DEVELOPMENT OF REMOTE CONTROL ROBOT CAR USING INFRARED SENSOR AND PWM

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ABSTRACT: In today's modern world, an autonomous driving system is capability of a vehicle or a robot moving without control with a promising technological concept. However, at the same time, manual control system are still playing a significant role in robotic field. The final goal of the project is to create a robot car system that utilizes both manual and auto control through usage of the infrared (IR) sensor. The infrared sensors enable robot to be control through manually or through obstacle while making the project low-cost and affordable. This technical report demonstrates the development of prototype of the IR sensor controlled robot car. The main objective of this design is to focus on versatility, durability, simplicity and improvised operations.

KEYWORDS: *FPGA, Infrared (IR) sensor, Pulse Width Modulation (PWM)*

1.0 INTRODUCTION

An infrared (IR) sensor is an electronic instrument that is used to sense certain characteristics of its surroundings and there are many applications by means of IR device. It does this by either emitting or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion. Buldu (2016) optimizes the use of IR transmitter to measure the pulse rate of the drive while driving the vehicle.

Infrared technology is not only found in the industry, but also in every-day life. Televisions, for example, use an infrared detector to interpret the signals sent from a remote control. Passive Infrared sensors are used for motion detection systems, and LDR sensors are used for outdoor lighting systems. The key benefits of infrared sensors include their low power requirements, their simple circuitry and their portable features.

Flynn A. M. (1988) has studied navigation system that utilize IR implementation for motion. Multiple sensors can be used on a mobile robot so that it can perceive its environment with better accuracy than if either sensor were used alone. Sonar and infrared sensors are used here in a complementary fashion, where the advantages of one compensate for the disadvantages of the other. The robot then combines the information from the two sensors to build a more accurate map. Another representation, a modified version of the curvature primal sketch, is extracted from this perceived workspace and is used as the input to two path planning programs: one based on configuration space and one based on a generalized cone formulation of free space.

2.0 PROJECT DEVELOPMENT

The purpose of this project is to build and develop a navigation system that takes input from IR sensors, using them to help the vehicle move forward and turn based on the inputs given. Overall process can be divided into 3 parts; (a) Picking up of surrounding signals through sensors, (b) Signals sent to central processor. Processor read the signals, computes the direction for the car, and send out the signals and (c) Wheels of robot receive the signals and move.

The main objectives are developing of a system that enables auto and manual control, in which auto mode enable detection and passing of obstacles in front, while manual mode ensure the car to follow the direction of motion from user.

The project was taking a concept introduced by Murat A. J. et al. (2014) to compare the physical and mathematical results conducted in accordance with the properties of radio controlled car with the results that come out from the simulation in FPGA platform. These results will depend on the physical properties of radio-controlled car and the properties of the environment. In order to have successful result, which leads to proper operation (desired movement) of a radio controlled, the car must choose the appropriate electrical component and the suitable electrical component for a safe movement. The project were following Sedra A. S. et al. (2004) and Gray P. R. (2009) on how to analyze and design electronic circuits.

3.0 MECHANISM AND PROJECT DEVELOPMENT

3.1 Components and functions

A few components are needed for the project. Two Direct Current (DC) motors are used as wheels, and L293D IC to act as the motor driver for both of the dc motors. For the computing unit / programmable integrated circuit (IC), in this project, Field Programmable Gate Array (FPGA) name Altera Cyclone IV E (ce115f29c7n) by Intel was used. Software use to program the FPGA is Quartus IV 12.1 edition.

Firstly, the IR sensors will pick up motion or object from three different direction (front, left and right). If a signal is detected, IR sensor will send it to FPGA for analysis, and output is given based on mode that has been chosen. For auto mode, the robot car will move to the right if left IR get reading, left if right IR give reading, and stop if straight path is blocked. For manual mode user can control the direction of car by blocking the IR sensor, (left if left sensor have reading, right if right and so on). Controlling of both left and right motor were done by using the L293D IC that act as motor driver.

