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An Intelligent Line Follower Using Ldr Sensor

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ABSTRACT **:** *Line follower robot is a robo car that can follow a path. The path can be visible like a black line on the white surface (or vice-verse). It is an integrated design from the knowledge of Mechanical, Electrical and Computer engineering. This paper presents a 700gm weight of a 9W LDR sensor based line follower robot design and fabrication procedure which always directs along the black mark on the white surface.*

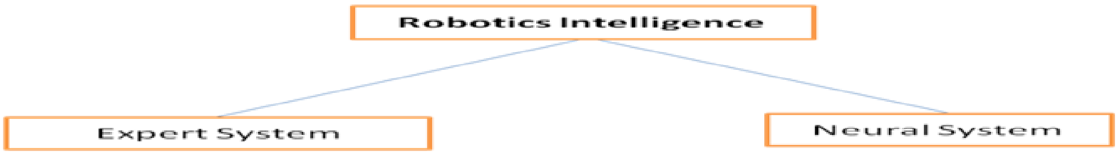
Keywords- *LFR, System Requirements, System Development, Experimental Result, Future Direction.*

I. INTRODUCTION

What is Robot?

Robots are machines which do a task which would otherwise be done by human labor. Robot may or may not possess intelligence.

Robotics Intelligence



Line Follower Robot (LFR)

What is Line Follower?

Line follower is a machine that can follow a path. The path can be visible like black line on a white surface (or vice versa) or it can be invisible like a magnetic field. The follower machine-LFR

Line Follower Robot (LFR)

Line Follower Robot (LFR)

How it works?

Sensors read how much light is reflected Microcontroller determines the light value Motors speed up or slow down to keep robot following line

II. SYTEM REQUIREMENTS

Actuator

Actuators are the muscles of the manipulators. Common types of actuators are servomotors, stepper motors, pneumatic cylinders etc.

Sensor

Sensors are used to collect information about the internal state of the robot or to communicate with the outside environment. Robots are often equipped with external sensory devices such as a vision system, touch and tactile sensors etc which help to communicate with the environment

Controller

The controller receives data from the computer, controls the motions of the actuator and coordinates these motions with the sensory feedback information.

- PIC 16F690
- Stepper motors
- While 2Pieces
- Copper Board
- Some Ware
- Sensor (LDR)
- Dc Motor
- Motor Driver IC-L293D
- Ferric Chloride
- Proteus 8
- Eagle Software
- Connector
- Mobile Battery 2 pieces +5v
- PCB Board
- Language Program

III. SYSTEM DEVELOPMENTS

Materials

The materials for building the body or framework of the robot must be strong enough for the job, easy to work, durable and low cost. Also it should look good — have a shiny or attractively colored surface. Some kinds of plastic food container have all of these qualities. Project 6.1 illustrates how-to build the robotic mechanisms and circuits into a ready-made box. If there happens to be a spare unused box in the kitchen cupboard, it costs nothing. The main snag is that it may not be exactly the right shape or size. Converting a sandwich box into a robot is a short-cut way of getting into robotics, and the programs it runs can be really high-level, but a purpose-built body is more professional. The following sections describe some of the most popular materials.

Wood

Wood is rarely thought of as a robot-building material but, at times, it can be just what we need. It is strong for its weight and easily cut, drilled, painted, carved and glued. Nylon nuts and bolts, from electronic parts suppliers, are necessary if there is a risk of the bolts causing a short circuit. This could happen if a circuit-board is bolted to a metal panel. In such cases use nylon bolts and nuts or plastic stand-offs. The tool is the glue gun, which melts glue sticks and has a nozzle for applying the molten glue to the work piece. A glue gun is a handy tool to have on the workbench for all kinds of gluing jobs. The glue sticks are melted by the electric heating coil in the gun. Press the trigger to extrude molten glue from the nozzle.

Tools

The tools you need for constructing robots partly depend on the materials you use. For Foam Board the main tools are a steel ruler, a craft knife and a plastic chopping board (use one discarded from the kitchen) or cutting mat. You need a few other tools for mounting the motor and circuit boards. For building an aluminum framed robot such as the Gantry, a drill press is almost essential and so is a hacksaw. When you have decided what materials are to be used, select your tools from those described below.

