ENGR 290 Technical assignment #1

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Instructor: Dr.Rastko Selmic
Section F
ENGR 290 Project
Submitted on Monday, October 2ed 2022

Work Distribution	
Activity	Team Member
Request materials/Collect data sheets	Rahul Uresh Patel
US rangefinder (HC-SR04)	Victor Gueorguiev
IR analog rangefinder	Victor Gueorguiev,Junpeng Gai
timers and Pulse-Width Modulation (PWM)	Victor Gueorguiev,Junpeng Gai
analog to Digital Converter (ADC)	Victor Gueorguiev
serial communication: Universal Asynchronous Receiver-Transmitter (UART)	Victor Gueorguiev,Junpeng Gai
Measurement and data collection	Rahul Uresh Patel,Victor Gueorguiev,Junpeng Gai
Formatting	Rahul Uresh Patel,Victor Gueorguiev,Junpeng Gai

Table 1 Experimental data

Sensor	ADC Vref, V	Actual distance reading, cm/ADC value										Expected reading (ADC value)		Error, %	
		Trial 1		Trial 2		Trial 3		Average		Standard deviation					
		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	x.xx	14.96/ 119	40.18/ 53	14.09/ 125	38.34/ 55	15.5/ 115	40.18/ 53	14.85/ 120	39.567/ 53	0.58/ 4.1	0.867/ 0.943	15cm/ 119	40cm/ 53	1%/ 0.84%	1.08%/ 0%
US	N/A	16 cm	39 cm	15 cm	40 cm	15 cm	40 cm	15.33 cm	39.67 cm	0.471 cm^2	0.5774 cm^2	15 cm	40 cm	0.825 %	2.2 %

1. Explain how you calculated the Vref

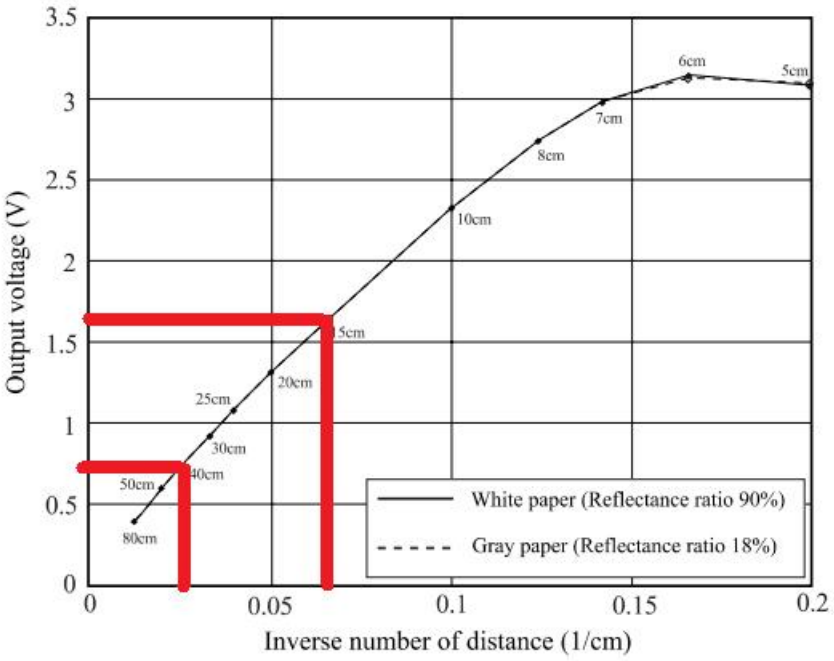

Figure 1 Voltage and inverse umber of distance

We chose gp2y0a21. As seen on the graph above, the output of the sensor ranges from about 0.4v to 3.3v.

A reference voltage of 3.34 volts was chosen to provide more resolution (3.34v/255=13.88mV per increment).

2. Did both sensors have the same performance for the distance range in this assignment?

No,they didn't. The ultrasonic sensor is more accurate and reliable compared to the infrared sensor.

3. How did each sensor behave when the obstacle was in its close proximity? Did you see something strange? Explain what went wrong and why.

For the infrared sensors,when the obstacle was moved really close, the distance displayed went down(7cm) and then increased again. For the ultrasound sensors, the readings remained accurate until about 2 cm, after which the displayed numbers stopped dropping. If the sensor is blocked, the reading of the counter register reaches 255, which means that counter TCNT1 is at its maximum value.

4. Where is in the datasheet the sensor's output vs. distance values can be found (for each sensors)? (Give the datasheet you used revision number, page and paragraph.)

