Real Time Pedestrian Detection and Mapping

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Abstract

Pedestrian detection is a key problem in computer vision and is a key element in vision systems for autonomous vehicles. For autonomous vehicles it is a very important task the main reason is safety. The pedestrian detection algorithms were explored widely and thoroughly by a wide range of explorers. Perhaps the best algorithm that can be found today in the pedestrian detection community is the algorithms and open code written by Piotr Dollar, which we are going to use in our work. However, detecting the pedestrians is just one piece of the puzzle, and the other piece is to map the pedestrian in the three dimensional world. In this paper we will show our results of working with Dollar's algorithm and our implementation for detecting and mapping.

1 Introduction

Autonomous vehicles and robots require a vision system and mapping capabilities. Whether this vision system and mapping is performed using LiDAR, cameras, or other sensors the vision and mapping is mandatory for the system to operate. Although LiDAR sensors are accurate robust and easy to use, they have some drawbacks such as high market prices, high energy consumption and especially the problem of extracting features from the points themselves. Cameras, on the other hand, are very cheap and mimics the human eye in the sense of getting the scenery input. However, extracting meaningful data from the images is extremely complicated, and 3D reconstructions of the scenery is nearly impossible without any prior information. It is desired to know the where about of the surrounding pedestrians for obvious reasons. There are numerous algorithms and methods [1, 4, 2, 5, 6]that can detect pedestrians such as VJ, Shapelet, and ConvNet that uses different types of features such as Haar, Gradients and HOG. Each method has its pros and cons in the sense of computation time and accuracy. For the time being, Piotr Dollar's is probably the best pedestrian detector algorithm for real time application due to its fast computation and accurate [3]. Indeed, the algorithm suggested by Piotr Dollar does not solve the solution completely, but gives only one piece of the puzzle. The algorithm finds the pedestrians in a given image, but still the mapping of the person into a 3D space is still an issue.

Figure 1: Dollar's algorithm for pedestrian detection.

In this project we would like to try to detect and map pedestrians in a 3D space while using and improving Dollar's algorithm. The improvement is performed by using a tracking algorithm, e.g. Kalman filter and using stereo algorithm for 3D projection.

2 Problem statement

The pedestrian detector we are intending to implement is the algorithm published by Piotr Dollar [3]. Dollar's algorithm (as seen in figure 1) detect pedestrians in real time computation speed with high assurance.

The next step, as proposed by our algorithm (see figure 2), is to project the pedestrian which is detected by Dollar, to a 3D map. This will be done using stereo vision techniques. Of course, this stage needs to be researched since the number of bounding boxes are not necessarily equal in both cameras, and detection is not guaranteed in both images. In addition the bounding boxes might not be equal so a simple Histogram filter will not assist in matching the pedestrians in both images.

Assuming the mapping of the pedestrian to a 3D world map is successful the next step will be to track the pedestrian on the map [7], while taking into consideration the dynamics of the cameras. The dynamics of the cameras are calculated using a GPS/IMU measuring system.

3 Gaps and meanwhile accomplishments

Till now we have managed to operate Dollar's algorithm and have started to export the algorithm from Matlab environment to C/C++ environment for Real-Time and better integration with the rest of the algorithms (note that we may continue till the end of the semester to develop in Matlab).

Good calibration and synchronizing of a stereo GigE camera system is in our possession, and a dataset of JPEG images has already been taken to work

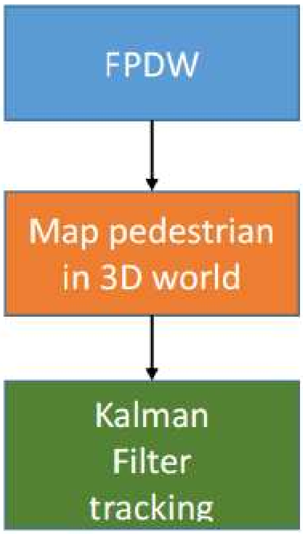

Figure 2: Proposed algorithm

with.

We still do not know, as mentioned, how to match the pedestrians in the two images received.

Another issue we are dealing with is how to track multiple targets using a Kalman Filter estimator.

4 Experiments

When we will finish the development of our algorithm we will perform a series of experiment that will show our results of the pedestrian mapping as opposed to the real position of the pedestrians which will be evaluated using a Velodyne LiDAR system.

5 Conclusions

This project has a huge impact potential and combines multiple techniques and algorithms. The resulted algorithm of this project is expected to be used in a real time application for autonomous cars, and we hope to submit it to a journal (not sure yet which one).

References

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