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Objective: Find “BEST” path from one pose to another around a 2D costmap with a non-holomorphic vehicle, taking into account vehicle dynamics(skid-steering). The vehicle is allowed to accelerate each wheel at a fixed rate.

Many path planners in the past such as variations of A* or potential fields plot a shortest distance path and provide smoothing over that path. However, these methods do not traditionally consider vehicle dynamics when determining the smoothed path. Our project aims to directly optimize the speed of the path taken by the vehicle using a parameterization of the total path from beginning to end and parameters from the vehicle.

The path is parameterized using cubic Bézier curves. With each pose determining a (x,y) and theta pose, each control point provides 3 degrees of freedom. The robot is assumed to be at zero initial velocity and that it must stop at the last pose. And as long as there exists a straight line path from one control point to the next through any costmap, a feasible solution exists for that problem.

We wish to compare the solutions generated by this routine and those from A* and algorithms which smooth other deterministic paths. This comparison will be done through the lens of time taken by the robot to complete the path. It is known that this algorithm will take longer to generate a path than the aforementioned methods.

In order to achieve the target dimensionality of the project, we will use at least 4 control points for demonstration with a reasonable costmap. The costmap dataset which will be used for this project will be our own generated costmaps. We will also investigate if more control points eventually leads to similar solutions

In order to evaluate the success of the approach we will analyze our methods based upon the following comparisons:

- Different optimization strategies(i.e. stochastic, gradient-based, second-order, genetic algorithm, Lagrangian) based on quality of the solution, and computation time.
- We plan to investigate the relationship/trend that different number of control points has on solution speed.
- For robustness evaluation we will consider different cost map configurations
- Robustness for different initial conditions (different initial angles and positions)