Ultrasound sensor :Ultrasonic Ranging Module HC - SR04,PAGE2,Paragraph 1(Timing diagram)

(https://cdn.sparkfun.com/datasheets/Sensors/Proximity/HCSR04.pdf)

Infrared sensor :SHARP-GP2Y0A21YK0F-PAGE5

(https://global.sharp/products/device/lineup/data/pdf/datasheet/gp2y0a21yk_e.pdf)

5. How did you convert ADC readings to distance?

First an ADC reading is taken of the output voltage of the sensor. (3.34v reference voltage).

Then it is converted to distance by using the linear approximation of the graph in figure 2 below.

$$V_{output} = \frac{ADC\_Reading * V_{ref}}{2\text{^}8 - 1}$$

$$V_{output} = 21.84 * \frac{1}{Distance} + 0.19$$

$$Distance = \frac{(\frac{ADC\_Reading * V_{ref}}{2\text{^}8 - 1} - 0.19)}{21.84}$$

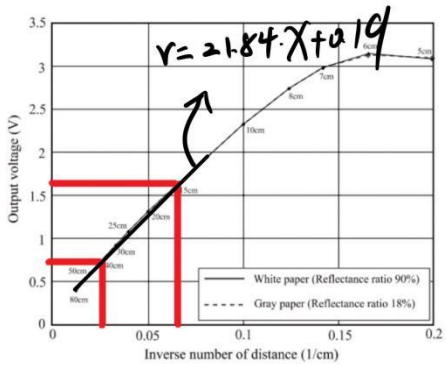

Figure 2linear approximation get output(v) vs. (1/distance(cm))

6. Given that you do not have to indicate or use actual distance expressed in cm in any way, how you would write your code that controls the LEDs without converting the ADC readings into distance (in cm) in your code? (Rationale: the distance in cm uses floating point variables, which are not “native” for the microcontroller used for this assignment and the project. It results in huge code inflation and decrease of overall system’s performance. Keep this in mind for your final project code.)

We are using 8 bits as precision for the ADC and TIMER control.In fast PWM, top is 0xFF the same value as our ADC reading.So we can directly assign the ADC reading to OCR2B to control the LED brightness or simply remap it from the ADC readings from 10cm to 40cm (which would be the values in the high 8 bits of the ADC register) to 0-255 for the PWM output. Simple integer algebra is required, which is much lighter for the microcontroller.

7. Did you observe something strange in the LED L’s behavior when it is connected to one sensor, but not to another? If so, explain, what happened.

The LED L state was unstable when it was close to the boundaries with the infrared sensor. This was due to the less accurate reading of the sensor.

8. Write a few sentences (no limit) about what you have learned in this assignment, what surprised, shocked and/or enlightened you, what difficulties you experienced, what kind of help you could have profited from, etc.

Through this study, our group learned how to use, program, and test two different sensors. By using the syntax we know about arduino, and then by learning the examples post on moodle. Studying the datasheet, we finally completed the coding and experiment process of the first half project with our own efforts.

What surprise me most was the first time we saw numbers scrolling on the monitor, and that was the first time our group had done a collaborative learning reading of ultrasonic sensor data.

Throughout the process, we learned how to use c to control the input and output reading of the pins, and how to use the built-in timer to measure the ultrasonic round-trip time and control the LED brightness in combination with PWM.

The second difficulty is when using uart to display our data, because we can only send one 8bit character at a time, so when we want to send numbers (for example, 328), we have to send hundreds and tens and a single bit. Of course, this is not difficult. We need to use integers division and modulus to find them and then referring ASCII table to convert them into corresponding numbers and send them to the computer.

We get help from each other , example code on moodle and varies online materials.In this process, we explained to each other what the other did not understand, and divided the work and cooperated until the project was completed.

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8. Your submissions must consist entirely of your own or your group's ideas, observations, calculations, information and conclusions, except for statements attributed to sources by numerical citation.
9. Your submissions cannot be edited or revised by any other student.
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11. For software, the code must be composed by you or by the group submitting the work, except for code that is attributed to its sources by numerical reference.

You must write one of the following statements on each piece of work that you submit:
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Course Number: ENGR290 Instructor: Dr. Rastko Selmic
Name: Thomas Taddeo I.D. # 40130070
Signature:  Date: 2022-10-01

[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

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Course Number: ENGR 290
Name: Junpeng GAI
Signature: 盖俊鹏

Instructor: Dr. Rastko Selmic
I.D. # 40009896
Date: 2022/10/02

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Course Number: Engr 290 Instructor: Rastko Selmic
Name: Victor Gueorguiev I.D. # 27209584
Signature: Date: 02/10/2022

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Course Number: ENGR 290
Name: Rahul Patel
Signature: Rahul P

Instructor: Rastko Selmic
I.D. # 40030149
Date: 02/16/2022

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