SYSC 4805 B

Lab Section – L3

Lab 1

Intro, AD2, Line Detection, and Obstacle Avoidance, Sensors

Group – 1

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Task 1: Build the basic robotic chassis

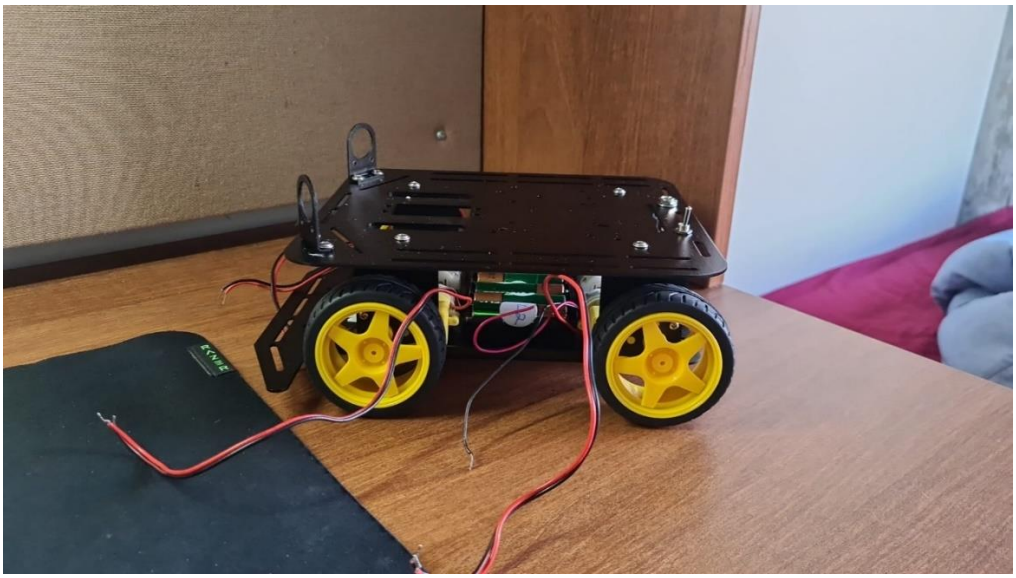

Figure 1: Built Robotic Chassis

Task 2: Introducing the Analog Discovery 2

The Analog Discovery 2 (AD2) is a compact instrument from Digilent that functions as an oscilloscope, waveform generator, voltmeter, power supply, and more. In this experiment, AD2 will be used to read I2C signals between a sensor and an Arduino Due board to verify sensor functionality [3].

Experiment 5.1: Test the AD2 by Loopback

5.1.2)

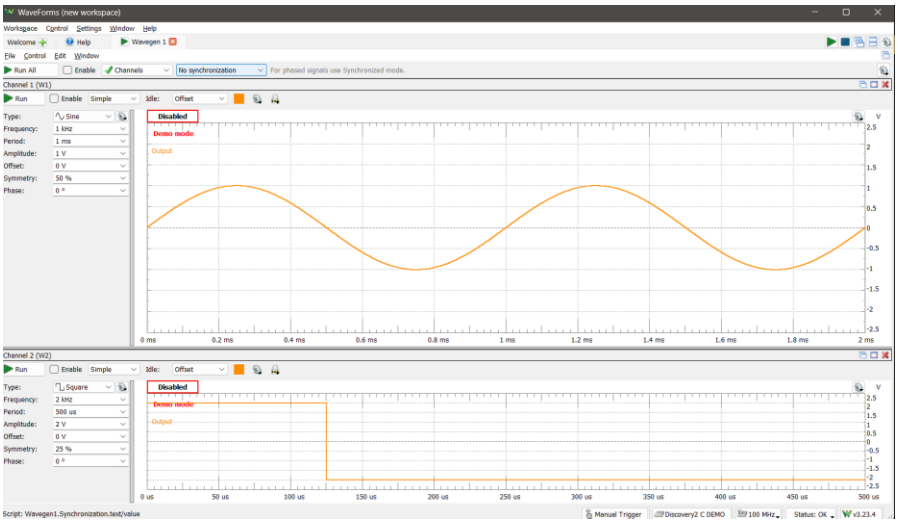

Figure 2: Waveform Configuration [1]

5.1.3)

