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DESIGN AND FABRICATION OF A SIMPLE LINE FOLLOWER AUTONOMOUS ROBOT WITH MAGNETIC GRIPPER

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Abstract*- Line follower is a machine that can follow a path. The path can be visible like a black line on a white surface or vice versa or it can be invisible like a magnetic field. Addition of arm with magnetic gripper provides material handling, automated cars running on roads with embedded magnets; guidance system for industrial robots moving on shop floor etc. The aim of the objective is to grip a material having magnetic property, follow a path to reach the desired destination and place the carrying object in proper place. For gripping magnetic gripper is used. Optical sensors are used for detecting the path. The logic of differential moving of wheel to follow the white line is also maintained. The follower robot properly followed the white line, picked up the object by magnetic gripper and placed it to the desired destination. This project is just a model which can be improved for implementation in industrial works for material handling.*

Keywords: Line follower**,** Stepper motor, LDR sensor, Magnetic gripper, Autonomous

1. INTRODUCTION

The line following robot is a model of a smart vehicle that can differs from the colors beneath and take the appropriate decision during its journey according to its position. It also have the ability to sense obstacles if found in a certain range and stops completely before it to allow the robot to engage other actions. To make use of the ability of the robot's capability of differing colors beneath it the line following robot can be implemented, that robot can keep tracking a black line on a white background which in real life situations represents the lane and its white mark. Along with a magnetic gripper it can pick up an object having magnetic property and placed it to the desired place.

A simple robot was designed by Jaseung Ku which is able to follow a black line on the ground without getting off the line. The robot consists of two sensors installed underneath the front part of the body, and two DC motors drive wheels moving forward. The control is done in such a way that when a sensor senses a black line, the motor slows down or even stops. Then the difference of rotation speed makes it possible to make turns [1].

Mohamad Aidil B. Abdul Jalal developed an autonomous mobile robot which exhibits line tracking and obstacles avoidance behaviours. The PIC16F877A microcontroller has been chosen as the brain to control the system. MPLAB IDE software used to program the PIC16F877A microcontroller in C language and the HI-TECH PICC Lite C Compiler was used to convert source code into machine instructions. Tracking system was developed for the mobile robot to have navigation ability. Contact detection approach was used in this project in order to avoid the mobile robot from colliding with obstacles. The testing phase results had shown that successful programming algorithm had been implemented [2].

Jegede Olawale introduced the method of interfacing the robotic arm stepper motors with the programmed 8051-based microcontroller which are used to control the robot operations. A sample robot which can grab (by magnetizing) and release small objects (by demagnetizing) is built for demonstrating the method explained. They deduced that in comparison to humans, robots can be much stronger and are therefore able to lift heavier weights and exert larger forces [3].

S. M. Htetconceptual designs of a robot gripper for a First Aid Robot System (FAROS), which was capable of handling unconscious patients. TRIZ is a very powerful tool, has been applied to generate new design concepts for a robot gripper. The final results generated from TRIZ, meet the objectives of the work and should yield a gripper suitable for the task of moving a casualty to the recovery position [4].

Sensor is one of the important components in line tracking robots. It is because the skills of line tracking robots are highly dependent on the effectiveness of the sensor. Surrounding light could make the sensor produce a signal whereas it should not. This will cause the controller to make a wrong decision. As a result the robots will make unnecessary movement and can't achieve its objective. The contrast between the background and the line can also cause a problem to the sensor. The sensor may detect the background as its line thus making a wrong decision.

The motor that are used able to contribute imbalance to the PIC microcontroller. Noise or interference consists of unwanted electrical signals which imposes on and masks the desired signal. Noise is always present in a system that involves high power and small signal circuitry. The source of the noise could be from the switching of the driver circuits or the motor itself. Internally, the relatively high current motor drivers are the source. Electrical unbalance occurs when the magnetic attraction between stator and rotor is uneven around the periphery of the motor [5]. This causes the shaft to deflect as it rotates creating a mechanical unbalance. Electrical unbalance usually indicates an electrical failure such as an open stator or rotor winding, an open bar or rings in squirrel cage motors or shorted field coils in synchronous motors. An uneven air gap, usually from badly worn sleeve bearings, also produces electrical unbalance.

