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Line Follower Robot & Obstacle Detection Using PID Controller

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Abstract. Navigation is the significant feature in applications of Mobile Robots. Various navigation tools are available based on accuracy & complexity. PID Controller is used for designing a Line follower Robot. Array of multiple sensors detects the black surface and travel along the line. Arduino Uno continuously monitors the signal from the sensors and turns the Robot as the line getting detected. Obstacle detection is performed by Ultrasonic sensor. Line follower Robots are applicable in military, intruder alarm systems and so on.

Keywords. PID, Arduino, obstacle detection, line follower, ultrasonic sensor

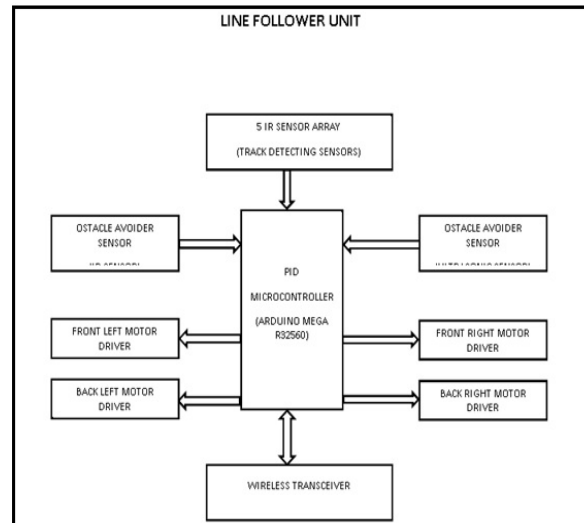
INTRODUCTION

Robotics is a branch of Engineering deals with concepts, design, manufacture and operation. Robotics involves multidisciplinary fields such as Computer Science, Electronics, Artificial intelligence, Nanotechnology & Mechatronics [1]. Line Tracking is significant and desired behavior of mobile robots which has significant importance in current scenario. Line tracking has evolved as the convenient and reliable navigation technique through which autonomous mobile robots navigate at indoor environment in a controlled manner [2]. A Line follower robot follows the predetermined path and determines its own procedure while interacting with obstacle. The path may be visible or invisible. In industries, it is mostly used to carry parcels in a track. With existing degree of autonomy, Mobile robots can move around in specific environment. Autonomous navigation is related to the availability of external sensors which acquires information from environment through visual images or distance. Path detection is determined by proximity sensor and Obstacle detection is determined by IR sensor [3]. Arduino MEGA R3 2650 is a Microcontroller based board recommended for Robotics & 3D Printers. It is compatible with most Uno boards [4].

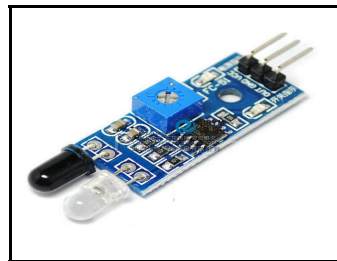
SYSTEM DESIGN

Arduino MEGA R3 2650, the most popular Proportional Integral Derivative (PID) controller is used. It is mostly used in industrial control applications for regulating variables as pressure, flow, level, temperature and so on [5].IR

Sensor uses LED for emitting light and measures the received light intensity for detecting the obstacle. Ultrasonic sensor measures the distance by using sound waves using sensors on its front [5-7]. It works in a range 3cm to 3m. The purpose of the motor driver for converting low current signal to high current signal for driving the motor coil [8-9]. It consists of 2 front drive motors and 2 back drive motors. Fig.1 (a) displays the Line follower unit, Fig.1 (b) shows the PID Controller-Arduino MEGA R3 2650 module. Fig. 1(c), Fig.1 (d) & Fig.1 (e) shows IR sensor, Ultrasonic sensor & Motor driver respectively.



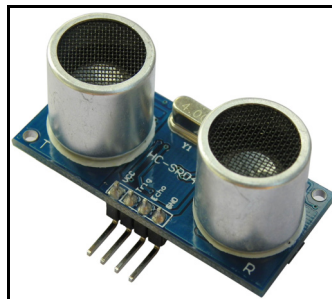
(a)



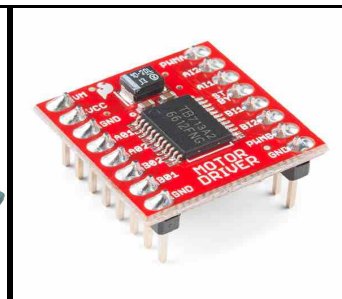
(b)



