The Robot Builder

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Notices

- Introductory Mobile Robotics Class - 10:00AM - 12:00PM
- Business Meeting - 12:30 - 1:00
- General Meeting - 1:00 - 3:00

Distribution

If you would like to receive The Robot Builder via e-mail, contact the editor at:

apendragn@earthlink.net

Inside this Issue

DUAL SENSORS for a STAMP

by Jim Ubersetzig

Introduction

Have you ever wanted to add sensors to your robot - but weren't sure how to do it ? In this two-part article I will show you how to build a pair of inexpensive sensors which share a Basic Stamp 1 computer.

This stamp-based sensor system will include both Sonar and Infra Red (IR) sensors. The Sonar sensor measures the distance to an object, and the infra red (IR) sensor gives the probability of objects to the right, left or directly ahead of the robot. By operating both sensors off the same stamp computer - you save cost.

This month we will build the sonar system and get it working. Next month an article detailing the addition of an infra red sensor will be included.

Parts List

Qty	Part No.	Description	Src	Cost
1	BS1-IC	Basic Stamp 1	Plx	$34.00
1		Perforated Board		$1.00
1		1 Meg Trim Pot		$1.00
1		10K Trim Pot		$1.00
1	255-400ST16	Sonar XMitter	Msr	$4.90
1	255-400SR12	Sonar Receiver	Msr	$5.80
1	G8157	Sharp I.R. Unit	Gld	$1.79
1	555	Timer I.C.		$0.75
2	10K	Resistor 1/4 W		$0.14
1	0.001uF	Capacitor		$0.25
1	0.01uF	Capacitor		$0.35
1	9v	9 Volt Battery		$3.00

Also...pieces of felt as needed.

Sources

Code	Name	Phone	website
Msr	Mouser	(800)346-6873	www.mouser.com
Plx	Parallax	(888)512-1024	www.parallaxinc.com
Gld	Goldmine	(602)451-7454	www.goldmine-elec.com

Table 1 - Parts List

Parts and Cost

Table 1 lists the parts you will need. Costs given are approximate. Other than the listed parts, you will need a PC to load the software in this article into the Basic Stamp. The stamp also uses the PC to display test results. If you use the remaining Basic Stamp pins to build a robot base to mount the sensor on, then the robot could operate without the PC.

Skills Required

You will need certain minimum skills to complete the device described in this article:

Soldering, electronic grade
Cutting plastic sheet
Drilling holes
Safety skills to avoid injuries.

Mechanical Construction

Begin by modifying the sharp IR module. It consists of a small circuit board enclosed in a metal box. Carefully bend the metal box and remove the circuit board.

Compare the IR board with that shown in figure 1. There are three metal leads on one side and two metal leads with a plastic blob on the other side. Carefully cut off the plastic blob LEAVING the metal wires on the IR board. These wires need to be as long as possible.

The plastic blob you cut off is a photodiode, which detects infra red light. This is used in IR remote controls and the

(see Sensor on page 2)

President's Message

March 1999

Welcome back!

I would like to apologize for missing a few months (OK, 13) of the Presidents Message column. I actually had WRITTEN a couple, but didn't get them to the editor on time. I will try not to let it slip quite so far in the future.

As you probably know, the RSSC has been conducting an Introduction to Robotics class just prior to the monthly meetings since the beginning of the year. The classes have been gaining in popularity and attendance was noticeably increased in the second class session in February. I would like to thank Art LeBouthillier for his work in designing the course and teaching the classes, as well as working to design the E-Bot controller for the class project. A big thanks also go to Don Fears for the platform design and to everyone else that helped get the class and E-Bot off to a great start.

There will be another "Build Session" on March 27th at the home of Henry Arnold. Details can be found in a notice later in the newsletter. Please be sure to bring your projects to work on!

That's about it for this month. If you have any thoughts, questions, or concerns about the RSSC, please feel free to contact me at reubanks@keyway.net

Now let's get out there and build something!

