University of Florida
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Special Sensor Report

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Abstract

All robots require sensors in order to familiarize themselves with their environment. Bob is no exception is this matter and it utilizes a variety of sensors to help in its movement and performance. These sensors range from IR detectors for obstacle avoidance to Ultrasound for the determination of objects lying around in the vicinity. Bump switches are also utilized as an increased measure to avoid any obstructions in the path.

Using the Ultrasound sensor, Bob scans the area for an object to be picked up. Once Bob has found some stuff to pick up in its shovel, it needs to proceed towards a designated dumping area to dump the stuff it picked up. Therefore a sensor is required to guide Bob towards this dumping site. To fulfill this purpose an IR beacon, comprised of two IR LEDs, was assembled in the lab on a PC board. An IR receiver was ordered from www.jameco.com and used for detecting the beacon. This beacon and receiver combine together to form my special sensor.

As an addition to Bob's navigation capability I have also decided to add a Dinsmore 1490 digital compass to it. This would simply help Bob in charting out its path a bit better and would aid it in returning to the original pickup site by tracing its path. Detail about the compass is provided in this report.

Components

LMC 555CN CMOS Timer

This CMOS timer chip from National Semiconductor was utilized to create the 56.8kHz beacon to be placed at the dumping site. The timer was used in an astable because a continuous train of a 56.8 kHz frequency train is required. The power consumption for this chip is really low and is capable of being operated at 5V. However, for my purpose, 9V – 10V of voltage supply was used.

Data sheet can be found at: http://www.national.com/ds/LM/LMC555.pdf

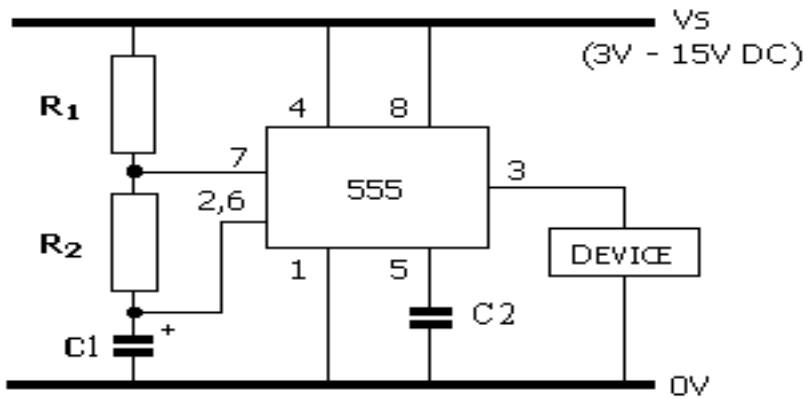
LITEONLTM9034 56.8kHz Receiver

This is a very common IR detector used in numerous appliances to receive IR signals such as TVs, VCRs and home stereos. Originally the output of this device is analog but by using Michael Hatterman's Hack, this receiver was modified to output analog voltage. See references for detail.

Construction

56.8 kHz Transmitter

Using the following circuit design, found at: www.eleinmec.com/article.asp?3, a 56.8 kHz frequency generator was constructed using a 555 timer chip:



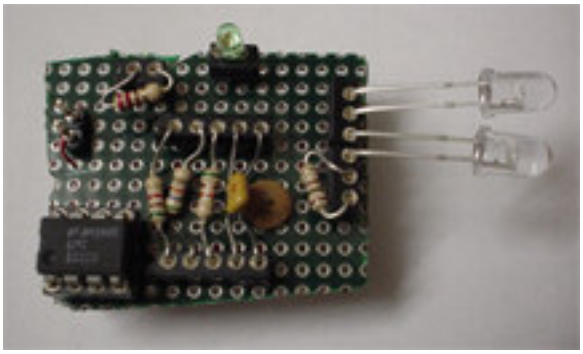
$$f = 1/T = 1.44/((R1 - 2R2)C1)$$

The above given equation for generating the desired frequency was obtained from the above given website. The values for the passive components were calculated and were found to be:

R1 = 5.6 K R2 = 10 K

C1 = 1 nF C2 = 0.01 uF

Real values of the resistors found to be the closest to the ones found were used in the design. The circuit was quite easy to construct and was laid out on a perforated board. An image of the constructed device is given below:



In our case the device, the load, is comprised of a100 ohm resistor in series with two IR LEDs. As the circuit is an astable circuit, we obtain a continuous IR frequency of 56.8 kHz.

