Odom Data

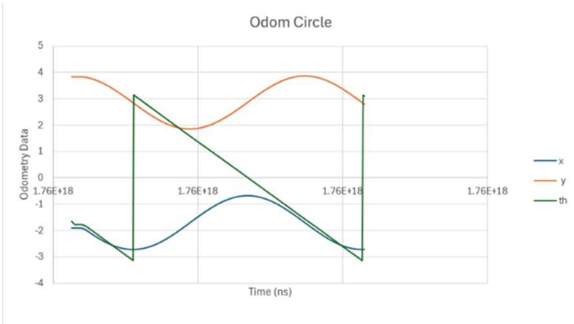

Figure 1: Odom Sensor Data for Circular Path

The Odom Sensor data is the encoder readings for the motors within the robot. When the robot moves in a circular motion, we should see that the x and y positional data form smooth sinusoids that are offset from each other by about 90 degrees, and the Yaw (th) should rotate linearly through the rotation from pi to -pi before wrapping back to pi. From *Figure 1* our data does accurately reflect our physical understanding and expectations for the data. However, the amplitudes of the x and y sinusoids are slightly different which could be due to a variety of differences including sensor noise, uneven calibration, etc.

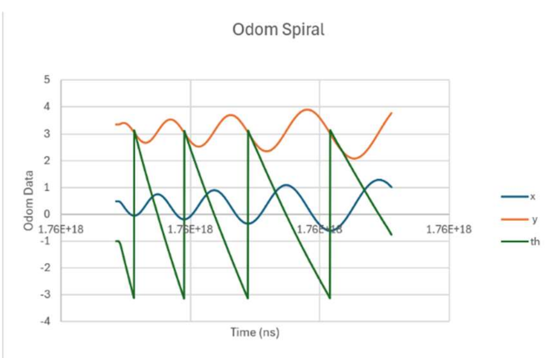

Figure 2: Odom Sensor Data for Spiral Path

When the robot moves in a spiral motion, we should see that the x and y positional data form smooth sinusoids that are offset from each other by about 90 degrees and the amplitude will increase as the spiral motion gets larger. The Yaw (th) like the circular path should rotate linearly through the rotation from pi to -pi before wrapping back to pi. From *Figure 2* our data does accurately reflect our physical understanding and expectations for the data. Also like the circular path, the amplitudes of the x and y sinusoids are slightly different which could be due to a variety of differences including sensor noise, uneven calibration, etc.

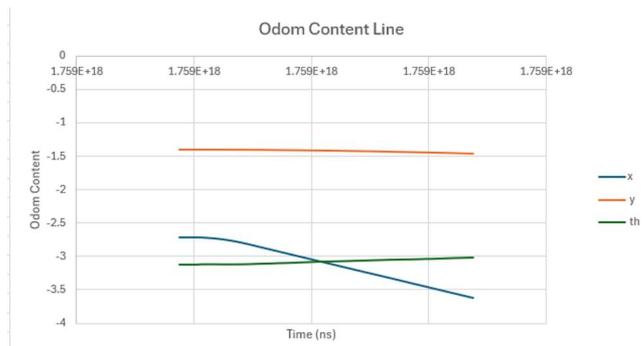

Figure 3: Odom Sensor Data for Line Path

As seen in Figure 3, the odometry data for the line path is shown. We see that there is very little variance in theta and the y position since the robot is moving in a straight line along the x axis. We can see that the x position does change over time which is consistent with the robot's path.

IMU Data

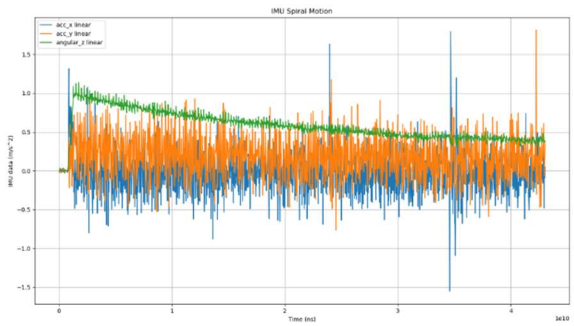

Figure 4: IMU Sensor Data for Sprial Path

As seen in Figure 4, the IMU data (angular acceleration along the X and Y axes and angular velocity about the X axis) is shown. In terms of quality, even though there are clear trends for each sensor measurement, the data is very spiky which suggests that the IMU is very sensitive to noise. As expected, due to the spiral motion, the angular Z velocity, and acceleration on the Y axis oscillate around 0. In spiral motion, the x-axis acceleration should increase, however, because we're measuring body-frame acceleration via the IMU, it doesn't show an upwards trend which we would expect if measuring world-frame acceleration.