Randy Eubanks
President

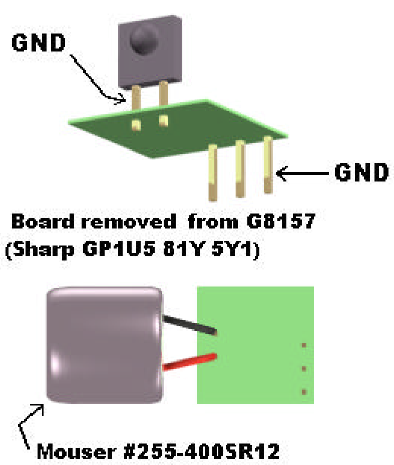

Figure 1 - The Sensor Board

Sensor from page 1

IR board is sensitive to 40KHz IR. We will substitute a 40KHz sonar transducer.

You will need to bend the leads on the sonar transducer closer together before soldering them to the two wires on the IR board. Be SURE to use the 255-400SR12 which is the receiver.

Note that one of the wires on the sonar transducer is welded to the metal can. This must solder to the IR board wire marked GND in the figure.

Now solder the group of three wire leads to the perfboard as shown in figure 2.

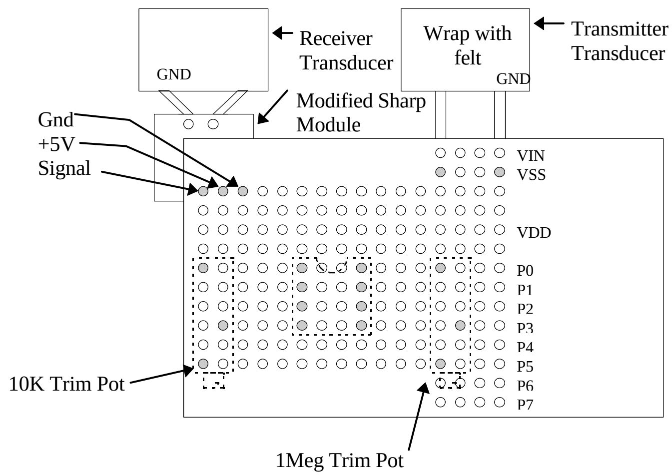

Figure 2 - Parts Layout

Note that the sonar transducer faces away from the perfboard. Next wrap the sonar transmitter with felt (except the end where the sound comes out).

Bend the wire leads at an angle so that the transmitter will point in the same direction as the receiver. Solder to the perfboard with at least one inch between the transmitter and the receiver.

Electrical Construction

Now install the rest of the parts and wires, saving the Basic Stamp 1 for last. The parts placement guide (Figure 2) and the schematic diagram (Figure 3) should provide enough information for installing all of the electrical parts.

(see Sensor on page 3)

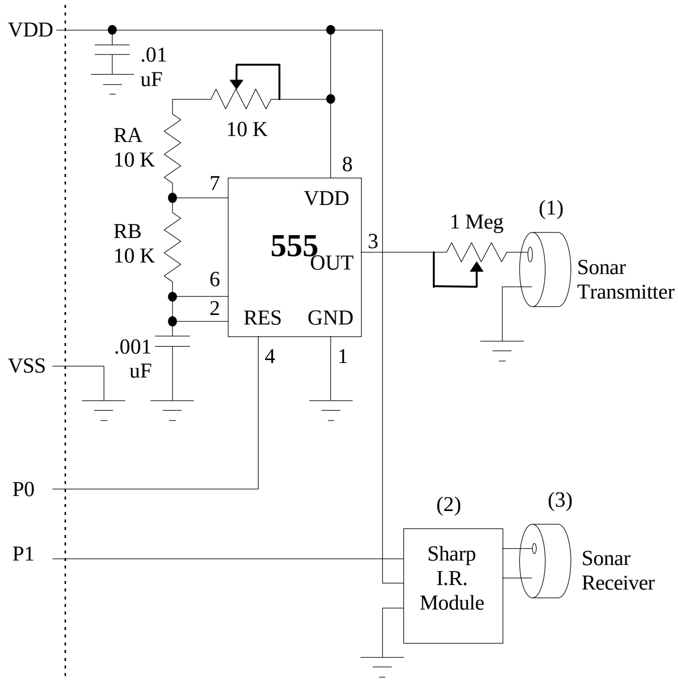

Figure 3 - Schematic

The author substituted a stamp carrier board ($ 15.00) for the perfboard because it has a socket for the Basic Stamp 1 and also has clips for the 9 volt battery. Using perforated board is less expensive.