The LiteOn IR receiver was modified using a previous design. The details are provided in the reference section.

Experimental Data and Graphs

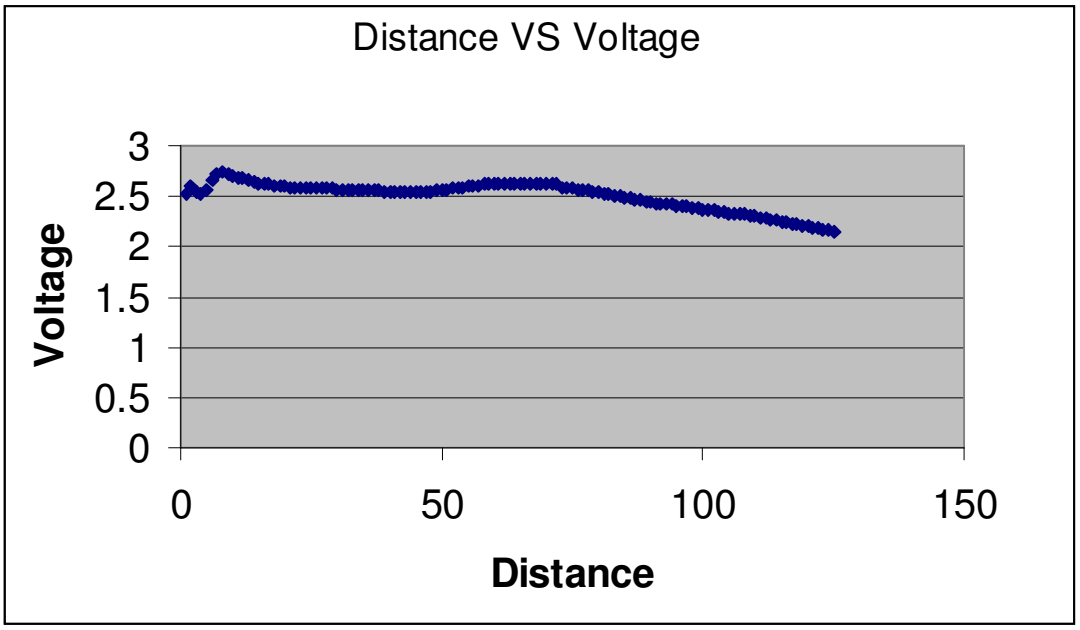
Experiment:

The transmitter and receiver were laid out on the floor and hooked up to their respective power sources. The distance between the two was increased and the voltage reading of the receiver was recorded at regular intervals. The data table is shown below: (For the voltages that were constant over large distances, only the readings are given for which there has been a change)

Distance(in)	Voltage Out	Distance(in)	Voltage Out	Distance(in)	Voltage Out
0	2.52	**17**	2.62	**70**	2.62
1	2.60	**18**	2.61	**73**	2.58
2	2.54	**19**	2.60	**76**	2.57
3	2.52	**20**	2.60	**79**	2.55
4	2.57	**21**	2.59	**82**	2.51
5	2.66	**24**	2.58	**85**	2.49
6	2.72	**30**	2.57	**88**	2.46
7	2.74	**37**	2.56	**91**	2.44
8	2.72	**39**	2.55	**94**	2.41
9	2.71	**46**	2.54	**97**	2.40
10	2.69	**49**	2.56	**100**	2.36

