ONE-TENTH SCALE AUTONOMOUS DRIVING ALGORITHM

Sanjot Bains | Luke Fugate | Alexander Lan | Connor Maurice | Vincent Migliaccio

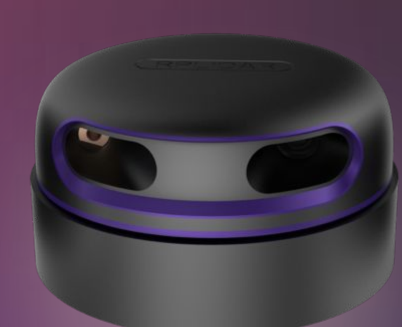
RAY-QUASAR

BACKGROUND

Ray-Quasar has developed a novel autonomous racing algorithm atop a one-tenth scale car. Our team has synthesized LiDAR sensing and simple kinematics to create a reliable and fast logic for the optimal navigation of any race environment. Motor-sport is the testing ground for the commercial auto industry. Greater acceleration and braking forces, faster reaction times mean that hardware is at its limit and we must write more robust, more intelligent, and more optimized software.

DESIGN SPECIFICATIONS

The car is built with popular hobby RC car parts, with modifications made to accommodate the sensors, controllers, and computer needed for autonomous navigation. Critical hardware and software components are detailed below. A laser-cut wooden platform was designed to make assembly easy, and 3D printed latches and hinges make maintenance and battery swaps effortless.



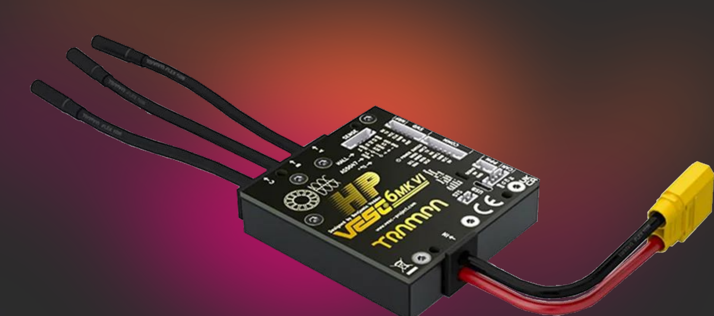
SLAMTEC RPLIDAR A3

360 degree FOV, 25.0 meter ranging.

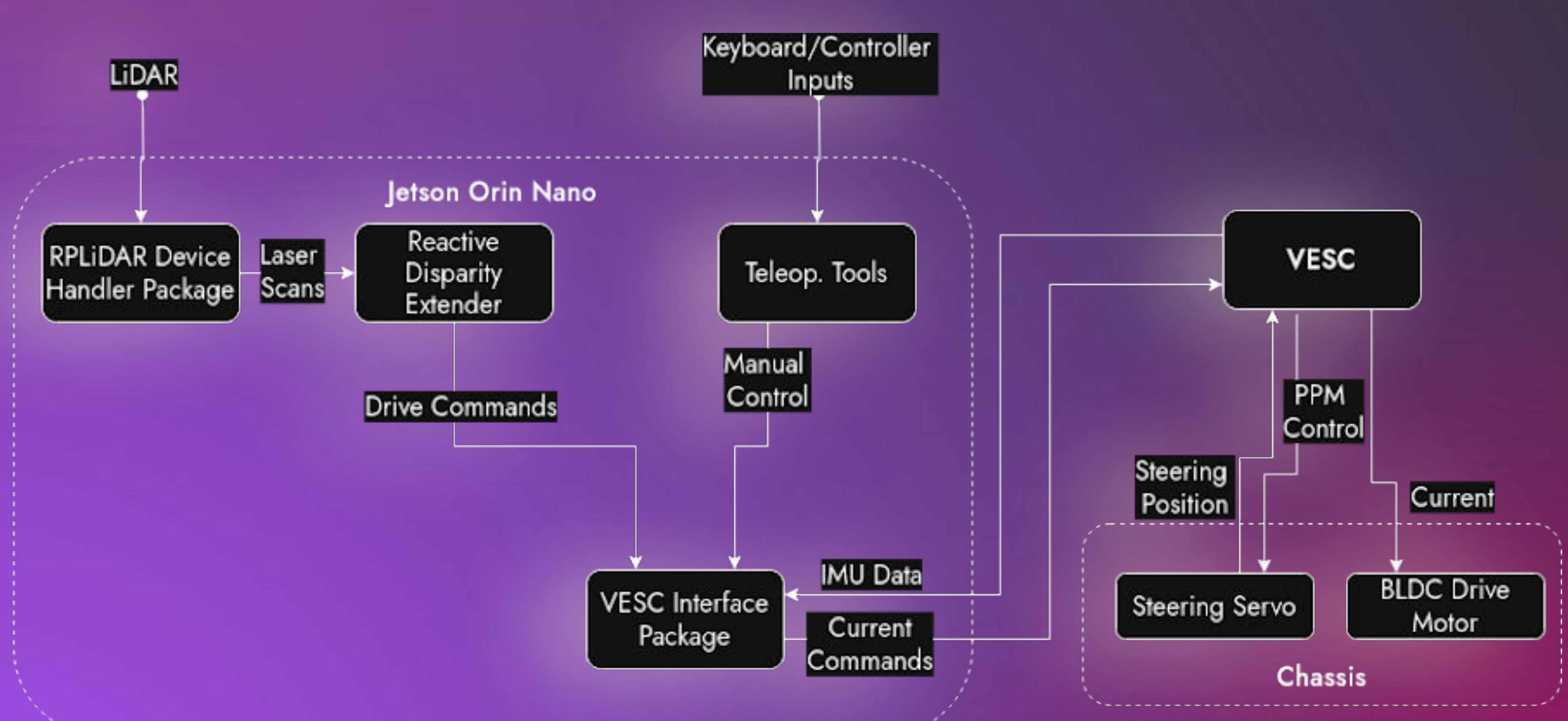
Configurable 5-15 Hz scan rate.

