Good day, everyone. In this video, I will discuss a study on the performance of the SLAMTEC RPLIDAR A2M12 and its impact on the Leo Rover robot. This video will begin with the fundamental principles of LiDAR, followed by an analysis of four experimental evaluations of RPLIDAR performance. We will then examine its implications for the applications of Leo Rover and propose potential improvement directions.

We conducted tests of the RPLIDAR in a semi-complex laboratory environment and identified several limitations in obstacle detection,such as distance miscalculation and environmental incompatibility.

First, we will introduce the basic operational principle of RPLIDAR. RPLIDAR utilizes the Time-of-Flight (ToF) methodology, which calculates the distance to an object by measuring the propagation time of laser pulses. This principle supports essential functions in robotic environment modeling and navigation.

Furthermore, RPLIDAR is capable of 360° panoramic scanning, operating at a rotational speed of 10 rotations per second with an angular resolution of 0.225°. Each full rotation generates approximately 1,600 data points, enabling the construction of maps and the perception of the surrounding environment.

Our first experiment focused on assessing the accuracy and stability of RPLIDAR’s distance measurements. To minimize manual measurement errors, we conducted at least three measurements for each distance and evaluated RPLIDAR’s performance across different ranges.

From the experiment, we observed that RPLIDAR demonstrates relatively stable performance within the range of 0.15 m to 4 m, with small and concentrated measurement errors. However, errors exceeding 2% were still observed due to the interference from background noise and ambient light. Beyond 6 m, errors and outliers increased significantly due to signal attenuation and reflective surface conditions, resulting in decreased stability. These limitations led to distance misjudgments, adversely affecting SLAM (Simultaneous Localization and Mapping), obstacle avoidance, and, in extreme cases, causing collisions.

We suggested close-range measurement accuracy should be optimized, and at medium and long distances, increasing signal strength or incorporating multi-sensor fusion techniques is recommended to minimize error fluctuations.

Our second experiment investigated the angular resolution capabilities of RPLIDAR at various distances. Multiple iterations of testing were conducted at different ranges.

We found that RPLIDAR maintains high angular resolution at close distances; however, this is affected by environmental noise and interference. As a result, the system struggles to capture details between adjacent walls or obstacles, impairing robotic localization and navigation. At longer distances, angular resolution decreases, which increases the actual distance between adjacent objects. While this enhances the robot's ability to distinguish between neighboring objects, the resolution remains insufficient to effectively discriminate between objects, potentially impacting obstacle avoidance.

To address this limitation, high-resolution sensors, such as cameras, can be integrated with RPLIDAR to enhance near-distance resolution capabilities.

Our third experiment aimed to quantify the minimum and maximum measurable range of RPLIDAR.

The results indicate that the radar’s minimum measurable range is between 14.6 cm and 15.1 cm, which may result in the robot failing to detect small objects or table edges, potentially leading to collisions. The maximum measurable range was found to be between 13.41 m and 13.47 m, limiting the robot’s operational suitability to indoor or small-scale environments.

Finally, we conducted a rough assessment of RPLIDAR’s vertical detection capability by measuring its maximum pitch angle.

Testing revealed that the radar’s pitch angle range is approximately ±8.17°. This limited vertical detection capability introduces blind spots, increasing the likelihood of collisions.

To overcome this limitation, additional sensors should be incorporated to expand the system’s 3D detection capabilities.

In conclusion, while RPLIDAR offers certain advantages, it exhibits significant limitations in obstacle detection. When used in isolation, it fails to meet the requirements for precise SLAM and obstacle avoidance. Optimizations through algorithmic improvements or integration with complementary sensors are essential.

Our future study will focus on enhancing the measurement accuracy and resolution of RPLIDAR, integrating multi-sensor fusion technologies, and improving the robot's overall global sensing capabilities.

Thank you for watching. If you have any questions or suggestions, please feel free to discuss.

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Finally, we conducted a rough assessment of RPLIDAR’s vertical detection capability by measuring its maximum pitch angle.

Testing revealed that the radar’s pitch angle range is approximately ±8.17°. This limited vertical detection capability introduces blind spots, increasing the likelihood of collisions.

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