It is also an importance to accuracy to follow the line and pick up the objects or materials by magnetic gripper. The timing should be carefully maintained in case of picking and releasing. The object should have magnetic property, so it will remain touched with the gripper.

2. RESEARCH MODEL DESIGN

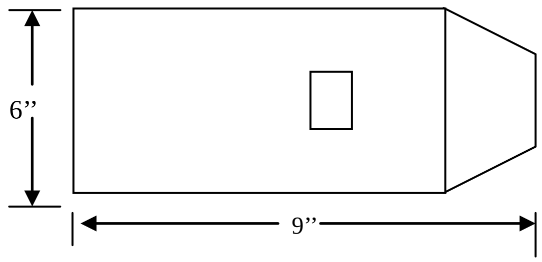
The majority of tasks will occur simultaneously, for simplicity, each set of tasks will be discussed separately. The first steps in the project will be to design a mechanical assembly and the electrical system for the arm structure and line tracker.

The logic of differential moving of wheel to follow the white line will be used. The sensor circuit has two LDR and two bright LED. Reflected light from the white lines will be measured. When the two LDR gives the same resistances then two stepper motor are in same speed.

When left LDR gives different resistance than the right stepper motor rotates slowly and when right LDR gives different resistance than the left stepper motor rotates slowly. Thus robot maintains its position accurately. The plastic arm pieces will be contracted out in desired shape then the electrical system of robot have been assembled in robotics lab and finally the program of the robot is executed.

2.1 Mechanical System

The mechanical system will consist of all non-electrical components of the robotic arm. The system will be used to reproduce or simulate the mechanics of human arm. The basic "bone" structure will be designed and constructed of some type of metal or plastic and like the human arm critical joints will connect these "bones" .These joints will need to be designed to provide both stability and the proper range of motion. A variety of motors will be used to actuate the assembly at these joints.



Fig, 1: Platform design

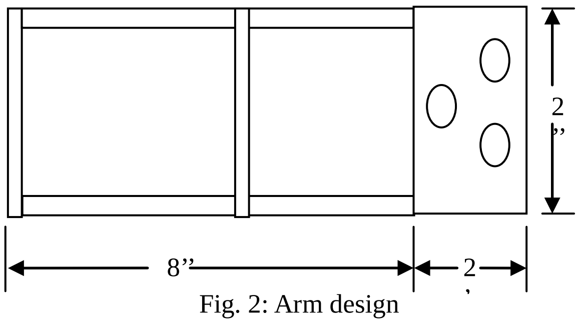


Fig. 2: Arm design

Arm mount: The first step will be to design a base (tracking robot) for the arm to be mounted to (Fig.1&2). The mount will be attached to a solid base that will sit on the ground or table. The mount must be long enough to provide the desired range of arm motion without making the system unstable. The arm mount and base will house the Robotic Actuator controller.

Shoulder: After the base is designed, a shoulder joint will be designed. The shoulder must provide three functions. It must anchor the rest of the arm to arm mount, provide the desired range of arm motion, and provide a connector for the upper arm. The shoulder will also house the electromechanical assembly used for the actuation of the shoulder. The upper arm must connect to the shoulder connector and provide an "elbow" joint for which the shoulder will be connected. The upper arm needs to be stable and long enough to support the range of arm. The elbow must provide a connector for the shoulder as well as holding the electromechanical assembly used for the actuation of the shoulder

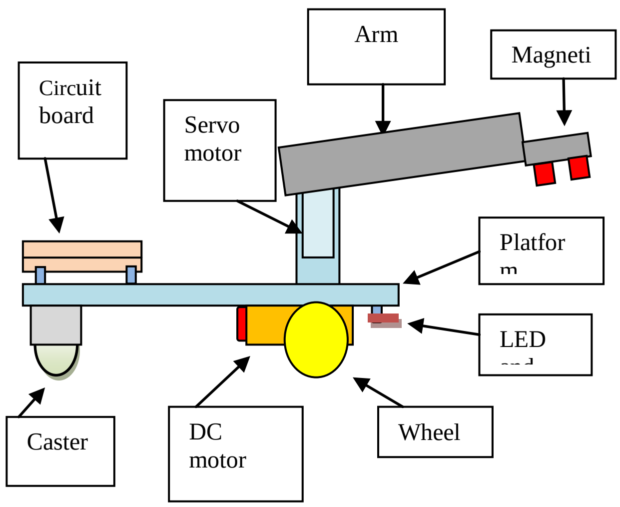


Fig 3: Designed model line follower robot

Magnetic Gripper: The end effectors of the robotic arm are gripper. A magnetic gripper has to be used to grip, hold, and release materials for handling purpose. As it works using magnetic force only metal which has magnetic property can be handled.

