Line Follower Robot

Mr. Pradeep Samal[1], Mr. Pranav Lokhande[2], Mr. Chaitanya Vikram[3], Mr. Nayan Patil[4], Mr. Shinde M.A[5],

[1,2,3,4]Student [5]Lecturer
[1,2,3,4,5]Department of Electronic and Telecommunication Engineering.
[1,2,3,4,5]JSPM, Bhivarabai Sawant Polytechnic, Wagholi, India.

Abstract: The Line follower robot is a mobile machine that can detect and follow the line drawn on the floor. Generally, the path is predefined and can be either visible like a black line on a white surface with a high contrasted color or it can be invisible like a magnetic field. Therefore, this kind of Robot should sense the line with its Infrared Ray (IR) sensors that installed under the robot. After that, the data is transmitted to the processor by specific transition buses. Hence, the processor is going to decide the proper commands and then it sends them to the driver and thus the path will be followed by the line follower robot. TABAR is a line follower robot designed and tested in order to attend at Tabriz line follower robots competition. But it encounter with some technical and mechanical problems. In this Paper, we have illustrated the process of design, implementation and testing TABAR, a small line follower robot designed for the line follower robots competition. The technical and mechanical issues and problems also have investigated.

Keywords:Line Follower; Problems and solution; Circuit; Actuator; Programing.

I. INTRODUCTION

Generally, the line follower robot is one of the self-operating mobile machines that follows a line drawn on the floor. The path can be a visible black line on a white surface (reverse). The basic operations of the line follower are as follows:

- Capturing the line position with optical sensors mounted at the front end of the robot. Most are using several numbers of photo-reflectors. Therefore, the line sensing process requires high resolution and high robustness.
- Steering the robot to track the line with any steering mechanism. This is just a servo operation; actually, any phase compensation will be required to stabilize tracking motion by applying digital PID filter or any other servo algorithm.
- Controlling the speed according to the lane condition. The speed is limited during passing a curve due to the friction of the tire and the floor.

This kind of robot can be used for military purposes, delivery services, transportation systems, blind assistive applications. Moreover, there are many annual line follower robots competitions organized by universities or industries around the world. They usually ask robotic teams for building a small robot with specific dimensions and weight according to the competition rules.

In order to attend at Tabriz line follower robots competition, Tabari Institute of Babol had functional support for design, implementation and testing TABAR, a small line follower

robot as can be seen in Fig. 1. In this paper, we intend to share our experiences. Therefore, the line follower robot structure and architecture issues and challenges along with their technical issues and problems will be discussed in section 2 and the programming subjects will be explained in section 3 and the algorithms and solution of passing the lines will be illustrated in section 4.

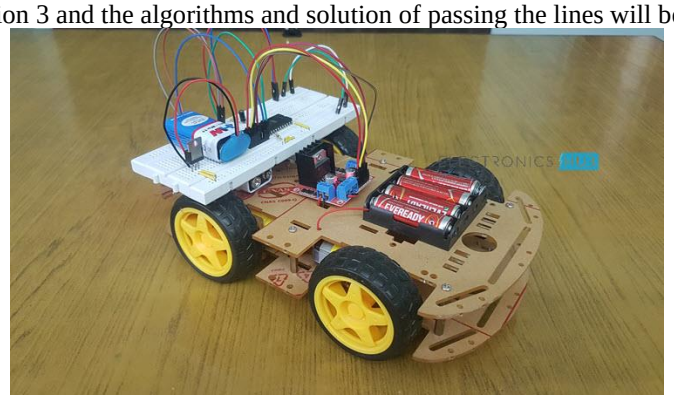

Figure 1. The Designed Line follower robot

II. LINE FOLLOWER ROBOT STRUCTURE

This robot can be divided into several parts:

- Sensors
- ADC (Analog to Digital Converter) and sensor circuit
- Processor
- Driver
- Actuators (Motors and wheels)
- Chassis and body structure

The electrical circuit of some line follower robots can compare the analog signal received form sensors and then transmit the result to the processor in digit '0' or '1' and some of them send the analog signals to the processor directly and the processor ought to convert them to digital form. Anyway, the analog signals must be converted to the digital form and then the processor can

process them. [2] The main elements of electrical structure are sensors, Analog to Digital Converter, Processor and Motor Driver.

