PROJECT REPORT

Line-following for Ackerman car

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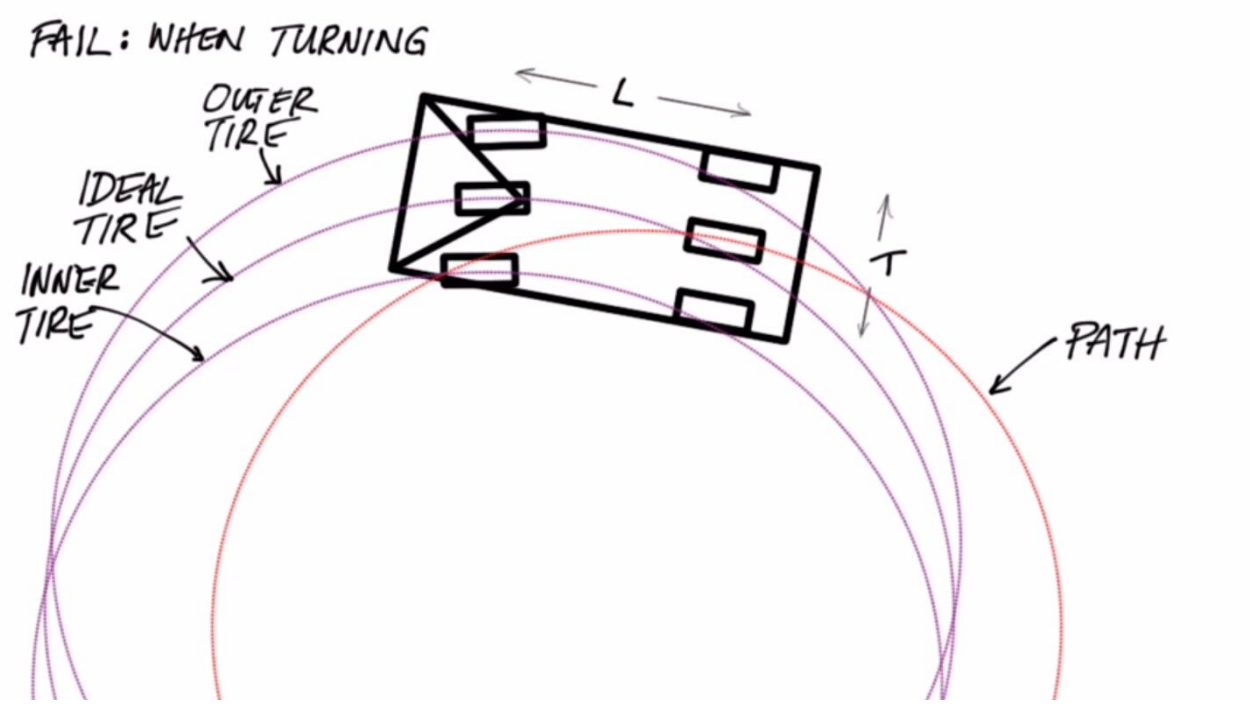
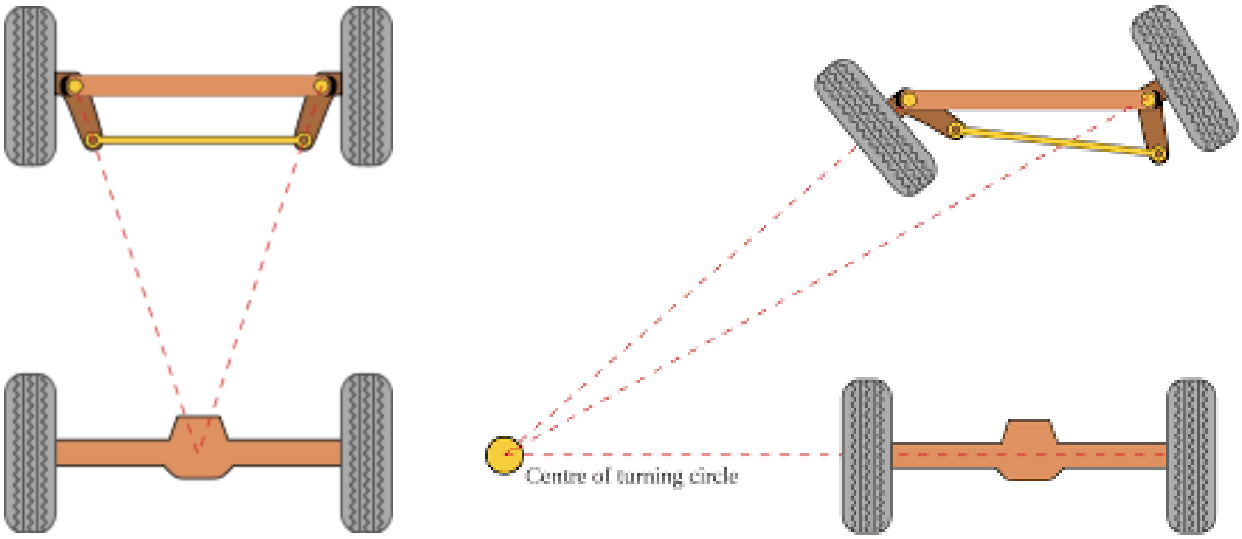
Introduction

Ackermann steering geometry is a geometric arrangement of linkages in the steering of a car or other vehicle designed to solve the problem of wheels on the inside and outside of a turn needing to trace out circles of different radii.

