AUTONOMOUS AI VEHICLE PROJECT BY USING 1 CHANNEL SENSOR AND RASPBERRY PI CAMERA

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Introduction

This project was undertaken to build and develop an autonomous vehicle that showcases the potential of autonomous vehicles in a fundamental but promising way.

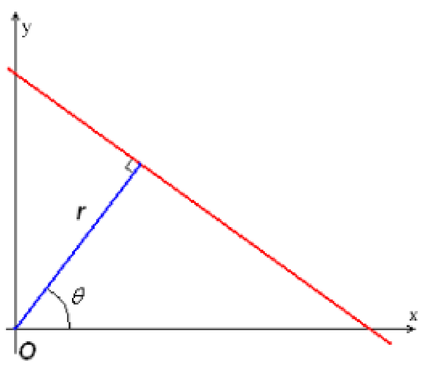
The main objective is for an autonomous vehicle to be built, which can act according to its environment without causing any issues from point A to B. Furthermore, it is aimed for this vehicle/car to have a compact design and form factor. If this car can be built with the expected functionalities in a tight package, the size can be changed according to the purpose of the vehicle.

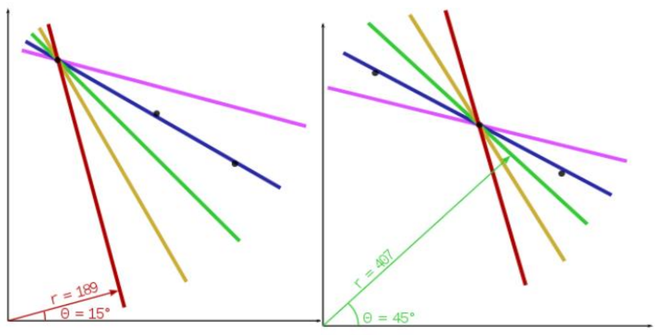
Overview

In this autonomous car, the car creates a decision mechanism according to the images it receives. This decision mechanism has different variables, for example, lane detection is made with Hough transform to ensure the movement and turns of the vehicle, and the vehicle decides on the direction according to the lanes. With Object detection and YD Lidar X4 sensor, it is ensured that the vehicle stops when it encounters any obstacle or object on the road. After scanning the environment with Lidar, if any object is detected on the road, the vehicle is stopped. It is aimed to prepare an artificial intelligence model according to the data collected from the road with the joystick controller and assist the lane detection part in the direction decision. The combination of all these features makes this project very different from other autonomous vehicle projects.

Mathematical Background

$$r = x\cos\theta + y\sin\theta,$$



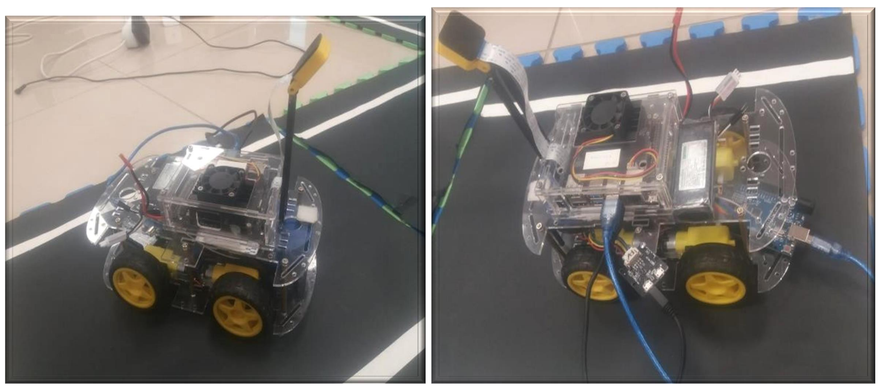


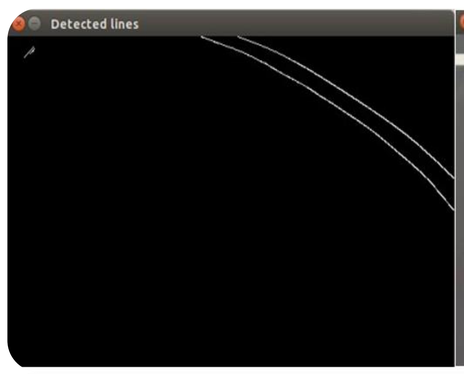
θ	r
15	189.0
30	282.0
45	355.7
60	407.3
75	429.4