Cutting tools

A junior hacksaw, with a 150 mm long blade is good enough for most jobs, such as cutting wood or plastic, and for circuit boards. For cutting aluminum or brass stock a regular hacksaw is faster and gives a straighter cut. If you have problems with cutting things square or if you need to cut at a particular angle, a miter saw is a great help. It keeps the saw blade vertical and perpendicular to the length of the work piece. It has gauges to help cut pieces to equal lengths. The frame that carries the blade can be rotated to cut at angles other than 90°, the angle being settable on a graduated scale. A miter saw is almost essential for building the Gantry. A file saw, reamer and junior hacksaw.

Drills

Although a hand-turned drill is adequate in many ways, an electric drill is a boon when there is much drilling to be done. Robot building seems to require a lot of it. If you already have a small power drill for jobs about the house, it may not be worthwhile to get anything more professional. A drill press is not expensive, is so much easier to use and produces better results. A drill press helps put the holes in the right places and at right angles. Use it for aluminum, brass, wood or plastic, preferably running it at its lowest speed.

Other tools

Screwdrivers are obviously essential but only small sizes with regular blades up to 4 mm wide. Metric bolts usually need a small-size Positive screwdriver. A set of jeweler's screwdrivers is useful on occasions. An assortment of small files of various shapes is handy for smoothing cut edges and shaping parts of mechanisms. A set of needle files is also worth having. An engineer's steel rule 300 mm long, graduated in millimeters, completes the tool kit.

Planning a Mobile Robot Body

Things before starting the building process,

Chassis

- Ready-made chassis such as a plastic food storage box. Easy and quickly built.
- An existing toy. Generally easy and quick, but there could be snags.
- Chassis made from sheet plastic or foam board. Easy but takes longer. Gives scope for invention.
- Chassis made from sheet aluminum. You need tools and experience to make it.

Wheels

- How many? Three is a popular number.
- Drive (traction) wheels at front or rear.
- Steering by tank method (two independent drive wheels, two motors).
- Steering by automobile method, one motor, with differential gear (complicated)

Shape

- A robot that is about as long as it is wide turns much more easily in a confined space (such as the average family room).
- A robot that is much taller than it is wide is more likely to fall over on uneven surfaces, if it hits an obstacle, or when it accelerates or decelerates quickly.
- If the robot is to have jaws for picking up a load, it needs to have a broad base for stability.

There are more detailed design points in the next two sections.

Road wheels

The main points about a road wheel are its diameter and the nature of its tread. A larger diameter is better on a rough or uneven surface because the wheel can more easily ride up over ridges and is less likely to get stuck in grooves. Also it allows there to be a larger clearance between the surface and the underside of the chassis. If the surface is smooth and even, for example the rails of a gantry, small wheels have the advantage of light weight. It is all too easy for a robot design to finish up by being heavier than the motor can drive. Using small wheels helps to avoid this. Types help the robot to run without slipping. The simply programmed robots usually start and stop abruptly. This leads to skidding or slipping. We rely on a robot being able to run in a straight line but slipping makes it run in irregular curves. Unless it is continually taking its bearings from a fixed landmark, it soon gets lost. Wheels slip, even when they have treys, but treys help to avoid serious slipping. **DC motor**

Although motors are electrical and therefore might be a topic for the electronics Chapter, they move the mechanical parts so need to be talked about here. The discussion focuses on small low-voltage DC motors. When selecting a motor for a project, one of the main points is its operating voltage, for this partly decides the size and weight of the battery that must be carried. Motors running on 12V need eight AA cells. These are too heavy a load for a small robot such as the Scooter. The Quipster is larger and heavier so needs more powerful motors to propel it. This robot runs on a pair of 12 V motors, powered by a battery of eight AA cells. If we needed maximum power we would use dry cells, but rechargeable cells are more economical. Eight LiMH cells produce 9.6 V, and will drive the motor with sufficient power. The next point to consider is the gearbox. It is rarely that a robot mechanism can be driven directly from a motor turning at several thousand revolutions per minute. If the motor does not have a built-in gearbox, it is almost certain that you will need to build or buy one. A built-in gearbox is neater, more convenient, and probably cheaper than a separate one.