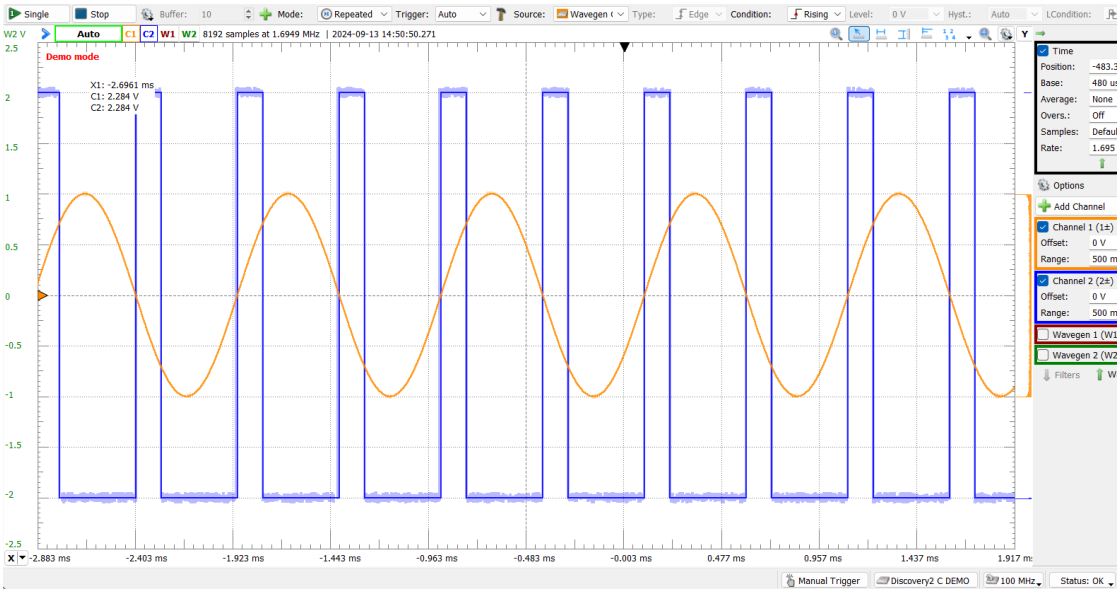

Figure 3: Signal Measurement [1]

Bonus

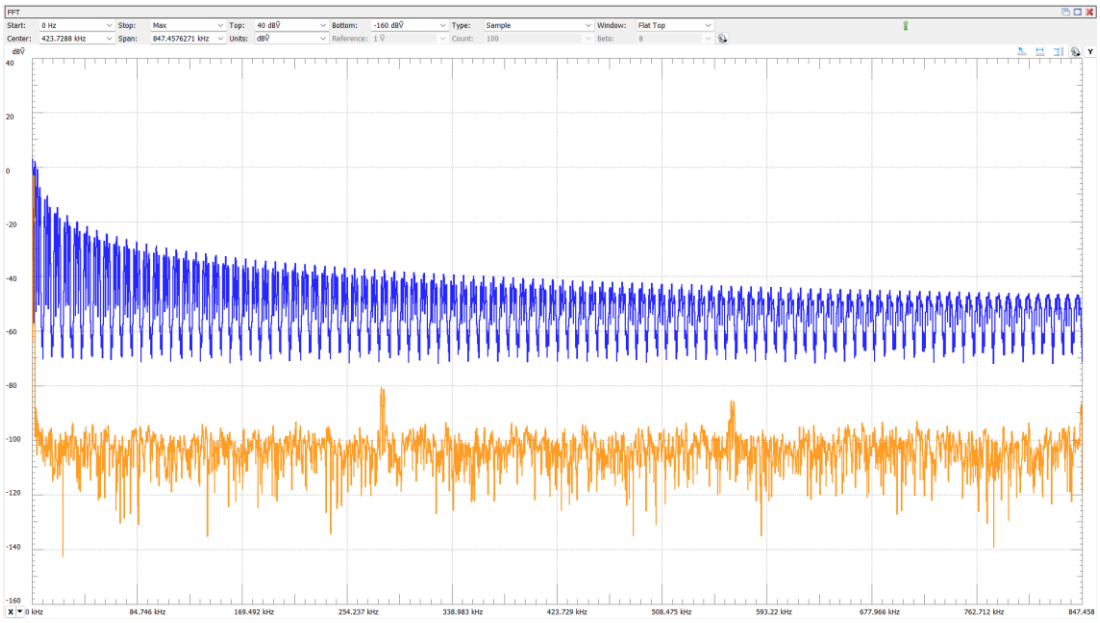

Figure 4: Fast Fourier Transform Signal [1]

