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WEEKLY REPORT IV

In this document, we will discuss our initial sensor tests. This week we were planning to test two types of distance measuring sensors namely an ultrasonic sensor (HC-SR04) along with a laser sensor (VL53L0X). However, VL53L0X has not been delivered yet. Therefore, we were only able to test HC-SR04. HC-SR04 works based on the time of flight principle. It transmits an ultrasonic sound wave, this wave travels, hits an object and gets reflected back. Finally, the receiver captures the reflected wave and based on the time it took, distance can be measured by the formula given in (1). It should be noted that the ultrasonic sound wave travels the distance between the sensor and the object twice hence the division by 2.

$$distance = \frac{speed \times time}{2} \tag{1}$$

One of the biggest weaknesses of using this sensor is the unintended echoes. Our area will be enclosed. Therefore, sound waves will bounce between the objects and the walls and they may get picked up by the sensor. Evidently, this would result in wrong readings. However, this can be dealt with by further shielding the heads of the sensor so that it only picks up reading from the front.

Our setup consists of a simple arena and a servo motor in order to rotate the sensor to take multiple measurements in the environment. The sensor was rotated between 10 and 170 degrees around the given axis in the figure below. We tried different object configurations and different rotation and angle parameters. The results are plotted in Matlab as polar plots.

Configuration 1: The arena setup can be seen in Figure 1. Zero-degree axis is shown as the red line an it increases in the arrow direction. Our sensor is in the origin. There are two boxes in the arena along with the walls around them. Rotation took place in steps of 10 degrees. Firstly, the rotation was from 10 to 170 degrees in one direction and the result is given in the Figure 2. Secondly, the rotation was two directional that is from 10 to 170 and then 170 to 10 degrees. The second result for this configuration is given in Figure 3. With these results, we concluded that sweeping the environment twice was redundant.

