LINE FOLLOWER ROBOT

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"I agree that this report is my own work except the quotation and summary, each that I mentioned the source"

Signature :

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Date : 02 March 2005

DEDICATION

For my beloved mother Saadiah binti Mohammed,
my father Mohd Taib bin Abu Bakar,
my brothers and sisters, my supervisor Mr. Kasrul bin Abdul Karim
and all my friends
who gave supported and encourage to me.

ABSTRACT

Nowadays, the word 'robot' is often applied to any device that works automatically or by remote control, especially a machine that can be programmed to perform tasks normally done by people. The follower is one of the self-operating robots that follow a line that drawn on the floor, just like industrial robot in factories. A light sensor that consists of infrared emitter and detector distinguishes the black color from the white background and control the electrical motor to follow it. The basic operation of the line following are as follows is capture line position with optical sensor mounted at front end of the robot, steer robot to track the line with any mechanism, and control speed according to the lane condition. Running speed is limited during passing a curve due to friction of the tire and the floor. A line sensor in its simplest form is a sensor capable of detecting a contrast between adjacent surfaces such as difference in color. From this project, it must consider the basics effects of light and what happens when it shines on a black or white surface and to control the function and action of line follower robot it is interfere with micro controller 16F84A. The objective can be achieved when using the appropriate sensors and micro controller. Sensor part facing a lot of problem because of sensitivity of the lighting from the environment and sensor are difficult to detect the line when robot running fast on the track. So, in order to increase sensitivity we used more than one pairs of infrared emitter-detector and isolated each other of emitter and detector. At the final project, student can design the line follower robot that can function greatly by using their knowledge about PIC, infrared emitter and detector sensor and direct current Motor.

ABSTRAK

Pada masa kini, perkataaan robot selalu diaplikasikan dalam pelbagai alat yang berfungsi secara automatik atau menggunakan alat kawalan jauh, terutamanya mesin yang diprogramkan untuk melakukan pelbagai kerja yang selalunya dilakukan oleh manusia. Pengikut adalah salah satu robot yang beroperasi untuk mengikut garisan yang terdapat pada permukaan lantai yang dapat dilihat di kilang-kilang industri robot. Penderia cahaya terdiri daripada pemancar dan pengesan inframerah untuk membezakan warna hitam di permukaan berlatarbelakangkan putih dan dikawal oleh motor elektrik. Operasi asas pengikut garisan ini adalah mengikut garisan yang dikesan pengesan optik yang diletakkan di bahagian hadapan robot dan mengemudi robot sepanjang laluan garisan dengan pelbagai mekanisme dan halaju dikawal menurut keadaan laluan. Halaju adalah terhad semasa robot melalui lengkungan yang disebabkan oleh geseran di antara tayar dan lantai. Penderia adalah ringkas di mana penderia mengesan perbezaan warna pada permukaan. Kesan cahaya dan konsep pantulan dan serapan perlu jelas untuk mengaplikasi pada penggunaan penderia dan fungsi robot itu juga dikawal oleh microcontroller 16F84A. Objektif projek boleh dicapai jika menggunakan penderia dan microcontroller yang sesuai dalam situasi ini. Penderia berdepan dengan pelbagai masalah kerana kepekaannya kurang kesan cahaya daripada persekitaran dan kelajuan gerakan robot juga menyebabkan kesukaran pada penderia untuk mengesan dengan cepat. Jadi, untuk meningkatkan kepekaan robot ini, maka kami menggunakan lebih dari satu penderia dan setiap penderia tersebut dibuat penebatan. Oleh itu, di akhir projek, pelajar boleh mengaplikasikan pengetahuan yang ada tentang microcontroller, pemancar dan pengesan inframerah, dan motor untuk membina satu robot yang berfungsi untuk mengesan garisan yang dapat berfungsi dengan baik.

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CHAPTER 1

LINE FOLLOWER ROBOT

1.1 Introduction.

The purpose of this project was to apply principles of robotics to a real-world application. When developing a line follower robot, it becomes apparent just how complex it is to navigate freely and dynamically in space. With each new environment, or task comes the need for new sensors or manipulators, the human body which is the ultimate line follower robot has and incredible number of sensors. To simplify this problem the designer can limit the robot to a predefined environment, such as our white paper with a black line. For some tasks this may be perfectly fine, such as a child's toy robot, or perhaps a coal bucket in a mining facility, or the famous automatic lawn mower, except that uses a wire instead of a black line.

