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Object Detection Method in Traffic by On-Board Computer Vision with Time Delay Neural Network

Jittima Varagula[a,]*, Panit-a-nong Kulproma[a], Toshio ITOb[b]*

[a]*Graduate School of Engineering and Science, Shibaura Institute of Technology, Saitama, Japan*
[b]*Department of Machinery and Control Systems, Shibaura Institute of Technology, Saitama, Japan*

Abstract

A collision avoidance system play an important role in reducing incidents occurring on the road, which the object detection is crucial to enable obstacle avoidance for this system. The objective of this paper is to improve general object detection methods for vehicles in order to prevent a collision of the vehicles and the obstacles - of which we do not know the exact shape, size or color. A combined computer vision system with artificial neural networks can improve the performance of the vehicle has the ability to see and recognize the obstacles like human beings. In this paper, the authors present the algorithm for vehicles to detect general objects, which can classify obstacles that are real obstacles or fake obstacles, such as a painting or text on the road. The proposed method, we combined on-board computer vision system based on Histograms of Oriented Gradient (HOG) and Time Delay Neural Network (TDNN). We extract feature of the obstacles by HOG and using TDNN to recognize and classify the obstacles. The experimental results showed that this system can detect general objects, and is not restricted to vehicles, objects or pedestrians. It has provided good results along with high accuracy and reliability, which it is accurate enough to provide a warning to the driver when a collision is imminent.

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Keywords: object classification; time delay neural network; computer vision; HOG

* Corresponding author.
E-mail address: nb15504@shibaura-it.ac.jp

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1. Introduction

Currently, there are many accidents that occur on the road. The most common cause is rear-end collisions and in several instances it is driver error such as fatigue, discomfort, or use of a phone while driving. These accidents can be reduced if these driver errors are eliminated. In recent years, there have been a lot of studies for a collision avoidance system, which is an automobile safety system designed to reduce the severity of a collision, namely to detect objects and obstacle avoidance. In the actual vehicle driving situation on the road, it is desirable to be able to recognize the preceding obstacles. In order to prevent a collision of the vehicles and the obstacles - of which we do not know the exact shape, size or color - it uses various sensors to detect the obstacles, such as optical sensors, radio detection and ranging (RADAR), sound navigation and ranging (SONAR), light detection and ranging (LIDAR), and laser sensor. After the detection is done, these systems either provide a warning to the driver such as a flashing dashboard icon, a beep, a tug from the seat belt or braking autonomously without any driver input when a collision is imminent. However, every detection sensor has both advantages and disadvantages.

The radar sensor system uses radio waves to determine the velocity, range and angle of an object. Radars can operate under all practical driving conditions such as rain, snow or fog. However, radar sensors suitable for the detection of large objects such as vehicles, may not suit small or narrow objects such as a pedestrian. In addition, the cost of the radar sensor is higher than a camera.

The lidar that measures distance using emitted light with high accuracy, which will work in every condition. Moreover, the minimum target size of lidar is a 1" square or larger. Therefore, it can detect objects of various sizes such as vehicles, motorcycles or bicycles. Nonetheless, due to lidar using light to detect objects, problems may arise when light is reflected from dark objects such as a black object, and they are still quite expensive.

The camera is a widely available sensors of classification and texture interpretation, which has low-price. Nowadays, low-price cameras with very high resolution are available. Furthermore, even a low-price camera has a resolution higher than lidar. It can detect every object, shape, size, and color. Therefore, it is able to understand things that can't be learned from lower-resolution lidar and radar. As a result, the authors would like to reduce the cost of the detector and improve the performance of the vehicle by making the vehicle has the ability to see and recognize the obstacles like human beings by computer vision system.

Many studies have been developed using computer vision with Artificial Neural Network (ANN) applied to obstacles recognition and classification, which ANN is mathematical model for a computer that can imitate the function of human brain. Hence, it can improve the performance of the vehicle has the ability to see and recognize like a human, which is an important task in an automotive safety application. For the objects that can be found on the road with several of sizes, shapes and colors. In particular, a detection of moving objects (pedestrians, cars, bicycles, etc.) as show in Fig. 1. Such real-time obstacle detection by computer vision was crucial in that we often found fake obstacles such as a text, sign, or painting on the road. When the vehicle moves closer to the high object, as long t1, t2, t3… as in Fig. 2., though the size of the object has changed, the shape of the object has not changed. However, when the vehicle moves closer to the non-high object, the size and shape of the object have changed as in Fig. 3.

Fig. 1. The moving objects on the road

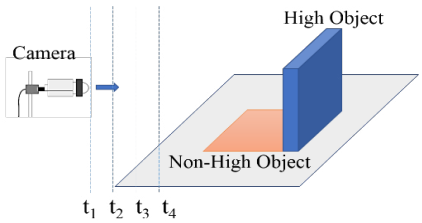

Fig. 2. Preview image of the camera perspective