Special Sensor Report

Jeff Panos
University of Florida
Department of Electrical and Computer Engineering
EEL 5666
Intelligent Machines Design Laboratory

Table Of Contents

Abstract:

The special sensor used for Gimp is a combination of two beacons. The first beacon is used for retreival of Gimp's stick, or more plainly said, to allow Gimp to find his stick and pick it up to bring it back to his designated area. That designated area is the second of two beacons, called Home Base. After Gimp finds his stick and gets a good grip on it, he then scans for Home Base and proceeds towards it once he finds its location. Gimp will finally stop a specified distance from Home Base once arrived.

Description:

TLC555

This chip is cheaper than the NE555, but is capable of accurate oscillations and is capable of monostable and astable operations like the NE555. The difference between monostable and astable operation is simply that astable has another resistor, R_B. The astable operation was used to create the frequencies wanted (i.e. 56.8 kHz, 40 kHz). This creates a 50% duty cycle and operates frequencies up to 2MHz. The TLC555 has very low power consumption that is typically 1mW at V_{DD}=5V. However, the low power consumption is not limited to only V_{DD}=5, one can range supply voltages from 2V to 18V. This chip works best when operated above 5V.

Jameco 56.8 kHz and Sharp 40 kHz Receiver

These receviers are very commonly used to receive signals for TVs and VCRs. They have three pins: Ground, Power, and Output Voltage. The output needed for these beacons is an analog output, not a digital output as these have. These have to be hacked to output analog voltages so that a signal strength will help out Gimp. See References for specific way to hack the receivers.

Beacon One:

The first beacon is the 56.8 kHz beacon. A transmitter was designed using astable operation of a 555 timer integrated circuit chip, TLC555, in Figure 1.

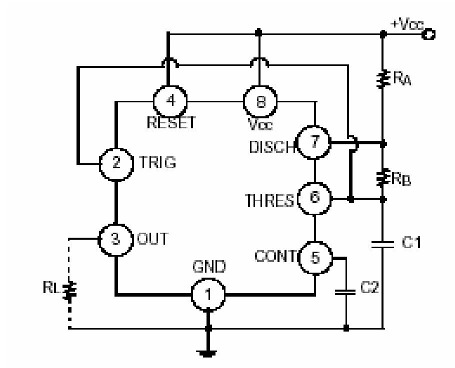

Figure 1

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B)C_1}$$

Figure 2

Using the equation in Figure 2 from the TLC555 datasheet, the circuit was designed using the following values: R_A = 5.6 kΩ, R_B = 10 kΩ, C_1 = 1 nF, C_2 = 0.01 μF. This would output a frequency of about 56.8 kHz. Using the real resistor values, the calculations came to within decimals of the wanted value. In this case, the real resistor values worked to my advantage. After concluding these values, the transmitter circuit was designed as seen in Figure 3.

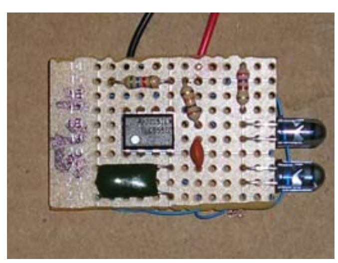

Figure 3

The load resistance, R_L, consisted of a 270 Ω resistor in series with two parallel infrared LEDs. This transmitter is powered by a 9V battery. It operates as necessary as long as the battery does not drop below 6V.

The transmitter is used along with a 56.8 kHz receiver from Jameco. This will help Gimp play "Hot and Cold" with the stick by determining signal strength through the processors Analog-to-Digital Conversion channels. Figure 4 shows how the 56.8 kHz receiver was hacked. See References for details.

Figure 4

Beacon Two:

The second beacon is the 40 kHz beacon. Another transmitter was designed using astable operation of the TLC555 timer integrated circuit chip in Figure 1. Using the equation in Figure 2 from the TLC555 datasheet, the circuit was designed using the following values: R_A = 5.6 kΩ, R_B = 15 kΩ, C_1 = 1 nF, C_2 = 0.01 μF. This would output a frequency of about 40 kHz. After concluding these values, the transmitter circuit was designed as seen in Figure 5.

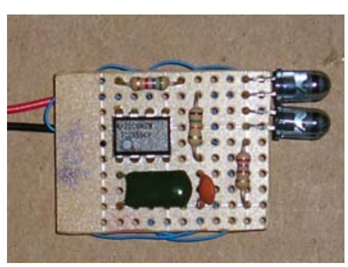

Figure 5

The load resistance, R_L, consisted of a 270 Ω resistor in series with two parallel infrared LEDs, just as in the 56.8 kHz case. This transmitter is powered by a 9V battery. It also operates as necessary as long as the battery does not drop below 6V.