By developing the sensors, hardware and software from scratch; the project enabled us to get a deeper understanding of what is required in the design of a line follower robot. The mechanical parts of the robot are taken from a shop that selling toy's car accessories, which has twin gear box DC motor and rear wheel. The logic was performed using a PIC micro controller, and motor control was performed with power from batteries. All the wiring was done using wire wrap.

What the logic works down to is that if the left sensor sees black, the robot turns left, and if the right sensors sees black, it turns right. The system can be compared to a monorail, except the rail is a black line.

1.2 Objective

The objectives from this project is:

i. To understand how line follower robot operation to move along the black line.
ii. To study about sensors that are appropriates used in this project.
iii. To study about PIC micro controller and how to program it with PIC programmer.
iv. To design line follower robot that can achieve a target to success in this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Sensor.

Without sensors, a robot is just a machine. Robots need sensor to deduce what is happening in their world and to be able to react to changing situations. The purpose of the sensor subsystem is to enable the robot to have some appreciation of its physical surroundings. In particular, the robot needs to be able to localize itself within the curling arena (i.e. planar x-y location and orientation correction).

2.1.1 Sensor as transducers.

The basic function of an electronic sensor is to measure some feature of the world, such as light, sound, or pressure and convert that measurement into an electrical signal, usually a voltage or current. Typical sensor responds to stimuli by changing their resistance (photocells), changing their current flow (phototransistor), or changing their voltage output (the sharp IR sensor). The electrical output of a given sensor can easily be converted into other electrical representations.

2.1.2 Sensing Modalities.

The robot has the following sensors technologies:

1. Tape sensors

   These sensor are effectively an IR LED (transmitter) physically package with a matching IR sensitive phototransistor. Given that non-IR reflective tape was applied to the arena, these sensors can be used to sense the presence of tape by the lack of IR signal reflectance. As noted in the specification sheet the sensors have to be very close to the surface of reflectance or the IR emitted by the LED will be scattered and not received by the phototransistor, which will lead to a false positive signal being registered. When coupled with a controller implemented in software this mechanism gives a fairly robust means of driving the robot in a straight line at relatively high velocities.

2. IR receiver

   This sensor uses a phototransistor in a sourcing configuration to detect the presence of an IR light source. When connected to a high-pass filter and rectifier, DC noise sources for the signal (e.g., sunlight) can be removed.

3. Virtual Switch (remote control)

   This sensor also uses the IR receiver's phototransistor technology. However, the signal is not filtered and is compared to detect if strong IR signal (presumably from the remote control) is present.

   In addition to the ones used, the following sensing technologies were considered during the design of the robot but were not implemented due to time and resource constraint:

a. Line follower – this technology can follow any optically visible lines and uses a photo resistor instead to measure the light reflected from the line (i.e., tape). The further aid with finding the line, the sensor is often uses in conjunction with a visible LED source.
b. Wheel position encoder – using reference designs detailed in Mobile Robots Inspiration to implementation, an encoder to determine wheel position was considered to aid with controlling the drift of the wheels. In particular, it was theorized that the encoder mechanism from a serial mouse could be used and readily interfaced with the HC-11 to provide this functionality.

2.1.3 Light sensor

2.1.3.1 Photocell

Photocells are made from a compound called cadmium sulfide (CdS) that changes in resistance when exposed to varying degrees of light. Cadmium sulfide photocells are most sensitive to visible light, with some sensitivity to other wavelength.

Photocells have a relatively slow response to changes in light. The characteristic blinking of overhead fluorescent lamps, which turn on and off at the 60hertz line frequency, is not detected by photocells. This is in contrast to phototransistors, which have frequency response easily reaching above 10,000 hertz and more. Therefore, if both sensors were used to measure the same fluorescent lamp, the photocell would show the light to be always on and the phototransistor would show the light to be blinking on and off.

2.1.3.2 Infrared Reflectance Sensor

The infrared reflectance sensor is a small rectangular device that contains a phototransistor (sensitive infrared light) and an infrared emitter. The amount of light reflected from the emitter into the phototransistor yields a measurement of a surface's reflectance, for example, to determine whether the surface is black or white. The phototransistor has peak sensitivity at the wavelength of the emitter by visible light sources. For this reason, the device should be shielded from ambient lighting as much as possible in order to obtain reliable results.

