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An Innovative and Inexpensive Method for Obstacle Detection and Avoidance

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Abstract: This project proposes a new design for an obstacle avoider whose main decision-making component is a decoder. The decoder acts as a substitute for the microcontroller. The obstacle detecting sensors provide the input for the decoder and the decoder conveys the inputs to the motor enabling the movement. The power of AND gates and OR gates is long forgotten. Every one of us remembers their truth table just like a fact. The truth that they can be used for application has become a practical joke. Microcontrollers have come into play regardless of the complexity of the application. An obstacle avoider is a simple robot that has one dimensional motion; it can find its way through obstacles. In such case an obstacle can be anything. It changes with every application. For e.g., (1) for a car the obstacle would be the road patches and (2) for a physically abled person in a wheel chair the obstacle would be people. Robots can be made without microcontrollers. Microcontroller can be reprogrammed to serve a different purpose. Generally, one cannot expect a common user to reprogram it. If it is coded as an avoider it is an avoider throughout. This led to the spark of the idea. The usage of a decoder instead of a microcontroller greatly reduces the cost; additionally the decoder being memory less the access time is negligible.

Key words: Microcontroller, obstacle, decoder

INTRODUCTION

Our project is an innovative obstacle avoider. An obstacle avoider is one which can detect the obstacles on its path and vary its course accordingly; it continues the motion without colliding on any obstacle it encounters. Avoider has sensors in front (generally IR sensors are widely used). The sensors provide the system with a signal whenever it encounters an obstacle (Shahdib *et al*., 2013). The system takes the signal into account and alters the inputs fed to the rotors thereby making the robot to turn right or left corresponding to the sensor that propagated the signal. An alternate option for a microcontroller, provided at a cheaper cost and a better computational time with no compromise in quality and performances. Most importantly, how a society can be benefitted by the design is discussed.

PROBLEM FORMULATION

Consider a system composed of a mobile robot as shown in the Fig. 1. The task of the robot is to dodge the obstacles coming in its way by changing its direction of motion (Barik *et al*., 2013).

Assumption and input parameters: Assume a set of tasks T. For every task t that belongs to T the goal is known.

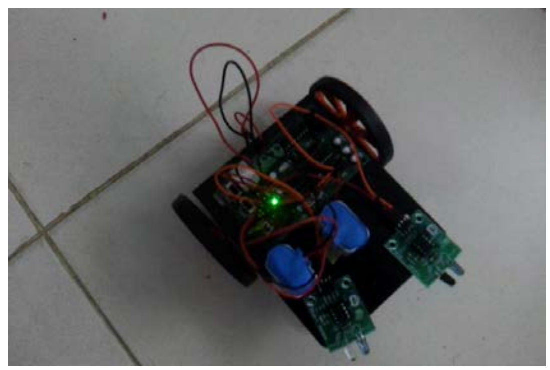

Fig. 1: A working model of an obstacle avoider with MU-C

Each task has its own time of occurrence. A particular task t_i in the scenario is a movement of the robot. So the task t_i is determined by the inputs given to the motors. Each wheel is driven by a motor; the model has 2 motor driven wheels. Each motor is allotted with 2 binary values. Thus every input to the motors is a set of four binary values $S = \{(A_1, A2) (B_1, B2)\}$. So it's obvious that there are $2^4 = 16$ possibilities of input combinations that can be given to the motors. The motor inputs (X_1, X2) determine the direction of the rotation. Usually (1, 0) is used for the clockwise rotation and vice versa. This pattern will be followed throughout (Sanjay Sarma *et al*., 2012).

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Task completion: Since we expect to build a very basic obstacle avoider, technically number of tasks we need our robot to do is 3. Figure 1 is a working model of an obstacle avoider which uses a microcontroller as its decision making component:

Forward motion: The initial movement of the robot when it is supplied with power

Right turn: When the sensor in the left picks up an obstacle this task is done

Left turn: When the sensor in the right picks up an obstacle this task is done

OVERVIEW OF PROPOSED METHOD

Controlling the inputs for the motors is the main function. That determines what the robot is going to do. So, the main aim is to regulate the four inputs accordingly.