16,000 samples/sec.

VESC 6: BLDC Motor Control



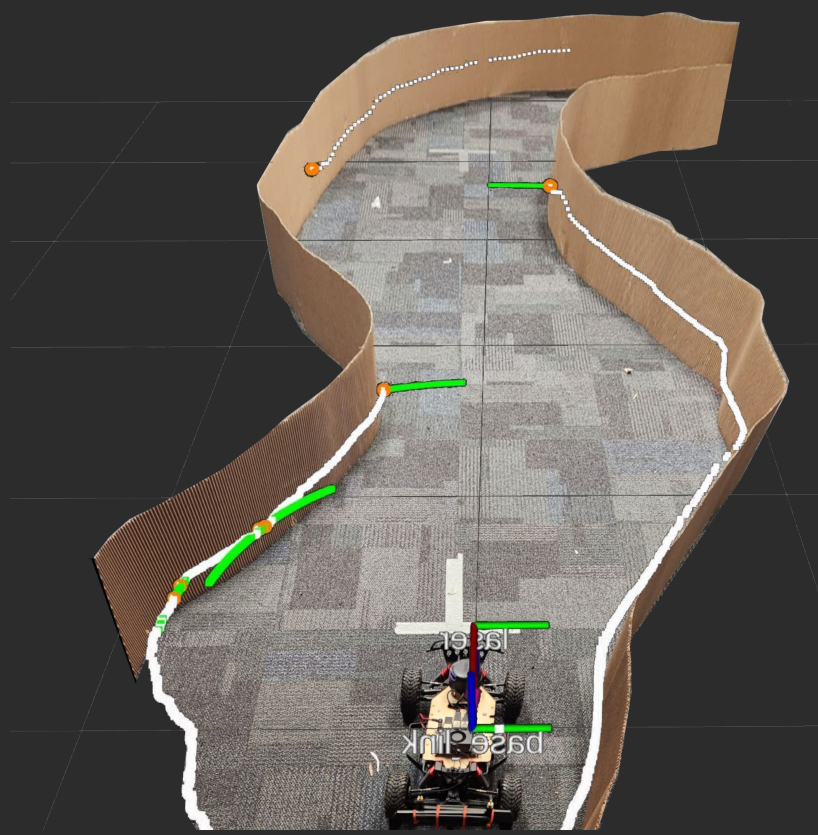
High Frequency Injection allows the ESC to determine rotor position at low speed, providing smoother acceleration and better control around obstacles. BLDC braking allows us to go faster, longer and respond to new challenges sooner.



