**Department of Electronics and Telecommunications Engineering**

**University of Moratuwa**

EN2090 – LABORATORY PRACTICE II

# Analog Line Follower Robot

Group No. : 29

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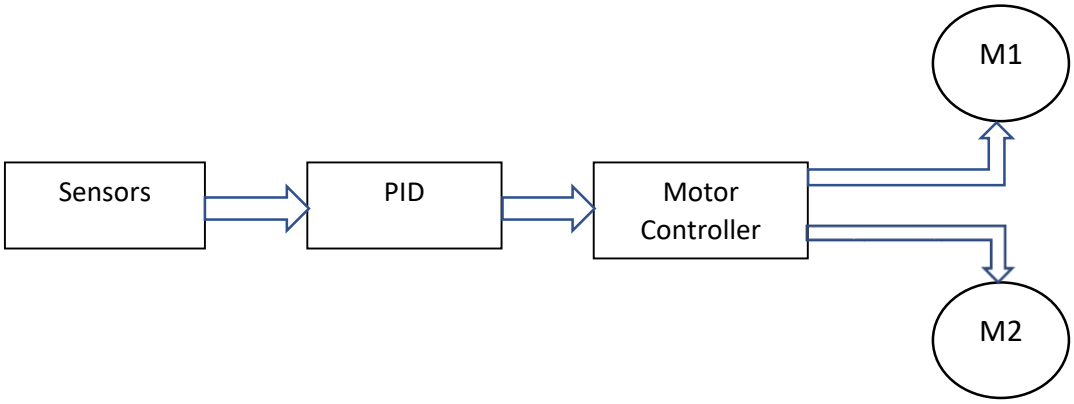
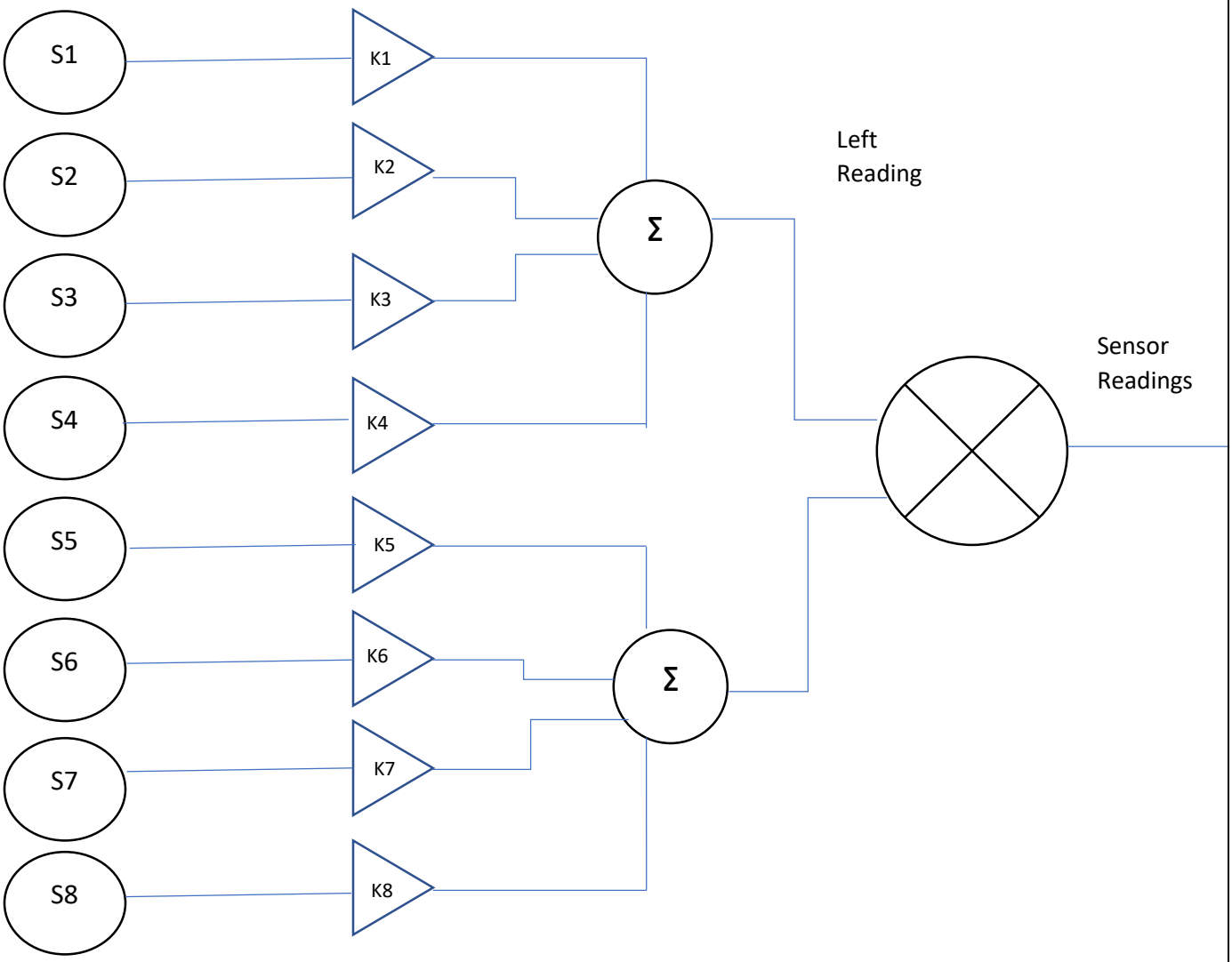
## Robot control block diagram