Robot Electronics

Circuit board

The components of an electronic circuit are nearly always assembled on a rectangle of circuit board. This is made from insulating material and has conducting copper tracks on its underside to make the connections between components. In the circuits described in this book, we use components that have wire terminals. The wires are pushed through holes in the board and soldered to the tracks on the other side of the board. Another type of component is the surface mount device (SMD) which has terminal pads that are soldered to tracks on the same side of the board. No holes are required. SMDs are very small and difficult to handle, so we do not use this type in the book. Take care not to ask for the SMD type by mistake when buying components.One of many more elaborate circuit boards intended for integrated circuits (which include PICs)

Connecting Wire: Three kinds may be needed:

- Single-stranded insulated connecting wire, 0.71 mm diameter. Used for wiring up circuit boards. Can be bought by the meter, and a meter or two in two or three different colors is worth keeping in stock.
- Multi-stranded flexible insulated connecting wire (sometimes called bell wire), 13 ×0.12 mm (that is, 13 strands, each 0.12 mm diameter). Use for connections to off- board components such as motors, and for connections between boards. Stock a few meters in a few different colors.
- Tinned copper wire, bare, 0.71 mm diameter. We prefer this to insulated wire for wiring up circuit boards. Not having to strip its ends saves time and the risk of short circuits is minimal. The exposed wires provide plenty of contact points for use when testing the circuits.

Solder

Solder is a mixture of 60% tin and 40% lead. It comes as wire with a central core of resin. For building electronic circuits the narrower gauge, 0.71 mm diameter is preferred. Recently introduced regulations mean that lead solder may no longer be used in certain countries, including those in the European Union. Lead-free solder must be used instead. This usually consists of a mixture of tin and antimony. It is available in wire form, 0.71 mm in diameter.

Insulation

It is often essential to stop currents from flowing where they should not flow. Use PVC insulating tape to wrap around wires or terminals that are at risk. Use it also to wrap round joints where two wires have been soldered together. A reel of red and a reel of blue will cover most needs. Insulated sieving is PVC tubing a few millimeters in diameter. It is made in a range of colures. It is handy for protecting bare wires or where two wires are soldered together. Most slaving is of the heat shrink variety. It fits loosely over the joint but, when heated by holding a hot soldering iron near it, it shrinks to half its original diameter. This anchors the insulation firmly in place. Heat shrink tubing is sold in packs of assorted diameters and colures. A pack will last for years.

Designing tools

Circuit designs are developed and tested on a breadboard before soldering them to a circuit board. The board has an array of sockets, connected in groups. Terminal wires are bare-ended wires which are pushed into these sockets to connect them electrically. An assortment of jumper wires of various lengths is used with the breadboard. They are sold as sets, but you can make them yourself by cutting and stripping the ends of a few dozen pieces of single cored (essential) connecting wire. Let them vary in length from about 2 cm to about 10 cm. It is a good idea to prepare a few wires stripped at one end and with a miniature crocodile clip soldered at the other. Another useful item for bread boarding and for circuit testing generally is a set of a dozen or so test leads in a variety of colors. These are made from light-duty flexible wire and have a hooked test clip at each end. Another indispensable item is a test meter, or millimeter. Preferably it should be digital and should measure DC voltages up to, say, 20 V. It may measure currents up to 1 A, but current measurements are not often made in robot circuits. It should measure resistance and capacitance. Continuity checking and diode testing facilities are well worth having. Digital meters are favored because of their low input impedance (they take very little current from the test circuit) and their 4-figure precision (but three figures are enough for most purposes). But a rapidly changing voltage produces an annoying and unreadable scramble of digits on the display. This is when analogue meters come into its own even a cheap old model that you nearly threw away. Its wavering needle tells you almost all you want to know about voltage swings.

Soldering tools

A soldering iron is an essential item. A soldering station with thermostatic control is nice to have but a simple electrically heated iron will do. The main points are that it should be low power, about 15 W, and the bit should be no more than 2 mm in diameter.

Other Tools for Electronics

A wire and cable stripper removes the insulation from the end of the connecting wire in a single action. It saves a lot of time. But most wire strippers are designed for use by electricians. They will strip the insulation from hefty mains cable, or TV antenna cables, but not from the thin wires such as we use in electronic hobby projects. Choose with care. Wire cutters of the side cutter type trim the component leads short after they have been soldered to the board or terminal. They give a neat finish to the work and no other tool does the job.