Experiment 5.2: Using AD2 as an Oscilloscope

5.2.5) (b)

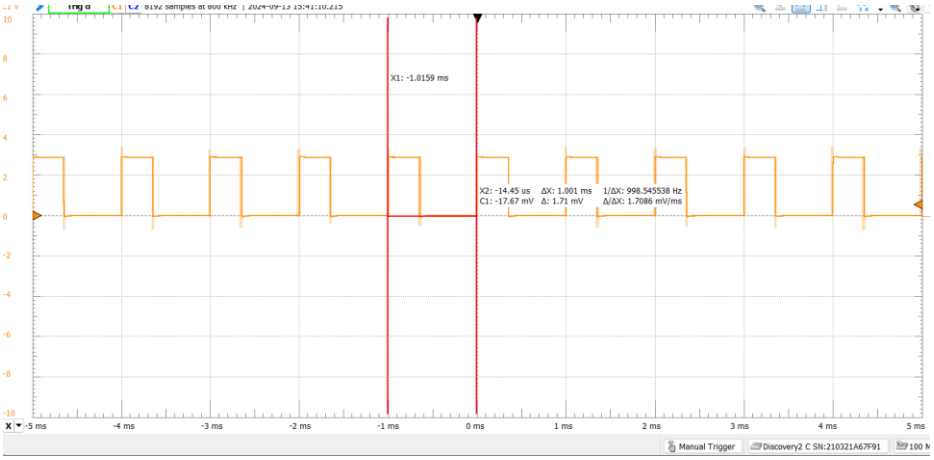

Figure 5: PWM Signal at 19.6% Duty Cycle [1]

Freq = 1KHz

Expected Duty cycle = (50/255) *100 = 19.6%

Measured Duty cycle = (591.9us /1us) *100 = 59.1%

Amplitude = 2.75V

5.2.5) (c)

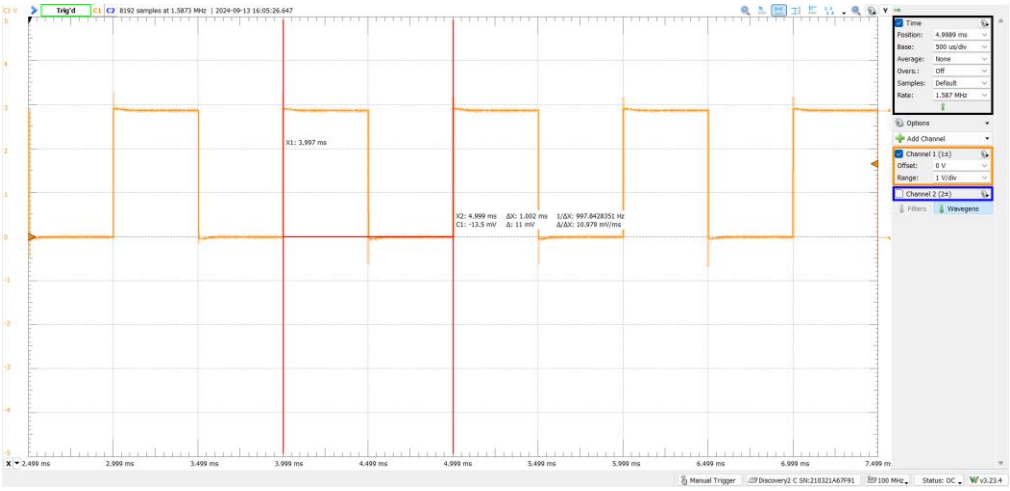

Figure 6: PWM Signal at 95.8% Duty Cycle [1]

Freq = 1KHz

Expected Duty cycle = (128/255) *100 = 50.1%

Measured Duty cycle = 960us/1002us) *100 = 95.8%

Amplitude = 2.88V

Task 3: Test the VMA330 IR Obstacle Avoidance Sensor Module

The VMA330 is a low-cost obstacle detection module for robotics, emitting infrared signals and detecting reflections to indicate the presence of objects. It produces a digital on/off signal for interfacing with controllers and features adjustable IR intensity and burst frequency via potentiometers [3].

