Monocular-Vision-Based Vehicle Detection and Distance Estimation

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Distance information for potential obstacles in the path of a vehicle is critical for intelligent automotive systems in order to avoid collision. We propose to develop a real-time vehicle detection and distance measurement algorithm using temporally correlated sequential images from monocular vision and implement it on **Android devices**.

Many distance determination algorithms has been proposed and developed in the last decade [1-3]. Active detection systems are widely implemented commercially in vehicles today because of their immunity to changing ambient light conditions; however, the cost is usually higher than passive systems because they involves transmitters and receivers. Among the passive detection systems, vision-based methods are the most common and effective techniques, which can be roughly classified into two categories: monocular and stereo vision. Stereo vision utilizes images from two or more cameras to construct the 3D space, which usually provides better accuracy than monocular vision; however, the cost is also higher, and it is prone to error if the parameters of the cameras are unknown or change due to vibration on the road. Therefore, we choose to focus on monocular vision.

A complete distance measurement system includes two steps: vehicle detection and distance calculation. Motion-based and Appearance-based are two main approaches for vehicle detections [3]. We will first apply the combination of Histogram of Oriented Gradients (HOG) descriptor and Support Vector Machine (SVM) classification for vehicle detection, because it has shown promise by many previous works [4]. There are also database online for us to train the SVM classifier [5]. Optical flow method, one of the popular motion-based methods, is another candidate. Once the vehicles are detected, the location in the 3D world needs to be computed. Because monocular vision is used, reference features with known dimensions are required. We will start from simple cases. For example, the parallel lines on the road can be used to calculate the vanishing points as a reference; the width of vehicles are roughly on the same scale, which can also be used as references; license plates are rectangular and have a fixed size serving as a great reference; however, detecting license plates from distance may be very challenging. While these techniques should be enough to measure the distance in the simplest cases, e.g. detecting a vehicle right ahead driving straight, we are also interested in investigating some edge cases, including occlusions, driving in the night or rainy days, presence of vibration, being lit by the headlights from vehicles driving from opposite direction, etc. We will combine different techniques to tackle these issues. And hopefully, we can implement our algorithm on Android devices at the end.

[1] Sun, Zehang, et al., "On-road vehicle detection: A review." Pattern Analysis and Machine Intelligence, IEEE Transactions on 28.5 (2006): 694-711. [2] Cualain, Diarmaid O., et al., “Distance detection systems for the automotive environment: a review.” In Irish Signals and Systems Conf. 2007. [3] Sivaraman, Sayanan, and Mohan Manubhai Trivedi. “Looking at vehicles on the road: A survey of vision-based vehicle detection, tracking, and behavior analysis.” Intelligent Transportation Systems, IEEE Transactions on 14, no. 4 (2013): 1773-1795. [4] H. Tehrani Niknejad, et al., “On-road multivehicle tracking using deformable object model and particle filter with improved likelihood estimation,” IEEE Trans. Intell. Transp. Syst., vol. 13, no. 2, pp. 748–758, Jun. 2012. [5] http://pascallin.ecs.soton.ac.uk/challenges/VOC/