Theory of Operation

The Sonar sensor operates by bouncing sound off objects. The transmitting element produces a brief burst of sound which is immediately detected by the receiver.

The receiver also detects the echo of sound bounced off the object being detected. By measuring the time between the transmitted sound and the received sound, the distance to the object can be determined.

The distance is reported as a number, which can be used by a robot to avoid running into obstacles.

In the timing diagram (figure 4), time increases to the right, and higher voltage is up. This is what you would see on an oscilloscope if you triggered on P0 of the stamp.

So how does it work ? Signal P0 is driven by the Stamp computer to control a 555 timer integrated circuit. P0 holds the timer reset until the sonar is used.

object - P0 is pulsed high long enough for the 555 to emit 25 cycles of 40KHz to the transmitter transducer, which emits the sound. The transmitter transducer has a high impedance of about 100K ohms, so the 1M ohm adjustable trimmer allows a 10 to 1 range of adjustment for loudness of the emitted sound.

The transmitter's internal arrangement is precisely made to resonate at 40KHz. In a way this is good, as the small electrical signal is greatly increased. But it is necessary to wrap the transmitter in felt (or other sound deadening material) to damp out the ringing which occurs after the electrical signal is no longer driving the transmitter.

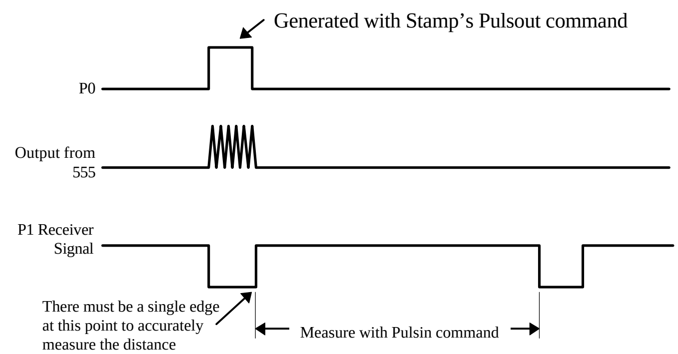

Figure 4 - Timing Diagram

The receiver is located close to the transmitter, so it detects the transmitted sound as well as the echo from any objects in the sound path.

Examine the receiver signal P1 carefully: normally the signal is logic high (near +5 volts) but when sound of the type used is detected the signal goes to logic low (near ground) for a while. This downward pulse occurs twice: once for the transmitted signal and once for the received signal. Note that the first downward pulse continues after the transmitted sound ends. This is critical to the design - as it allows the Stamp's pulsin instruction to be used to measure the signal high period between transmit and receive. The pulsin instruction returns a number that is bigger for objects that are farther away.

There are a couple of things to keep in mind when using this number:

(see Sensor on page 4)

Sensor from page 3

1. Objects closer than 10 inches are not detected.

2. The number is about 12 counts per inch of distance.

3. If there is nothing to reflect the sound, the number is zero.

Software

The following is the Basic Stamp 1 code to test your sonar:

```
' Software for the 40 KHz Sonar
' by Jim Ubersetzig
'
' Runs on the Basic Stamp 1            10 Jun 98

' P0      xmit modulation    high = xmit
' P1      rcvr signal        low = detect

' symbols
symbol range = w2
symbol x     = w3
symbol loop  = w4

dirs = %00000001     ' P0 is output, P1 is input

        low 0
start:
        for loop = 1 to 5
                pulsout 0, 25             ' 10 cycles at 40 KHz
                for x=1 to 60 :next x
        next loop
        pulsout 0, 25             ' 10 cycles at 40 KHz
        pulsin 1,1,range
        debug "range ",#range,cr ' in units of 1/12 inch, 0 for nothing
        for x=1 to 60 :next    ' delay for reading display.
        goto start

' End of the software
```

Get It Working ?

