EE368 Project Proposal

Fall 2015

Obstacle avoidance with stereo vision in Self-driving cars

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Motivation

Autonomous vehicles are the future of mobility and to realize this future, the costs associated with the current technology have to be reduced significantly. Most autonomous vehicles use lidar systems, with prices in the range of $60,000-$80,000, for perception. An alternative to lidar systems for perception are cameras and vision systems. Vision systems are comparatively inexpensive but are not nearly as accurate as lidar systems. As part of this project, we plan to explore the potential of vision systems to detect obstacles using stereo vision.

Description

The plan is to implement a simple obstacle detection program and test it on an existing self driving car. The current self driving car we plan to do our tests on is X1, Stanford's student built drive by wire, steer by wire test vehicle. The two major stages that constitute the technology of an autonomous vehicle are 1) Perception and 2) Planning. Perception is the stage where the car observes its surroundings and makes a map of all the neighbouring obstacles relative to its location. Planning is the stage where the car decides on what to do once it knows everything about its environment. Currently a sampling based motion planning algorithm FMT* has been developed and tested on X1 and thus the planning part of the car is already implemented. We intend to add a perception framework on X1 that utilizes stereo-vision to complete the loop.

The project will involve installing cameras on the X1 and using stereo vision techniques as done in [1] and [2] that employ the cameras to create depth maps and extract 3D information about the surroundings. We plan to use two 360 degree cameras as done in [3] to replace the usual lidar. In this way we are not restricted to mapping only the direction in which the cameras are pointed . This also enables the car to do more complex manoeuvres such as parallel parking or backing up once it has a more detailed knowledge about all its surroundings.

Planned demonstrations:

- Obstacle avoidance by changing lanes
- Path following
- Parallel parking and other complex low speed manoeuvres.

Implementation

Hardware:

Ricoh theta S spherical digital cameras may be used to obtain 360 degree images. An alternative would be to use multiple cameras which cover the entire 360 degree field of vision.

Software:

We plan to develop our algorithms in python or matlab and may use openCV. We will not be developing applications on android.

References

[1] Massimo Bertozzi and Alberto Broggi. Gold: A parallel real-time stereo vision system for generic obstacle and lane detection. *Image Processing, IEEE Transactions on*, 7(1):62–81, 1998.

[2] Reinhard Klette. *Stereo-vision-support for intelligent vehicles-the need for quantified evidence*. Springer, 2008.

[3] Hansung Kim and Adrian Hilton. 3d scene reconstruction from multiple spherical stereo pairs. *International journal of computer vision*, 104(1):94–116, 2013.