Experiment 6.1: VMA330 Basic Functionality

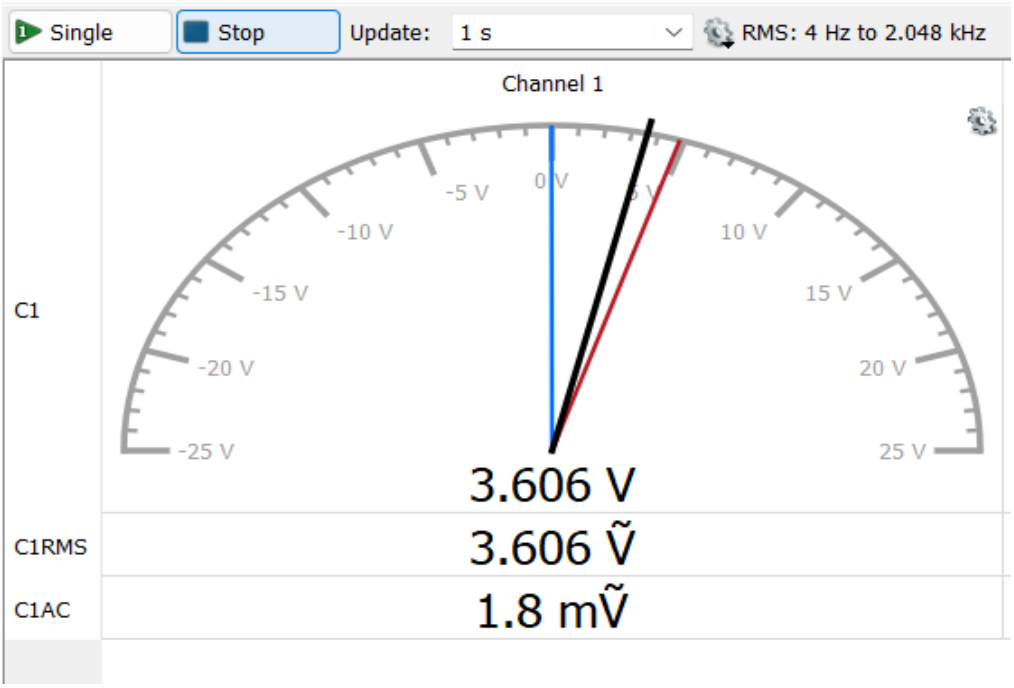

Figure 7: Voltmeter Reading of VMA330 IR sensor at 5V Input [1]

6.1.5)

Table 6.2: Experiment 1 Measurements

	Vcc = 5V	Vcc = 3.3V
Voltage when there is an obstacle	41.1mV	15.3mV
Voltage when there is no obstacle	3.6V	3.1mV
Maximum detection distance	6.4cm	6.5cm
Minimum detection distance.	0cm	0cm

6.1.7)

Use a light source (like the flashlight of your mobile phone) to illuminate the IR receiver. Does this change the module's detection state?

Shining a light, like a phone flashlight, on the VMA330's IR receiver won't affect it, as it only detects IR frequencies.

Experiment 6.2: Interfacing the VMA330 with Arduino Due

6.2.3)

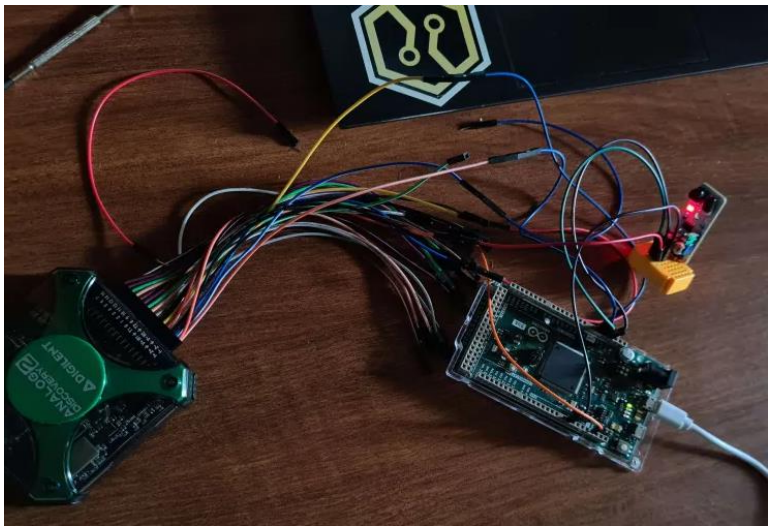

Figure 8: No Obstacle Detected (Yellow LED on the Arduino is OFF)