2.1.3.3 Phototransistor

The light falling on a phototransistor creates carries in the base region of a transistor, effectively providing base current. The intensity of the light determines the effective base drive and thus the conductivity of the transistor. Greater amounts of light cause greater currents to flow through the collector-emitter leads. Because a transistor is an active element having current gain, the phototransistor is more sensitive than a simple photo resistor. However, the increased sensitivity comes at the price of reduced dynamic range. Dynamic range is the difference between the lowest and highest levels that can be measured.

2.1.3.4 Infrared Emitter

The light-emitting element (an LED) uses a resistor to limit the current that can flow through the device to the proper value of about 10 milliamps. Normally the emitter is always on, but it could be wired to one of the LED output ports if wanted to control it separately. In this way we could use the same to detect the starting light (using phototransistor with the emitter off) and then to follow a line on the board (normal operation with the emitter on).

2.2 PIC Micro controller

The PIC family has many cousins with various unique features. Despite this, Microchip designed the PICs to share many common attributes such as memory layout and packaging layout. For example, the pin-out for the 18 pin package is the same whether it's a device with standard I/O, or analog comparators, or even analog-to-digital converter ports. They also share the same set of core assembly language commands and memory location for special function register. What this means is that upgrading from one version to another with more features requires very little code "tear up" or hardware changes. In fact some upgrades require no changes at all.

2.2.1 Program Memory.

Program memory is the space PicBasic program resides. From the data sheet and we will see the PIC is 0.5k, 1k or 2k, they are referring to the program memory space. Those sizes 0.5k, 1k, 2k, 4k, and 8k they are the program memory sizes for the majority of the PIC devices. This may seem incredibly small, but for the functions a PIC is designed to do, it's not.

A PicBasic program can have several hundred commands and still fit in a 1k device. Because each PicBasic command is so powerful, a 1k program could control a motor with feedback and direction control, or monitor a burglar alarm system while displaying information on a liquid crystal display (LCD). Adding a serial port to send the status of the system sensors to a PC is a easy as a single SEROUT command.

It's possible to fit so much in because we are creating what is known as embended software. There is no operating system like DOS and no printer devices or graphic drivers to include. The embended software just controls the switching of the I/O ports to control surrounding electronics that are connected to the PIC.

2.2.2 Data Memory

Data memory is where all variables are stored. This is RAM (random Access Memory), which means when the PIC is disconnected from power all the data memory is lost. The data memory is 8-bit wide, which is why the PICs are considered 8-bit micro controllers. The PIC data memory is also banked just like the program memory. The first section of data memory is reserved for special function register. These register are the key locations that control most of functions within the PIC.

Some of the registers are located in Bank 0 while some are located in Bank 1. Some are even repeated so they are available in both banks. To select which bank to control, a bit is set or cleared in the STATUS register. Because we need to access to the STATUS register from both bank, it is located in both banks.

PicBasic makes it easy for the beginner that in most cases we do not need to manipulate the STATUS register. The PicBasic commands take care of it.

CHAPTER 3

RESEARCH DATA AND EXPERIMENT

3.1 Sensor

3.1.1 Theory of Operation

A line sensor in its simplest form is a sensor capable of detecting a contrast between adjacent surfaces, such as difference in color, roughness, or magnetic properties, for examples. The simplest would be detecting a difference in color, for example black and white surfaces. Using simple optoelectronics, such as infrared phototransistor, color contrast can easily be detected. Infrared emitter/detector or phototransistor are inexpensive and are easy to interface to a micro controller.

The theory of operation is simple and for brevity, only the basic will be considered. Suffice for now; we will consider the basic effects of light and what happens when it shines on black or white surface. When light shines on a white surface, most of the incoming light is reflected away from the surface. In contrast, most of the incoming light is absorbed if the surface is black. Therefore, shining light on a surface and having a sensor to detect the amount light that is reflected can detect contrast between black and white surfaces. In figure 1 shows an illustration of the basics just covered.

