

TUTORIAL 6: DISTANCE FINDER AND PID

THE F1/10 TEAM

INTRODUCTION

This article contains the transcript of the week 2 Video Tutorial 6: Distance finder and PID. The aim of this tutorial is to give a brief explanation of simple algorithm to maintain the car parallel in a corridor. It involves how to use the sensor data from lidar and how to formulate a controller for the same.

TRANSCRIPT OF VIDEO TUTORIAL

In this tutorial we will learn how to make our car run parallel to a wall at a fixed distance. We will implement two nodes, a node that uses the laser scans from the lidar to determine the distance from the wall and an other node to apply pid on this error to determine the steering angle. We shall follow the algorithm described in the lectures.

Lets go through a simple procedure to calculate the distance of the wall from the car and hence calculate the deviation from the desired trajectory. The lidar scans from right to left corresponding to 0 to 180 degree with 90 degree being the front of the car. We pick 2 rays at 0 degree and theta degree, theta being some angle between 0 to 70 degree.

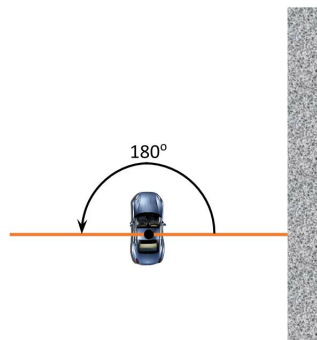


Figure 1: Lidar scan angles

Let alpha be the orientation of the car with respect to the wall. By solving the geometric problem we can establish alpha as tan inverse of $\frac{a \cos(\theta) - b}{a \sin(\theta)}$, and AB as $b \cos(\alpha)$.

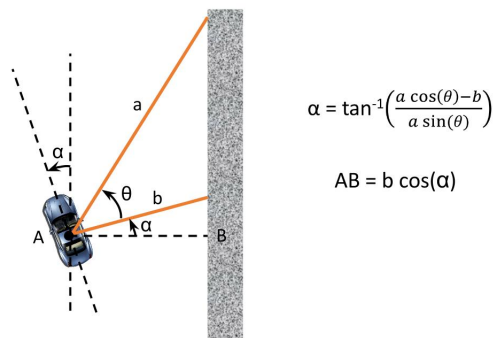


Figure 2: Calculating the orientation and distance from the wall

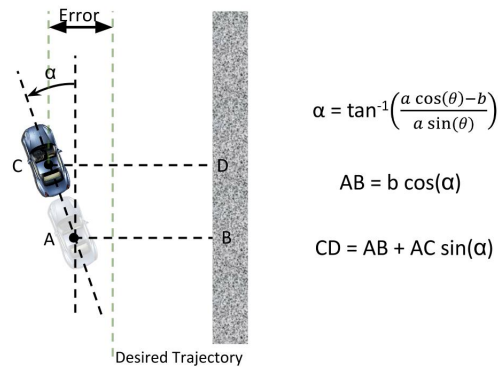
If the desired trajectory is 1m from the wall then generally the error that has to be controlled by the PID is $1 - AB$.

But we cannot use this distance directly. Due to the high speed of the car and a finite delay in execution of the manoeuvre we project the car forward certain distance from its current position. Hence now the distance of the car from the wall becomes $AB + AC \sin(\alpha)$

Hence the error to be compensated for is the difference between CD and the desired trajectory.

Now we have the error, we can use it in the PID equation to determine the amount of correction to be given to the steering.

Figure 3: Projecting the car future in time



We use the standard PID[1] equation, where $e(t)$ is the error from the desired trajectory. As seen in the lecture we will be using only K_p and K_d controls.

Hence we implement this as a tunable variable K_p times error plus another tunable variable K_d times the difference in error.

$$V_{\theta} = K_p \times e(t) + K_d \frac{de(t)}{dt}$$

$$V_{\theta} = K_p \times \text{error} + K_d \times \text{previous error} - \text{current error}$$

Use this value to increment or decrement your your steering angle.

In the practice session you will be implementing this in code.

REFERENCES

- [1] [A simple PID tutorial](#)