On your PC type stamp <enter> and the stamp development system will come up. If you don't have this file (stamp.exe approx. 15K bytes), it's a free download from the parallax web site. It also comes with the developer's kit, along with the cable. If you don't have the cable, instructions for building one are on the web site.

On your PC you should see a blue screen. Type in the software, then ALT-S to save the software in a file. Type in a suitable file name, then <enter>. Now ALT-Q to exit. The software is saved on your PC.

To operate the sonar sensor: On the PC type stamp <enter>.

You'll see the blue screen again. ALT-L will let you select the software you have previously saved. Once you see the software on the PC display, hook up the cable from your PC's com port to the stamp. NOTE that the cable can go two different ways on the stamp. Line up the marks ! Now ALT-R will start the software running. You should see a list of numbers on the computer screen. These are the distance numbers reported by the sonar sensor.

Place an object where the sensor should see it and the numbers should change.
Experiment with different objects and different distances.

Troubleshooting

If things don't work as expected, there are several adjustments. First, check the software you typed in. Did you copy it exactly ?

If all the numbers are zero - the receiver is not working. Try adjusting the 10K ohm trim pot. You want 40 KHz at pin 3 of the 555. This can be measured with a frequency counter, some digital voltmeters have this built in. Alternately you can measure the period with a scope. The period for 40KHz is about 25 microseconds. If you need to adjust this, type in this single line software "HIGH 0"

If the sonar only detects objects that are very far away, the transmitter is ringing. The solution is to add more felt. Wrap it around the transmitter can. It the sensor is too sensitive (detects when there is no object), turn down the drive level to the transmitter. This is done by adjusting the 1M ohm trim pot.

The Future ?

Next month we will add an Infra Red (IR) sensor that reports probability numbers (range 0 .. 10) for objects to the right, to the left, and directly ahead of the robot.

Optical Rotation Encoder on an R/C Servo

By Art LeBouthillier

Remote control model airplane servos have become popular as drive motors among roboticists because they provide a low-cost, easily-available gear motor with a built-in digital speed controller. When modified, they permit the rotational speed of their output shafts to be controlled with a simple digital pulse-width modulated signal. Although easily controlled, they are often difficult to get accurate, high-speed feedback on their actual speed. One can easily utilize a cheap, reflective optosensor to detect the speed of these modified R/C Servos.

The Omron EE-SY124 [Digikey OR520-ND] is a cheap, tiny Infrared LED and phototransistor reflective sensor packaged in a tiny 4-pin DIP which is approximately .100” wide X .200” long (fig. 5). Because of its small size, it can easily be mounted inside of a servo in order to detect the motion of the gears.

Servo Mechanics

The gear train of many servos consists of a five-gear arrangement where there is a gear on the output of the drive motor, three intermediary gears and a final output shaft gear.

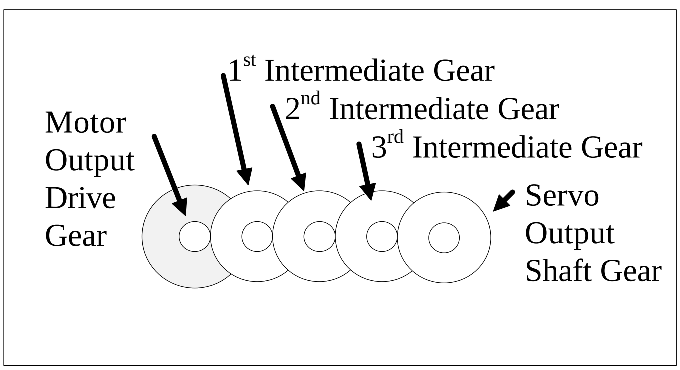

Figure 1 - Servo Gear Train

In this application, we will add reflective foil to the 2nd Intermediate Gear and position the photosensor so that it detects the reflective foil as it passes in front of the sensor while the gear is rotating. The 2nd Intermediate Gear contains a wide cylindrical region between its input and output gears.

This region is smooth enough that aluminum foil reflectors can be glued to it such that the sensor can provide a measurable feedback of rotation rate.