Initially, the readings obtained from the 8 sensors are combined to get the final reading required for the PID controlling. This output voltage signal will be used to determine the current position of the robot. In the second stage, the signal will be fed to the PID controller to calculate the error. Then, an appropriate PID response will be calculated by the PID controller. Using this response, the required motor speeds will be determined by the motor controller. Depending on the motor speeds, a suitable PWM signal will be generated and it will be fed to motor driver unit. An overview of the control structure of the robot is shown below.



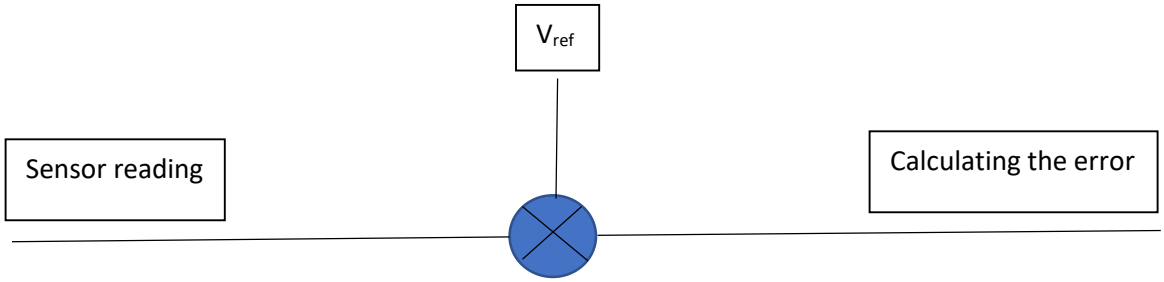

## Sensor readings

The sensor array consists of 8 sensors. The sensors S4 and S5 will detect the line when the robot lies exactly on the midline of the path. The sensors S1, S2, S3 and S4 will be used on the left whereas the sensors S5, S6, S7 and S8 will be used on the right. Moreover, the gains assigned to the sensors will be symmetric in magnitude but will have opposite signs. In other words, if the gain for S1 is +4, then the gain for S8 would be -4.