3.2 Block diagram

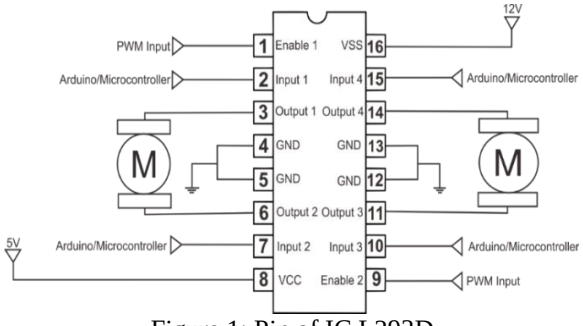

Figure 1: Pin of IC L293D

A diagram showing in schematic from the general arrangement for the L293D IC of a complex system can be found in Figure 1 that shows the circuit for both manual and auto mode.

3.3 Motor Part Design

Manual Mode:
There are two inputs for each motor. In this case, one input, O1 for left motor and O2 for right. I1, I2 and I3 represent IR straight, left and right.

Table 1: Manual truth table

I1	I2	I3	O1	O2
0	0	0	0	0
0	0	1	1	0
0	1	0	0	1
1	0	0	1	0

Auto Mode:

Table 2: Auto truth table

I1	I2	I3	O1	O4
0	0	0	1	1
0	0	1	0	1
0	1	0	1	0
1	0	0	0	0

Logic gates were utilized to build the circuit. K-maps was used to find out which logic gates to be used.

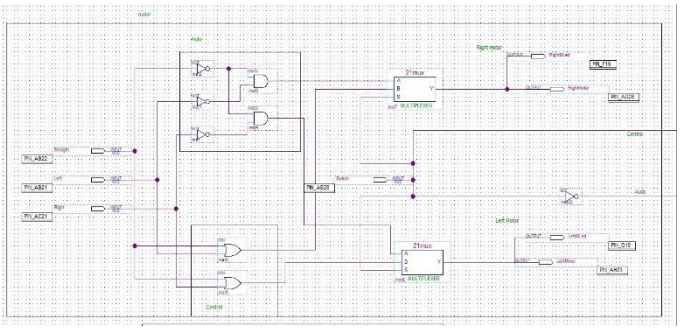

Figure 2: Motor circuit as in Quartus 12.0

3.4 PWM (Pulse Width Modulation)
PWM technique was applied in this project to utilize digital input to control output and to modulate the speed of dc motor. Frequency divider was used to decrease the frequency of original clock. Three different frequency square wave are produced through 3 bit up-counter (Q1, Q2 and Q3) and each is use for 25%, 50% and 75% speed. A 100% power was achieved by directly taking the Vcc as input.

Table 3: Truth table for T flip-flop

Qi	Qi+	T
0	0	0
0	1	1
1	0	1
1	1	0

Truth table for Counter with output as mention is build.

Table 4: Truth Table for counter

Q2	Q1	Q0	Q2+	Q1+	Q0+	T2	T1	T0
0	0	0	1	0	0	1	0	0
1	0	0	1	1	0	0	1	0
1	1	0	1	1	1	0	0	1
1	1	1	0	0	0	1	1	1

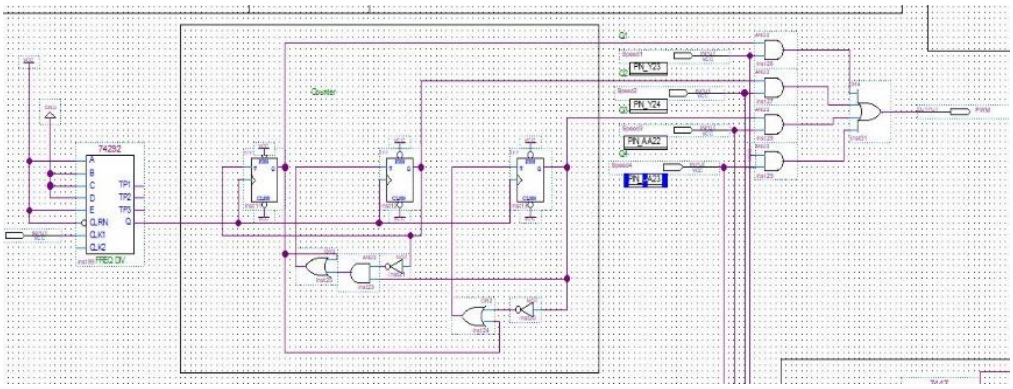

Figure 3: Counter circuit.