Description of the model: A working model of an avoider can range from a basic one to a far advance and complex one with precise algorithms and superior hardware. The focus is to build an avoider that can actually work. The basic requirements are:

- 2 Motors
- A Breadboard
- 2 IR sensors
- Batteries
- Connection wires
- Two wheels, one any direction roller
- L293D IC
- 2×4 decoder

Figure 2 is a D.C motor with a single shaft. There are several types of motors available. This motor is used widely. As per the design depicted it would require two motors to control both the wheels.

Figure 3 explains the PIN configuration for IC L293D. This IC is used to control the motor, the input set S is feed into PINs 2,7,10 and 15 as shown in the Fig. 3. The output pins 3,6,11 and 14 will be connected to the motors (McRoberts, 2010).

A common platform is set on the wheels to position the breadboard, sensors and batteries. The two wheels

Fig. 2: Generally used single shaft D.C motor

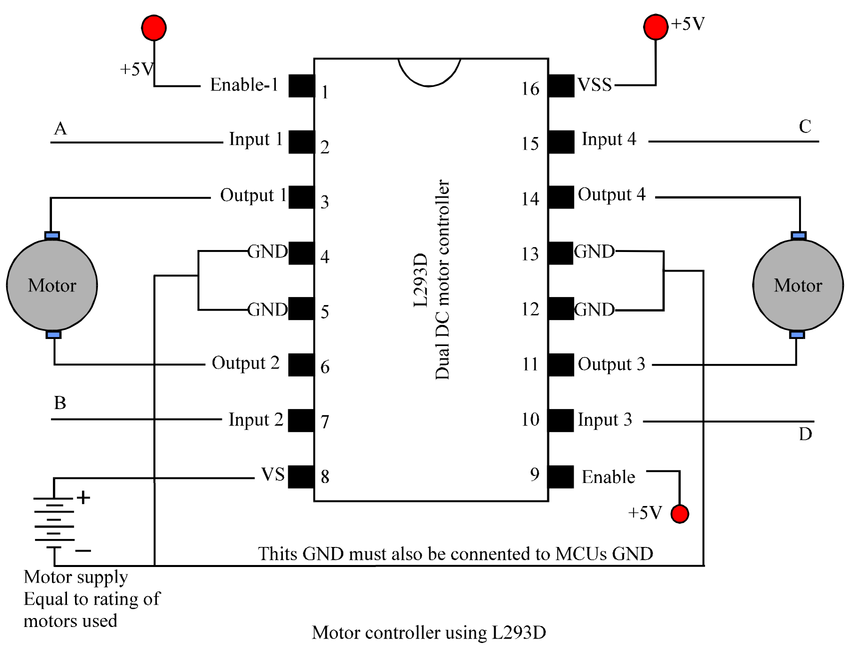

Fig. 3: Pin configuration for the Motor driven IC L293D

which are powered by the motor are kept as the hind wheels and the one any direction roller is placed as the front wheel.

Figure 4 shows the working of IR sensor. It shows the emission and receiving of IR rays. Being a sharp IR distance sensor it can detect an obstacle at distance accurately. This is the advised sensor to be used for the model.

Implementation: The principle used to physically turn the robot is by making the wheels move in opposite direction. Let's consider the different cases where specific tasks will be used and formulate the 3 tasks in terms of the input set (Elshamarka and Sayuti Saman, 2012):

Case 1: If there are no obstacles sensed by any of the sensors then the robot moves forward without any changes. To make the robot move forward the left wheel has to move in anticlockwise direction and the right wheel has to move in clockwise direction so the input set S will be {(0, 1) (1, 0)}

Case 2: If the sensor on the right senses an object in front then it is time to take a left turn so both the wheels have to rotate in clockwise direction. Hence the input set S will be {(1, 0) (1, 0)}

Case 3: If the sensor on the left senses an object in front then it is time to take a right turn so both the wheels have to rotate in clockwise direction. Hence the input set S will be {(0, 1) (0, 1)}