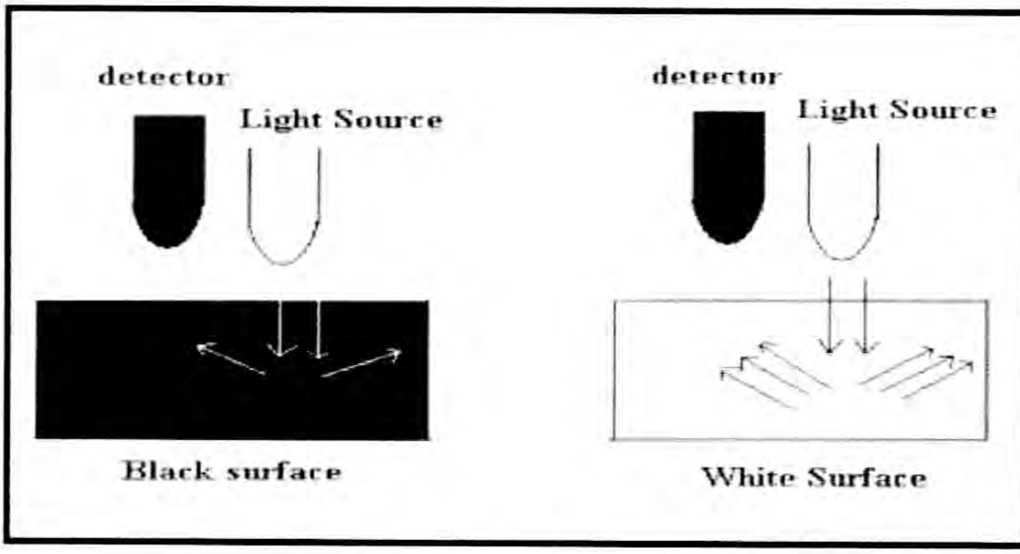

Figure 1: light reflecting off a white and black surface. More light is reflected from the white surface compared to the black surface.

Using what we know about light, and black and white surfaces, the objective of tracking a line is simple can be achieved using the appropriate sensor. For example, if we consider using of three pairs of emitter and detector as shown in figure 2 below. The drive configuration for the robot is assumed to be differential, i.e., like the tracks of an army tank vehicle. From the figure, the three pairs of sensors are used to keep the robot on the lines as it moves. Each sensor output is monitored to determine the location of the tape relative to the robot. The main objective of the robot is to position itself such that the tapeline falls between the two extreme sensors. If the tapeline ever ventures past these two extreme sensors, then the robot corrects by turning in the appropriate direction to maintain tracking. Two different types of light sensors set up in the configuration shown below will be used for line tracking.

to maintain tracking. Two different types of light sensors set up in the configuration shown below will be used for line tracking.

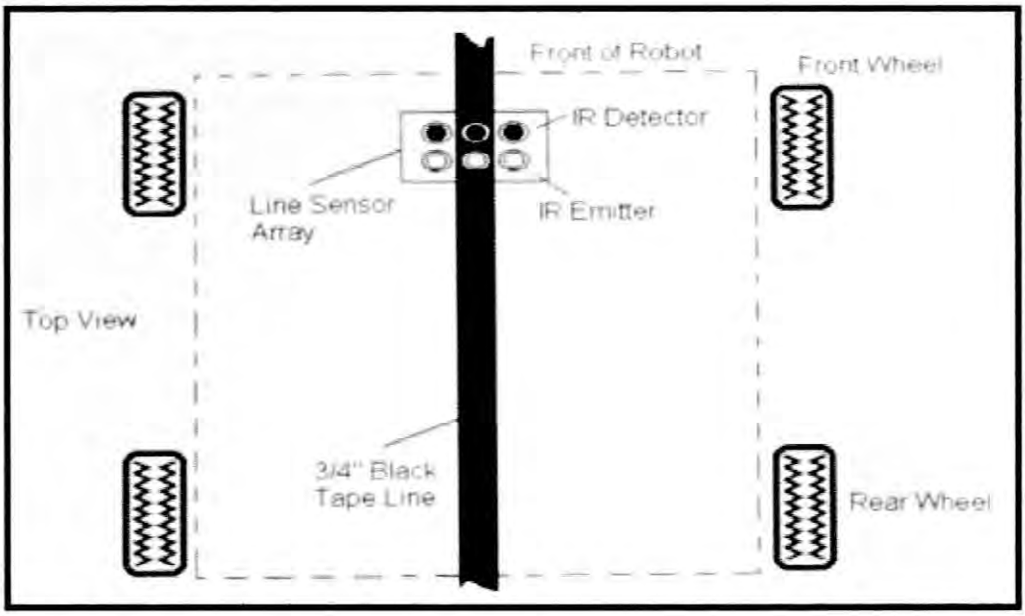

Figure 2: Top view of robot using three pairs of emitter and detector sensors for line following.

3.1.2 Construction

Construction the line sensor is straightforward. I would recommend that a prototype be made to test the operation of the sensor before committing to any permanent construction. Suggestions are presented below relating to sensor separation and placement.

