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DEVELOPMENT OF AN AUTONOMOUS LINE TRACKING ROBOT WITH MECHANICAL GRIPPER

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Abstract- *This is a very simple and fundamental line tracking robot. It can follow through a white line. Two stepper motors are used to move the wheel and LDR sensor circuit is used to detect the white line. To control the stepper motors microcontroller is used. C programming is used here as programming language. Loading and unloading the objects by magnetic gripper is controlled by a another stepper motor which can rotate both clock and anti clockwise. This robot can follow white path as well as after loading object from a certain destination it backs to its starting position then it unload the object properly. As it is an autonomous robot, it does not need to keep any type of manual control over it during its moving along the line.*

Keywords: Stepper motor, LDR sensor, Robot, 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.

Autonomous robot means that kind of robot which performed and controlled by programming automatically without any additional command or control over it during its movement. A line tracking autonomous robot can follow a path of line of any color. This line tracking autonomous robot is completely automatic and can move sensing white line by its sensor. When there will no path, it will stop its running.

Disregarding the early machines that were made to mimic humans and their actions and concentrating on the recent history, one can see a close relationship between the state of industry, the revolution in numeric and computer control of machinery, space explosion, and vivid imagination of creative people. Starting with karel Capek and his book, Rossam's Universal robots, and continuing with movies like flash Gordon Metropolis, lost in space, The Day the earth stood still, and the Foruman's job.

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].

MohamadAidil 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].

The aim of this research is to design and construct an autonomous robot model which can follow the definite path as well perform the loading and unloading objects with mechanical gripper.

2. DESIGN AND FABRICATION OF THE ROBOT

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. Two power transistor circuits are used here to switching the stepper motors. An op-amp is used in the sensor circuit as voltage comparator.

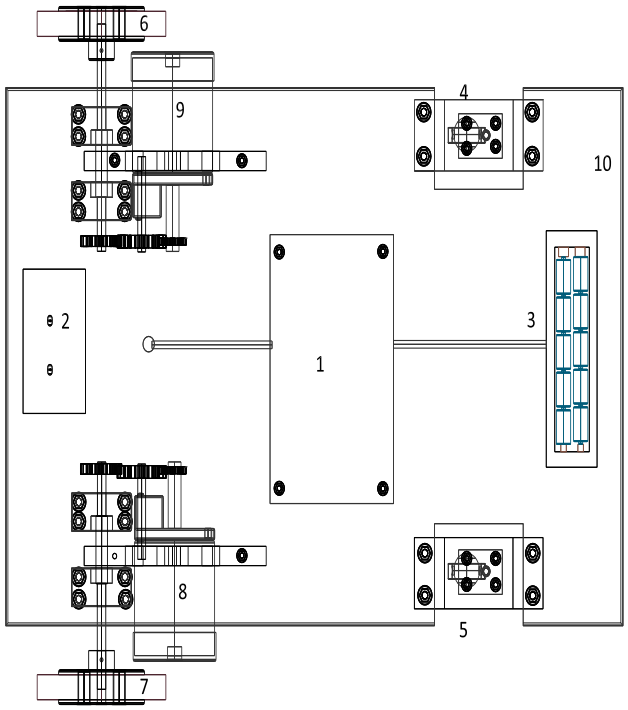

Fig.1 Schematic View of the Robot The complete design of the robot (top view): 1: Circuit box, 2: Sensor circuit, 3: Battery box, 4: Back free wheel 1, 5: Back free wheel 2, 6: Front power wheel 1, 7: Front power wheel 2 8: Stepper Motor 1, 9: Stepper Motor 2 and 10: Base

The metallic robotic arm 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.

We initially designed this robot using manual drawing. After manual drawing we drowned the robot design in AutoCAD 2006 with proper dimensions(Fig.1 & Fig.2).