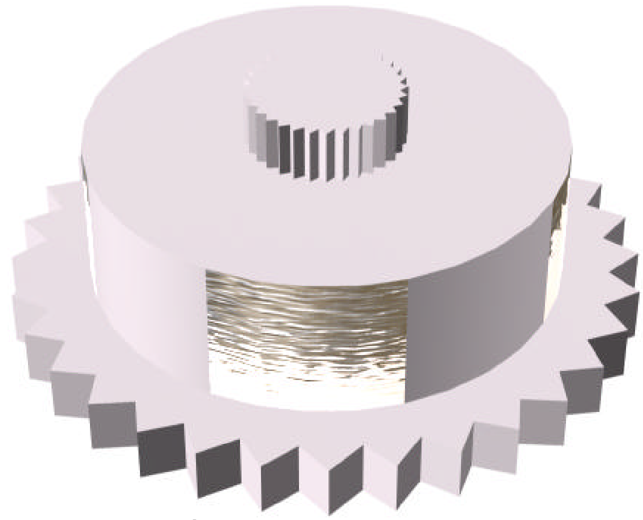

Figure 2 - 2nd Intermediate Gear with reflective foil on alternating octants.

Adding Reflectors

Remove the second intermediate gear from the servo. Cut a small strip of aluminum foil that will cover the middle smooth area of the gear parallel to the rotational shaft. This strip should be about .200” wide and 1” long. Test fit the aluminum strip on the gear. Using a cyanoacrilate (Crazy) glue, tab down one end of the aluminum strip to the gear. Make sure that the shiny surface of the aluminum foil is facing away from the gear. Be careful not to get the glue all over the place, especially not on the gear teeth. Rub glue evenly on the smooth surface all the way around. Finish tacking down the aluminum to the gear so that there is a smooth expanse of aluminum all around the middle area. Trim away any excess foil.

Using a razor-sharp hobby knife, cut eight lines equally spaced around the foil parallel to the shaft axis. Be sure to cut cleanly so that each octant is of

(see Servo on page 6)

Servo from page 5

equal size. Again using the hobby knife, peel off the alternating regions of aluminum foil so that there are four regions of equal size foil reflectors equally spaced from each other.

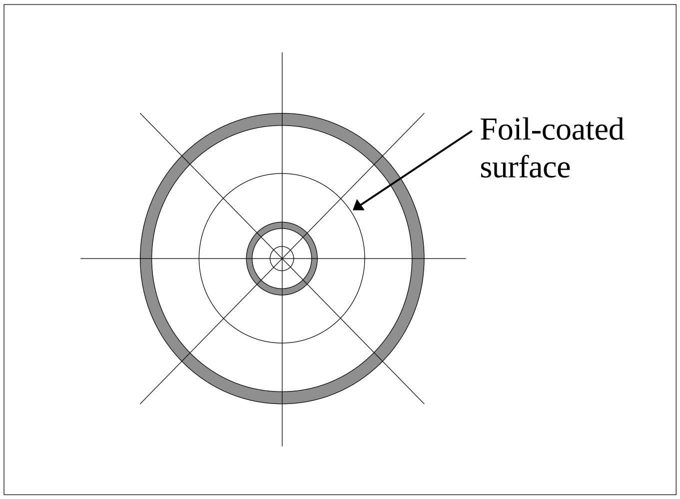

Figure 3 - Dividing foil into octants

Installing the Optosensor

The optosensor is assembled in a 4-pin DIP package which is about 0.100" wide by 0.200" long. The leads are long enough that they can fit through the servo gearhouse casing. In order to do this, reassemble the gears into their housing and identify the shaft axis of the 2nd intermediate gear. Scratch a line on the outside of the housing so that you can identify where this is after the gears are removed. Additionally, notice the position of the foil surface on the 2nd intermediate gear. You will need to identify where the legs of the optosensor can be drilled so that the housing of the Omron EE-SY124 does not touch any of the gears.

