WiP Abstract: A Low-Complexity Scheme for Partially Occluded Pedestrian Detection using LIDAR-RADAR Sensor Fusion

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***Abstract*—Object detection has been researched using a camera, a LIDAR and a RADAR. However, camera-based techniques have heavy image processing and are sensitive for light intensity. LIDAR can measure precise distance from objects, but it is difficult to classify objects. Further, it is known that when pedestrians are partially occluded, detecting them is extremely difficult because of insufficient data to determine them. To address this problem, we use LIDAR and RADAR sensors to improve the detection accuracy. We present a sensor fusion scheme for detecting partially occluded pedestrian with low-complexity.**

Keywords—LIDAR-RADAR sensor fusion; pedestrian detection; occluded detection; low-complexity

I. INTRODUCTION

Intelligent vehicles are one of the hot research areas. Above all, the safety of pedestrians and drivers in the age of intelligent vehicles is a critical issue and has been studied by a number of researchers. A camera, LIDAR, and RADAR have been used for object detection in intelligent vehicles. However, a camera requires heavy image processing and has unreliable results when light intensity changes. LIDARs are able to obtain precise location and shape of objects in visible region. However, compared to a camera, LIDARs are hard to classify object. RADARs can present range and velocity of objects using Doppler Effect [1]. However, the classification of the objects is complicated since it is difficult to obtain the characteristics of the objects such as shape, color and size extracted from RADARs. A Camera-LIDAR fusion approach aims at low image processing cost and high confidence level [2]. However, such an approach cannot be used at night since classification is performed using image processing. To address this problem, we propose LIDAR-RADAR sensor fusion scheme.

II. LIDAR-RADAR FUSION SCHEME

We propose LIDAR-RADAR sensor fusion scheme for pedestrian detection. The proposed scheme is consisted of several steps: calibration, object detection, and occluded volume generation.

In the calibration step, errors which are induced with the distance between mounted positions of sensors are corrected. After that, the object detection step is executed at each sensor. RADAR can detect the objects by using Doppler Effect and generate the ROI of objects. In LIDAR process, objects are identified by ROIs extracted from RADAR. In next step, the occluded volume is generated with LIDAR data and occluded objects are determined considering RADAR ROIs in the volume. The occluded volume means a shaded area behind objects, and some objects can exist in this area. Fig. 1 shows an example of an occluded pedestrian and an occluded volume. LIDAR data is represented by green dots. Red and yellow circles are pedestrians. One pedestrian in the yellow circle is occluded by other pedestrian in the red circle.

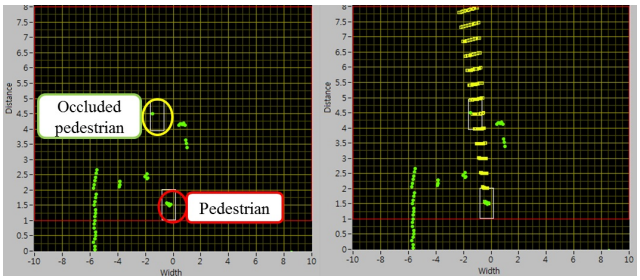

Figure 1. An example of partially occluded pedestrian detected by LIDAR: not include occluded volume (left) and include occluded volume (right)

III. CONCLUSION AND FUTURE WORK

In this paper, we propose a detection scheme for partially occluded pedestrians. The scheme can be used for object detection mechanism of intelligent vehicles at daytime and night. In addition, the complexity is reduced by using the ROIs generated from RADAR. In the future, we plan to find an efficient classifier and develop classification steps to improve the detection accuracy.

ACKNOWLEDGEMENT

This research was supported in part by Global Research Laboratory Program (2013K1A1A2A02078326) through NRF, DGIST Research and Development Program (16-RS-01 and CPS Global Center) funded by the Ministry of Science, ICT and Future Planning (MSIP) of Korea.

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978-1-5090-2479-7/16 $31.00 © 2016 IEEE
DOI 10.1109/RTCSA.2016.20