It allows preventing situation in which left and right wheels of a car move different trajectories (as on the picture below).



Ackerman steering was invented for solving this problem.



Geometry of Ackerman car

On the picture below, you can find description of the car's maneuvers.

For Ackerman car with L – distance between front and back axis (spindle), T - distance between front left and back wheels, r – desired trajectory radius, desired rotation angle δ can be found as

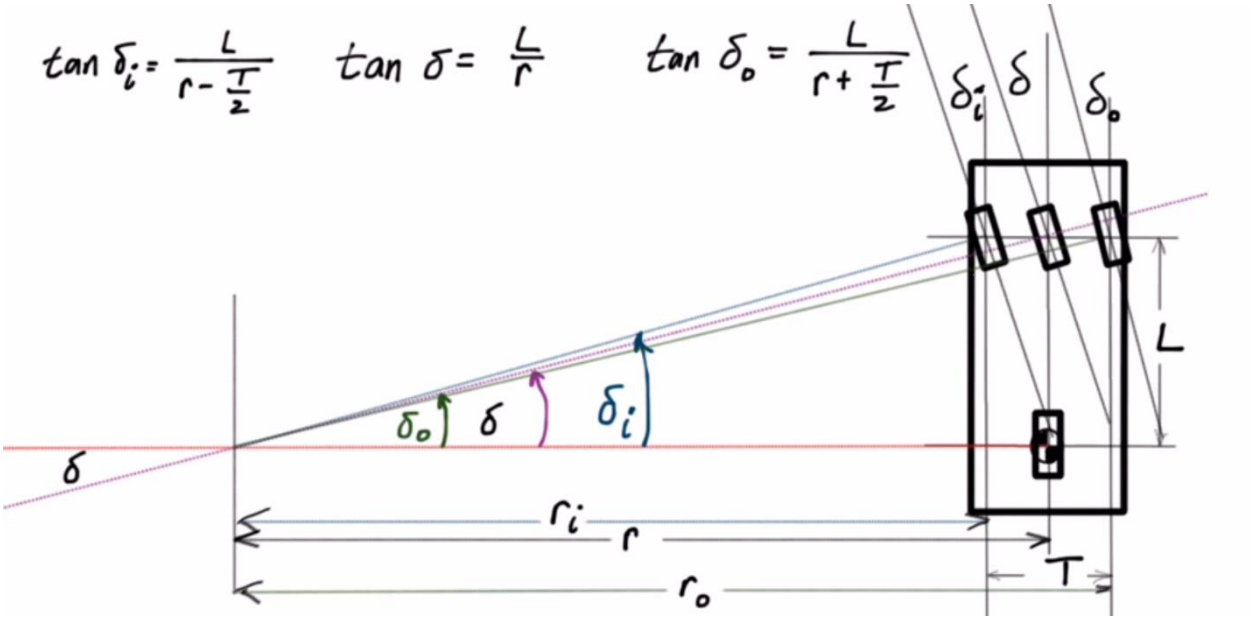
$$\delta = artan\left(\frac{L}{r}\right), \delta_i = artan\left(\frac{L}{r_i}\right), \delta_o = artan\left(\frac{L}{r_o}\right)$$

$$\tan\delta = \frac{L}{r} => \ r \ = \ L \ / \tan\delta$$

With $r_i = r - T/2 = L * \tan\delta - T/2$, $r_o = r + T/2 = L * \tan\delta + T/2$:

$$\delta_i = artan\left(\frac{L}{L / \tan\delta - \frac{T}{2}}\right), \delta_o = artan\left(\frac{L}{L/\tan\delta + \frac{T}{2}}\right)$$

These equations will be used later.



Implementation

For scanning state of the system I use 2 vision sensors. Their output value varies in [0, 1] (0 for black and 1 for white colour). The difference of value taken from these sensors (value in [-1, 1]) helps to determine size and direction of error (car's deviation from the centre of path line).

The algorithm uses principle of discrete PID controller, so, as a value of integral is computed as a sum of all errors, derivative as a difference of current and previous errors.

The car in the system moves with constant angular velocity of all wheels, and we control its position by changing front steering (desired) angle (δ). The value of this angle depends on components of PID controller. Values of angles on each of front wheels are computed by formulas revealed in one of previous parts of report.

References

https://en.wikipedia.org/wiki/Ackermann_steering_geometry

https://www.youtube.com/watch?v=i6uBwudwA5o)