Components

- Variable resistors: The miniature horizontal preset type is good for bread boarding. Sometimes called trim pots. Handy values are 470 Ω, 1 kΩ, 4.7 kΩ, 10 kΩ, 100 kΩ, and 1 MΩ.
- Capacitors: Their main use in our circuits is for smoothing spikes and pulses out of the supply. Stock a few MKT polyester capacitors, value 100 nF.
- Transistors: Probably the most often needed is the BC548 for use in transistor switches, but other types can be used for this purpose. The table lists types to choose from.

Power Supplies

The various types of power supply — batteries and PSUs — are discussed on p. 57. Here we work out what voltage the supply should have and go into more detail about how to provide it. The first stage in planning the supply is to list the devices and circuits in the system and what they will need. All systems will include one or more PICs so start with this. The most recent PICs operate at any voltage between 2 V and 5.5 V. This wide range gives a degree of flexibility except that it does not include 6 V, which could be conveniently provided by four alkaline cells. The nearest is four NiMH (or NiCd) at 4.8 V. In practice, though rated at 1.2 V per cell they give 1.3 V when fully charged. The system will almost certainly include one or more motors. Usually the motor is chosen for its dimensions and its running speed (and perhaps its price). Provided its operating voltage is not more than 12 V, we either run it at this voltage or on a lower voltage on which it will run fast enough. Other devices in the system may have special requirements. For example, CMOS logic circuits of the 4000 series require between 3 V and 15 V, which is easily met, but the 74HC series need between 2 V and 6 V. They cannot be run on the same supply as a 12 V motor. Some of the solid state buzzers and bleeper's have a wide range of operating voltages but others have not, so check this point before you buy. If everything can run at the same voltage it makes the circuit design much simpler. This is why it is preferable to use low-voltage (3 V or 6 V) motors that can run on the same supply as the PIC. Sometimes a 12 V motor, solenoid or relay is the only suitable type and we have to set up two supplies. The power supply circuit, single or double, should also include an on-off switch and preferably an indicator LED to light when it is switched on. Some circuits for this are shown overleaf. If the drive motors have their own supply it is a good idea to give them a separate switch. It is then possible to run the PIC and test it without the robot shooting all over the place.

The Controller Circuits

Because the electronic system of the robots is modular, the controller board has little on it except for the PIC. The drawing shows the essentials. The switch S1 is the power supply switch seen in the drawing opposite. The polyester capacitor C1 is to absorb voltage spikes on the positive supply line. When power is first switched on, channels RA0 to RA2, RA4, RB4, RB5, RC0 to RC3, RC6 and RC7 are all analogue inputs. The rest are digital inputs. The analogue channels can be defined individually as digital and all channels except RA3 can be defined as outputs. Outputs are always digital. When they are configured as inputs, the channels of Ports A and B (except for RA3) can all have weak pull-ups. These can be brought into action individually. The weak pull-up acts like a high-value resistor between the input pin and the supply line. The input is read as logic high, unless it is strongly grounded to the 0 V rail. Channel RA3 is an exception. It can be configured as a digital input with no weak pull- up. The circuit for this is shown in dashed lines. It requires an external resistor. If the channel is configured as MLCR, to reset the controller, it automatically has a weak pull- up and does not need the external resistor.

Input Circuits

Analogue Input

The analogue output from a sensor such as a photodiode (see above) or light dependent resistor circuit can be read by using the PIC's internal analogue-to-digital converter. This has a 10-bit output, so we can read the sensor with high precision. It is not just a matter of high versus low. The PIC van is programmed to do different things at different light levels.

Sensors

A robot needs to be aware of what is happening in the world around it. That is why all our robots are equipped with several sensors linked to the controller. This section lists sensors that are often used in robotics. Resistive sensors respond to changes in a quantity such as light or position and their response is a change in their resistance. A change in resistance is easily measured by passing a current through the sensor and generating a changing voltage which is sent to the controller. Usually the sensing circuit is a potential divider with the sensor as one of the resistances.