2.3 Electrical Systems

Electromechanical Assemblies: It is required to design assemblies for each of the three - shoulder, elbow and magnetic gripper electromechanical assemblies systems used to actuate the arm. In order to actuate the arm, each robust assembly will house the motor circuits and provide connectors for the systems wiring harness that will provide control signals to the motors(Fig.3).

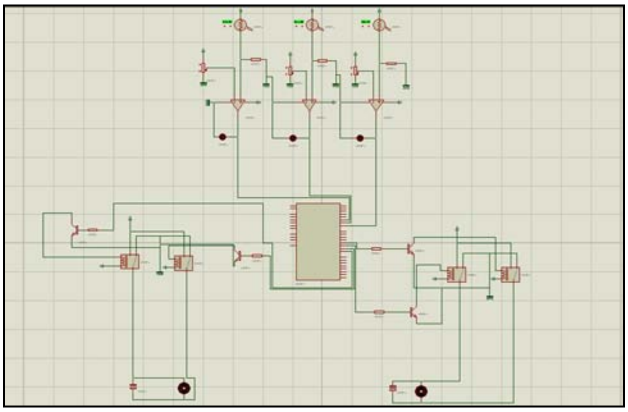


Fig. 4: Electrical Circuit Diagram

Robotic Actuator controller (RAC): The control signals will be sent via the wiring harness from the Robotic Actuator Controller to the electromechanical assemblies' .The RAC will be based off of a microprocessor that will be programmed based on the designed control algorithms. The microprocessor will need to interface with both the motor circuits and the inputs into the robotic arm system. The interface circuits for each aspect of the control system will need to be designed and housed within the RAC unit. The RAC unit will also provide connectors for the attachment of the wiring harness (Fig.4).

3. FABRICATION OF THE MODEL AND WORKING PRINCIPLE

3.1 Material of the Frame

Plastic is the material of choice because it can be readily molded to shape. The typical plastic molding process involves molten plastic injected under high pressure into specially-made metal forms. Injection molding is a manufacturing technique that is not readily adaptable by the amateur robot builder. Instead, our plastic material of choice is the raw shape: sheet, bar, rod, and so forth, which are then cut into the desired form. These sheets, bars, rods and more can be purchased at home improvement stores, specialty plastics retailers, and sign makers .

3.2Components used

- DC motor
- PIC 16F72 microcontroller
- LDR AND LED
- Relays
- Variable resistor
- Comparator
- Wheels
- Ball Caster
- Vero board
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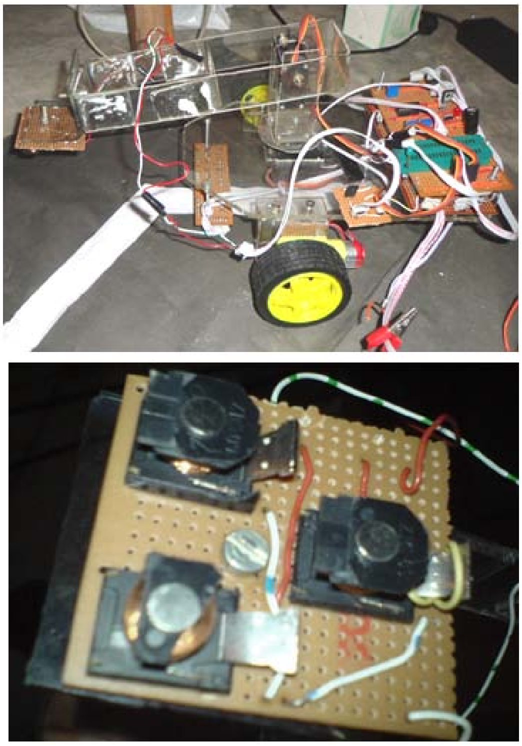