Kinematic Car Model

Front-wheel steering vehicles cannot change to a new linear trajectory instantly. They must turn along a circular path, determined by the maximum wheel angle and wheelbase. To reach a target point we must plot an arc starting normal to the rear axle to the target point. Sometimes, this minimum curvature path is impossible, directing us too close to a wall or through it. We compare the arc to the car's surrounding and modify our target point accordingly.

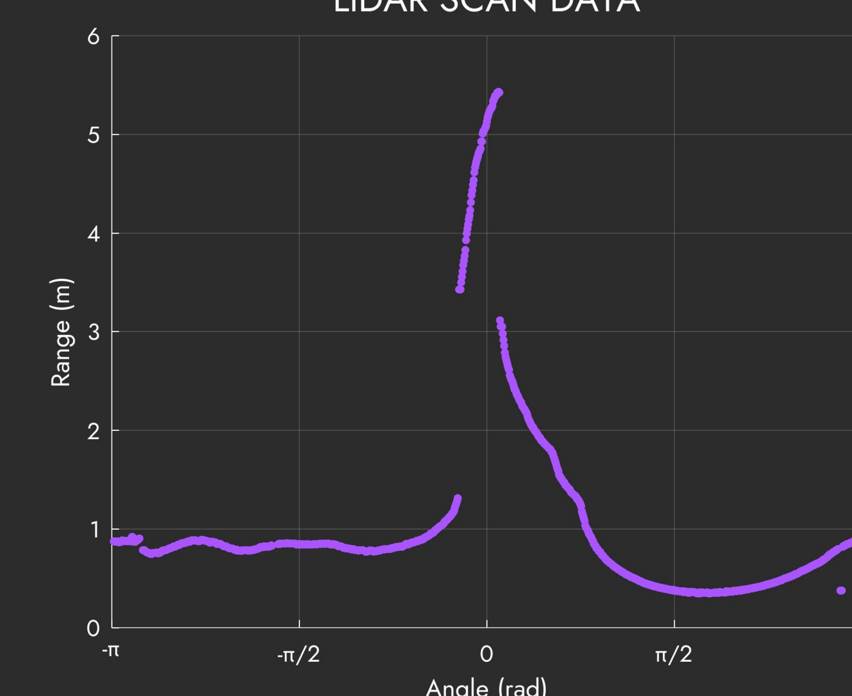
THE DISPARITY EXTENDER



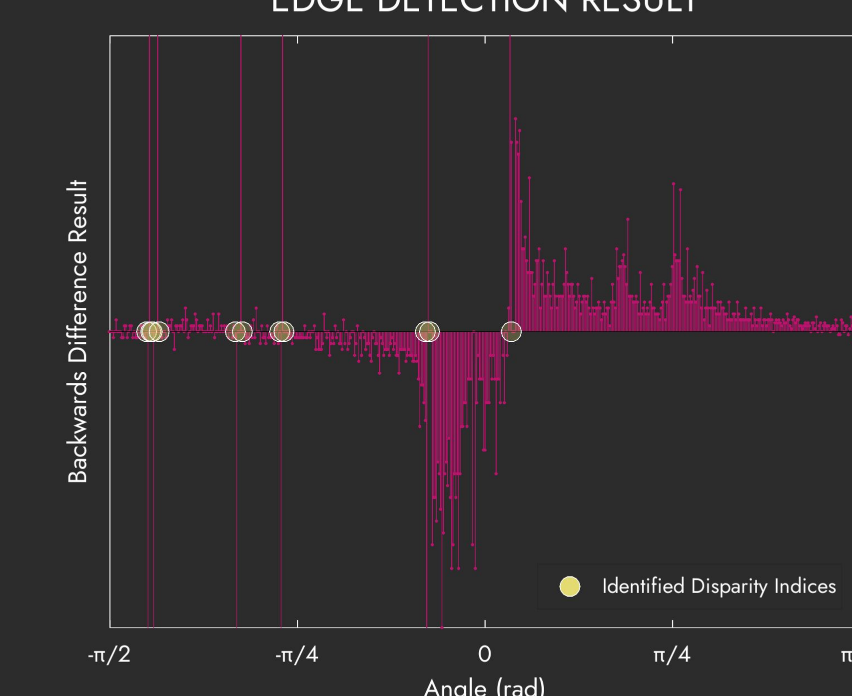
The disparity extender places the car in a quasi-configuration space, only with respect to the cars width. It is a simple algorithm that relies on finding large jumps, termed disparities, in LIDAR readings.

