Self-Driving Obstacle Avoidance System

Project Report : Digital Logic & Design

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January 7, 2018

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Abstract

The world is moving towards self-driving vehicles to automate everyday transportation and optimize fuel as well as infrastructure. Such efforts have been using at least microcontrollers for even very basic applications. Under such circumstances, safety is the most important parameter throughout the process of development. Therefore, even delays in microseconds play a vital role. Hence we recommend using Digital Logic over other higher level technologies to prioritize *safety override systems* in terms of processing time. Using digital logic as a safety override can ensure that even for the most chaotic situations, an accident can still be averted using a bare digital but well-designed logic.

Design presented here reacts to the distance against the obstacle and come up with a swift turning technique to avert any miserable incident. Our design uses *timer technologies to get data from infrared sensor and manipulate logic required to turn a car* even in sharp situations without letting the car itself topple. A block diagram for the project has also been attached herewith.

The project is supposed to be a prototype for self-driving cars as an obstacle avoidance system. It includes simulation as well as physical prototyping for the demonstration purposes.

Present day obstacle avoiding techniques all involve full-fledge microcontrollers. Microcontroller itself being an overhead for the signal to be processed, employs a loop logic which increase the time for data to be processed which, although still very small, cannot be ignored for critical applications as obstacle detection and avoidance. Therefore, a digital logic is a secure and thus, better choice for considered application. This logic does not promise only a pretty short, but *constant response time.*

As mentioned earlier, this project is dedicated to self-driving cars but it has several other non-trivial implications as well. Productions lines need products to be transported from one place to another on wheels. These systems can be automated using line followers which is only possible with a promising safety system, same as we have proposed.

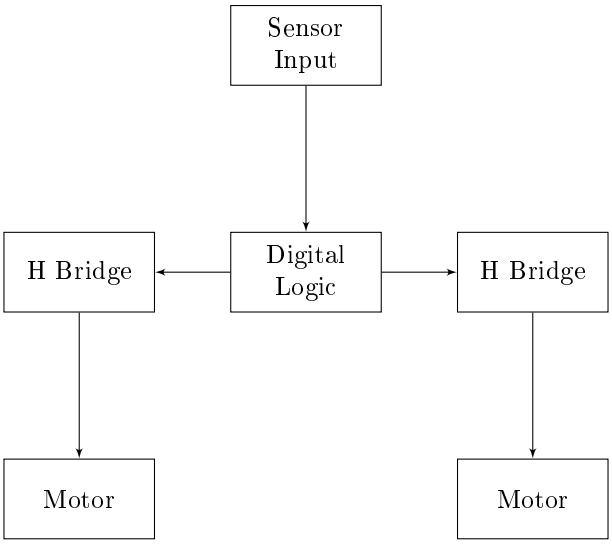
Moreover, this project can also be extended to an unsupervised system of artificial intelligence in which *low-cost* hardware will be utilized for trivial applications as automatic room cleaning, or even harvesting purposes in the field of automation in agriculture.

1 Introduction

1.1 Overview

The project is devised to be an obstacle avoidance system using digital logic and design. it will be a precise and concise circuit implemented on a prototyping car. Design and implementation details of the project and describe herein.

1.2 Block Diagram



2 Design

2.1 Problem Statement

Design and prototyping implementation of an obstacle avoiding vehicle through digital logic and design techniques.

2.2 Solution

Design techniques used in this project are not-so classic in nature. *Divide and Conquer* approach has been quite instrumental in design as it is more of a practical scenario than theoretical design problems.
The obstacle avoidance problem can be divided into two parts.

- Obstace Detection
- Smooth Turning

these major distributions have been discussed in detail.

2.2.1 Obstacle Detection

There is a whole range of sensors that exist in today's world dedicated to detect obstacles. Some can even respond to specific obstacles and be irresponsive to the other. On contrary, sesors belong to analog genre, responding specific distances, and digital world as well, prompting to specific distances only.
Sensor employed in this obstacle avoidance architecture is *Insfrared Proximity Sensor*. It is a relatively inexpensive and works fine for prototyping purposes. Although range of the particular sensor is quite short, it can be increased for application purposes through custom designs which can easily be achieve because of simplicity in its architecture.