Experimental Descriptions:

Beacon One:

Two experiments were performed on the 56.8 kHz beacon. This was done to determine whether it operated properly or not, but mostly to get a better idea of the range and signal strength of the beacon.

The first experiment performed was setup on a flat, large surface across at least a six foot distance. The receiver was setup on a breadboard with the receiver's output connected to a voltmeter to take constant readings. Then a tape measure was lengthened to a little over six feet just to the left of the breadboard, starting parallel to the edge of the receiver. Finally, the transmitter was offset above the ground to be directly level with the receiver on the breadboard. All of this can be seen in Figure 6.

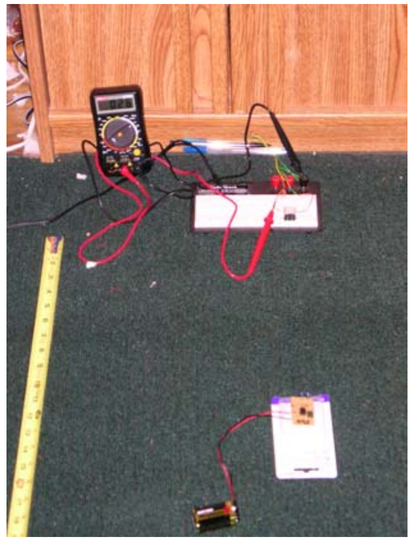

Figure 6

This concluded the setup of the experiment. Next, the transmitter was moved along the six foot tape measure with output voltage values taken every two inches. See the *Data and Graphs* section for details.

The second experiment was setup similar to the first experiment except that the receiver was now hooked up the processor's Analog-to-Digital Conversion (ADC) channel 0. This was taken along a seven foot distance with values recorded every foot except for within the first foot due to various change in values.

Beacon Two:

The second beacon's experiments were the same two experiments performed for beacon one. However, the setup of the second experiment was a little different. The range for the hacked 40 kHz receiver was amazingly different. I was able to obtain very strong readings from 1 to 15 feet. Readings were taken every foot for 20 feet. See the *Data and Graphs* section for details.

Data and Graphs:

Beacon One (56.8 k):

Experiment 1:

Distance (in)	Output (V)	Distance(in)	Output (V)
0	1.58	36	2.62
2	2.62	38	2.61
4	2.61	40	2.6
6	2.59	42	2.56
8	2.58	44	2.53
10	2.58	46	2.5
12	2.57	48	2.46
14	2.57	50	2.43
16	2.57	52	2.39
18	2.56	54	2.35
20	2.56	56	2.28
22	2.55	58	2.22
24	2.55	60	2.31
26	2.54	62	2.28
28	2.54	64	2.23
30	2.54	66	2.22
32	2.6	68	2.18
34	2.61	70	2.14
		72	2.12

Table 1

Figure 7

Figure 7 shows a voltage linear decrease with distance as it should. The small differences that take away from the graph being a straight line could have been due to improper direction toward the receiver, i.e. transmitter not being at correct angle. As seen in Table 1, when there is no infrared signal being detected, the receiver's output is 1.58V.

This experiment was accomplished under 3, 100 watt, every day light bulbs and in the the complete darkness. It was concluded that there was no extremely direct effect from the light used under testing conditions and having no light at all. All the values matched up perfectly.

Experiment 2:

Distance (ft)	Output (V)	ADC Digital Value
0	1.58	88
1.5 in	2.62	135
2 in	2.58	131
2.25 in	2.56	129
2.75 in	2.52	128
3.5 in	2.46	127
5.5 in	2.41	126
1	2.38	126
2	2.44	127
3	2.32	120
4	2.27	120
5	2.04	112
5.5	1.92	103
6	1.87	97
7	1.77	96

Table 2

This experiment was completed to familiarize myself with the digital values and to possibly find a correlation with the distance and the ADC value. Once distance goes past 2 feet, then the distance becomes a little vague. It seems that the 56.8 kHz beacon is best at close distances, whereas the 40 kHz beacon is completely the opposite. This definitely made it useful to determine how close Gimp is to the stick. It became absolutely necessary for me to know this so that Gimp could pick up the stick with his jaw accurately.