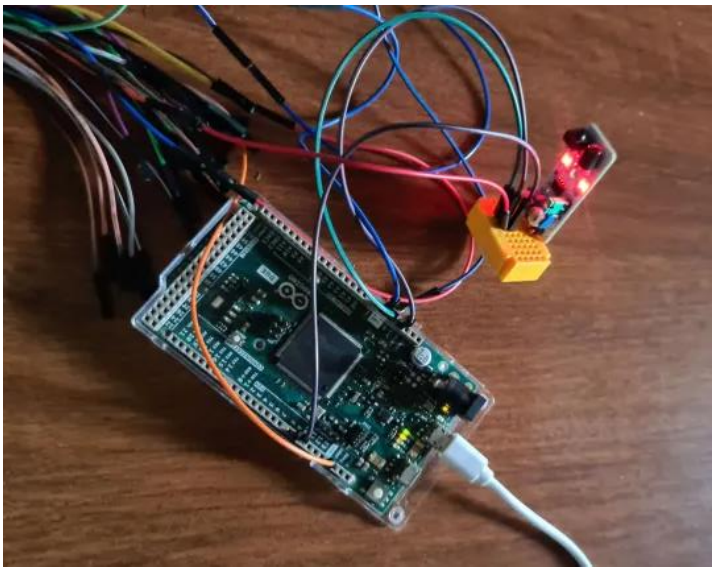

Figure 9: Obstacle Detected (Yellow LED on the Arduino is ON)

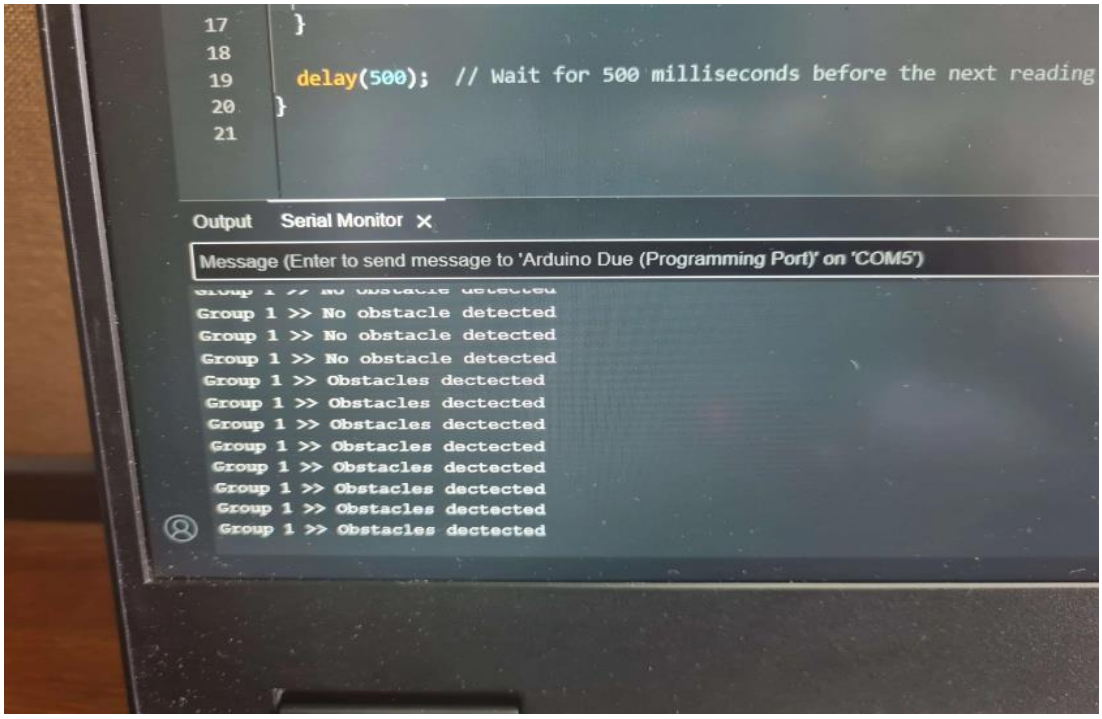

Figure 10: VMA330 Readings on an Arduino IDE Serial Monitor [2]

Discussion

1- Is there a difference in the module performance when operated with 3.3V compared to 5V?

The VMA330 performs better at 5V than at 3.3V, giving a stronger signal and longer detection range.