2.2.2 Smooth Turning

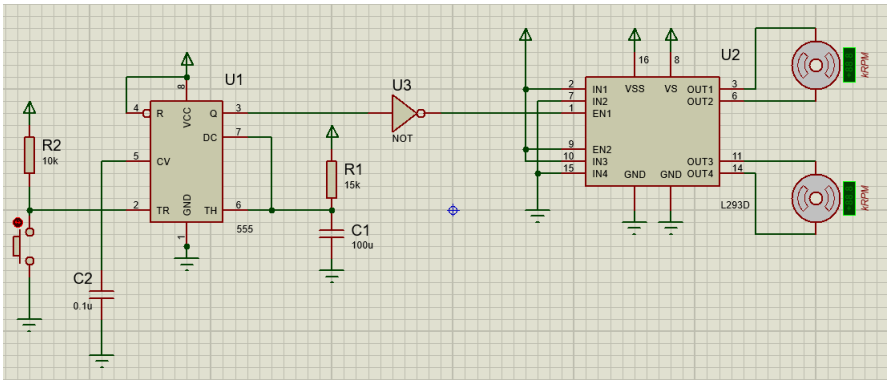
The prototyping vehicle employed is a two-wheeler and according to its mechanical structure, best and sharpest turning tehcnique that can be suggested is that of rotating one wheel in reverse direction as of other. It will make the vehicle turn sharpest and over the same position as it is. Thus fulfilling its purpose of obstacle avoidance.
There is another problem that is immersed in very nature of this problem. It is that of smoothening the turn. When obstacle is detected and the vehicle turns, the sensor turns the output to positive. But as soon as the car turns momentarily, the signal of the sensor turn positive again and vehicle is prompted to move still ahead although obstacle has not been really avoided yet. If we want to smoothly turn the vehicle, then we'd have to *extend the signal* for some time. Solution of this problem can be suggested as :

- Sequential Logic

- 555 Timer

Here we prefer to use *555 Timer* whose implementation details and reason of choice is explained in detail in next sections.

2.3 Circuit Diagram



here button simulates the sensor.

3 Hardware Implementation

3.1 ICs

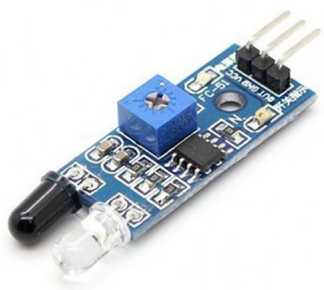
Name	Number
555 Timer	LM555
Hex Inverter	SN54LS04
H-Bridge	L293D
Voltage Regulator	LM7805

3.2 Sensor

The sensor works on *Infrared Signal detection*. Signals are transmitted through a photodiode and received using a ligth dependent resistor whose intensitiy is compared to a signal predefined via potentiometer.

State	Logic
No Obstacle	H
Obstacle Detected	L

which is perefectly coherent with input required by timer and no digital manipulation is required.



3.3 Motors

DC motors have been used for prototyping purposes which can be easily operated through digital logic using h-bridge.

3.4 Hardware Issues

The project has some problems of its own and most of them are related to its intrinsic capability of being mobile.

3.4.1 Power

Powering the circuit as well as motors for mobile application of such a scale was quite a task achieve through a couple of batteries and regulation using a voltage regulator.

3.4.2 Timer Functionality

The timing circuitry is quite difficult to control particularly because of individuality of the component and lack of coverage to this dynamic design in class.

3.4.3 Scaling Time

Scaling the timing of the circuit was another issue which was partly resolved through mathmematical calculations and simulations and partly through *hit-and-trial* on practical hardware.

3.5 Observations

The most important observation one can conclude from this Obstacle Avoidance architecture is that of *careful choice of sensor*. Sensor used here undoubtedly states that it can detect to a distance of 30 cm but for all practical purposes, this range is no more than 5 cm. Which, withough smart turning technique would have turned the project out to be a chaos.

4 Future Horizons

Such a project is of immense importance in the modern world of connecting thing. Such safety overrides have been essential since automation is gaining more and more control over everything. This sype of system can be utilized in

- Line Following Transportation Robots in Industries.
- It can be used over SLAM mapping technology.
- Advanced form of such systems can be implemented in Self Driving vehicles.

5 Further Recommendations

This project can be extended by adding control operations in it. Controlling such devices through remote media, employing Internet of Things Technology can result in a care-free environment for product damage.

6 Bill of Materials

Description	QTY.	Unit Cost	Total Cost
555 Timer	1	10	10
Hex Inverter	1	20	20
Motor Bridge	1	90	90
Voltage Regulator	1	10	10
Capacitors	2	5	10
Resistance	1	5	5
Sensor	1	120	120
Motor	2	75	150
Prototyping Vehicle	1	500	500

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I also declare that the intellectual content of this assignment is the product of my own work.