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Real-time vehicle distance estimation using single view geometry

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Abstract

Distance estimation is required for advanced driver assistance systems (ADAS) as well as self-driving cars. It is crucial for obstacle avoidance, tailgating detection and accident prevention. Currently, radars and lidars are primarily used for this purpose which are either expensive or offer poor resolution. Deep learning based depth or distance estimation techniques require huge amount of data and ensuring domain invariance is a challenge. Therefore, in this paper, we propose a single view geometric approach which is lightweight and uses geometric features of the road lane markings for distance estimation that integrates well with the lane and vehicle detection modules of an existing ADAS. Our system introduces novelty on two fronts: (1) it uses cross-ratios of lane boundaries to estimate horizon (2) it determines an Inverse Perspective Mapping (IPM) and camera height from a known lane width and the detected horizon. Distances of the vehicles on the road are then calculated by back projecting image point to a ray intersecting the reconstructed road plane. For evaluation, we used lidar data as ground truth and compare the performance of our algorithm with radar as well as the state-of-the-art deep learning based monocular depth prediction algorithms. The results on three public datasets (Kitti, nuScenes and Lyft level 5) showed that the proposed system maintains a consistent RMSE between 6.10 to 7.31. It outperforms other algorithms on two of the datasets while on KITTI it falls behind one (supervised) deep learning method. Furthermore, it is computationally inexpensive and is data-domain invariant.

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