2- What is the IR wavelength emitted by the LED in the VMA330 module?

The LED emits infrared light at a wavelength of about 880 nm.

3- What is the importance of the bandpass filter (the epoxy layer) for the module's operation? What will happen if this filter is removed?

The bandpass filter blocks unwanted light, only letting specific IR frequencies pass. Without it, the module could detect false signals.

4- Why shouldn't the module be powered by 5V when connected to the Arduino Due, although the Arduino provides a 5V power pin?

The Arduino Due's 5V pin might not handle enough current for the VMA330, risking damage.

Task 4: The Line Follower Sensor

A line follower sensor helps robots detect and follow a path by using an IR emitter and receiver to differentiate between dark and light surfaces. It produces an analog voltage based on the reflected light, with high contrast setups resulting in near-digital on/off signals. For line following, at least two sensors are needed for directional control, and more sensors improve tracking accuracy. The Robotshop sensor combines three-line follower sensors on one PCB, which can be separated if needed [3].

Experiment 7.1: Line Follower Basic Functionality

7.1.12)

Table 7.2: Experiment 7.1 Measurements

Case	Output Voltage (V)
Nothing below the sensor	3.13V
White plane below the sensor	1.32V
Black track below the sensor	2.94V

Experiment 7.2: Interfacing the Line Follower Sensor with Arduino Due

7.2.6)

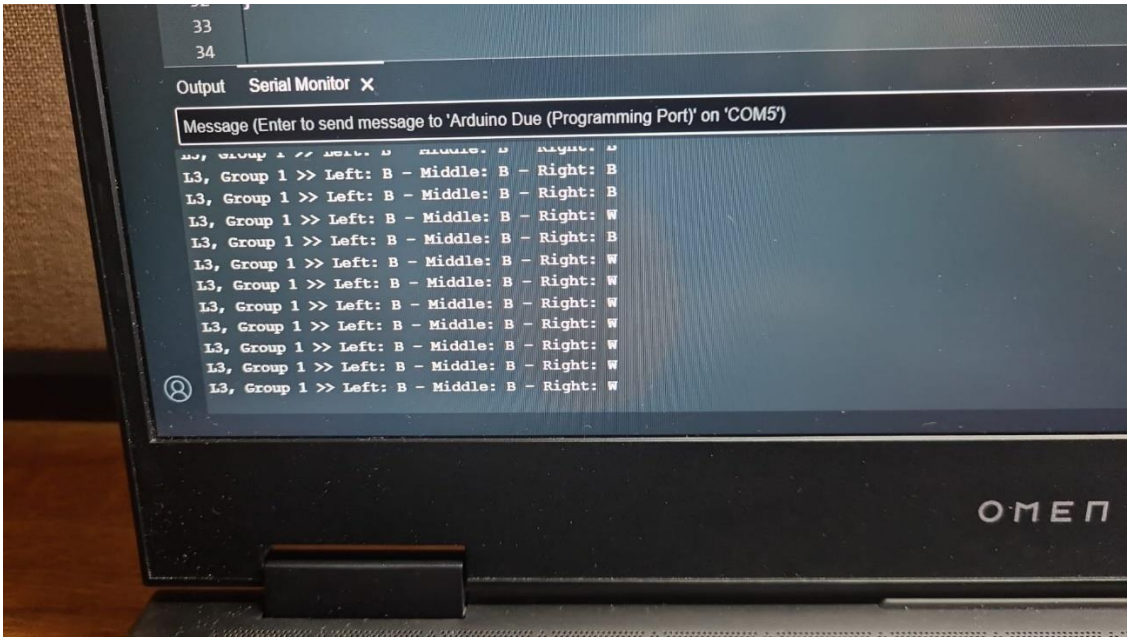

Figure 11: Line Followers Readings on an Arduino IDE Serial Monitor [2]

Discussion

5- Does the module work with 3.3V?

The module works with 3.3V, but its range and sensitivity are reduced compared to 5V.

6- When there is nothing near the sensor, is the measured voltage equivalent to the case when there is white surface below the sensor or black surface? Why?

When nothing is near the sensor, the voltage is like when a white surface is present since no IR reflection reduces the signal.

7- Why shouldn't the paper surface touch the sensor directly?

The paper shouldn't touch the sensor to avoid damage and ensure proper distance for accurate IR detection.