3.1.3 Circuit Diagram

The infrared emitter and detector sensors are shown below in figure 3.

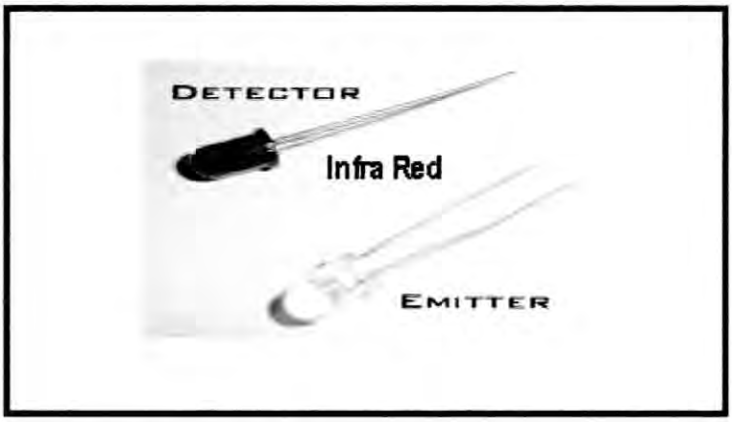

Figure 3: Infrared emitter and detector sensors.

The circuit diagram is shown below in figure 4 and only one set of emitter/detector sensor is depicted. The remaining two are constructed in the same manner. Pay close attention to the anode (+V) and cathode (GND) lead for these sensors. If you plan on making the sensor from color LEDs and Cds photocells, use the same circuit diagram shown below in figure 4, but replace the IR emitter with a red LED and the IR detector with a Cds photocell.

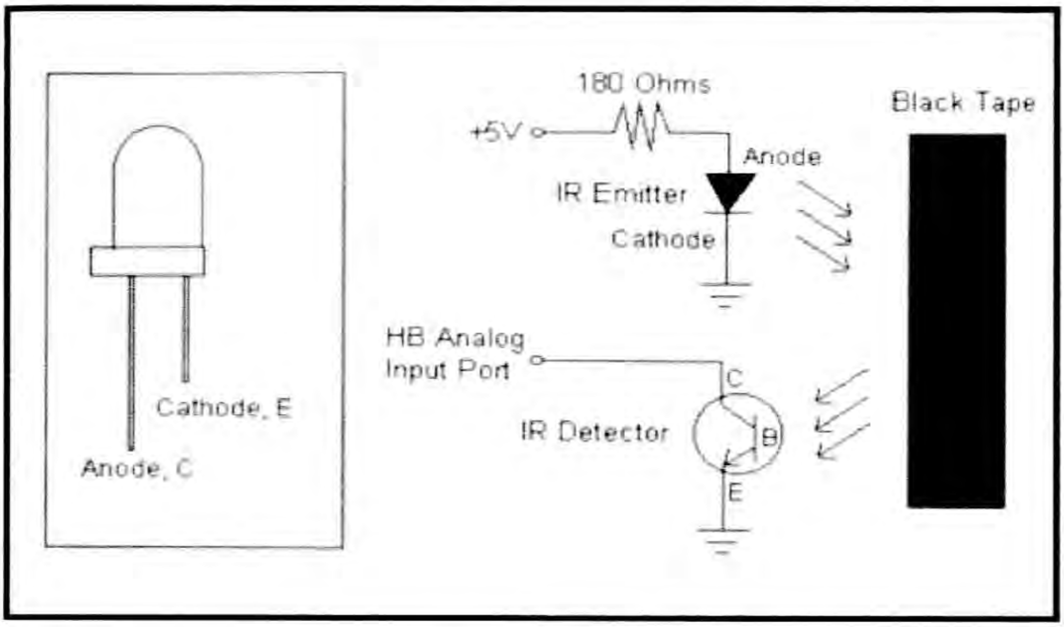

Figure 4: Circuit diagram for the infrared emitter/detector line sensor.

3.1.4 Performance

A comparison was made between the IR and LED/Cds photocell line sensor. Both sensors were easy to construct and cost about the same amount, however the IR sensor out performed the LED/Cds version because of two observed reason: 1) larger sensor output range and 2) robustness. First, the output of the IR sensor showed higher contrast between black and near white surfaces. During test runs, the IR sensors worked great, even when the black tape was place on a wooden floor or on a gray/white floor. The sensor could easily track a black tapeline on almost by color floor other than black or near black, which makes it a very robust and reliable line sensor.