Light sensors

The most commonly used light sensor in our robots is a light dependent resistor which, as its name implies is a resistive sensor. The resistance of a typical LDR, such as the ORP12, ranges from 1 MΩ or more in darkness to about 80 Ω in bright sunlight. Indoors, with indirect daylight or artificial illumination, their resistance is a few kilo ohms. LDRs respond to light of most colors, with a peak response in the yellow. Of all the light sensors, the LDRs are the slowest and their response times are several tens or hundreds of milliseconds. Although this is seems quite fast to humans, the PIC works much faster than this. Programs may need a short delay to allow time for the LDR to catch up with it. The potential divider (see drawing opposite) can have a fixed resistor, a variable resistor, or both. The variable resistor allows for setting the output voltage for any given light level. The total resistance should be in the same range as the average resistance of the LDR under the expected operating conditions. Another popular light sensor is the photodiode. The action of these depends on the fact that the leakage current when the diode is reverse biased varies with light intensity. The circuit is on p. 73. The leakage current is very small. In darkness it is only a few nanoamps and rises to about 1 mA in bright light. The resistor has a resistance of a few hundred thousand ohms, so the current generates a reasonable voltage across it. Often a 330 kΩ resistor provides suitable output voltage. The output must be connected to a high impedance input so that the voltage is not pulled down. The PIC is a CMOS device so has high-impedance inputs. A photodiode is generally more responsive to light from the red end of the spectrum. Some are especially sensitive to infrared. These are used with infrared LEDs for reading optical encoders (p. 84). They are employed as sensors in line-following robots because they are less subject to interference from external sources of visible light. The response time of a photodiode is fast, generally a few hundred nanoseconds, so there are no problems with this. A phototransistor (overleaf) has properties similar to those of a photodiode, though their response time is longer. They are connected in the same way as an npn transistor in a common-emitter amplifier. Phototransistors often lack a base terminal and, if present, the base is usually left unconnected. The reason that a phototransistor can operate with a base current is that the light falling on the transistor releases a supply of electrons. These electrons act in the same way as a base current. Phototransistors are often packaged with an amplifier circuit or a Darlington transistor output on the same chip for greater sensitivity. There are similar devices based on photodiodes.

Digital Output

The analogue output from a light sensor is usually processed by the PIC's in-built comparators but sometimes there are not enough of these, and in any case it is simpler to handle the triggering level in the hardware. This circuit uses an op amp comparator to convert the analogue output into digital.

The op amp has two inputs and there is no feedback, so the difference between the input voltages is multiplied by the open loop gain of the amplifier. The output swings very sharply from low to high when the voltage at pin 3 exceeds the voltage at pin 2. The voltage at pin 3 is always half the supply. The voltage at pin 2 varies directly with light intensity. It is set by adjusting VR1 to bring it to half supply when the LDR is receiving light of the triggering intensity.

Detecting Colors

A robot may be required to detect the color of an object. For example, it may have the task of sorting building blocks of different colors. A simple way to do this is to illuminate the object with light from two or three different colors, one at a time. A single LDR light sensor measures the amount of light reflected from the object. As a test run of the technique, small (30 mm) squares of colored paper are illuminated by light from red, green and blue high-intensity LEDs. An LDR is exposed to the light reflected from these squares. The LDR is part of a circuit like that on p. 75, and the output voltage is sent to a comparator. With a suitable setting for its reference Voltage, the comparator's output is read for each colored paper and for each colored LED. The output is 0 for low reflection or 1 for high reflection. Here are some typical readings.

Output Circuits

Direct drive

The maximum current that can be sourced at any single terminal pin is 25 mA. The maximum current that can be sourced by the three ports at any instant is 200 mA. The same figures apply also to sinking current. A current of 25 mA is sufficient to drive a regular LED but not the high brightness or extreme brightness types, which take 30 to 50 mA or more.

Stepper Motors

As their name suggests, stepper motors turn step by step. The commonest type has a step size of 7.5°, so that it takes 24 steps to make one revolution. This produces a slightly jerky motion but it is satisfactory for most purposes and the programming is simple. This description refers to unipolar stepper motors which have permanent magnets and 7.5° steps. The motor generally has six wires, which are connected to the windings as shown in the drawing opposite. The robot projects in this book are based on the PIC16F690 microcontroller, made by Microchip Technology Inc. But all PICs have a common basic architecture and electrical properties so the circuits described in this book can usually be made to work with several other types of PIC.

