# Embedded Microcontroller Based Autonomous Photovore Robot With Obstacle Avoidance

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## Abstract

*A Photovore Robot is a robot which moves in the direction of light i.e. it will always move to a direction where the intensity of light is higher. Obstacle Avoidance in a robot means an intelligence which will guide the robot in such a way that it will always be able to avoid collisions with other objects. In this project, mechanical and electronic designs have been accomplished for an Autonomous Photovore Robot which also has the capability of Obstacle Avoidance.*

## 1. Introduction

'Photo' means 'Light' in Greek and 'Vore' means 'Swallow Up' in Latin. So the literal meaning of a Photovore Robot is a Light Eating Robot! In practical sense it is a robot which has affinity for light i.e. it is a light-seeking robot. It will chase light and can be made using simplest of all sensor algorithms. Using two light detecting sensors i.e. typical Photoresistors, this algorithm can be implemented. On the other hand, Obstacle Avoidance is a familiar term in the field of robotics which stands for the capability of a robot to avoid unnecessary collisions. The simplest algorithm for this can be done using IR Sensors though with the use of image processing or artificial intelligence, very high precision algorithm for Obstacle Avoidance can also be made. In this project the simplest approach has been made to detect obstacles using IR Emitter and IR Detector.

## 2. Working Principle

### 2.1. Differential Drive

The movement of the robot has been done using Differential Drive algorithm. To move forward, both front wheels are moved in the same direction. To move to right, right wheel is stopped and left wheel is moved forward. To move to left, left wheel is stopped and right wheel is moved forward. To stop the robot, both front wheels are stopped. A schematic diagram for Differential Drive algorithm is given below

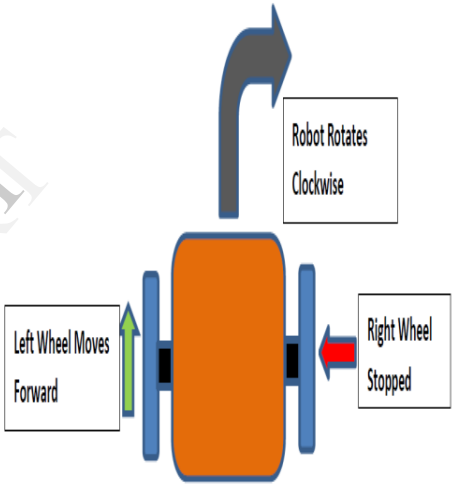


Figure 1: Differential Drive

For the servo motors used in this project, the Base Positive Pulse Time is 1.5 ms with an interval of 20 ms (From motor datasheet).

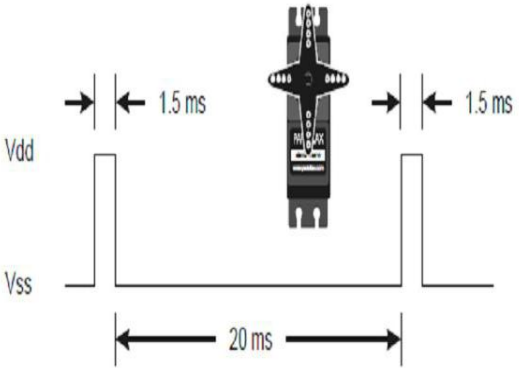


Figure 2: Base Positive Pulse Time

Decrease in Base Positive Pulse Time increases sped in clockwise direction. In this project a positive pulse of 1.33 ms has been given to move the motor in clockwise direction.

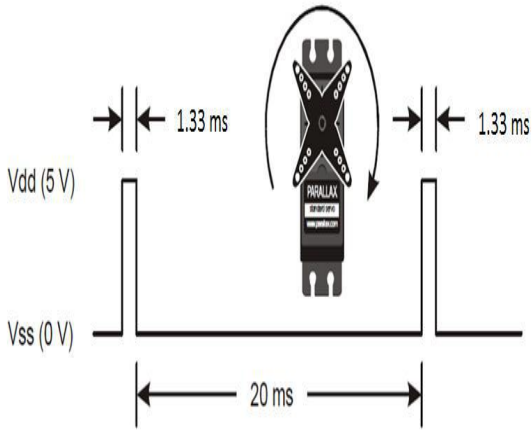


Figure 3: Movement in clockwise direction

Increase in Base Positive Pulse Time increases speed in counterclockwise direction. In this project a positive pulse of 1.67ms has been given to move the motor in counterclockwise direction.

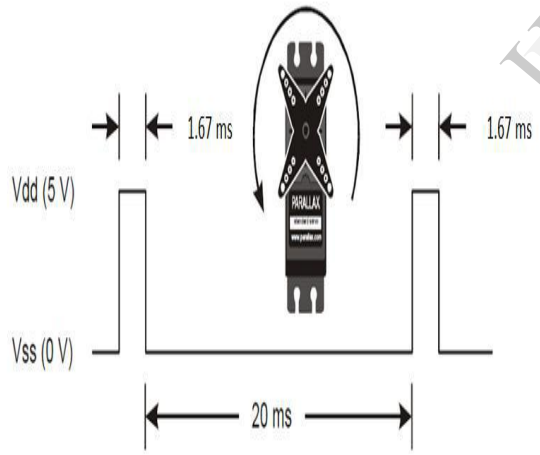


Figure 4: Movement in counterclockwise direction

Time interval between two positive pulses is always kept 20 ms for smooth operation.