Beacon Two (40 k):

Distance (in)	Output (V)	Distance(in)	Output (V)
0	1.62	36	2.52
2	2.52	38	2.52
4	2.52	40	2.52
6	2.52	42	2.52
8	2.52	44	2.52
10	2.52	46	2.52
12	2.52	48	2.52
14	2.52	50	2.52
16	2.52	52	2.5
18	2.52	54	2.49
20	2.52	56	2.47
22	2.52	58	2.45
24	2.52	60	2.44
26	2.52	62	2.42
28	2.52	64	2.4
30	2.52	66	2.39
32	2.52	68	2.36
34	2.52	70	2.34
		72	2.33

Table 3

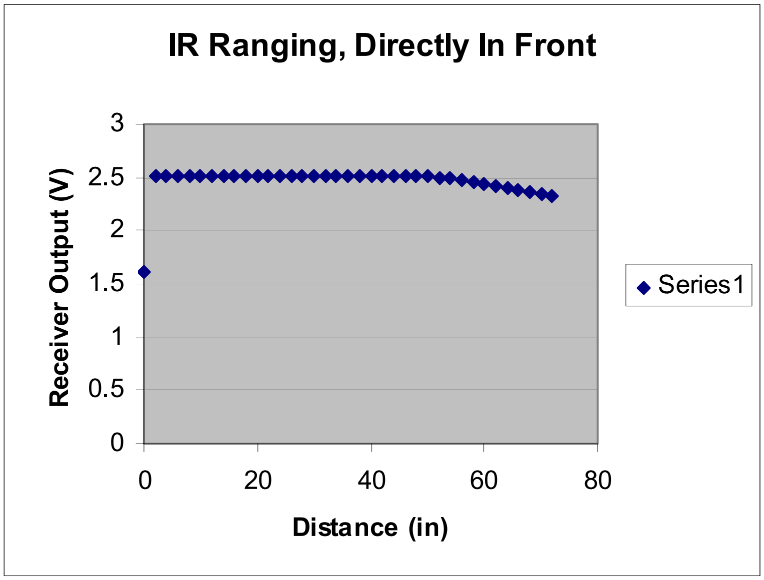

Figure 8

As one can see from Table 3 and Figure 8, it is clear that there is a linear decrease as distance increases. There is a very inherent problem to look at with the output value not changing much over greater distances. I seemed that within about 0 to 5 feet it acted like a digital signal almost. It either saw it, or it didn't. However, more interesting readings were taken in Experiment 2 for this beacon.

Experiment 2:

Distance (ft)	Output(V)	ADC Digital Value
1	2.37	127
2	2.37	127
3	2.38	127
4	2.38	127
5	2.39	127
6	2.36	127
7	2.3	126
8	2.21	120
9	2.15	120
10	2.1	112
11	2.05	112
12	1.98	112
13	1.94	108
14	1.87	103
15	1.84	99
16	1.81	97
17	1.79	96
18	1.76	96
19	1.75	96
20	1.73	96

Table 4

Comparing Experiment 2 for both beacons, there is a clear difference in the way the digital values work. If one wanted to get technical with the correlation of the digital value to the distance, it is possible to make a good argument. First, there is the issue of the distance versus the digital value. This beacon obtained much greater values over a greater distance compared to the first beacon. However, as stated under Experiment 2 for the first beacon, that beacon is better at close distances. Beacon two is not. Beacon two is best for greater distances as can be seen in Table 4. The problem arises with the argument of the corrleation to distance. The best that someone could conclude from this is that if a digital value of 127 was being read back by the processor, then the processor could say, "I'm between 1 and 6 feet away from the transmitter." Anywhere past that the distance is easier to conclude upon within a reasonable accuracy. But there is no way to determine whether that distance is from the left or the right side. This makes it very difficult to determine which way to turn to obtain a greater signal strength. This is why scanning by trial and error is necessary to determine which way to go.

Cost:

Jameco:

Receiver, Part # 173541CF, 56.8 kHz, $2.99 ea.

RadioShack:

TLC555 Timer, $1.69 ea.

High-Output 5mm IR LED, $1.79 ea.

0.01 μF Capacitor, 2-pack, $0.99

1 nF Capacitor, 2-pack, $1.19

ICB90 PC Board, $1.69 ea.

References:

Jameco 56.8 kHz Receiver Hack. Credited to Michael Hatterman, Spring 2002. http://www.mil.ufl.edu/imdl/papers/IMDL_Report_Spring_02/michael_hatterman/hacked_ir.pdf

Jameco 56.8 kHz Receiver Datasheet. http://www.jameco.com/Jameco/Products/ProdDS/176541.PDF

RadioShack, 3315 SW Archer Rd, Gainesville, FL 32608. http://www.theshack.com/

Sharp 40 kHz Receiver Hack. http://www.mil.ufl.edu/5666/handouts/radio_shack_ir_hack.htm