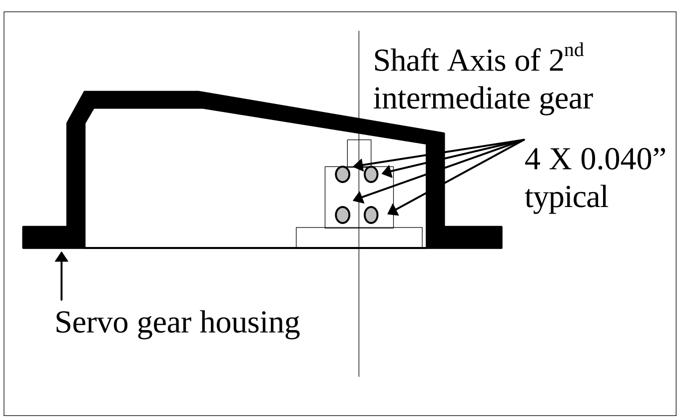

Figure 4 - Approximate location of drill holes

Drill four 0.040" (No. 60 drill) holes equally around the shaft axis of the 2nd intermediate gear and aligned such that the sensor will not touch any gears when re-assembled.

Push the pins of the optosensor through the drilled holes and bend the leads back to hold in place.

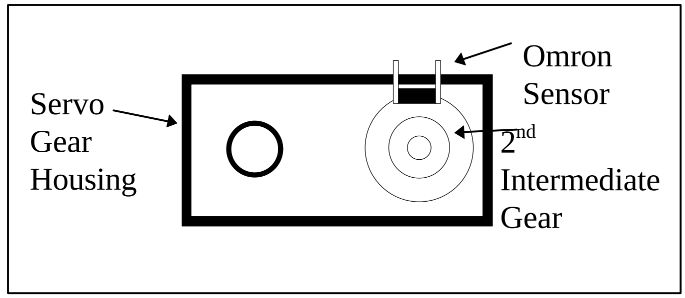

Figure 5 - Position the optosensor through the case

Reassemble your servo. You may now solder wires to your optosensor to attach it to your electronic circuitry. I have found that a small dab of cyanoacrilate glue fastening the wires to the case where they are soldered to the optosensor helps mechanically hold the wires so that they don't bend or break its leads.

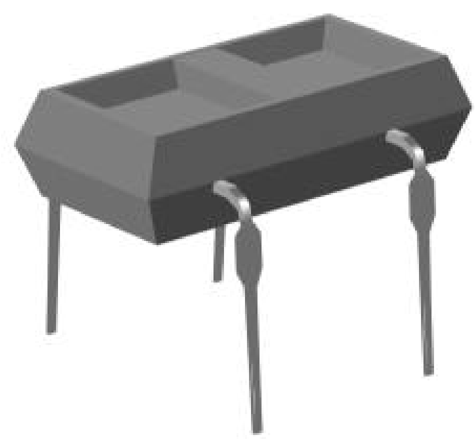

Figure 5 - Omron EE-SY124 Reflective Optosensor

Robotics Society of Southern California

The Robot Builder (TRB) is published monthly by the Robotics Society of Southern California. Membership in the Society is $20.00 per annum and includes a subscription to this newsletter.

Membership applications should be directed to:

Robotics Society of Southern California
Post Office Box 26044
Santa Ana, CA 92799-6044

Manuscripts, drawings and other materials submitted for publication that are to be returned must be accompanied by a stamped, self-addressed envelope or container. However, RSSC is not responsible for unsolicited material.

We accept a wide variety of electronic formats but if you are not sure, submit material in ascii or on paper. Electronic copy should be sent to:

apendragn@earthlink.net

Arthur Ed LeBouthillier - editor

The Robotics Society of Southern California was founded in 1989 as a non-profit experimental robotics group. The goal was to establish a cooperative association among related industries, educational institutions, professionals and particularly robot enthusiasts. Membership in the society is open to all with an interest in this exciting field.

The primary goal of the society is to promote public awareness of the field of experimental robotics and encourage the development of personal and home based robots.

We meet the 2nd Saturday of each month at California State University at Fullerton in the electrical engineering building room EE321, from 12:30 until 3:00.

The RSSC publishes this monthly newsletter, The Robot Builder, that discusses various Society activities, robot construction projects, and other information of interest to its members.

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