## 2.2. Photovore Algorithm

Photovore Algorithm is implemented by using 2 photoresistors placed at the front side of the robot. A photoresistor is a Light Dependent Resistor (LDR). So its resistance changes with the change in intensity of the light falling upon it. In this project, a Voltage Divider Circuit has been made for each photoresistor and voltage across each one has been measured using ADC. It has been found that the voltage across each photoresistor decreases with the increase in the intensity of light. So the difference between voltage of left and right photoresistors are taken to sense the intensity of light. The following figure shows the Voltage Divider Circuit made across each photoresistor.

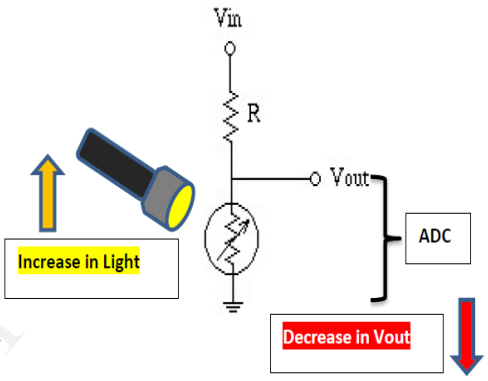


Figure 5: Voltage Divider Circuit (Photoresistor)

From calibration, it has been found that if the voltage difference is more than 0.08V, then the robot should change the direction to right of left based on the intensity of light. So a C code has been written using this criterion. The following figure shows a schematic diagram of Photovore Algorithm.

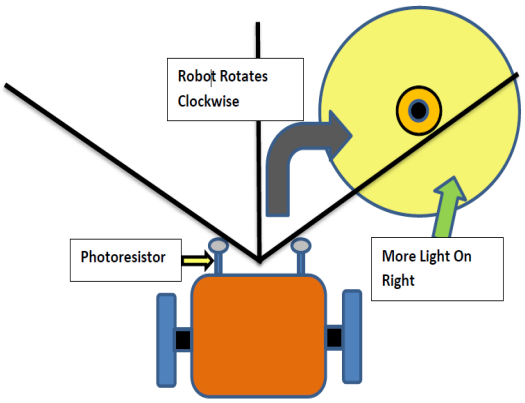


Figure 6: Photovore Algorithm

### 2.3. Obstacle Avoidance

It has been implemented using one IR Emitter and one IR Detector. The IR Emitter emits IR light continuously in the forward direction. If there is an obstacle in the front, then IR light bounces back. The IR Detector receives the reflected IR light. An IR Detector is actually an IR Phototransistor which converts IR light into voltage. In this project, it is found that the voltage across the IR Detector decreases with the increase in IR light upon it. So a Voltage Divider has been made across the IR Detector and voltage has been measured using ADC. The following figure shows the Voltage Divider Circuit made across the IR Detector.

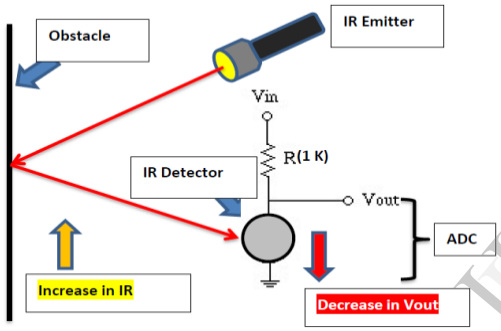


Figure 7: Voltage Divider Circuit (IR Detector)

For detecting a distance of 6 inches in room light, if the voltage is less than 4.94V, then robot has been turned to right. This voltage has been found after calibration. The following figure shows a schematic diagram of Obstacle Avoidance.

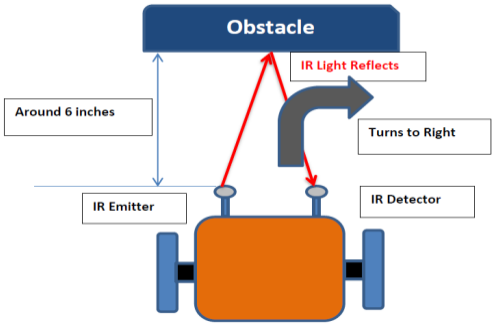


Figure 8: Obstacle Avoidance

### 2.4. Operation

When power is given to microcontroller, by default, it works as a Photovore Robot. If anyone presses button (PIN_A4) on the Development Kit, then an external interrupt occurs at PIN_B0 and the robot works as an Obstacle Avoiding Robot. Another interrupt will make the robot to work as a Photovore Robot and these operations continue alternatively with each button press until power is taken off.

## 3. Applications

The main tit Photovore Algorithm and Obstacle Avoidance can be utilized in many ways such as:

1. A Photovore Robot can be used with a solar cell to get direct sunlight all the time of the day.
2. Obstacle Avoidance can be used to avoid undesired collisions such as in Mars Rovers.

## 4. Conclusion

In this project we have written the code for a photovore robot which moves in the direction where the intensity of light is high. The robot that we have designed also supports an intelligent obstacle avoidance quality. This feature in the robot helps in guiding the robot when it comes across objects and othe obstacles in its way.

## 5. Future Scope

As an extension of this project these future works can be done:

1. A Photophobe Robot can be made by changing the code of Photovore Robot which will move away from light or will seek darkness.
2. A Fire Fighting Robot can be made using IR Detector of this robot. In fact it was almost done but enough time to write an efficient code was not available.
3. A Line Following Robot can also be made using the Photoresistors of this robot.

## 6. References

[1] Society Of Robots (http://www.societyofrobots.com/)
[2]http://simonpstevens.com/Content/Projects/Microcontrollers/Posts/MicrocontrollerIntroEquipment_Files/Breadboard.jpg
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[12]http://www.t2retail.co.uk/lg_images/Dayga-T2-infrared_Emitter_And_Detector.jpg