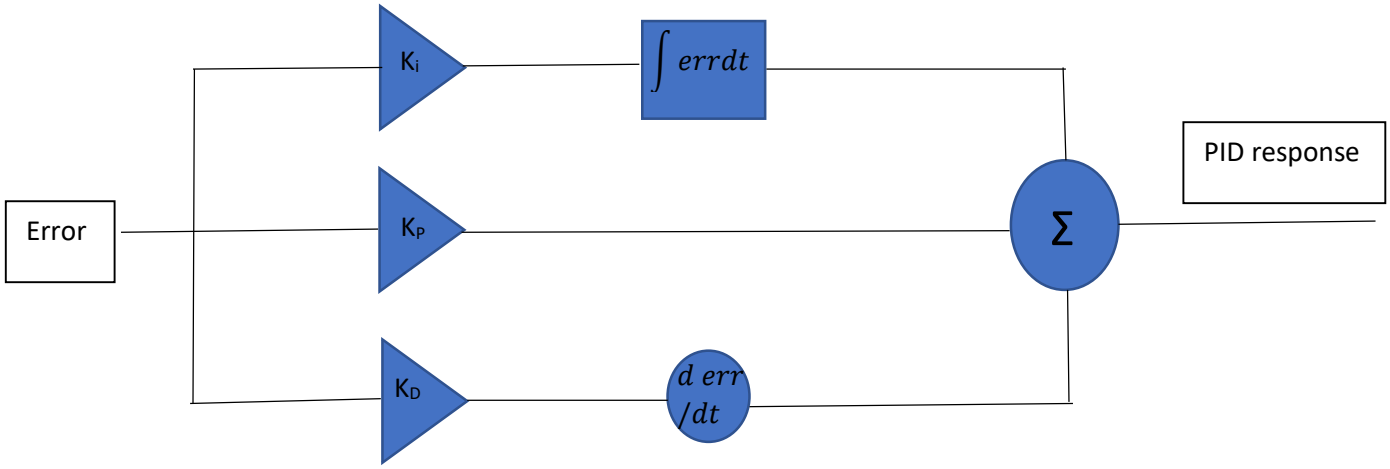

Error calculation

The output of the sensor panel is an indication of the current state of the robot. The difference between the output and the reference will denote the error.



PID calculation

The PID calculations depend on the results of the error calculation and the PWM generated depends on the results of the PID calculations.



