Department of Robotics and Mechatronics Engineering

University of Dhaka

Laboratory Report

Course: RME 3112 (Advanced Mechatronics Engineering Lab)

Experiment number: 01

Name of the experiment: Mapping surrounding structures and shapes using LIDAR

Group no.: 01

Group members:

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Submitted by: Abdul Monaf Chowdhury

Experiment performed on: 19th January 2022

Date of submission: 13th May 2022

Submitted to:

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Objective:

The objective of this experiment is to map the surroundings and learn the usage of Lidar under some constraints.

Theory:

Lidar, which stands for Light Detection and Ranging is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth. These light pulses—combined with other data recorded by the airborne system — generate precise, three-dimensional information about the shape of the Earth and its surface characteristics.

A lidar instrument principally consists of a laser, a scanner, and a specialized GPS receiver. Two types of lidar are topographic and bathymetric. Topographic lidar typically uses a near-infrared laser to map the land, while bathymetric lidar uses water-penetrating green light also to measure seafloor and riverbed elevations. Aeroplanes and helicopters are the most commonly used platforms for acquiring lidar data over broad areas. Lidars can be used for vision systems of a self-driving car. Lidar systems allow scientists and mapping professionals to examine both natural and manmade environments with accuracy, precision, and flexibility.

Figure: A Lidar Device

A Lidar system calculates how long it takes for beams of light to hit an object or surface and reflect back to the laser scanner. The distance is then calculated using the velocity of light*. These are known as ‘Time of Flight’ measurements.

The distance of the object = (Speed of Light x Time of Flight)/ 2
The speed of light is 299,792,458 metres per second.

Depending on the sensor used, Lidar scanning units can fire hundreds of thousands of pulses per second. These light waves bounce off objects and return to the LiDAR sensor. The sensor uses the time it takes for each pulse to return to calculate the distance (time of flight). Each of these pulsed laser measurements, or returns, can be processed into a 3D visualization known as a ‘point cloud’.

Lidar maps can be used to give positional accuracy – both absolute and relative, to allow viewers of the data to know where in the world the data was collected and how each point relates to objects in terms of distance. Advanced lidar systems can be used to map entire cities, enabling decision-makers to accurately pinpoint structures or areas of interest in millimetre perfect detail. Features and objects such as road networks, bridges, street furniture and vegetation can be classified and extracted.

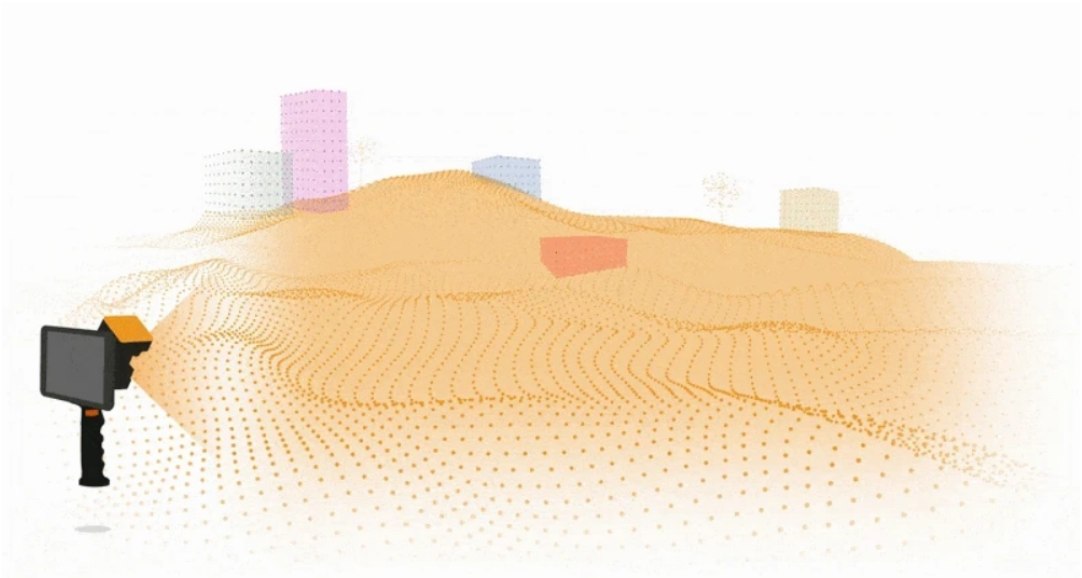


Figure 2: A lidar system mapping its surroundings

Advanced Lidar technologies generate 3D maps. However, much cheaper and easy to access devices produce 2D maps. Here is a sample of the 2D map created using Lidar technology.

