MA635P-Scientific Programming Laboratory

Numerical Interpolation Project

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Deadline: March 16, 2025

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भारतीय प्रौद्योगिकी संस्थान तिरुपति
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Autonomous Vehicle Tracking

Title of the Project

Trajectory Planning for Autonomous Vehicles Using Newton’s Divided Difference Interpolation

Background

- Autonomous vehicles rely on smooth and efficient trajectory planning to navigate safely through their environment.
- These trajectories are often defined as a set of waypoints provided by a higher-level navigation system.
- However, due to unevenly spaced waypoints, the vehicle needs to interpolate intermediate positions to ensure continuous, safe, and optimized movement.

Objective

- Develop a system that uses Newton's Divided Difference Interpolation to compute smooth trajectories for an autonomous vehicle between given waypoints.
- The system should handle unevenly spaced waypoints and generate a trajectory that minimizes abrupt changes in direction or speed.

Requirements

Input:

1. Collect list of waypoints $(x_0, y_0), (x_1, y_1), \cdots, (x_n, y_n)$
2. Give Constraints such as maximum allowable speed, acceleration, or turning radius.

Output:

1. A smooth trajectory interpolating the given waypoints, represented as a continuous function or discrete points for execution.
2. The trajectory should be optimized for vehicle dynamics and safety.
3. Ensure that the autonomous vehicle is jerk free (that is third derivative should be zero or constant)

Steps to Solve

Preprocessing:

1. Collect unevenly spaced waypoints.
2. Normalize and scale the data to fit within the vehicle's operational constraints.

Interpolation:

1. Use Newton's Divided Difference method to interpolate intermediate positions between waypoints.
2. Ensure smoothness by checking for abrupt changes in gradients or curvatures.
3. Ensure that the autonomous vehicle is jerk free (that is third derivative should be zero or constant)

Deliverable

1. A Python-based system that takes input waypoints and generates a smooth trajectory.
2. Visualizations of the interpolated path using tools like Matplotlib and Animations.
3. Simulation results showing the trajectory’s performance under constraints like speed and turning radius.
4. Test it for some real-time data collected from mountain path which has more zig-zag route (e.g Tirumala Hill)

Team

Team

- MA23M001 ADITYA PANDEY
- MA23M002 AJAY KUMAR YOGI
- MA23M014 SHEFALI
- MA23M019 SWATI RANA

Thanks

Doubts and Suggestions

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