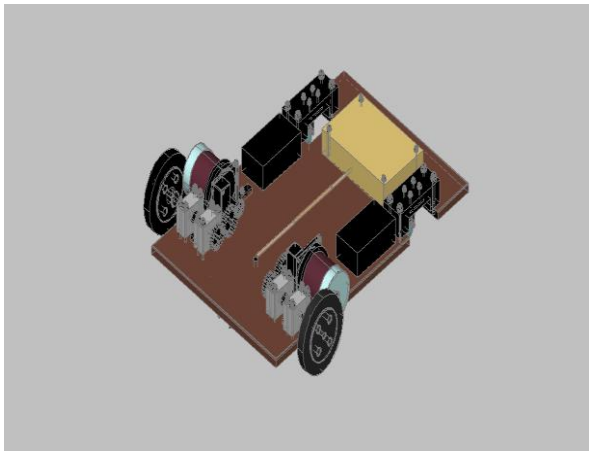

Fig.2 Three dimensional view of the robot without mechanical gripper

2.1 Mechanical Construction

The mechanical construction consists of a base, wheels with 2:1 gear mechanism. A flat surface plate made of plywood is used as the base of the robot where the stepper motor, nylon box, circuit box, battery boxes are fixed on the surface of the base. Clamps are used to hold the stepper motors and the batteries with the base. There are four bearings used in the two front power wheels. The shafts of the front power wheel shafts are stainless steel (SS) metal. Back wheels can move freely in 360^0 on the plane of the floor. We did not use any pin joint here. All of the joints here made with nuts and bolts and all nuts and bolts are of SS metal.

The robotic arm with mechanical gripper is made of a simple aluminium pipe of 12.5mm diameter, 0.5m length and aluminium angle bars. One end of the gripper is attached with a stepper motor by a cord for loading and unloading the objects. The arm is revolve on a stand made of wood.

Materials of mechanical construction are

- Ply wood
- Nylon block
- Nut & bolts
- Clamps
- Wheels
- Nylon shafts
- SS metal shaft
- Wooden block
- Aluminium shaft
- Gear and pinion
- Rubber pad
- Bearings
- MS metal pins
- Nylon cord

2.2 Electrical Construction

The electrical construction consists of stepper motor and its controller, LDR based color sensor circuit and transistor switching circuit. A voltage comparator op-amp is also used in the color sensor.

Integrated circuits (as shown in Fig.3) contain transistors, capacitors, resistors and other parts packed in high density on one chip. Although the function is similar to a circuit made with separate components, the integral structure of the components are different in an integrated circuit.

In this project we used two IC, one op-amp IC

(LM324) and a micro controller IC (PIC 16F72).

Materials of electrical construction are

- Stepper motor, 1.8o/phase,0.96A,8.4V
- Microcontroller : PIC 16F72A
- 3 volt White LED
- Electric wires
- Transistor: BD 135 (NPN)
- Electrolyte Capacitor: 1000µF 50V, 2200µF 50V
- Resistance:330Ω,10kΩ,1kΩva. pot.
- Crystal: 20MHz
- LDR
- IC base
- Vero board
- COM port
- Battery: 6V, 4A/h
- Op-Amp: LM 324

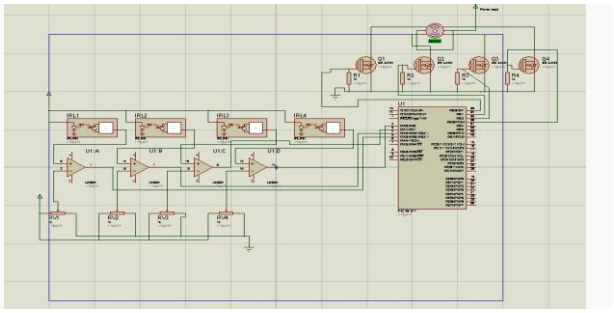

Fig.3 Electrical circuit of the robot

3. METHODOLOGY

Flow chart: Programming language C is used here. The flow chart is given in the Fig.4

