**Abstract**

Vehicle autonomy is critically dependent on an accurate identification and mathematical representation of road and lane geometries. Many road lane identification systems are ad hoc (e.g., machine vision and lane keeping systems) or rely on polynomial approximations of road data and GPS positioning. A novel system is proposed in which geodetic road data is parsed along road directions and digitally stored in a road data matrix. Using mapping algorithms, the road data is converted to a smooth, differentiable path which connects critical road coordinates with curvature vectors and changes to road tangent angles. Different road data sources such as GPS or geographical scans were evaluated with this method and compared to current road design standards as per the American Association of State Highway and Transportation Officials. This approach takes advantage of standard roadway design practices, which rely on speed limit, superelevation, and empirical data for maximum lateral acceleration tolerance to determine acceptable radii of curvature for different classes of roadways. Successful implementation of this technology could accelerate autonomous vehicle’s navigation research and development for new guidance paradigms in addition to traditional machine vision-based systems.

Keywords: Trajectory Generation, Path Generation, Curvature, AASHTO, V2I, Vehicle-to-Infrastructure

**Introduction**

The overall system consists of using Vehicle to Infrastructure (V2I) Communications to send the vehicle a path to follow any given curve. A controller needs to be developed to address the trajectory and modularity in any given sedan vehicle. This path is computed offline and stored in a transmitter that resides on infrastructures. This transmitter will send the desired path and a trajectory will be computed onboard. The transmission of the signal will be desired to be small as possible.

The following assumptions were considered:

* Vehicles contains enough technology to drive itself given a set amount of data (in this case, ideal heading angle, curvature)
* Method is not built considering collision avoidance, though it could be implemented
* Only sedan vehicles were studied, but can be extended to other vehicles
* Random animals and extreme accidents are ignored
* Anomalies in the road profile such as potholes are ignored
* Road is assumed to be in drivable conditions

The end goal of this project offers a backup system to detection sensors such as camera and lidar which will allow vehicles to travel under weather disruptions. To achieve this goal, the project was divided into three main parts. The first one is vehicle local trilateration, which establishes a vehicle position through transmission in between infrastructures and vehicles. The second part involves offline path generations and the minimization of data transmission of navigation data. The third part focuses on developing a controller to navigate with the road paths from the second part. For this paper, only the second part will be analyzed.

**Problem Statement**

The problem formulation involves generating an offline path that minimizes the data size needed to traverse a curved road.

**Trajectory Generation Background**

In motion planning, a path is defined a set of possible ways a vehicle is allowed to go from Point A to Point B. While trajectory is defined as the profile needed to go through that path given different constraints. For example, many trajectories can lie inside of a given path as shown in Figure 1. Given constraints can be in the form of differential constraints from equations of motion, geometrical constraints or dynamic constraints from vehicle limits.