The car is free to travel forward without fear of its extremities hitting a wall so long as the green extensions of the detected walls are respected as actual walls. The image (left) shows the robot's navigable area.

LIDAR SCAN DATA



EDGE DETECTION RESULT



We read in the scan data, and preprocess for noise and filter out invalid readings.

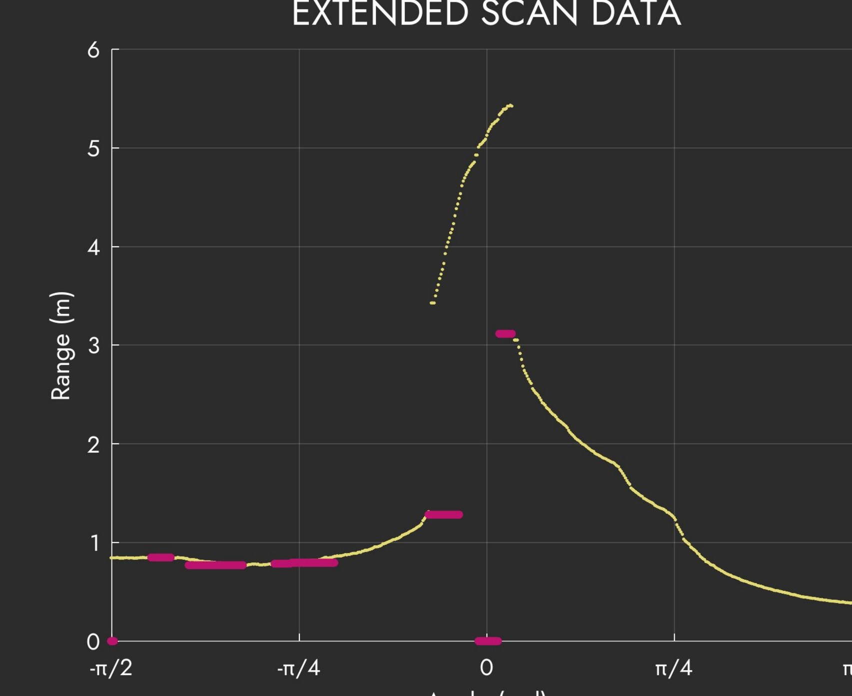
The data array is convolved with a simple edge detection kernel to yield the backwards difference between range values.

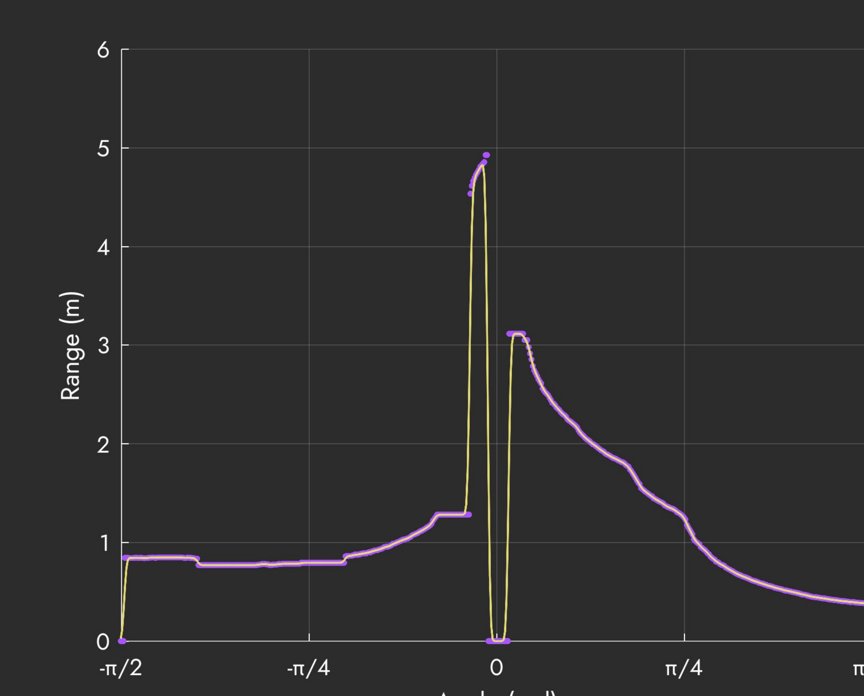
Disparities are identified as the point before a large increase or after a large decrease– critically, the point of lesser distance from the car.