Figure 3: Sample 2D map of surroundings created from Lidar

Equipment:

The required equipment was:

1. **Lidar**: Lidar was the main life source of this experiment. It was the core and the processes revolved around using it properly
2. **Computer Software:** Computer software was used to map the surroundings and control the revolution of the lidar.
3. **Wood:** As the lidar wasn't advanced, it couldn't generate 2D maps properly with walls from a large distance. Thereby walls within a nearby distance were created using some wood.
4. **Cable:** A cable was used to connect the lidar with the computer so that the software can be operated under proper supervision.

Procedure:

1. At first, the cable was connected with the lidar and the computer device to create the connection between them.
2. The software app was opened and the settings were reset.
3. As the lidar wasn't advanced, a wall was created with the woods giving its shape. Initially, the shape was a square.

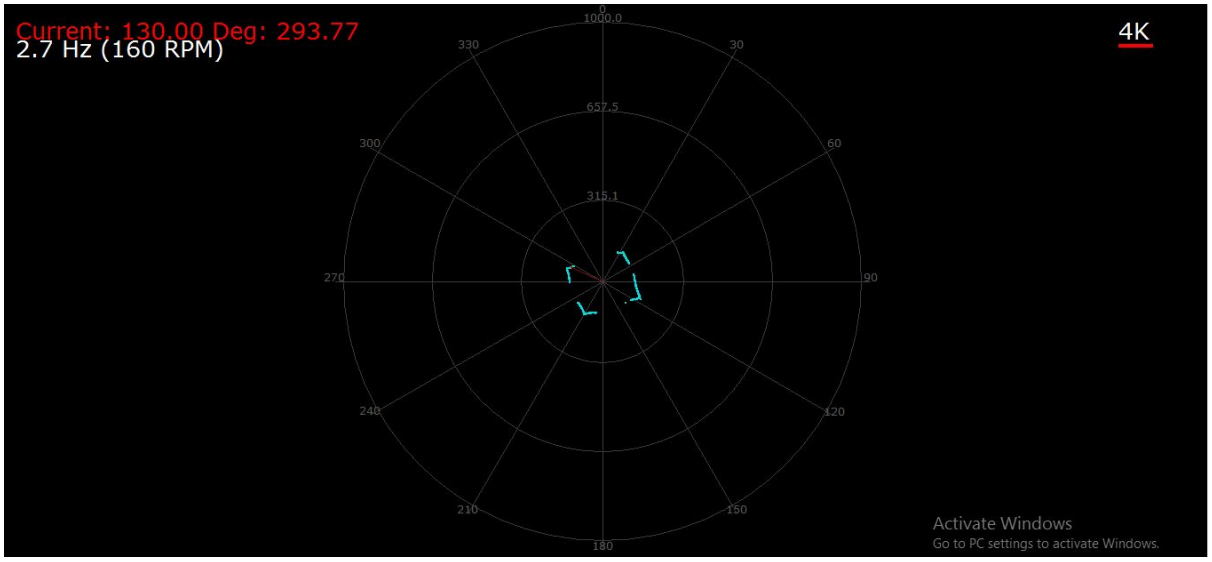
4. After giving the shape, the app kickstarted the lidar and it started moving at a decided rpm.
5. The lidar moved at three different speeds generating the 2D images and the images were snapshotted.
6. Process 3 to 5 were looped two more times. The shapes for the second and third time were pentagon and hexagon correspondingly.
7. Thus the experiment was concluded after collecting all the data and snapshots.