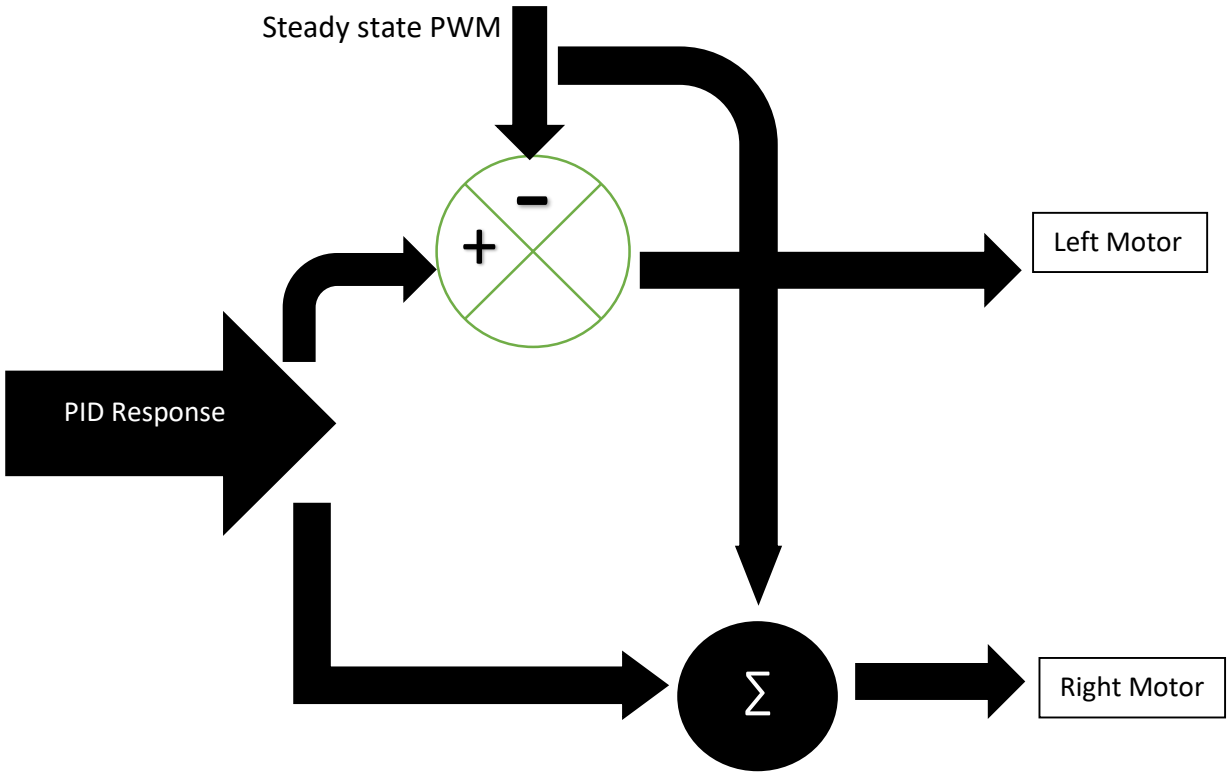

Motor speed calculation

The output of the PID calculation is not a direct indication of the base speed of the robot. It is a direct indication of the deviation. Accordingly, if the error is zero, then the output of the PID calculation can be zero. An output of 0 does not necessarily mean that the speed of the robot is zero. Accordingly, we will assign a default value to the base speed and this base speed will vary based on the results of the calculations.

PWM converter

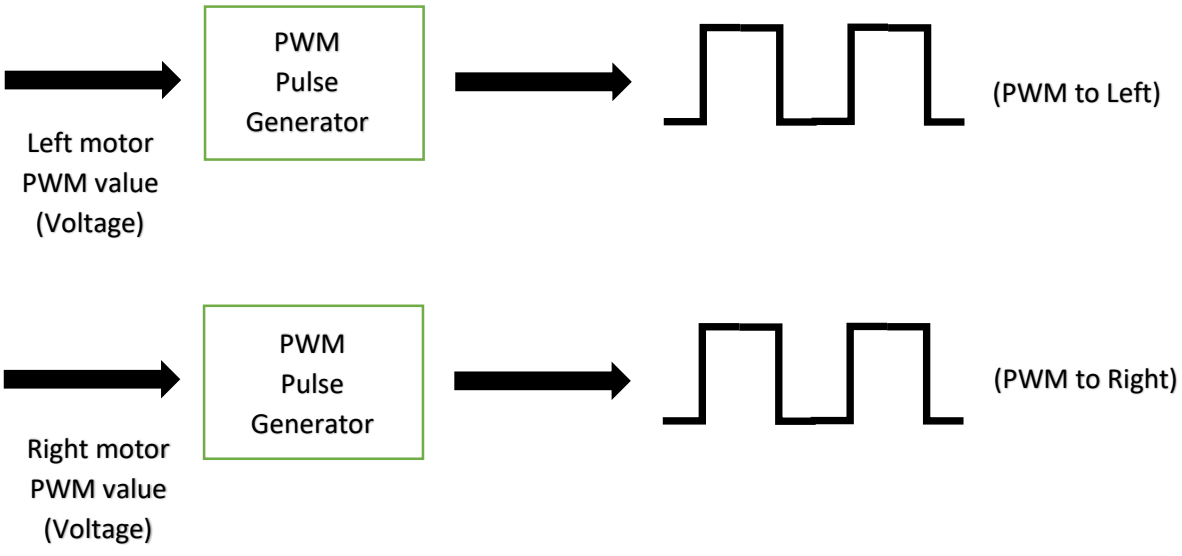
The output of the previous unit is not the PWM signal. It is just a voltage. Using two PWM converters, two PWM signals will be generated for the two motors.

PWM Value Calculation Unit



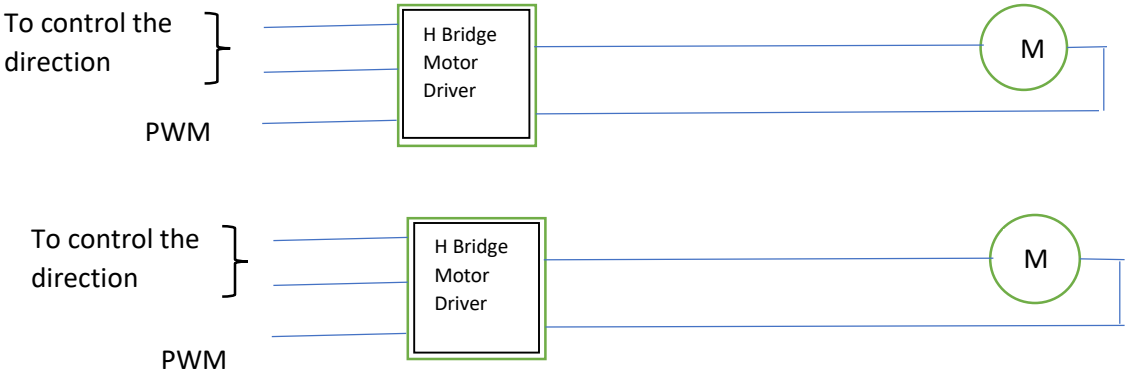

Motor Controllers

PWM Pulse Generator



## Motor driver

The two PWM signals generated by the PWM generator is fed to two H-bridge motor driver units. Accordingly, the drivers will control the direction of motion of the robot.