(c)



(d)



(e)

FIGURE 1 : (a) Line Follower Unit (b) PID Controller –Arduino MEGA R3 2650 (c) IR Sensor (d) Ultrasonic Sensor (e) Motor driver

HARDWARE MODULE

Using array of IR sensors, Line follower detects the black surface and travel in the specified path as it is an automated guided vehicle. As black surface absorbs and permits the Robot along its path as detected by Arduino Uno, which detects the changes and indicates to motor driver accordingly for movement. The motor speed is slowed down on the direction decided using PWM, while the other side motor runs at normal speed. Robot is stopped, if an obstacle is detected by Ultrasonic sensor in a range of 5 cm. Fig. 2, Fig.3 & Fig.4 shows the Top view, Side view & Front view of the hardware module respectively. Fig.5 shows the IR sensor array view. Fig.6 shows the Moving forward status. Fig.7 & Fig.8 shows Turning Left and Turning Right respectively. Fig.9 shows the Stop status.



FIGURE 2 : Top view of Prototype



FIGURE 3 : Side view of Prototype

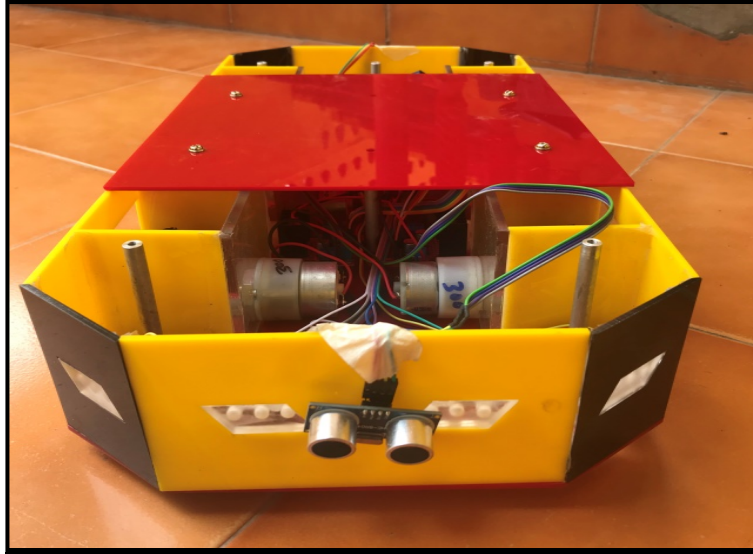


FIGURE 4 : Front view of Prototype

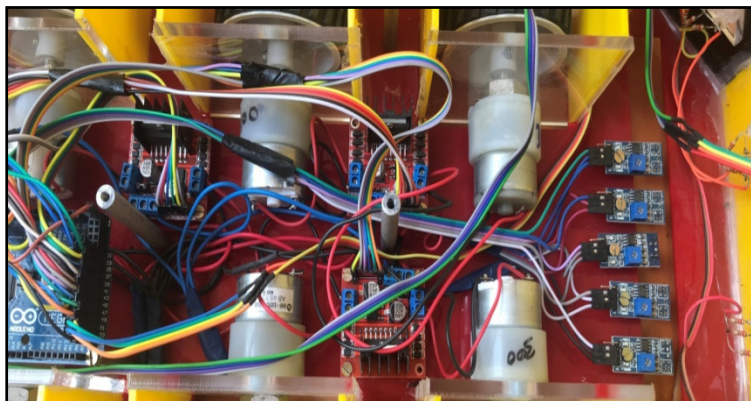