Result:

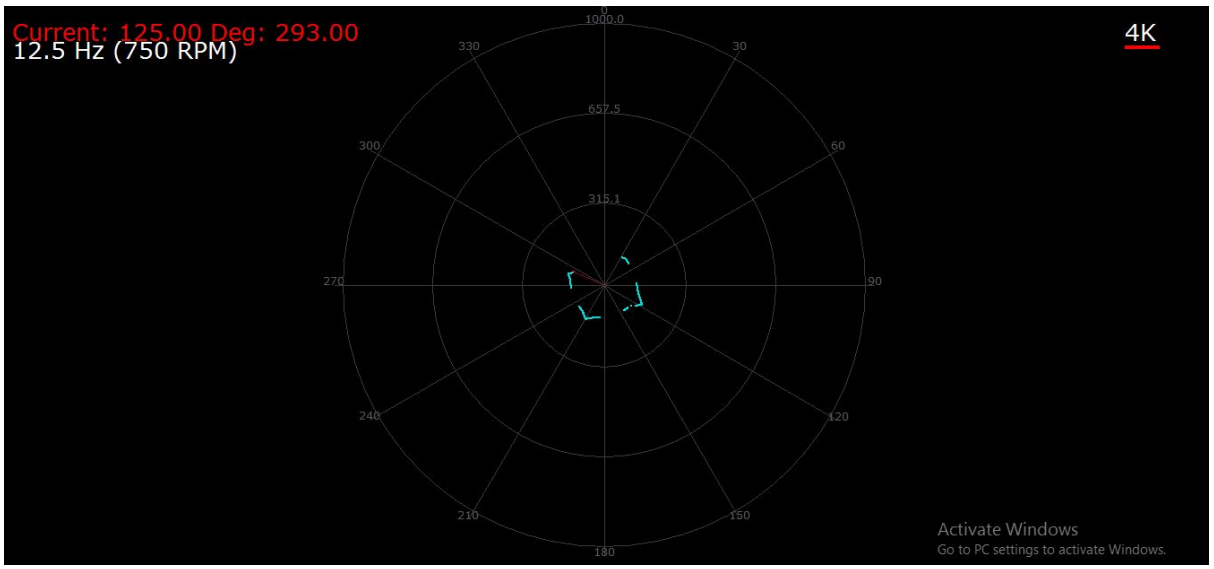
The data readings and the snapshots are given below:

Square

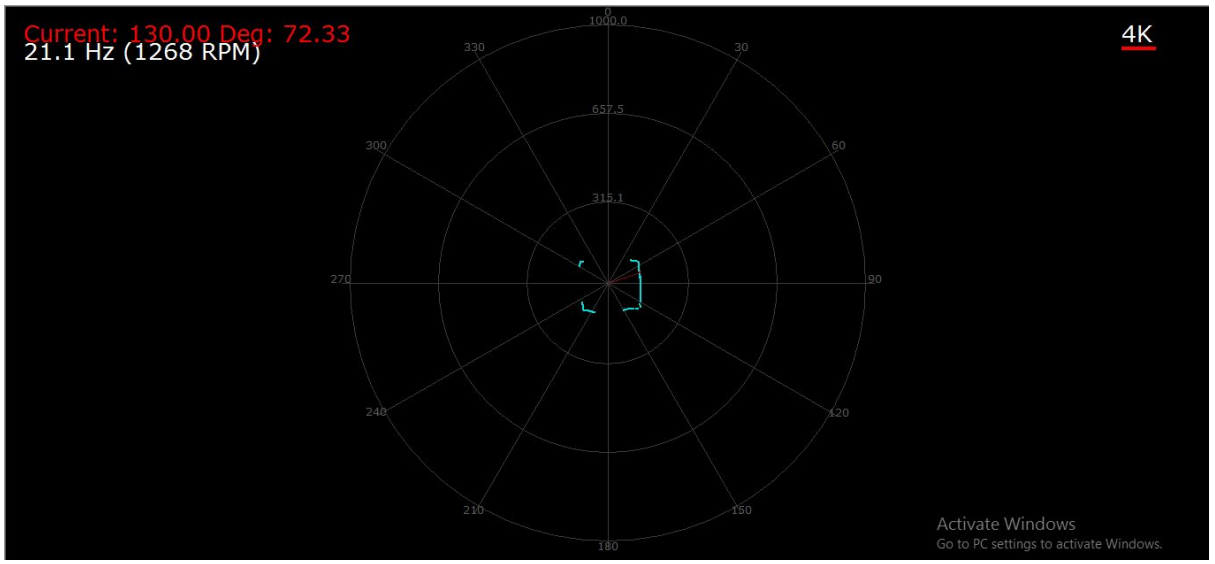
1. At 2.7 Hz, 160 rpm (low speed)