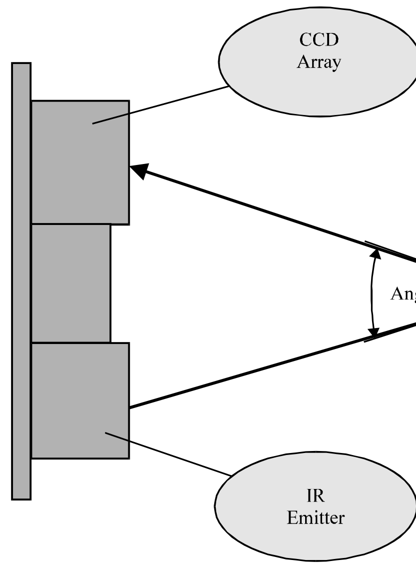

Fig. 4: Working model of sharp IR distance sensor (Margolis, 2012)

Method and circuit

Circuit diagram: The Fig. 5 is the circuit diagram for the design. The connection has to be done as shown in the Fig. 5. S1 and S2 are the outputs from the left and right sensors respectively. Vcc is the voltage supply from the batteries. X1, X2, Y1 and Y2 are the inputs to the motor; it should be given to the respective pins of the IC L293D.

Working: Figure 6 is a screenshot of the implemented working circuit. It is also the proof that the design is