Programming a PIC

The PIC16F690 is especially suitable for hobby robotics because:

- It is one of the newer PICs.
- It uses the latest nano Watt Technology. The standby current is only 1 nA when operating on a 2 V supply. At the other end of the scale, its operating current when running at 4 MHz, on its maximum supply of 5.5 V, is less than 1 mA. Low voltages and currents are ideal for driving mobile robots.
- If we opt to base timing on the built-in internal oscillator, all but two of its 20 pins are available as digital inputs and outputs. The robot can have what it needs – lots of sensors and actuators.
- It has Flash memory, ideal for programming hobby robots.

Programming a PIC

```
void main() {
TRISA = 0x04;
TRISB = 0x00;
TRISC = 0x00;
PORTA = 0x04;
PORTB = 0x00;
PORTC = 0x00;
CM1CON0 = 0x00;
CM2CON0 = 0x00;
ANSEL = 0;
ANSELH = 0;
PORTC = 0x00;   // Enable initial value of LED
while(1)
{
// condition for car going on forward
if(RC0_bit == 0 && RC1_bit == 0) //  Two sensor
ON when car on forword
{
PORTC = 0b01010000; // RC4 And RC6 pin will be
high and car will on forward
}
// condition for car going on left
else if(RC0_bit == 0 && RC1_bit == 1)
{
PORTC = 0b01000000;  // RC5 and RC6 hight now
car will go on LEFT
}
// Condition for car going on right
else if(RC0_bit ==1  && RC1_bit == 0)
{
1PORTC = 0b00010000;  // RC4 and RC7 hight now
car will go on right
}

// Condition for car going on Break
else
{
PORTC = 0x00;
}
}
}
```

As you can see if you look at the programming examples of the projects, there are program routines that we use over and over again. Some may differ in detail but essentially they are repeats. It makes more sense to save these as separate text files, so that you can load them and put them into your current project. They may need a little editing here and there but this is nothing compared with the effort needed to type them in from scratch every time you need them. Not only does it save typing effort, but it reduces the risk of typing errors too. The program segments listed in this Part are a selection of the most often needed routines. The listing opposite begins with a title frame. It is not strictly necessary, but in a few months' time you may have forgotten what the program is supposed to do. Every line of the title frame must begin with a semi-colon so that it is ignored by the assembler. The first active line of the listing tells the assembler which PIC you are using. Then comes the configuration directive which sets up the key features of the way the PIC is to operate.

The PIC16F690 Block Diagram

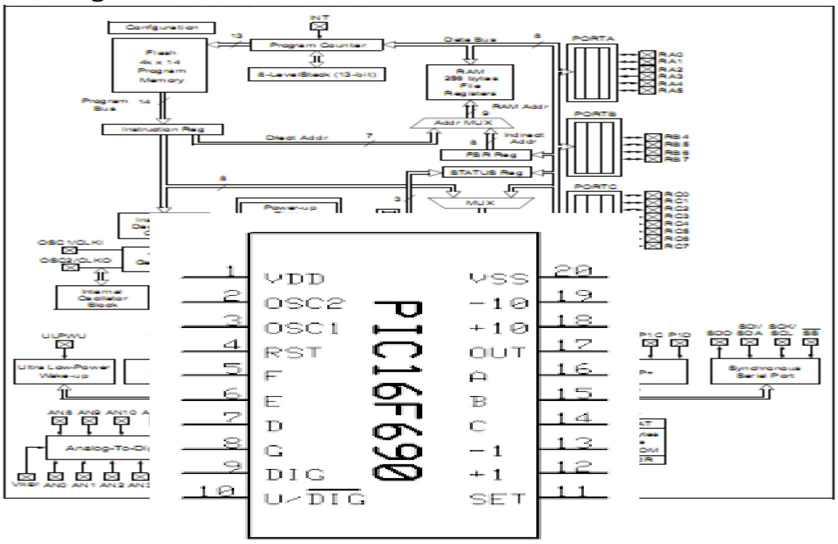


Fig: The PIC16F690 Block diagram.