2. At 12.5 Hz, 750 rpm (medium speed)

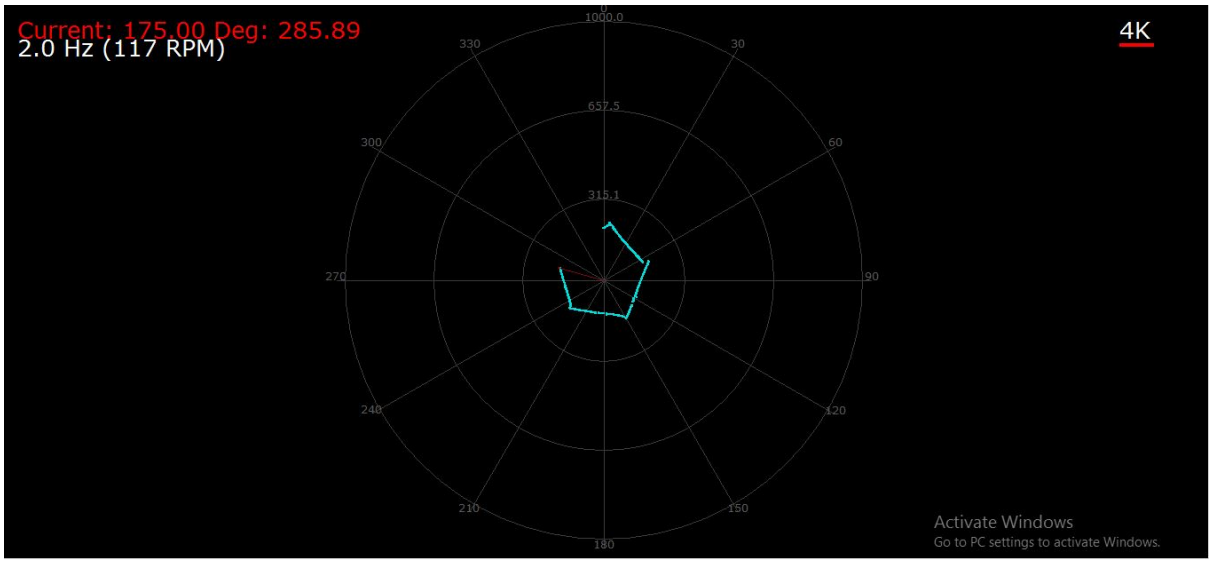


3. At 21.1 Hz, 1268 rpm (High Speed)