The distance from the car to the point determines how many points of the range array is to be rewritten.

The data is Gaussian blurred to account for small discrepancies between scans and the maximum value is chose as the target.

EXTENDED SCAN DATA





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Thank you Chris Cheney, Madeline Hesse, Prof. João Hespanha, Prof. Ilan Ben-Yaacov, and RoboRacer for providing invaluable guidance throughout the research process. Funding for the project was provided by UCSB Undergraduate Research & Creative Activities.

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BLDC Motor Control

High Frequency Injection allows the ESC to determine rotor position at low speed, providing smoother acceleration and better control around obstacles.

BLDC braking allows us to go faster, longer and respond to new challenges spone

DEVELOPMENT PLATFORM

Kinematic Car Model/Pure Pursuit

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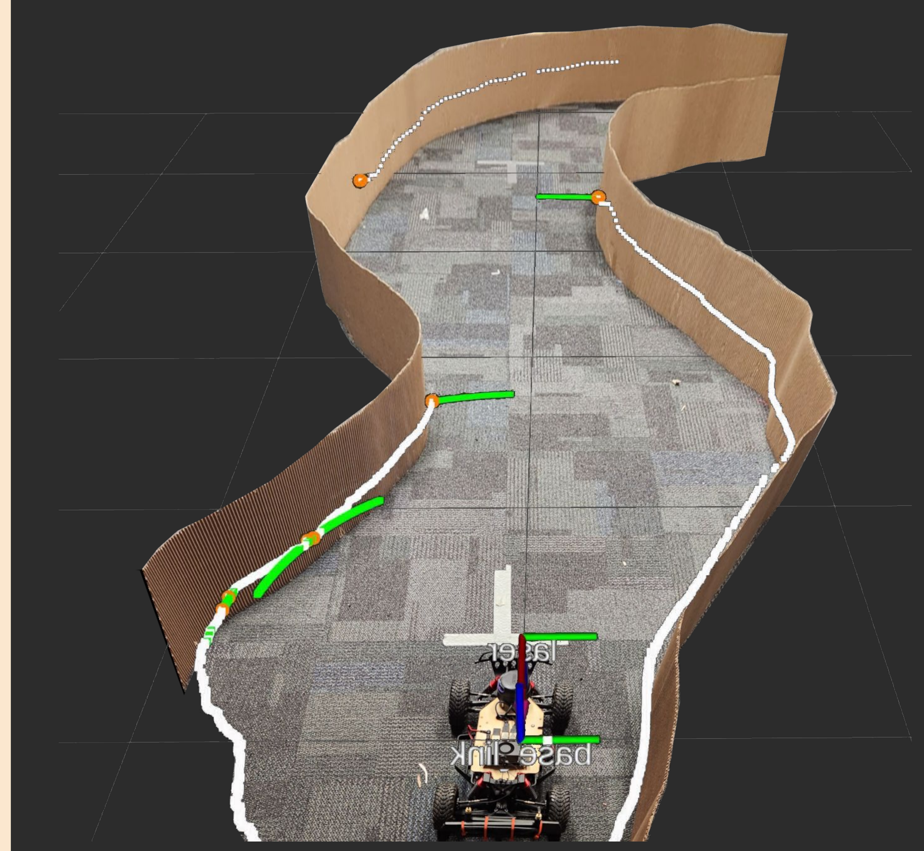
THE DISPARITY EXTENDER



