will send data to alert the car behind.

From the testing of the IR transmitter and receiver it has shown that the time taken for data transmit between the vary distance is small. Though different between each of the distance has small delay but it still can transmit faster than we can ever realize the difference. The time taken varies with the distance. The longer the distance the longer time taken. The longer distance also will make data unstable in transmission data It is good to know that short distance time taken to transmit is faster as for this project design to avoid collision especially during traffic jammed and the new future of driverless car.



Figure 10: 80% of PWM duty cycle.

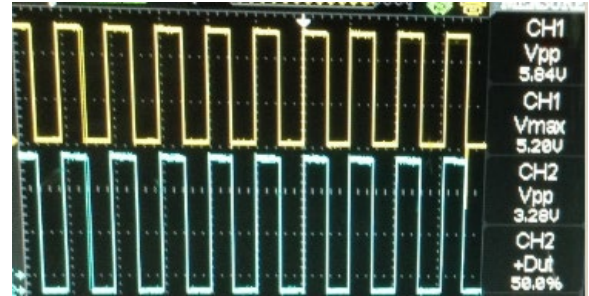


Figure 11: 50% of PWM duty cycle.

Figure 10 and 11 show the speed of DC motor that has been control according to the how much duty cycle being set.

LCD plays the role as indicator displaying the speed of the car in front as awareness for the car behind in order for the user to notify the receiving data. Buzzer also use to alert user when then the receiver receive the data. The car behind will reduce speed automatically but not too drastically as being set at PWM. The car speed still can be control since it only reducing speed when receiving the data. User can choose either to continue with the speed or increase backs the speed when receiving the data. It is just one of the precaution steps for the driver to be cautious of the environment on the road.

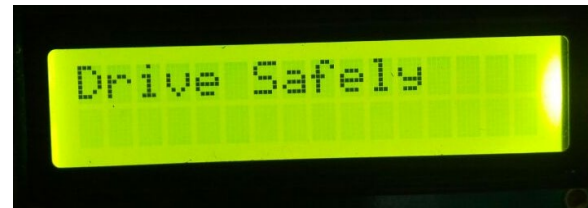


Figure 12: Normal condition for LCD display.

In the normal condition where users do not receive the data, the LCD will display “Drive Safely”. Thus, this means that the condition between vehicles or the distances is still in safe situation for the driver.

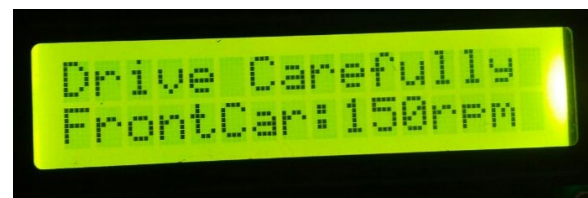


Figure 13: LCD display when receive information

Figure 13 shows the display of indicator when the system has received the signal from the transmitter. It will show the present speed of the front vehicle each time the vehicle receive the information. Only from the match IR transceiver that IR receiver can receive the data. User can monitor the condition from the LCD.

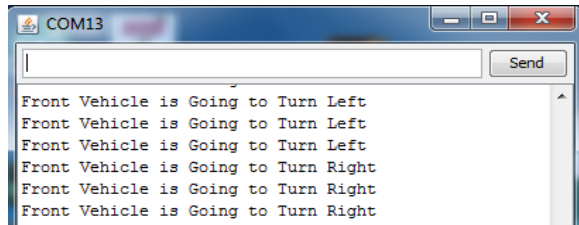


Figure 13: Indicator display when receive signal

Apart from the brake system, this system also has signal system. When a front vehicle turn on left or right signal, the receiver will receive the data from the transmitter. Figure 14 shows the display when a from vehicle turn on the signal.

IV. CONCLUSION

This paper has presented an Automotive Industry Safety using Virtual Light Communication. This project shows that, the model do not only manage to transmit and receive signal but able to control the mechanical output using PWM technique. As long as the transmitter and receiver is still in the range of 38 kHz and both of them is powering on, the VLC model can transmit and receive the data. Transmitter will transmit signal when the input goes HIGH and automatically reduce duty cycle of the DC motor on receiver part. Vehicle will operate with normal duty cycle if do not receive data. The only transmitting necessary is when the input asserted HIGH. In recommendation, for the project to be marketable, more features need to be added and improved since the project prototype has some limitations for example in detecting the range or distance between vehicles. It is hoped that the low cost commercial version of this device could be developed to benefit the entire road user in the future.

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REFERENCES

- [1] L. A. N. Navin Kumar, Rui L. Aguiar, "Visible Light Communication for Advanced Driver Assistant Systems," Universidade de Aveiro, Portugal 2006.
- [2] B. S. Cen Liu, Edward W. Knightly, "Enabling Vehicular Visible Light Communication (V²LC) Networks"
- [3] E. S. o. Jens Eckstein, "Dynamic Collision Detection in Virtual Reality Applications," Saarland University, Germany.
- [4] Komine, T.; Nakagawa, M. (2003) Integrated System of of White LED Visible-Light Communicaiton and Power Line Communication, IEEE Transactions on Consumer Electroincs, Vol. 49, No. 1, (2003) (71-79), 0098-3063
- [5] J M Kahn, J R Barry, "Wireless Infrared Communications", Proc. of IEEE, Vol. 85, February1997.
- [6] E. F. Schubert, Light-Emitting Diodes. Cambridge, U.K.: Cambridge Univ. Press, 2003.
- [7] Yuichi T. and M. Nakagawa, "Indoor Visible Light Data Transmission System Utilizing White LEDs Lights", IEICE Trans, Commun. vol. #86-B, no. 8, Aug. 2003.
- [8] Y. Hayashi, "Application of Traffic Signals for Wireless Visible Light Communication System," Technical Report of IEICE, ITS2001- 147, March 2002.
- [9] T. Komine, M. Nakagawa, "Fundamental analysis for visible light communications using LED lights," IEEE transactions on Consumer Electronics, Vol. 50, Number1, pp. 100-107, February 2004
- [10] J. Kahn, R. You, P. Djahani, A. G. Weisbin, B. K. Teik, and A. Tang, "Imaging diversity receivers for high-speed infrared wireless communication," IEEE Communications Magazine, vol. 36, no. 12, pp. 88-94, December 1998