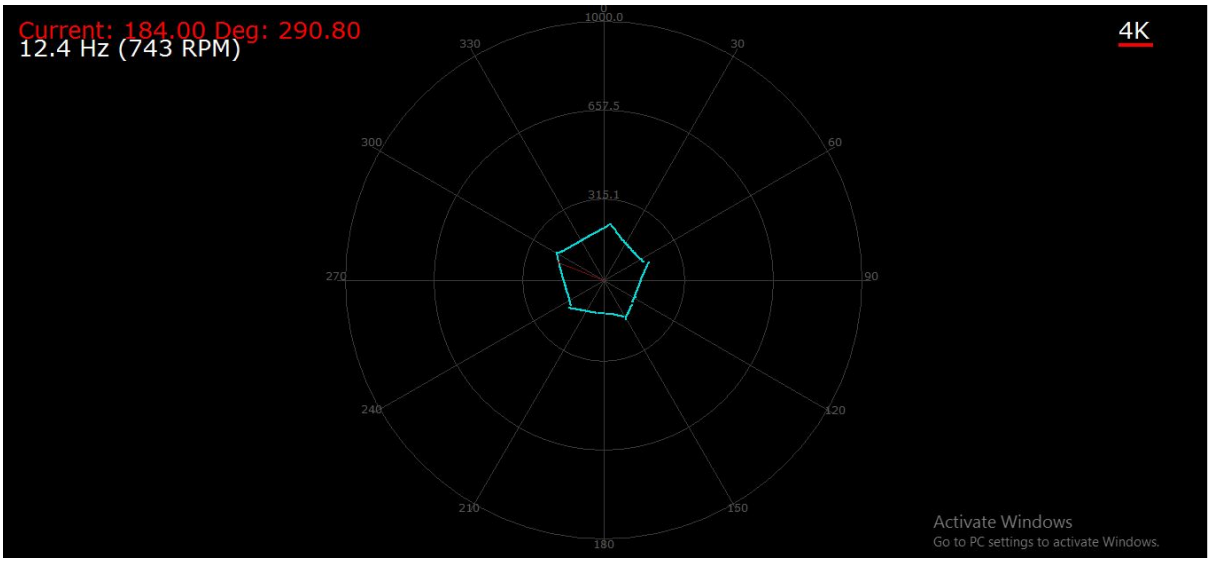


PENTAGON

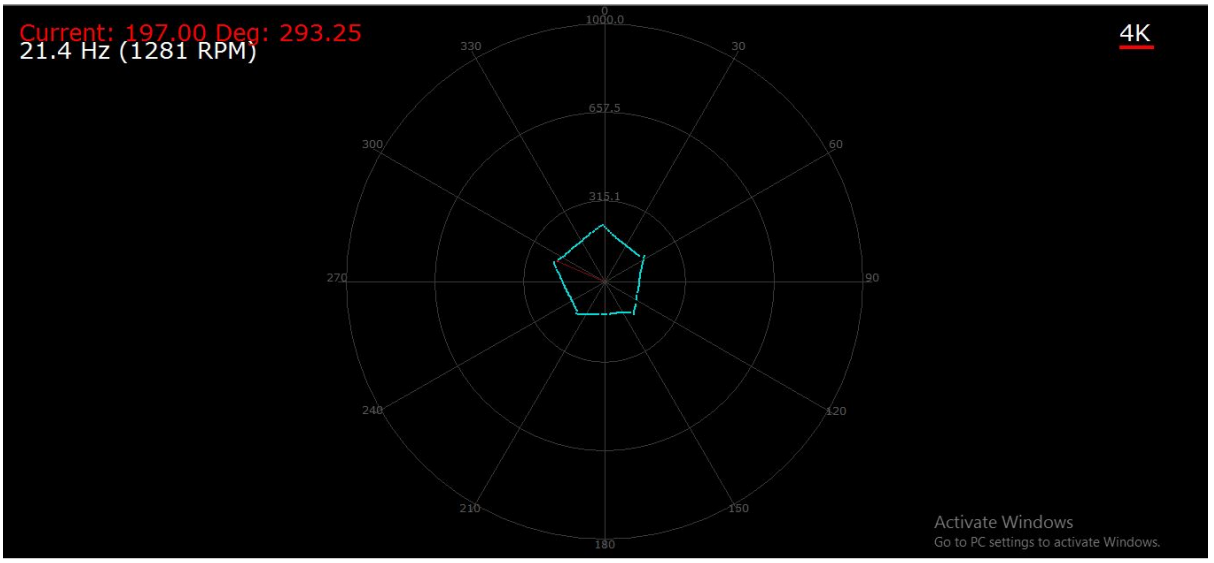
1. At 2 Hz, 117 rpm (Low Speed)



