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ENGR 290
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Technical Assignment 1

Questions:

1. Vref was calculated by verifying the maximum voltage value for the Sharp infrared sensor on the manual's plot (gp2y0a21yk_e.pdf (global.sharp), page 5, figure 2). This suggests a maximum reference voltage value of 2.6V which is optimal for reading the distance values. In the document provided on Moodle, Vref optimal was shown to be equal to Vref maximum as well.
2. The ultrasonic sensor was proved to deliver more reliable readings than the infrared sensor. The data transmission rate of the infrared sensor was shown to be more unstable than the ultrasonic sensor.
3. When the sensors were tested in close proximity, erratic behavior in terms of readings from the serial monitor and LED was observed. This could be due to the ultrasonic sensor receiving sound reflections which alter the signal. The infrared signal, on the other hand, may have faced problems revolving around lighting.
4. For the infrared sensor: Sheet No.: E4-A00201EN, page 5 (fig. 2). gp2y0a21yk_e.pdf (global.sharp) highlights the equation to determine the distance vs output values.
   For the ultrasonic sensor: Page 2, first paragraph in the datasheet "HC-SR04 (sparkfun.com)" highlights the equation to determine the distance vs output values.
5. For the ultrasonic sensor, a timer was used in which each count corresponded to a small time segment. The total number of counts between the emission and retrieval of the ultrasound signal gave the total travel time, which using the speed of sound was used to determine the distance. For the infrared sensor, each ADC value was given a voltage value based on the V_{ref}, which was then used to find the distance using an equation that linearized the voltage/distance relationship.
6. The ADC values can be used directly to control the LED brightness. This would remove mapping or converting the ADC values to the distances.
7. The infrared sensor caused the LED to behave slightly differently than the ultrasonic sensor. When an object was placed very close to the sensor or very far, the light would act more unstable than the ultrasonic sensor. This can be due to the ultrasonic sensor picking up less sound noise at close proximity than the infrared which picks up more light noise or light reflections at a closer distance to the object.
8. The output which measured distance was the main parameter tested. The mathematical equation derived after calibrating the sensors was seen to correlate with the measurements seen with the ruler. This demonstrates that the ADC setup and conversion equation were successful for the ultrasonic and infrared sensor.
9. The pure C code was seen to be a major challenge during this assignment as it was a new concept to learn how to properly integrate with the Arduino. The functionality of both sensors and how they compare with each other was also another point of interest. How each sensor is better suited to a different condition was also very interesting to test and observe.

Table 1: Experimental data

Sensor	Parameter	**Expected value**		Trial 1		Trial 2		Trial 3		**Average**		**Standard deviation**		**Error, %**	
		15 cm	40 cm	15 cm	40 cm	15 cm	40 cm	15 cm	40 cm	15 cm	40 cm	15 cm	40 cm	15 cm	40 cm
IR	ADC value	**630**	**295**	650	295	650	290	646	305	649	297	1.91	6.24	**3.02**	**0.68**
	Distance, cm	**15**	**40**	16.32	47.38	16.24	47.24	16.17	47.64	16.24	47.42	0.061	0.166	**8.27**	**18.55**
US	Pulse length, ms	**0.87**	**2.32**	0.85	2.32	0.85	2.33	0.86	2.33	0.85	2.33	0.006	0.006	**2.3**	**0.43**
	Distance, cm	**15**	**40**	14.60	39.81	14.6	39.91	14.71	39.86	14.64	39.86	0.48	0.041	**2.4**	**0.35**

ADC expected value calculations:

ADC value = (Vin * 1024) / Vref

According to the distance vs voltage graph in the datasheet, 15 cm corresponds to about 1.6V:

(1.6 * 1024) / 2.6 = 630

In the same graph, 40 cm corresponds to about 0.75V:

(0.75 * 1024) / 2.6 = 295

Pulse length expected value calculations:

According to the datasheet, pulse width (us) / 58 = cm, so solving for pulse width gives us:

Pulse width (us) = 58 * cm, and to convert it to milliseconds, we divide by 1000:

Pulse width (ms) = (58 * cm) / 1000

(58 * 15) / 1000 = 0.87ms

(58 * 40) / 1000 = 2.32ms

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3. Material paraphrased or taken from a source must be attributed to the source by a numerical reference citation.
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[1] Rules for reference citation can be found in "Form and Style" by Patrich MacDonagh and Jack Bordan, fourth edition, May, 2000, available at http://www.encs.concordia.ca/scs/Forms/Form&Style.pdf.
Approved by the ENCS Faculty Council February 10, 2012