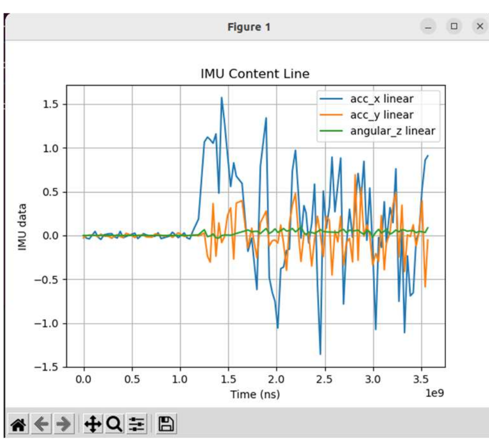

Figure 5: IMU Sensor Data for Line Path

As seen in Figure 5, the IMU sensor data for a straight line path is shown. The data for linear acceleration in the X, Y axes along with the angular velocity about the Z axis is expected. They all have relatively low spiky values which can be attributed to noise, but the values all oscillate at 0.

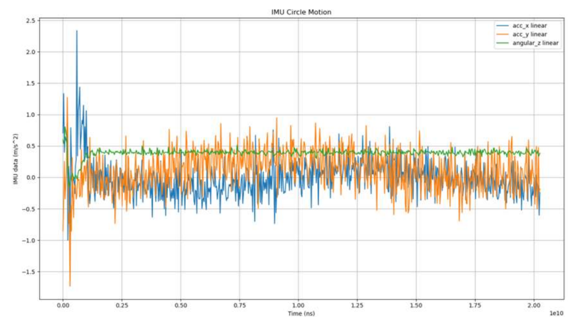

Figure 6: IMU Sensor Data for Circular Path

As seen in Figure 6 the IMU data (angular acceleration along the X and Y axes and angular velocity about the X axis) is shown. In terms of quality, even though there are clear trends for each sensor measurement, the data is very spiky which suggests that the IMU is very sensitive to noise. Like the IMU data of spiral motion, angular velocity about the Z axis and linear velocity along the X and Y axes remain constant which matches the data above. All values oscillate around 0.0.

LiDAR Data

As seen in Figure 7, Figure 8 and Figure 9, some of data from collected from the lidar sensor is visualized. Since the lidar sensor is continuously collecting data that is related to the robot's current position, which is constantly moving, only the data captured from one rotation of the lidar sensor is shown.

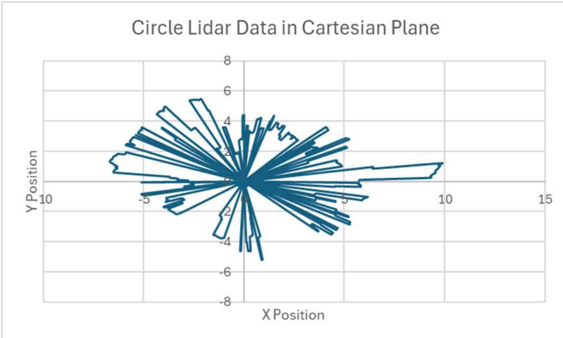

Figure 7: Lidar data from circle path

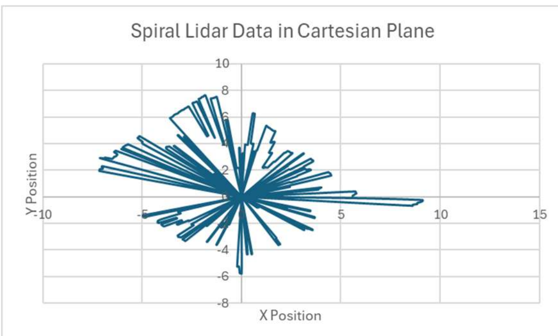

Figure 8: Lidar data from spiral path

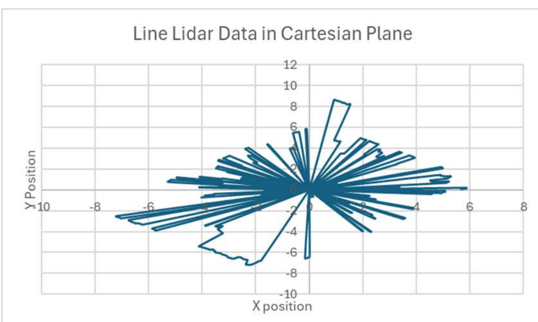

Figure 9: Lidar data from line path

From these graphs it is hard to discern the type of motion the robot is travelling in. One rotation of the lidar sensor doesn't give enough context to make any meaningful observations about the robot's motion.

Figure 10: SLAM Map

As seen in Figure 8, is the map of the lab room which taken with the LiDAR sensor and SLAM package. WE can see the doors, along with multiple stations along the edges of the four walls.