2. At 12.4 Hz, 743 rpm (Medium Speed)

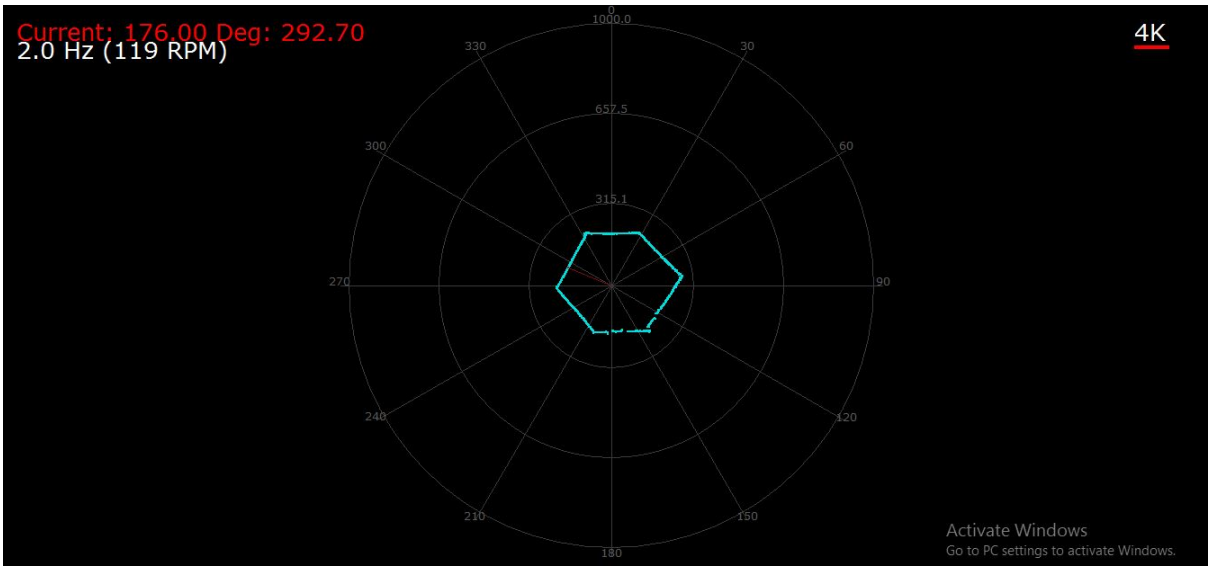


3. At 21.4 Hz, 1281 rpm (High Speed)

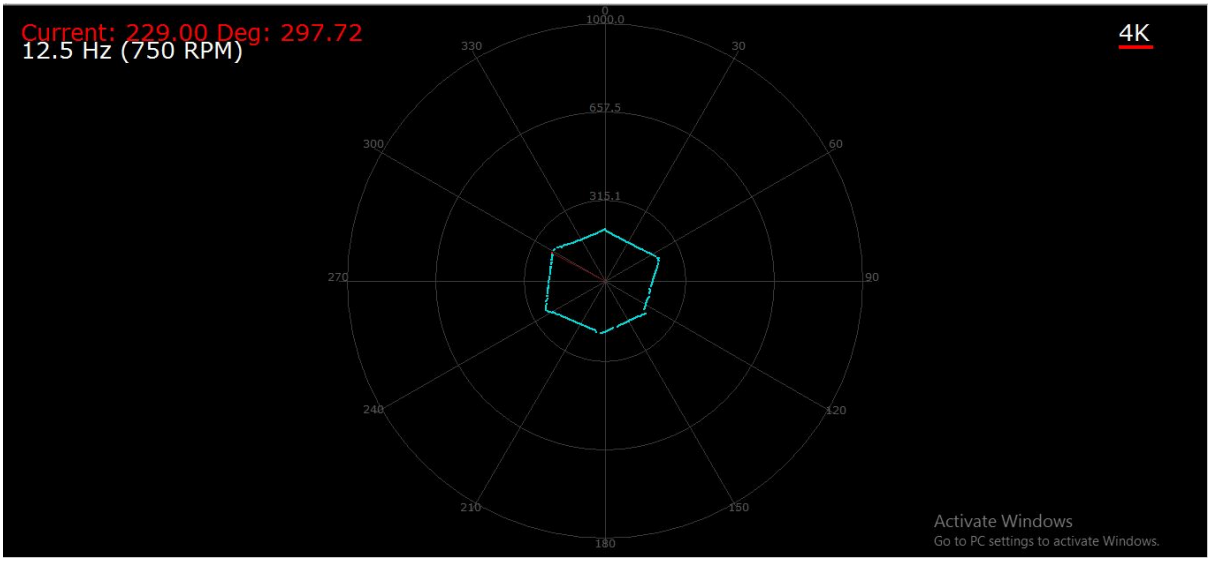


Hexagon

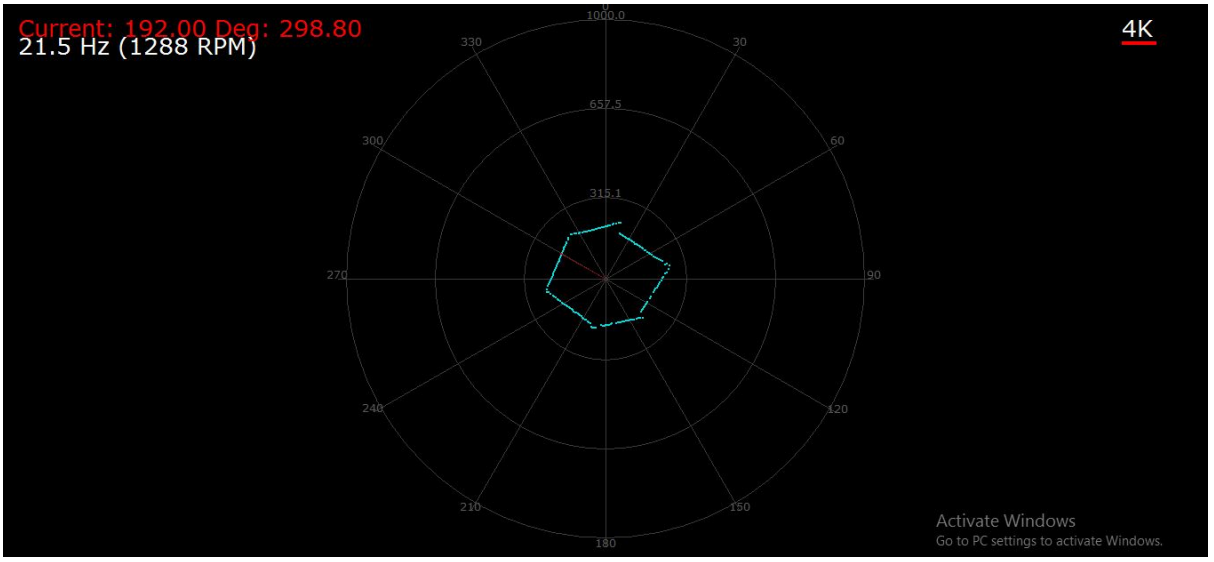
1. At 2 Hz, 119 rpm (Low Speed)



2. At 12.5 Hz, 750 rpm (Medium Speed)



3. At 21.5 Hz, 1288 rpm (High Speed)



Discussion:

Lidar generated the 2D map successfully. The task didn't go fully to the expectation as the lidar itself was not up to the mark. It couldn't cover wider spaces. Therefore, small borders within its range were created with the help of wooden structures.