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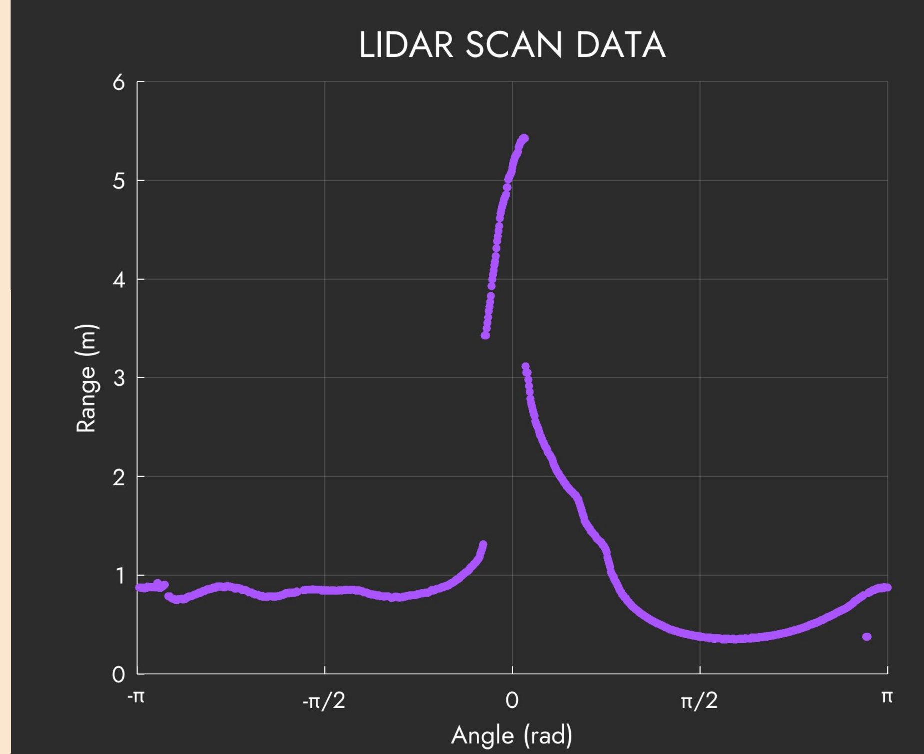