Task 5: GP2Y0A51SK0F Distance Measuring Sensor

Experiment 8.1: Basic Functionality of The GP2Y0A51SK0F Module

8.1.5)

Table 8.2: Experiment 8.1 Measurements

Distance (cm)	Sensor Output Voltage (V)	Distance (cm)	Sensor Output Voltage (V)
0	980.9mV	13	382.8mV
1	2.31V	14	366.3mV
2	1.84V	15	346.7mV
3	1.46V	16	324.2mV
4	1.13V	17	292.3mV
5	930.1mV	18	273.5mV
6	777.7mV	19	268.9mV
7	701.1mV	20	254.9mV
8	609.2mV	21	237.4mV
9	535.6mV	22	230mV
10	496.7mV	23	209.9mV
11	476.3mV	24	189.4mV
12	419mV	25	189mV
		Infinite	

8.1.6)

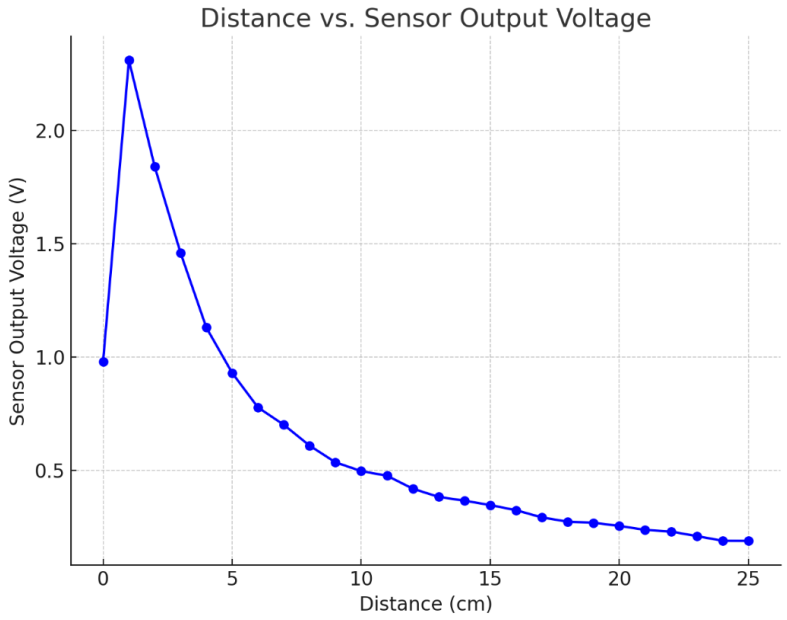

Figure 12: Line Graph Representing Distance(cm) v Output Voltage(V)

Experiment 8.2: Changing the operating conditions of GP2Y0A51SK0F

-What is the output voltage of the sensor with an obstacle at 4 cm? does it change from the case when the supply voltage is 3.3V?

At 4 cm, the sensor's output voltage is higher when using a 5V supply than with 3.3V, meaning it detects objects better at 5V.

- Change the paper you used as an obstacle to a one with a different color (like black and white). Does the output voltage of the sensor changes?

At 4 cm, the sensor's output voltage is higher when using a 5V supply than with 3.3V, meaning it detects objects better at 5V.

Experiment 8.5: Measuring Distance with GP2Y0A51SK0F

1- Does the module work with 3.3V and 5V power supplies?

The module works with both 3.3V and 5V, but it performs better at 5V, providing more accurate readings.

2- What is the IR wavelength emitted by the LED in the GP2Y0A51SK0F module? (check the datasheet)

The LED in the sensor emits infrared light at a wavelength of 940 nm.

3- What are the minimum and maximum obstacle distances that can be detected by this module?

The sensor can detect objects between 0 cm and 25 cm away (approx. From the table above).

4- What are the corresponding maximum and minimum output voltages? Are the voltage boundaries safe to the analog input pins of the Arduino Due?

The output voltage ranges from 189mV to 2.31V (from the table above)

5- For an object distance of 5 cm, what is the difference in the output voltage when using the white paper and black as obstacles?

At 5 cm, the voltage is higher with white paper than with black due to more IR reflection from the white surface.

References

[1] - “Digilent waveforms,” Digilent, https://digilent.com/shop/software/digilent-waveforms/.

[2] - Docs.arduino.cc, https://docs.arduino.cc/software/ide/#ide-v2.

[3] - https://brightspace.carleton.ca/d2l/le/content/292069/viewContent/3933819/View (Lab Manual)