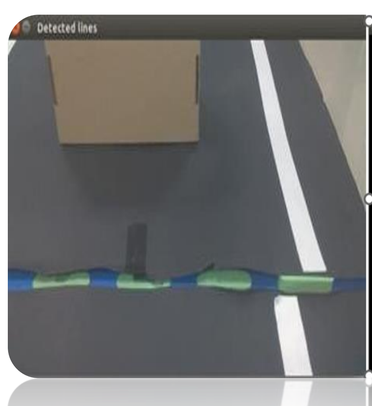
θ	r
15	318.5
30	376.8
45	407.3
60	409.8
75	385.3

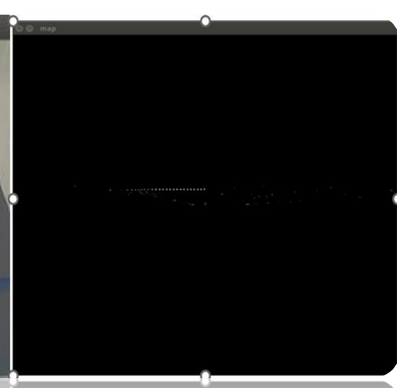
The intuition for this form, similarly to the plane equation, is that every vector on the line must be perpendicular (orthogonal) to the straight line of length r that comes from the origin. It is easy to see that the intersection point of the function line and the perpendicular line that comes from the origin is at $P_0 = (r\cos\theta, r\sin\theta)$. So, for any point P on the line, the vector $P - P_0$ must be orthogonal to the vector $P_0 - 0 = P_0$. Therefore, we get that for any point $P = (x, y)$ on the function line, the equation $(P - P_0) \cdot P_0 = 0$ must be satisfied. Therefore, $P \cdot P_0 = P_0 \cdot P_0$. Since $P = (x, y)$ and $P_0 = (r\cos\theta, r\sin\theta)$, we get $r(x\cos\theta + y\sin\theta) = r^2(\cos^2\theta + \sin^2\theta)$. Since $\cos^2\theta + \sin^2\theta = 1$, we get the final form of $x\cos\theta + y\sin\theta = r$.

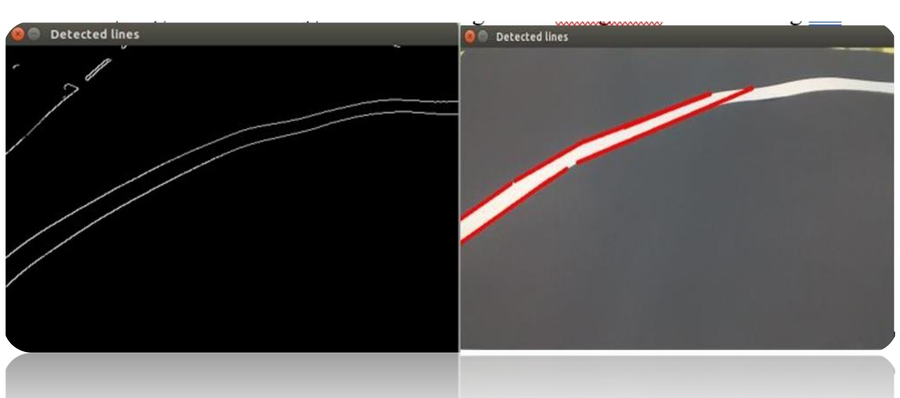
Results

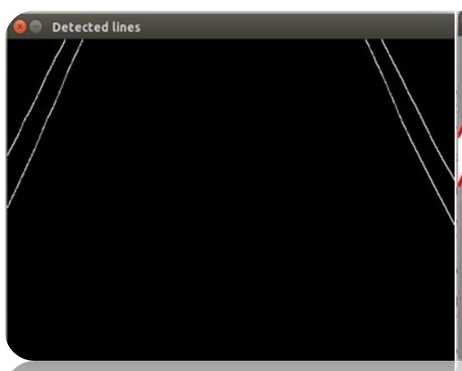












Conclusions

The goal of this project is to develop a self-driving vehicle by combining advanced technologies. The vehicle uses received images to make decisions based on different factors. For lane detection and safe movement, the Hough transform technique is utilized, and the vehicle decides on the direction based on the detected lanes. Object detection and the YD Lidar X4 sensor are used to detect obstacles on the road, and the vehicle stops when an object is detected by the Lidar while scanning the environment. The initial stages of the project experienced delays due to hardware-related challenges. However, the first work package shows that the car is fully completed, with all modules in place, including protective cases for Jetson Nano and Raspberry camera. The second work package demonstrates successful turning operations and the vehicle's ability to center itself on the road. The third work package successfully stops the vehicle using Lidar when an object is detected within 50 cm. Despite some setbacks and delays, 90% of the project has been successfully completed, and the car remains fully functions.