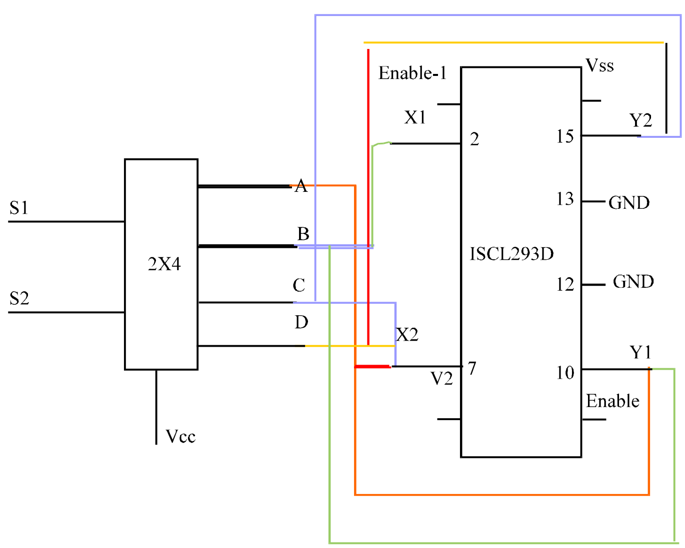

Fig. 5: Circuit diagram of the proposed design

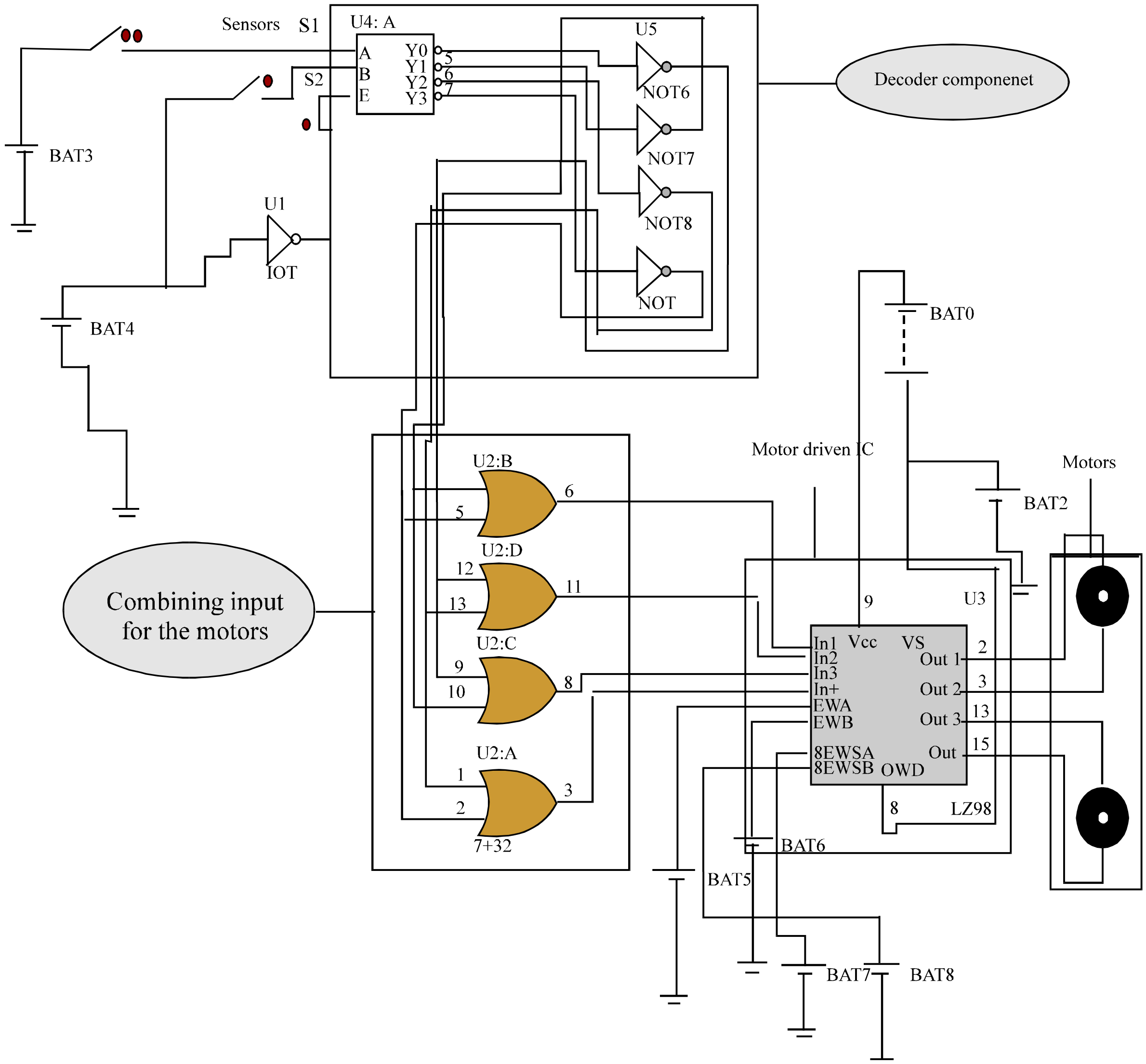

Fig. 6: Screenshot of the implemented working circuit done in Proteus (Bates, 2006)

Table 1: Truth Table for the design

S1	S2	X1	X2	Y1	Y2
0	0	0	1	1	0
0	1	1	0	1	0
1	0	0	1	0	1
1	1	1	0	0	1

perfectly correct and has no error whatsoever. The red coloured connection is for the robot to move forward. Likewise, the colours green, blue and yellow are for left, right and backward motion of the robot, respectively.

Table 1 shows the signals given by the sensors S1 and S2 followed by the corresponding inputs to be given to the motor X1, X2, X3 and X4. The input X1, X2, X3 and X4 are connected to the IC L293d in pins 2, 7, 10, 15, respectively (Sudheesh and Kumar, 2012).

CONCLUSION

The obstacle avoider itself has its own advantages as explained in the introduction section itself. First of all building is a sole purpose of all engineers. Once any individual or an organisation finishes a product both mechanically and technically they let it out in the market, where the cost of the product plays huge role in the product's success. In electronic markets the computational time also plays a vital role. In our project we have reduced these both factor drastically. A basic PIC microcontroller costs around 30 dollars whereas a decoder costs around 20 cents. This clearly depicts the advantage in case of cost in our design. Similarly since we have used a decoder there is no memory to be concerned, so the memory access time is nearly negligible. This design provides a better choice in terms of both cost and time (Padmanabhan and Patmanapan, 2007).

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