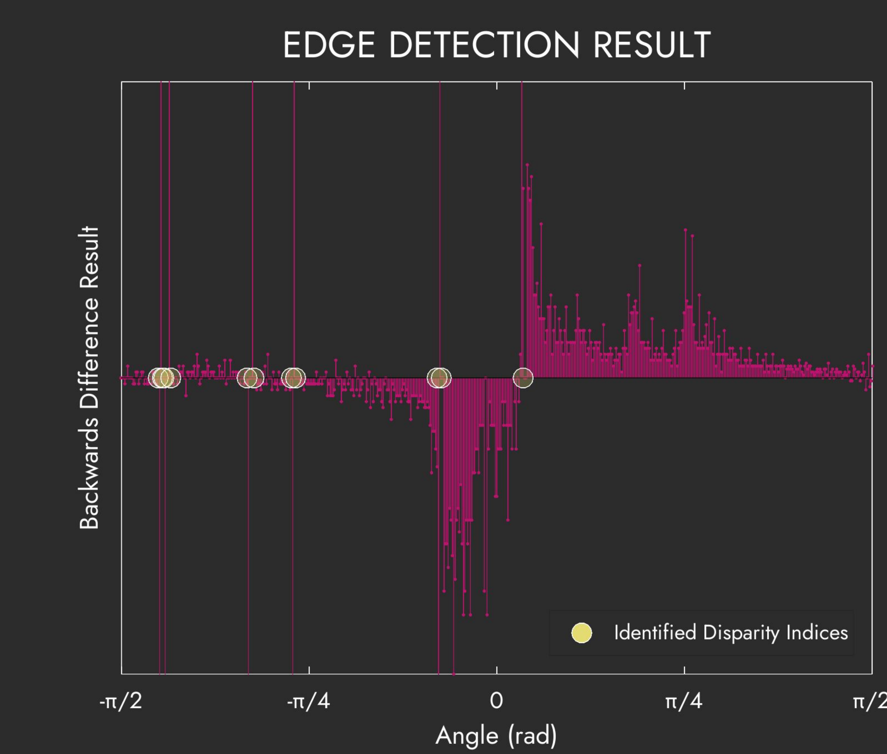

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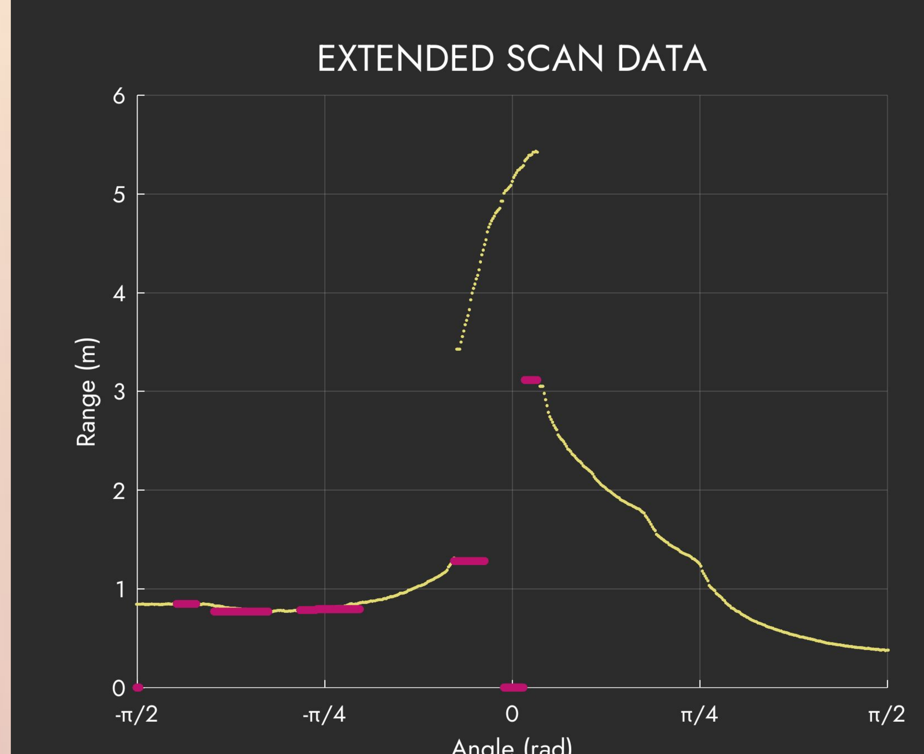

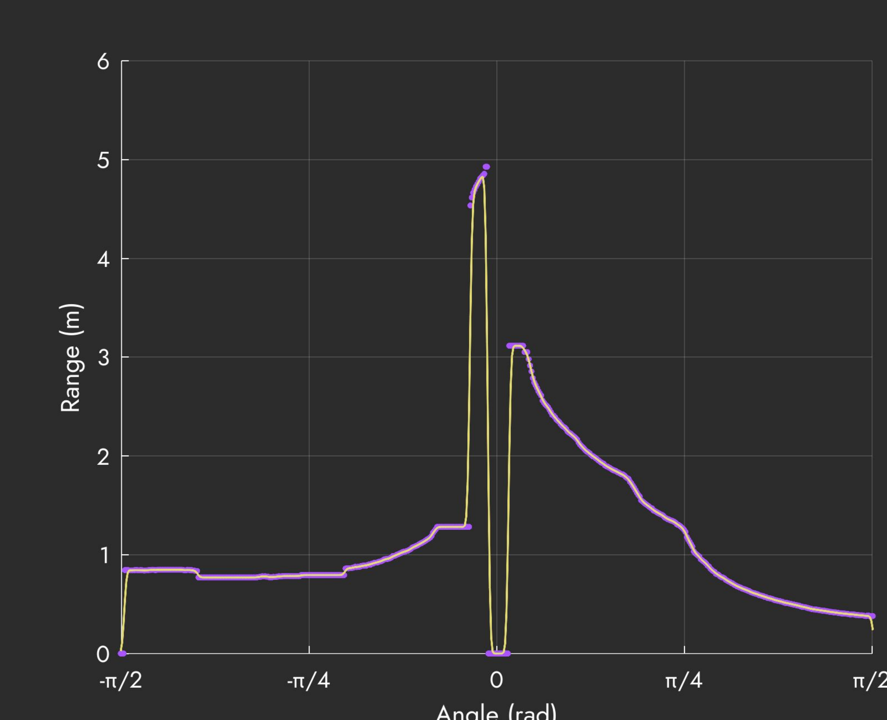

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