Simulation of car kinematics

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Motivation

• Make the car move along a continuous trajectory

• Integrate the simulation with Google earth
A Path in Google Earth

Drawn manually
The Representation of the Path

In ‘kml’ or ‘kmz’ format. Generally follows ‘xml’ standard.
The Path in Matlab

Waypoints are sparsely scattered. Difficult for the car to follow.
General Outline of Preprocessing

- Insert points linearly (Upsampling)
- Optimize points position using least squares optimization
- Spline Interpolation
Direct Spline

Result in ridiculous curves
Upsampling

The waypoints are densely laid along the curve. The $N \times 2$ matrix could be used to represent the curve.
The Simulink model
Main Components

- Velocity control
- Steering control
- Motion model
Velocity Control

Calculate the accumulated angle change in the coming 10 waypoints.

• If exceeds a higher threshold, decelerate.
• If smaller than a lower threshold, accelerate.
• Otherwise, keep the velocity.
Motion Model
\[ \delta(t) = \psi(t) + \arctan \left( \frac{kx(t)}{u(t)} \right) \]
Steering Control

Two issues:

• Find the point on curve that is closest to car
• Find the tangent line through the closest point
Fig. 11. The front wheel drive car.

\[ \begin{align*}
\dot{x}_1 &= \cos(x_3) \cos(x_4)u_1 \\
\dot{x}_2 &= \cos(x_3) \sin(x_4)u_1 \\
\dot{x}_3 &= u_2 \\
\dot{x}_4 &= \frac{1}{L} \sin(x_3)u_1
\end{align*} \]

Motion Model
Simulation Result (l)
Simulation Result (II)
Thanks!