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Full Length Article

A Study on Real-Time Detection Method of Lane and Vehicle for Lane Change Assistant System Using Vision System on Highway

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ABSTRACT

In this work, we introduce an approach to detect information about lane and vehicle for the driver assistance system, or the lane change assistant system. Most previous research works could only detect the lanes or vehicles separately. However, the combination of lane information and vehicle information is able to support the driver assistance system, or the lane change assistant system, and to improve the reliability of results. For the lane change assistant system (LCAS), it must detect the frontal lanes and discover the vehicles around a test vehicle. Therefore, in this study, a vision system is utilized including three cameras, two of them are under the right and left wing mirrors, the left one is equipped on the windscreen of the test vehicle. The images from the cameras are used to detect three lanes, and detect vehicles. In the lane detection, the line detection is used. For the vehicle detection, we combine the horizontal edge filter,the Otsu's thresholding, and the vertical edge. The horizontal edge filter and the Otsu's thresholding are used to detect the vehicle candidates, then the vertical edge is used to verify the vehicle candidates.Moreover, Kalman filter is used to track the detected vehicle. Finally, the relative speed between the detected vehicle and the test is computed in this work. The proposed algorithm works in an average of 43 ms for each frame with resolution on a 3.30 GHz Intel CPU. The system was tested on the highway in Korea.

1. Introduction

According to the WHO, each year lives of approximately 1.25 million people cost as result of road traffic crash. Between 20 and 50 million people suffer from non-fatal injuries, which sometimes incur disabilities [1]. Road traffic injuries bring considerable economic losses to victims, their families, and nations as a whole. Therefore, in 2016 many firms or corporation has declared that they were and will participate in the development of the automatic vehicle. Volvo Corporation has promised that by 2020, nobody will be faced seriously accident by one of its new cars by using driving assistance system and warning [2].

Intelligent vehicle technologies have strongly developed in recent years because there are many new people who use vehicles, and the number of vehicle accident has increased annually. These technologies utilize some kind of sensor such as Lidar, Radar, and vision sensors. In which, Lidar and radar are only used for obstacle detection, unique vision sensors is used for lane detection and vehicle detection. Detecting lane markings and vehicles enables vehicles to evade collisions and support a warning system. Moreover, today vision sensor are cheaper, smaller, and higher quality than before. In addition to, strong of graphical processing units (GPU) and hardware permits approach for lane detection and vehicle detection to implement in real-time. For these reasons, lane detection and vehicle detection using vision sensor is an interesting topic for researchers and engineer.

Many researchers have proposed the approaches to monitor vehicle and lane, but most of the works have been performed severally. Based on previous researches using vision camera to detect lane information, we can group into three main methods including feature information, model of the lane markings, and color information. Feature information for lane detection includes edge, gradient and intensity [3,4], these features is relied on the difference intensity between the road surface and the lane markings. Many researchers used the edge information [5] and Hough transform [6] to find straight line, which can be the lane markings. In addition, the modified Hough transform approaches have been proposed for faster [7].

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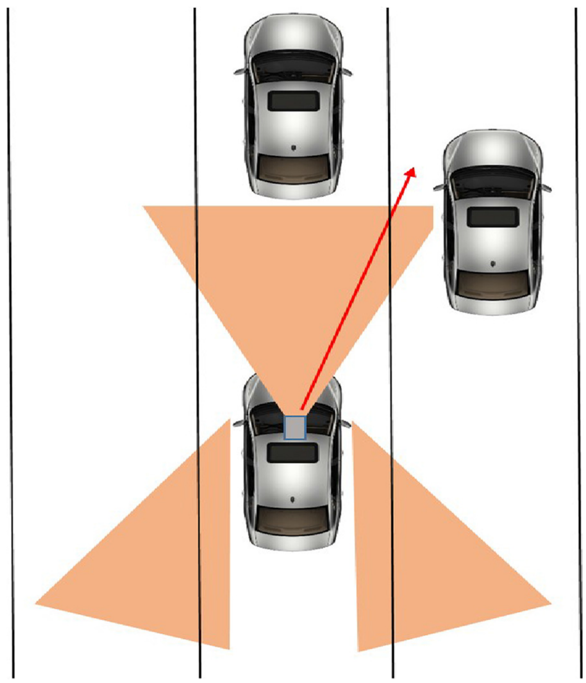

Fig. 1. Vehicle monitoring for lane change.