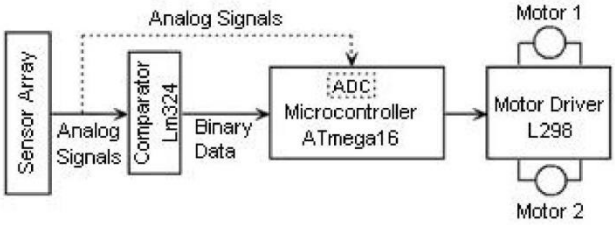

Figure 2. Line follower block diagram

A. The Sensors

This kind of robot uses Infrared Ray sensors to find the path and direction; Infrared Ray sensors contain a match infrared transmitter and infrared receiver pair. White surfaces generally reflect well, but while black surfaces reflect poorly. If the receiver receives the reflection ray, it means that the robot is on white and if it cannot receive it, so the robot is on black. These devices work by measuring the amount of light that is reflected into the receiver. Because the receiver also responds to ambient light, the device works best when well shielded from ambient light, and when the distance between the sensor and the reflective surface is small (less than 10mm). IR reflectance sensors are often used to detect white and black surfaces. White surfaces generally reflect well, but while black surfaces reflect poorly.

Hence, the distance between sensors and ground surface is important and it is more important that how we put sensors near each other. The distance between sensors and ground surface must be 2 to 10 mm and the distance between each sensor is dependent on the line width. [1]

In the designed robot, we have used eight sensors and they have suitable distance by each other as can be seen in Fig. 3 and our competition line width was 18 mm.

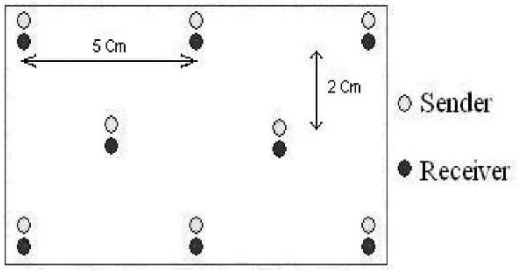

Figure 3. Sensors location method

If the line width is thin, the distance between sensors must be reduced; otherwise, while curving the line, the robot will not be turned on time.

B. The ADC and sensor circuit :

Generally, the received signals from the sensors are analog and must be converted to the digital form. Therefore, the circuit can be designed to send the sensors' signals to the processor, directly. Hence, the processing time can be managed just by using an external ADC. LM324 is good ADC that we have used in our project. Two LM324 can support eight sensors. The resistance of the receiver sensor is decreased when infrared is radiated on it. A good sensor will have near zero resistance in the presence of the ray and have a very large resistance in the absence of the ray. We can use the property to form a potential divider. [2] You can see schematic of sensor circuit in Fig. 4.

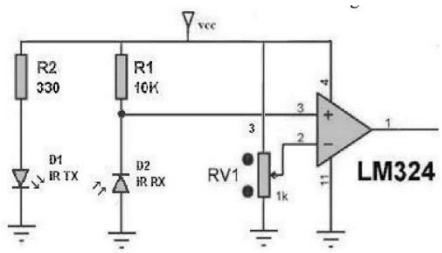

Figure 4. Schematic of a IR sensor

C. The Processor :

For very small line follower that has 2 to 4 sensors, we can use electrical gate such as AND/OR to decide and send simple instruction to the driver but it hasn't any precision and its speed for processing is very low. Moreover, it cannot follow bad curves or cycloid lines. It is momentous to use a processor, undoubtedly. We have used the Atmel's AVR microcontroller "At Mega 16" in our project. The Atmel's AVR microcontrollers have a Reduced Instruction Set Coding (RISC) core running single cycle instructions and a well-defined I/O structure. Internal oscillators, timers, UART, SPI, pull-up resistors, pulse width modulation, ADC, analog comparator and watch-dog timers are some of the features you will find in AVR devices. AVR instructions are turned to decrease the size of the program whether the code is written in C or Assembly. With on-chip in-system programmable Flash and EEPROM, the AVR is a perfect choice in order to optimize cost. [5, 3] One of the best AVR is "At Mega 16" which has four ports for I/O and 16 MIPS speed in 16 MHz. The microcontroller power is 5V and it is better to use the 7805 regulator.

D . The Drive : Robot needs a driver IC for controlling and giving power to the motors. The microcontroller sends a signal to the driver which acts as a switch. The microcontroller only sends a signal to the switch and then the switch must give required voltage

to the motors. If the received signal by the driver is high, it will rotate the motors. A good motor driver is IC L298 which can be used to control two motors. It is an integrated monolithic circuit in 15-lead Multiwatt and Power SO20 packages. It is a highvoltage, high-current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC, and stepping motors. Two enable inputs are provided to enable or disable the device independently of the input signals. L298 has 2 amperes per channel current capacity and it can support up to 45 volts for outputting. Moreover, L298 works happily up to 16 volts without any heat sink.

References:

1. Ashari, S., Line, Gap and Color Sensors, in Dept. of Electrical Engineering. 2004, University Tenaga Nasional: Malaysia. p. 70.
2. "Robo Tour and Programming Contest, 2015", Organized by IEEE RUET Student Branch, Bangladesh.