

Pedestrian Detection Techniques using Sensor Fusion in Autonomous Vehicles

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Abstract

In the past decade, a lot of techniques have been continuously studied and applied in autonomous vehicles fields. For example, there are a few techniques such as Advanced Driver Assistance System (ADAS), Advanced Smart Cruise Control (ASCC), Lane Keeping Assist System (LKAS) and Autonomous Emergency Braking system (AEB). In spite of the technical development, there are still the problems such as pedestrian accident. In this paper, we survey the previous techniques for pedestrian detection in autonomous vehicle. Furthermore, we introduce pros and cons of a camera, LIDAR and RADAR sensors, and explain the necessity of sensor fusion.

Keywords: Autonomous vehicle, Pedestrian detection, Sensor fusion.

1. Introduction

In recent years, research on intelligent vehicles has become one of interests of many people. Safety of the pedestrian and driver is one of the most important factors to consider in the autonomous vehicle [1, 2]. According to the US statistics, annually pedestrian fatalities in traffic crashes are more than 10% of the total fatalities from 2004 to 2013. Also, most of the accidents occurred at night [3]. According to the EU statistics, pedestrian fatalities in road traffic crashes are about 22% in 2013 [4]. Therefore, accurately detecting the pedestrian is important to protect pedestrians from autonomous vehicles. In this field, the researchers study pedestrian detection and collision avoidance techniques. Typically, a camera and LIDAR sensors are used for pedestrian detection techniques.

2. Pedestrian Detection Techniques

In this section, we survey the recent studies on the pedestrian detection techniques for autonomous vehicles. A camera has been used in human detection. Mainly, the detection techniques utilize methods such as face detection, motion detection and machine learning [5, 6]. However, cameras have the disadvantages which are to be sensitive for light intensity with heavy image processing. The techniques using LIDAR generally are applied in measuring width or height of the object as well as detecting legs or body [1, 7]. LIDAR is difficult to recognize the colour and to classify objects in comparison with a camera. Also, it is difficult to detect velocity of objects compared with RADAR. RADAR cannot classify the types of objects. Also, it has low angular resolution and narrow field of view. Therefore, sensor fusion techniques have been developed to compensate disadvantage of each sensor.

A. LIDAR-Camera Sensor Fusion

One of the fusion techniques is LIDAR-Camera sensor fusion as the most popular technique [2]. The fusion technique can reduce the processing time, but the problem of the light intensity still remains. Usually, LIDAR-Camera sensor fusion technique is made of three steps: calibration between sensors, acquisition of ROI (region of interest) and classification of objects.

B. LIDAR-RADAR Sensor fusion

LIDAR-RADAR fusion techniques can solve the problem of velocity detection by using RADAR. The velocity of objects can be accurately measured by using the Doppler Effect from RADAR [8]. LIDAR-RADAR sensor fusion techniques are divided into two steps. In first step, LIDAR is used for obtaining the environment and objects. In next step, RADAR measures the velocity of objects.

3. Conclusions and Future Work

In this paper, we have surveyed various techniques for pedestrian detection. We mainly introduced the pros and cons of pedestrian detection technologies. In addition, we presented the necessity of sensor fusion. In the future work, we will study pedestrian detection technique through sensor fusion. For this study, we will implement sensor fusion algorithm and build our test-bed.

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