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EE 554
Final Project Proposal

Roadway Image Vanishing Point Detection/Tracking Using Monte Carlo Methods

For the final project I have been toying with the idea of implementing a vanishing point detector/tracker for roadway images (taken from the viewpoint of the driver's seat). The idea would be to make linear estimates of the lines between similar objects (i.e. tops of telephone poles/power lines, roadway markers, etc.). Ideally where these lines intersect, this would be where the vanishing point is located. However since roadways curve, lines closer to the vehicle will appear to vanish straight ahead while lines further in the image would appear to head left, right or straight. This should create one to two highly probable regions that the vanishing point is located with potentially many outliers in-between.

Using the idea of particle filter trackers (or Monte Carlo/sampling-based methods), and the arguments made in the "Monte Carlo Localization for Mobile Robots" by Dellart et al., I could start with a uniform sampling of the image as the initial estimates for the vanishing point. Then the intersections of the vanishing lines estimated above could be used as the measurements/observations during the Update phase. As for the control input used in the prediction phase, we should know what steering commands the driver gave (i.e. left, right, straight) and how long ago (frames per second) such that if we steer right then the vanishing point should move left since we are turning towards it and vice versa for steering left. Eventually, it would seem that, the Monte Carlo estimator should converge to the roadways vanishing point which in-turn provides a steering point for the driver.

In order to create the vanishing lines I've thought of a few approaches. The first is to use some edge detection algorithms within Matlab to see if there are edge features that stand out as possible vanishing lines (linear estimates would need to be made). Another idea is to segment the image based on color or texture, perhaps based on the work done in "Local Color Transfer via Probabilistic Segmentation by Expectation-Maximization" by Tai et al., where once the regions are segmented a linear fit of a line through the data would create an approximation of the vanishing line (in this case the image may have to be divided into four quadrants to possibly get better vanishing point estimates for the measurement model used in the update phase).

The last approach for the vanishing point measurements is borrowing the image segmentation idea from the paper "Hidden Markov Models for Face Recognition" by Nefian and Hayes, where the image could be compartmentalized such that from the top down we have (sky, horizon, roadway) and left to right we have (grass/trees/buildings, opposite side of road [may not need this one], road, grass/trees/buildings) then the intersecting area where the horizon from the top/down and the road from the left/right meet would provide the probable space for the vanishing point as the measurement in the update phase.

One hurdle that is expected is the occlusion of the vanishing point due to other vehicles but even these objects are traveling towards the vanishing point so that could also be considered in some way as a vanishing point.