# Technical Assignment #1

**By**
**Alexandre Nasseri**
**id: 40281158**
**Callum Gagnon**
**id: 40255747**
**Frederic Gagne**
**id: 40278058**
**Jose Del Portillo Neira**
**id: 40295303**
**Maxime Genion-Perron**
**id: 40246477**
**Zaid Amer**
**id: 40286306**

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# 1.0. RESULTS

| Sensor | **Parameter** | **Expected value** | | Trial 1 | | Trial 2 | | Trial 3 | | **Average** | | **Standard deviation** | | **Error, %** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | d1 | d2 | d1 | d2 | d1 | d2 | d1 | d2 | d1 | d2 | d1 | d2 | d1 | d2 |
| IR | ADC value | 826 | 256 | 825 | 253 | 840 | 260 | 841 | 255 | 835 | 256 | 8.97 | 2.35 | 1.1 | 0 |
| | Measured distance, cm | 12 | 46 | 12.60 | 50.40 | 12.33 | 48.81 | 12.32 | 49.93 | 12.42 | 49.71 | 0.16 | 0.82 | 3.5 | 8.1 |
| US | Pulse length, ms | 0.70 | 2.68 | 0.73 | 2.68 | 0.73 | 2.68 | 0.73 | 2.71 | 0.73 | 2.69 | 0 | 0.04 | 4.29 | 0.37 |
| | Measured distance, cm | 12 | 46 | 12 | 46 | 12 | 46 | 12 | 46 | 12 | 46 | 0 | 0 | 0 | 0 |

**Table 1: Experimental data**

# 2.0 DISCUSSION

## 2.1 Question 1: Calculation of Vref

Based on Sharp's data, we determined 2.6V as the optimal Vref for our infrared sensor. Using a voltmeter, we measured the AREF pin with the positive probe and ground with the negative. We then adjusted the potentiometer until the voltage reached 2.6V.

## 2.2 Question 2: Sensors's Performance

Both sensors did not have the same performance for the distance range in this assignment. The infrared sensor provided quicker and more precise readings with decimal values but became less accurate at longer distances, also it had a smaller range (10-80cm). On the other hand, the ultrasonic sensor was slower but was more accurate with all distances.

### 2.3 Question 3:
### Sensors' Behaviors in Close Range Detection

When an object was closer than 10 cm, the infrared sensor still displayed 10 cm, its minimum range, and became unstable when in direct contact. The ultrasonic sensor remained accurate as the object got closer but displayed the max distance when in direct contact.

### 2.4 Question 4:
### Sensor's Output vs. Distance Values

For the Module HC-SR04, the information can be found on row 4 and 5 of the last table within the first page of Elecfreaks's document**.** For the GP2Y0A21K0F optoelectronic device. The information about the distance can be found in the first table in the fifth page of SHARP's 2011 documentation.

### 2.5 Question 5:
### Conversion of ADC to Distance

We first converted the ADC readings to voltage by dividing the ADC value by 1024 (10-bit scale) and multiplying by the reference voltage (Vref = 2.6V). Using the SharpIR distance formula, Distance = 29.888 ×(voltage) $^{-1.173}$, we calculated the distance based on the voltage. This formula models the relationship between voltage and distance, which is specific to the sensor's calibration.

https://github.com/guillaume-rico/SharpIR/blob/master/SharpIR.cpp

### 2.6 Question 6:
### LEDs Implementation Without Converting Adc Values Into Distance

It would be possible to compare raw ADC readings to predefined threshold values determined experimentally. Defining these thresholds requires an extra step, but significantly reduces our program's code. Each threshold allows a specific LED brightness by assigning a code of block to each one of the thresholds.

### 2.7 Question 7:
### Led's Odd Behavior When Connected to Different Sensors

Yes, the LED flickers slightly when connected to the ultrasonic sensor but not with other sensors. This happens because both the LED and the sensor's Trigger share pin PB5. The sensor requires brief LOW-HIGH pulses to function, causing LED fluctuations.

## 2.8 Question 8:
## Comparison of the Sensors' Performance for Varying Distances and Angles

The ultrasonic sensor measured distance better but failed when touching the table and at all angles. The infrared struggled with distance but performed well at angles. These conditions reflect challenges the hovercraft may face in the maze, such as detecting obstacles at various angles and distances.

## 2.9 Question 9:
## Takeaways from the Experiment

During this assignment, we learned to code an Arduino without using its built-in library. It was surprising to see how inefficient the Arduino library can be, often requiring over eight lines of code for something that could be done in one. We struggled with the blinking LED due to delays in the system and faced challenges with UART communication. Understanding the ATmega328P's functions, like timers, ADC, and pin setups, was difficult at first, but we now have a better understanding of them that will be helpful in the future. We also could have made better use of the PODs to find information efficiently and get a clearer starting point for our ideas.