Light Dependent Resistor (LDR) Diagram

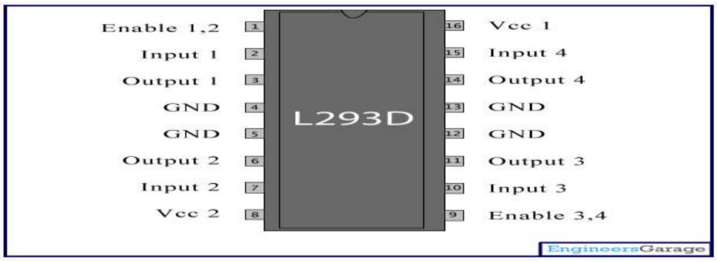


Fig: Light Dependent Resistor (LDR) diagram

Motor Control Board

This has an H-bridge for controlling the direction of the motor. It is mounted on the lid, beside the motor/gearbox unit (photo p. 180).

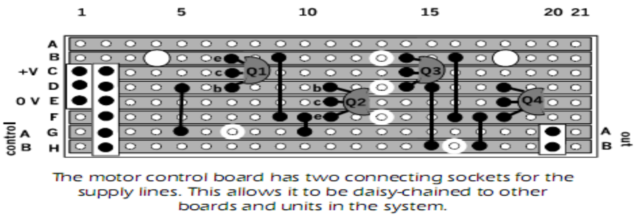


Fig Moto Driver IC-L293D diagram.

Connections are made to this board in the same way as to the controller board, by pushing the stripped ends of the wires into sockets. Alternatively, solder the wires directly to terminal pins or to individual sockets that push terminal pins.

Circuit Diagram

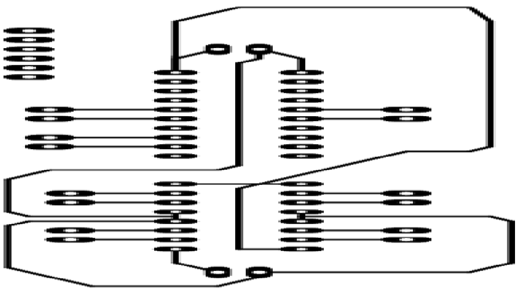


Fig: Circuit Diagram

Activities of Mobile Robots

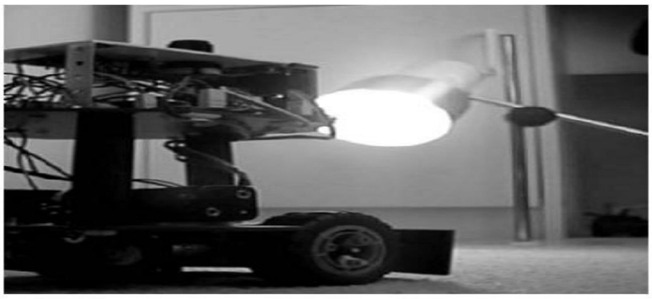
Moving around

By definition, all mobile robots move from place to place. They need to be able to move forward, to reverse, and to turn to the left or right. Robots are often operated in confined spaces so it useful to be able to spin on one spot. Variable speed is less important and often unnecessary.

The chassis of the programming C has two motors, one for the rear drive wheels and the other for steering

Detecting and Responding to Light

Sight is probably the most important of all human senses. The same applies to mobile robots. Some can detect a lamp which is several meters distant, and aim themselves towards it. Or maybe they will go in the opposite direction, to end up in the safety of dark corner.



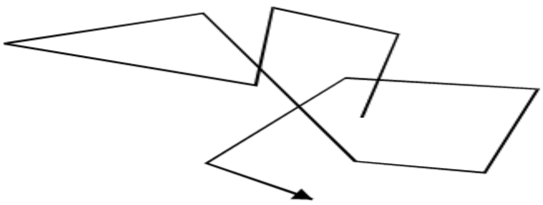
The *Quester* robot homes on a source of light.