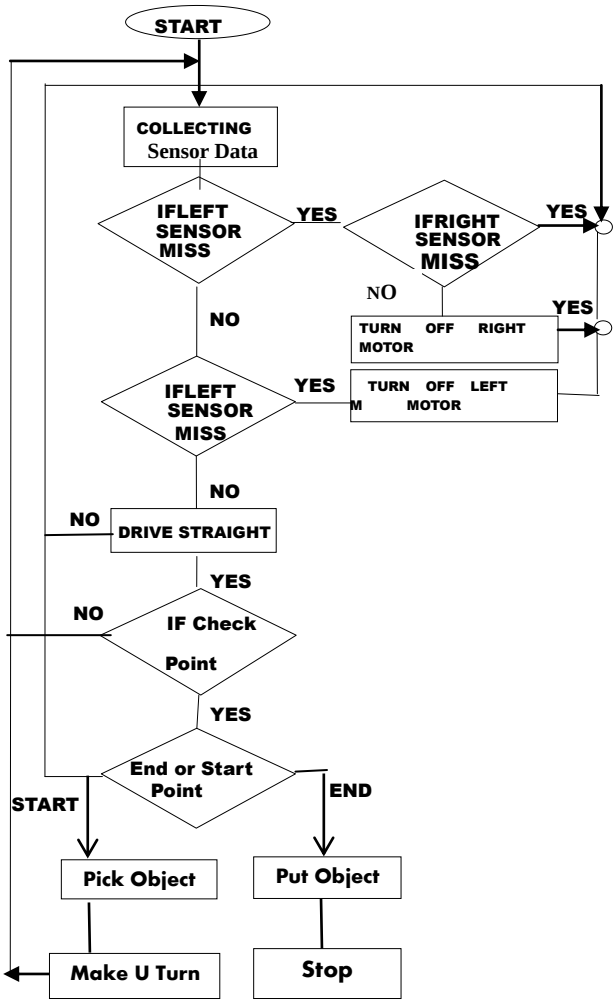

Fig 4: Flow chart of the line Tracking autonomous robot

We used here the logic of differential moving of wheel to follow the white line. The sensor circuit (see Electrical Construction) has two LDR (left and right LDR) and two bright LED (left and right LED). The reflected light of LEDs from the floor falls on the LDR and the LDR shows various resistances. We measured the resistance of LDR when light reflects from the white line. Reflected light from other color gives various resistances by the LDR. So this resistance difference gives the direction of the path of white line. When the two LDR gives the same resistance then the two stepper motor rotates in same speed. When left LDR gives different resistance then the right stepper motor rotates slowly and when the right LDR gives the different resistance then the left stepper motor rotates slowly. Thus the robot maintains its position correctly. The sensor measured the light intensity and the sensor circuit sends left and right signal to the micro controller and the micro controller drives the actuators according to the input signal and programmed logic.

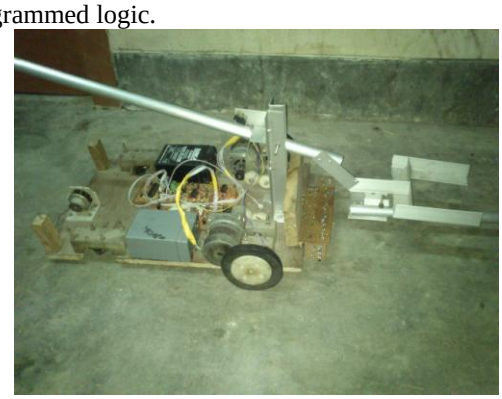

Fig.5 Complete picture of the robot with mechanical gripper

4. DISCUSSION AND CONCLUSION

The Line following robot was finally completed (as shown in Fig.5). A lot of effort was put into the design, implementation. The robot was finally running with a few glitches here and there which were sorted in the later revisions of the firmware.

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 unload the object at the desired place . For picking up object mechanical gripper is used which successfully gripped objects property. It can carry ring type object maximum350gm. without jerking.

5. CONCLUSION

From the above aim and discussion the following conclusion can be drawn

1. The robot follows only white color line and can distinguish white color line from multiple lines.
2. It can as follow any kind of zigzig and curved white lines.
3. The maximum load can be carry about 300gm
4. The robot can turn any angle from 0 to 180^{O}

6. REFERENCES

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