11	2.68	**52**	2.58	**103**	2.33
12	2.67	**55**	2.60	**106**	2.30
13	2.66	**58**	2.63	**109**	2.26
14	2.65	**61**	2.63	**112**	2.22
15	2.63	**64**	2.63	**115**	2.16
16	2.62	**67**	2.63	**118**	2.10

The data of the above plot has been plotted below:



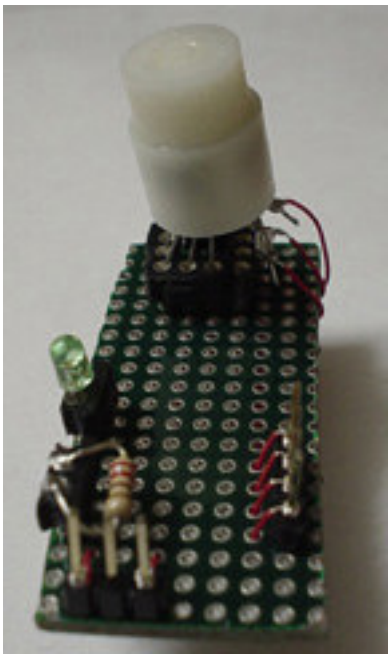
As expected the graph is found to be quite linear with the exception of a few irregular values. The whole graph has a very smooth linear curve and there are no spikes or 'hills', which indicates the correct operation of the beacon and the receiver. From the graph it was obvious that if more readings, further away from the receiver, were taken, they would also follow the above set pattern.

Dinsmore 1490 Digital Compass

Once Bob reaches the dumping site and dumps the contents of the shovel, it is supposed to return to the original pickup site and pickup some more stuff from there. There can be two ways for Bob to do that. It can go in reverse for some time and then use its Ultrasound sensor once again to locate the site. But this process would take time. In order to save time, I would like Bob to have an idea about what path it followed to reach the dumping site in the first place. This can easily be accomplished using a compass. The compass will not be used for any mapping or navigational use, therefore I would like the compass to be as simple as possible. While searching online I came across the Dinsmore 1490 Digital Compass manufactured by the Robsonco company.

Digital 1490 Compass

This compass seemed well suited for my needs because it does not require any complex calculations to calculate the direction. The compass magnetically indicates the N,S,E,W direction by outputting the respective pin to high. By overlapping the four cardinal directions four intermediate NE, NW, SE, SW directions can also be determined. Thus this compass is great for a robot like Bob that only needs to have a general idea as to in which direction is it headed. The socket for the compass had to be created but the rest of the connections were very easy to make as there were only 12 pins altogether. I used a small-perforated board to mount my compass and an image of the compass is given below:



The four outputs of the compass are to be directly connected to four of the port pins on the microprocessor board. To check the direction in which Bob is heading, all that needs to be done is to use polling to determine which pin has been set high and then use the if statements to get the direction.

Sources for Parts

Robsonco Company:

www.robsonco.com

Dinsmore 1490 Digital Compass @ 6.5 a piece (Student price)

Jameco Corporation:

www.jameco.com

LiteOn 56.8 kHz IR receiver

IMDL LAB:

IR LEDs (Free)

Perforated Board

Resistors

Capacitors

References

LiteOn 56.8 kHz receiver hack By Michael Hatterman. IMDL. Spring 2002

http://www.mil.ufl.edu/imdl/papers/IMDL_Report_Spring_02/michael_hatterman/hacked_ir.pdf

LiteOn 56.8 kHz receiver Data Sheet

http://jameco.com/Jameco/Products/ProdDS/176541.PDF

Referred to Jeff Panos special sensor report. IMDL. Spring 2004

http://www.mil.ufl.edu/imdl/papers/IMDL_Report_Spring_04/panos_jeff/gimp-ss.pdf

Referred to the following websites

http://www.eleinmec.com

http://www.national.com