From the experiment, it can be said that the higher the RPM, the clearer the 2D mapping of the surroundings. High RPMs enable the lidar to hit a particular spot multiple times. As it hits these spots numerous times, the IR bounces back to equally a high number of times making it easier to generate a much clearer image of the surrounding area in 2D.

Overall, the experiment was a success and the use case of lidar was implemented effectively.

Date - 18/01/2022

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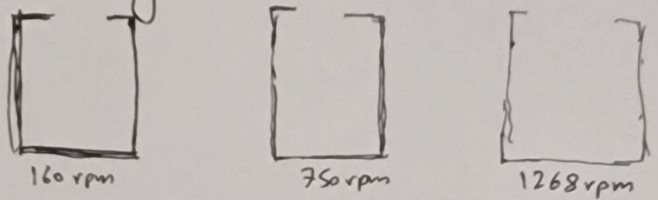
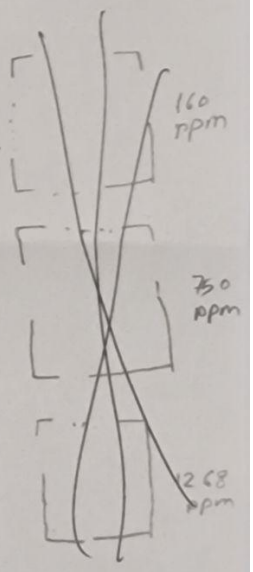
Dataset:



Shape	Rotor Speed (RPM)
Square	160
	750
	1268
Pentagon	117
	743
	1281
Hexagon	119
	750
	1288



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19.01.2022