The second approach uses the road information to make the mathematical model of the lane markings. A widely used model is a B-spline [8,9]. In order to use the B-splines, the set of candidate points must be extracted from the lane markings. Truong used the non-uniform B-spline model [10]. Approach of Li is combination between a Kalman filter and B-spline [9]. For the color information, this approache usually convert RGB to HSI or custom color spaces [11], or color feature [12].

Among the vehicle detection approaches, there are also many approach methods based on features, such as Haar-like Feature [13], Haar-like feature and artificial neuron networks [14], Histogram of oriented gradients (HOG) and support vector machine (SVM) classifier executed [15,16]. These proposed algorithms, which are powerful and robust, operate in real-time with high accuracy. However, only road detection or vehicle detection is not sufficient to support driving assistance system, warning system, or lane change system.

For instance, when the test vehicle changes to right lane as in Fig. 1, it has to detect the right lane and the vehicle on this lane and frontal lane, Jongin [11] and Toan [17] only detected the road lane, not the vehicles, hence the system do not assist for change lane system or warning system. Moreover, Yanfeng [18] only detects vehicle on the road, not include lanes, so the system can not support for change lane or lane keeping. Because of these reasons, we propose a new approach.

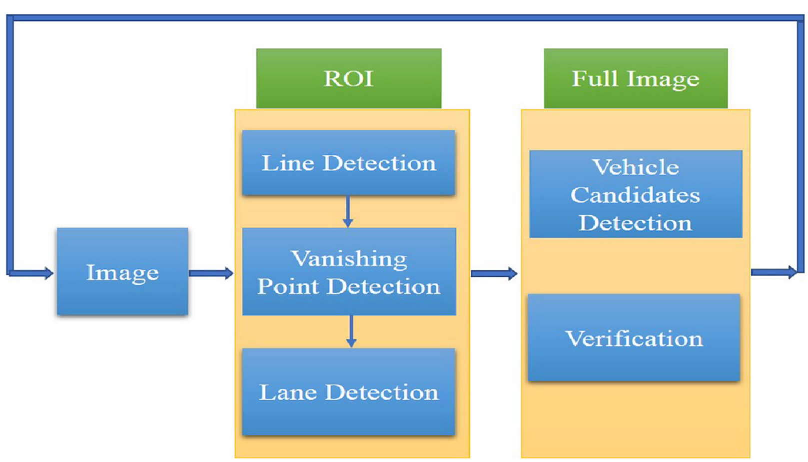

Fig. 2. The proposed algorithm.

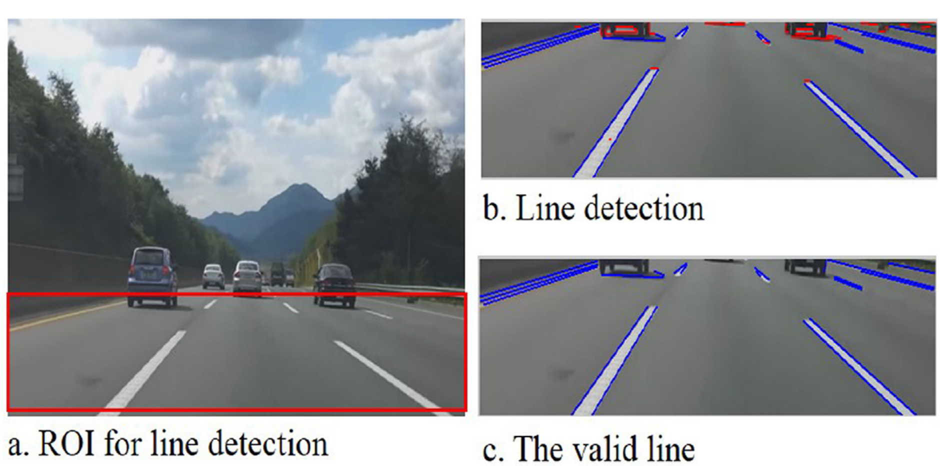

Fig. 3. Line detection and analysis.