FIGURE 5 : Sensor array view

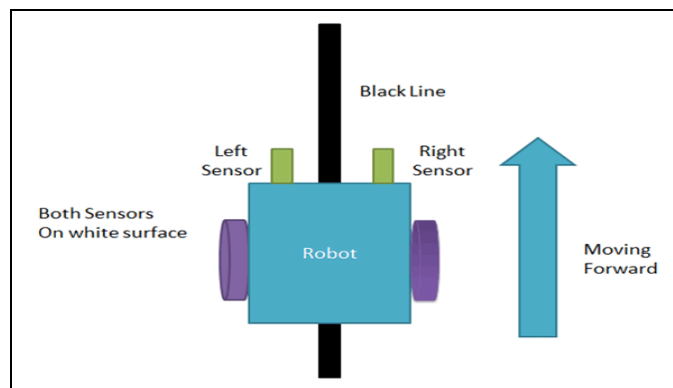


FIGURE 6 : Moving forward

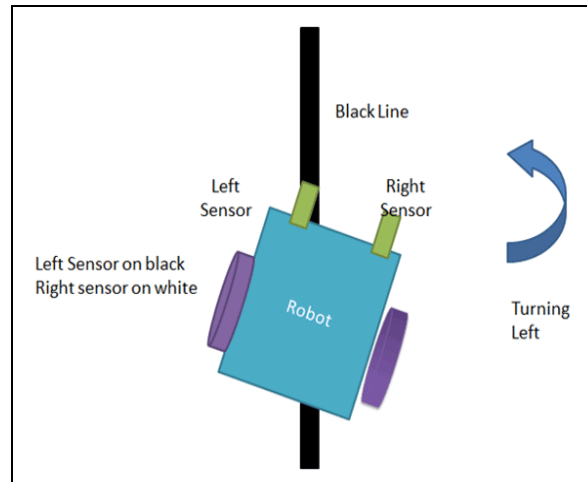


FIGURE 7 : Turning left

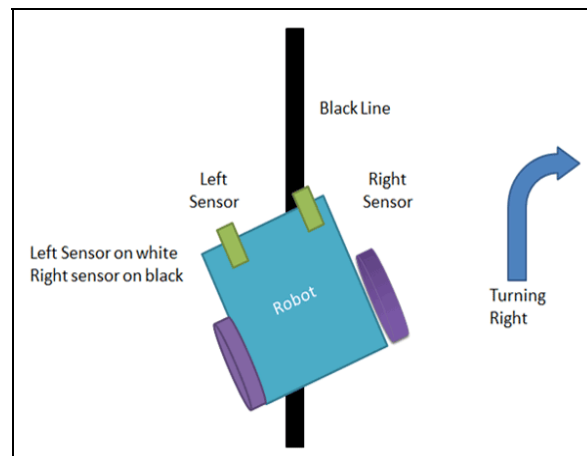


FIGURE 8 : Turning right

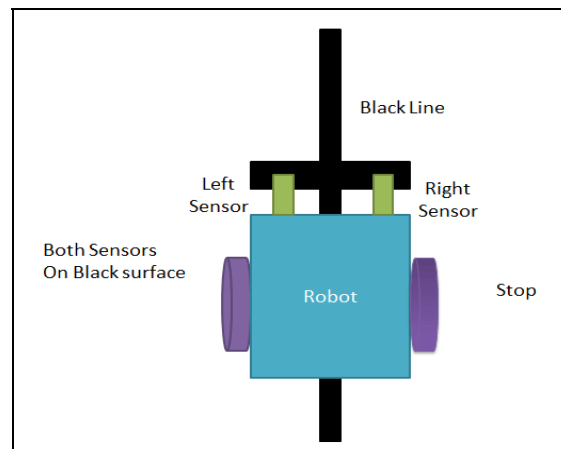


FIGURE 9 : Stop

RESULTS & DISCUSSIONS

LED is used to indicate the turn of the line follower Robot either Left or Right. PID controller detects the exact track and obstacles in the path. Fig. 10 shows the right turn of line follower Robot. Fig. 11 shows the Obstacle detection. Fig. 12 shows the Line follower Robot motion after obstacle detection.



FIGURE 10 : Right turn of Line Follower Robot

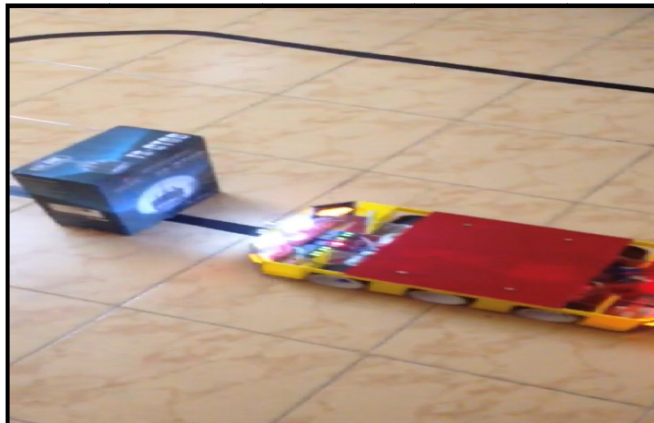


FIGURE 11 : Obstacle detection



FIGURE 12 : Robot motion after Obstacle detection

CONCLUSION

The designed Line follower Robot detects the obstacle and follows the path effectively. The Camera used can be enhanced to capture images and send to intended user through Bluetooth or any wireless communication technologies for more control options.

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