In Figure 3, four and gates and one or gate were used as switch to choose between suitable speed.

3.5 Display
7-segment display was used on FPGA as display to monitor activities on the system. There are two types of displays were set up; mode display and speed display.

3.5.1 Mode display
The truth table and k-maps were utilized in order to obtain all needed output and build the circuit through or gate.

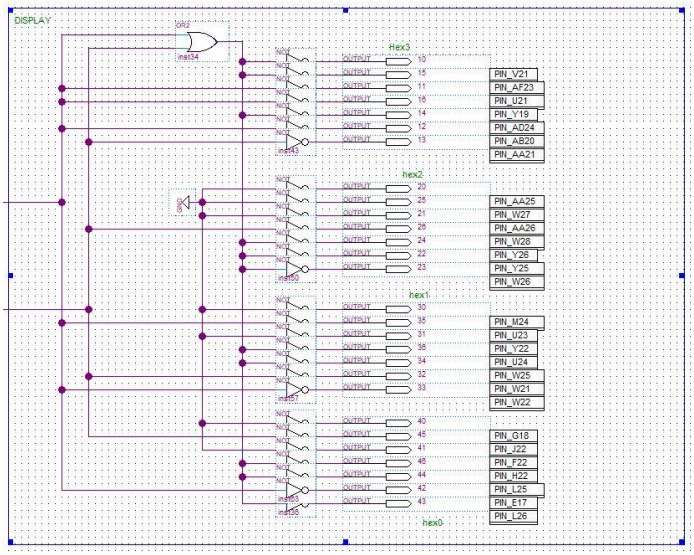

Figure 4: Circuit for mode display.

3.5.2 Speed display

Then, truth table and K-maps were applied to acquire needed output from input.

Table 5: Truth table to get binary order of number

I4	I3	I2	I1	C	B	A
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	1	0
0	1	0	0	0	1	1
1	0	0	0	1	0	0

Binary number generated corresponded to the switch pressed. Then, IC 7447 is used to convert binary code to 7-segmented code.

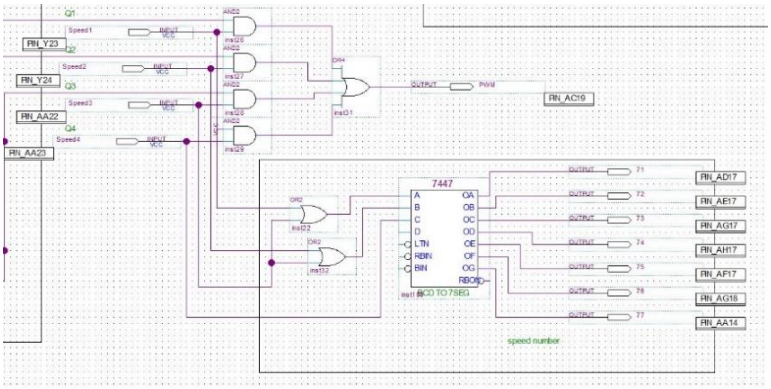

Figure 5: Circuit for switch display

There is a total of four speeds set 25%, 50%, 75%, and 100% in order to control the car's speed and move efficiently.

4.0 CONCLUSION

The utilization of the IR sensors in the robot car is suitable to be used for object/motion detection when navigating around an environment. Provided that users properly control the IR sensors, the robot car will successfully conduct its course of driving without any difficulty. This solution is economically viable, due to the simple construction method and the use of affordable materials and components. Several further improvement can be done, including implementation of PMW system that enable speed changing of wheels into turning mechanism to increase its mobility and flexibility. Further modification can be done so that the robot not only can sense the obstacles, while also can avoid them and even move them from the path. This may help in the development of low-cost household robot or life-saving robots during disaster.

5.0 ACKNOWLEDGEMENT

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