Fig. 3. (a) LFR with magnetic gripper on track; (b) Magnetic Gripper

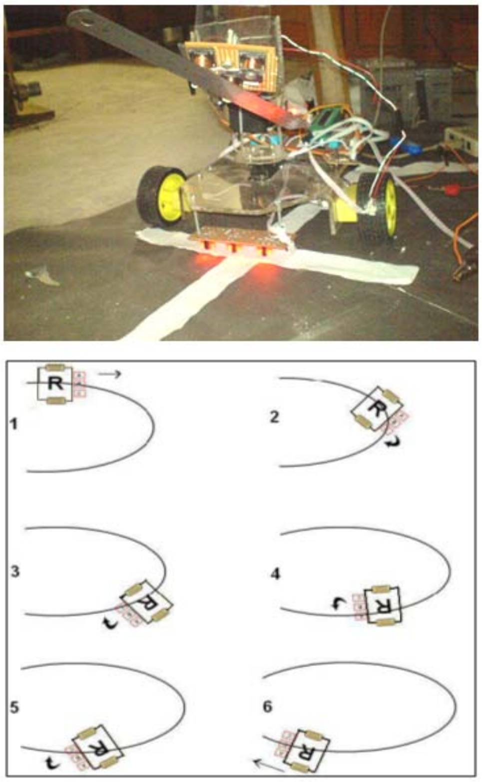

Fig. 4. (a)LFR holding steel; (b) Curved line analysis

3.3 Robot Working Principle

The action of a robot is decided according to received signals through sensor receiver circuit. The robot movement according to Curve Line behavior of the Robot is shown in Fig. 4 (b).

- If A (Left Sensor) reads 1, B (Middle Sensor) reads 0, and C (Left Sensor) reads 1, then the S1 and S2 signals are generated from RC transmitter and the robot moves in forward direction as shown in Fig.4(b)case: 1.
- In contrast if A (Left Sensor) reads 1, B (Middle Sensor) reads 1, and C (Left Sensor) reads 0, then the S2 signal is generated from RC transmitter and the robot moves in right (Clockwise) direction as shown in Fig.4(b) case: 2.
- And finally if the Robot moves in the left direction (anticlockwise), then the Relay number 2 is triggered, to generate signal S2 as shown in Fig.4(b)case: 4.

When sharp edge turning is faced by the tracker some problem occurs. It cannot detect the movement or turning to 90 degree angle. In such cases the path is modified to the small angle curve path and the meshed with the path right angel with the previous path. It is illustrated in below in the figure 5.

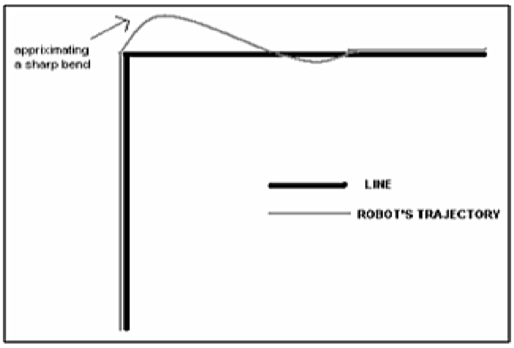

Fig. 5. Modification of 90 degree turning

4. RESULTS AND DISCUSSION

The Line following robot was finally completed. A lot of effort was put into the design, implementation and days of toil in front of the computer, writing and debugging the code. The robot was finally running with a few glitches here and there which were sorted in the later revisions of the firmware. The line following robot still has a few shortcomings but achieves most of the objectives.

Curved line following is one of the crucial part for the LFR. Straight paths as well as smooth curve are properly followed. The model properly followed the lines, picked the object from the desired path and placed the object where the line is finished. For picking up object magnetic gripper is used which successfully gripped the metal having magnetic property. High current supply with proper voltage is required for the proper operation of the magnetic gripper. Minimum 150mA current is required for gripping a small object weighing 10gm.It can carry maximum 150 gm. without jerking, but minimum 350mA has to be supplied to the gripper.

5. COCLUSION

This line follower robot with magnetic gripper is mainly designed for automation system in industry. It can follow the white straight and curve paths except right angle paths. Magnetic gripper is properly designed, so it can grip the material having magnetic property and can place the object at given location

6. REFERENCES

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