## Motors

Metal gear motors and plastic gear motors are the commonly used motors in line follower robots.

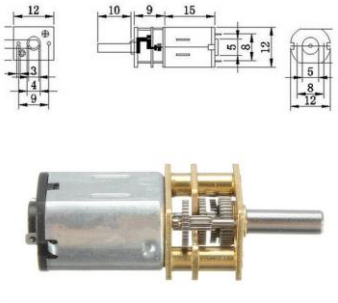
In plastic gear motors, the gears are made of plastic. Hence, the gears tend to be damaged easily due to the heat generated during operation. On the other hand, metal gear motors have more resistance to damage. Given the requirements of the project, we decided to use 6V N20 300rpm gear motors. Some of the advantages of this motor are mentioned below.

1). Relatively, smaller in size

2). Mid-range torque (sufficient for this project)

3). Considerable rotational speed (300rpm)

4). Low cost



N20 gear motor

Plastic gear motor

N20 gear motors are generally used along with Pololu 32 x7 wheels. Therefore, we will be using Pololu 32x7 wheels.

The robot has only two main wheels. In addition, a mini ball castor will be used as the third wheel (or the supporting wheel) of the robot.

## Sensors

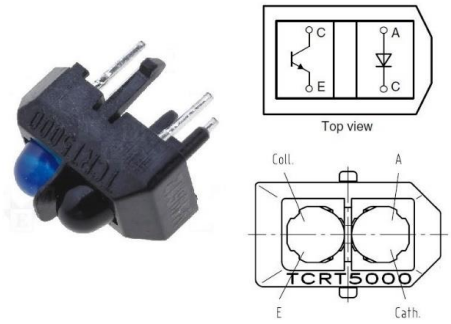
To detect the path, we can use one of the two techniques stated below.

1). Photodiode or phototransistor along with separate IR LEDs

2). Using built-in IR sensors

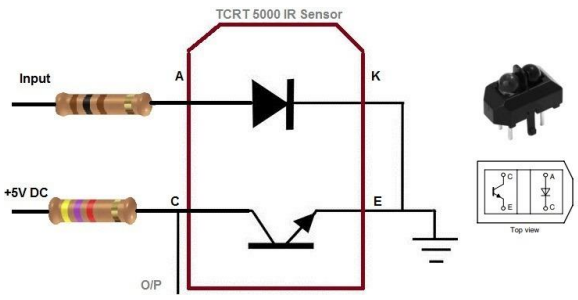
Both techniques utilize IR to detect the path. We assumed that we can negate the effect of ambient light by using built-in IR sensors. Moreover, these IR sensors are easily available in the market and therefore, considering factors such as; the price, accuracy, sensitivity, etc., we opted to use TCRT5000 sensors.

Photodiode and IR led




TCRT5000

The IR LED emits IR rays to the surface facing the sensor. These IR rays be reflected on to the photo-transistor. The refection intensity depends on the surface colour, distance and the surface nature. However, if the surface color is black, then reflective intensity is low. Similarly, reflective intensity is high when the surface color is white. Accordingly, the current through the phototransistor varies with the reflected light intensity. Therefore, by connecting a resistor in serially, we can obtain a potential output from the sensor.



## Power Distribution

The current and voltage requirements differ from one circuit to another. The motors require a voltage of 6V and a current of 300mA. Therefore, we decided to design a 6V buck converter circuit using LM2570 adj. buck convertor IC. It can supply a maximum current of about 2A.

Other circuits such as the sensor panel, PWM generator, PID calculation circuit do not require large currents. Therefore, we decided to power those circuits via regulators.

## Power Source of the Robot

Batteries will be the main power source of the robot. We are yet to decide the type and the capacities of the batteries to be used.