Figure 1: Arena configuration 1

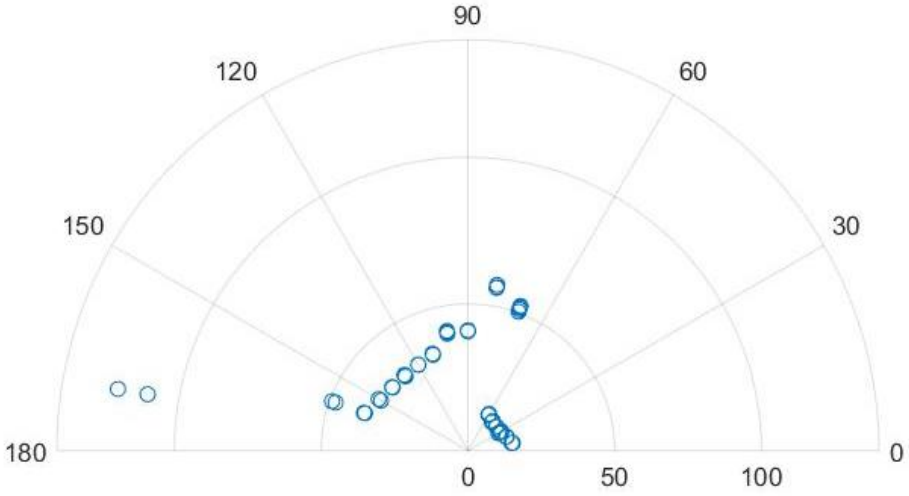

Figure 2: Sweeping in one direction

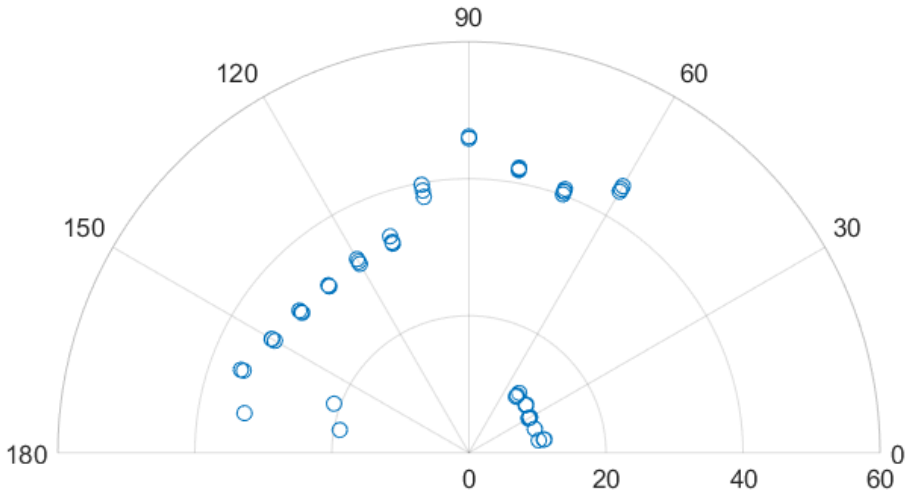

Figure 3: Sweeping forward and back

Configuration 2: The arena setup is shown in Figure 4. As can be seen from the figure, we kept the boxes in the same orientation and added a cylinder-like object which was a coffee cup. This time we tried different angle steps and obtained the results. In Figure 5, the result of sweeping with 10 degrees is shown. Whereas in Figure 6, the angle step was reduced to 2 degrees in order to improve the resolution. However, it took a lot of time to complete the sweep. The optimal angle step can be determined by doing more tests. This is a tradeoff between time and resolution.

Figure 4: Arena configuration 2

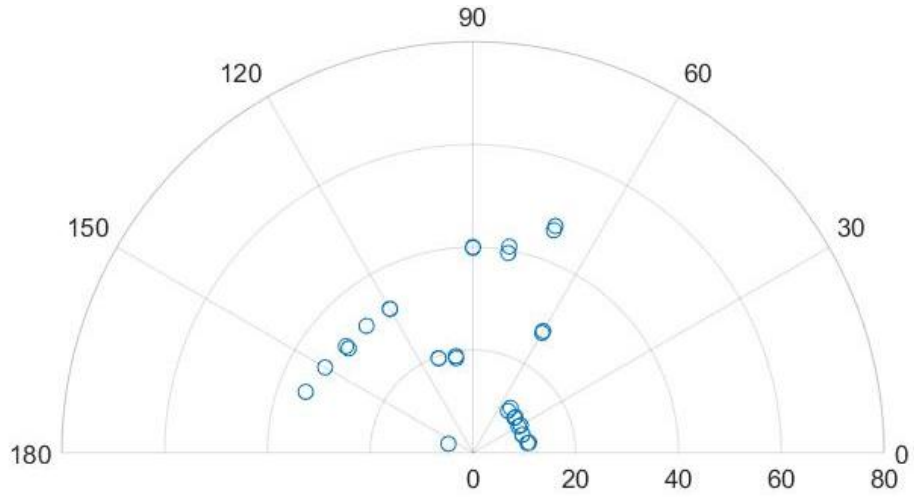

Figure 5: 10 degrees angle step

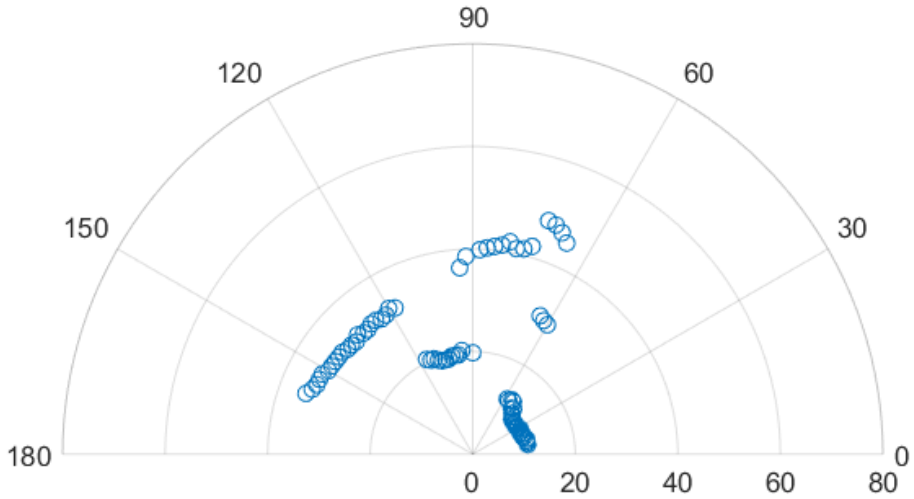

Figure 6: 2 degrees angle step

From the tests we have run, we saw some of the discrepancies caused by the sensor and the environment. Firstly, the measured lengths of the objects with respect to each other were not proportional. Secondly, if the object is not directly facing the sensor, we cannot obtain a reading and finally, the material of the object affects the reflected sound wave. Therefore, in the standard committees, we must make sure that the material used for the objects and the walls do not absorb sound waves as much. At this point the choice of the sensor is not finalized as discussed before. However, this sensor is still a consideration for us. During this week, we will test the laser sensor (VL53L0X).

The datasheets for the sound sensor and servo motor can be seen from the links below.

HC-SR04

https://www.mouser.com/ds/2/813/HCSR04-1022824.pdf

Servo Motor SG90

http://www.ee.ic.ac.uk/pcheung/teaching/DE1_EE/stores/sg90_datasheet.pdf