Activities of Gantry Robots

A gantry robot operates over a clearly defined rectangular area. It picks up objects from any point in the area and sets them down at another point in the area. The tool (often a gripper) is suspended from a small trolley-like frame, and can be lowered and raised. The frame has wheels and runs on a pair of rails so that it can travel from one side of the area to the opposite side. This set of rails is on a larger frame at right angles to the first set, so the smaller can be moved to any point within the area. Thus the location of the tool is defined by two coordinates, its x-position and its y-position. It is easy to design sensors that can read the x and y coordinates and a gantry robot is therefore much easier to program for applications that require precise navigation. Gantry robots are used in industry when very heavy loads are to be handled. The hobby versions are suited for less strenuous tasks. They are excellent for playing board games such as chess, draughts and checkers. Like mobile robots, gantries can be programmed to solve mazes. But mobile robots are apt to lose their bearings. Because the travelling frames can be precisely positioned beekeeping track of their x and y coordinates, a gantry robot can never lose its bearings.

Random Activity

Randomness may sound an unlikely topic for a robotics book but it has its applications. A robot that is reliably built and programmed performs its tasks in an orderly and inflexible manner. Humans are not normally like this. Indeed, if people are too rigid in their behavior we may complain that they are 'acting like a robot' or that the person is 'an automaton'. If a robot is programmed to run for a short, randomly-chosen distance, then turn through a random angle, and continue indefinitely in the same routine its path is totally random. We say that it is literally performing a Monte Carlo Walk. We say 'literally' because the same term can be applied to other random sequences that are not actually walks.



A Monte Carlo Walk usually results in staying in more-or-less the same place.

Usually we do not aim for total randomness. For example, a robot detects an obstacle in its path, backs up, turns slightly to avoid the obstacle and then continues forward. The stopping, backing and turning are fixed responses. Whether it turns left or right on given occasion is determined as random. We cannot predict which way it will turn next. This introduces randomness into its behavior, but not too much. Random behavior is produced in the software, using a random number generation routine. Actually its output is not genuinely random, but a predictable series of values that repeat after such a long interval that it appears to be random. This is actually pseudo-random. Randomness has other and more serious applications. A robot that is solving a maze maybe programmed to make a random choice whenever it has to go either left or right at adjunction. If it is also programmed to remember which choices it made at each junction and which choices took it successfully to its goal, it can eventually learn to run the maze correctly. This is the basis of learning by trial and error. The same type of learning technique can be applied to other learning tasks.

IV. EXPERIMENTAL RESULT

The line following robot project challenged the group to cooperate, communicate, and expand understanding of electronics, mechanical systems, and their integration with programming. The successful completion of every task demonstrated the potential of mechatronic systems and a positive group dynamic. Overall, the line following robot was a tremendous success and an incredible learning opportunity for everyone involved.

Cost Estimation for the project

1)	PIC16F690	1.8 $
2)	Soldering Iron	5.55 $
3)	Mini hand PCB driller for student version	24.63 $
4)	LDR sensor (7.89X2)	0.20 $
5)	Glue gun	3.08 $
6)	Glue stick	0.25 $
7)	40 pin premium male to female connecting wires	2.41 $
8)	DC gear motor box and wheel pair(260X2)	6.42$
9)	L293D IC	1.06$
10)	Project board	3.15$
11)	Printed circuit board (PCB) 40”X24”	11.00$
12)	Diode 1A10 (5X2)	0.15$
13)	Ball caster	0.62$
14)	White LED (1.20X2)	0.15$
15)	Ferric chloride for PCB design 500gm	4.35$
16)	Transistor BC517 (31X2)	0.78$
17)	Mobile battery +5V (350X2)	7.42$
18)	Miscellaneous	13.00$
	Total	**86.02$**

Application

- Industrial automated equipment carries.
- Automated Guided Vehicles (AGV).
- Second wave robotic reconnaissance operation.
- Tour guides in museums and other similar application
- Restaurant services.

V. CONCLUSION & FUTURE DIRECTION

Conclusion and Future Direction

Light Dependant Resistor (LDR) can be used to differentiate different color lines with different sensitivity levels.

Our future target is to enhance performance of the existing Line Following Robot with integrating,

- Software control of the line type (Dark or light) to make automatic detection.
- Obstacle detecting sensors to avoid physical obstacles and continue on the line.
- Distance sensing and position logging and transmission.
- Weight carry move to 24 hours any manufacture company.
- Choice of line is made in the hardware abstraction and can not be changed by software.

- Calibration is difficult and it is not easy to set a per fact value.
- The steering mechanism is not easy.
- Few curves are not made efficiently and must be avoided.

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