Study on Speed-limit Sign Recognition using Deep learning

Hyun Jae Lee
Information and Communication Engineering
Yeungnam University
South Korea
guswo82@ynu.ac.kr

Hyun Gyu Jang
Information and Communication Engineering
Yeungnam University
South Korea
say920506@naver.com

Gyu Sang Choi
Information and Communication Engineering
Yeungnam University
South Korea
castchoi@ynu.ac.kr

Abstract— **In this article, we propose a method regarding the identification of traffic speed-limit signs from image using camera on vehicle. The speed-limit signs have circle shape and border line is red. The candidate's images of speed-limit signs extracted by using different features. Then the images have been classified by using the CNN (Convolutional Neural Network) and provide a good result in pattern recognition. The data sets used for the experiment is a GTSRB (German Traffic Sign Recognition Benchmark) having an 8 different types of speed-limit signs.**

Keywords-component; Speed-limit sign, Hough Transform, SVM, CNN,

I. INTRODUCTION

Nowadays, advanced driver assistive system is receiving growing attention from the public. This system protects drivers and pedestrians from accidents, and through computer vision technology, it could be applied in variety of functions such as pedestrian protection, traffic sign recognition, automatic parking system, blind spot warning recognition and etc. This paper specifically addresses the recognition of speed-limit sign. The previous approaches were different. For example [1] used HOG (Histogram of Gradient), [2] proposed a SIFT (Scale-Invariant Feature Transform), [3] the recognized the traffic sign using SVM(Support Vector Machine), [4] used the Random Forest[4] and [5] used the Artificial Neural Network. Also, as the problem of overfitting of artificial neural network was recently resolved, it came upon into the machine learning field while deep learning has reduce the risk of over fitting. Deep learning is an artificial neural network model that optimizes by learning weighted value for the ease of categorization. Application of deep learning technology induces the machine to self-recognize, induction and make judgement. Currently, deep learning technology is applied in variety of fields such as voice recognition, image recognition and photographic analysis. Especially in the field of image recognition, CNN [6] is widely used.

In this study, we propose an efficient speed-limit sign identification method by using CNN which is widely used in image recognition. In section II, we will explain the architecture of suggested method. Furthermore, through candidate's extraction and CNN for traffic sign recognition, it deals with speed-limit sign recognition. Section III deals with research environment and the section IV concludes this paper.

II. SYSTEM ARCHITECTURE

The Figure 1 architecture of the model that first extract candidates images from speed-limit sign by using Hough transform [7] and SVM. We recognize speed-limit sign using CNN through extracted candidates.

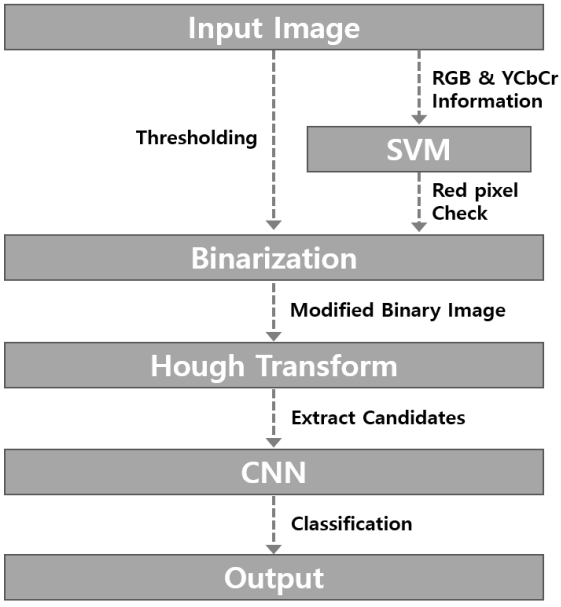

Figure 1. Model flow.

A. Extract Candidates

Generally, speed-limit sign is a static image and does not change its form so it is convenient to recognize. However, there are many images that look like speed-limit sign. To find a circle of speed-limit sign, we converted input image into binary image and applied Hough transform. In this process, candidates such as speed-limit sign and vehicle tyre were extracted. To find a solution on this problem, we added an algorithm to find red boundary of speed-limit sign. When we discover red pixel only through RGB (Red, Green and Blue)

information within the input image, it is difficult to extract red color because of weather, light and brightness. So by learning through SVM of RGB [8] information and YCbCR [9] information, we assorted the red pixel. Using the assorted pixel, we modified binary image, and could achieve a good result as depicted in Figure 2 through Hough transform.

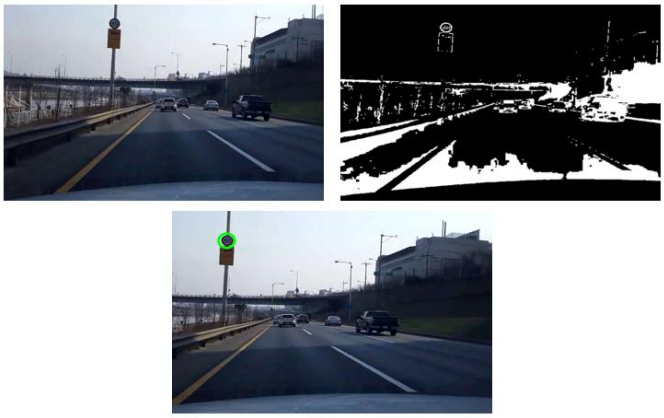

Figure 2. From top, left picture is original image and right picture is binary image and in bottom is an image of Hough transform.

B. Convolutional Nertal Network

In this model, we used a structure of LeNet[6]. Yann LeCun first developed CNN by combining notions of Local receptive field, shared weight and sub-sampling. Originally, he developed it for the recognition of postal code and cursive on the check, and the final structure that this group announced is now famous LeNet. Structure of LeNet is consisted of 3 Convolution layers, 2 sub-sampling layers and one fully-connected layer as shown in Figure 3.

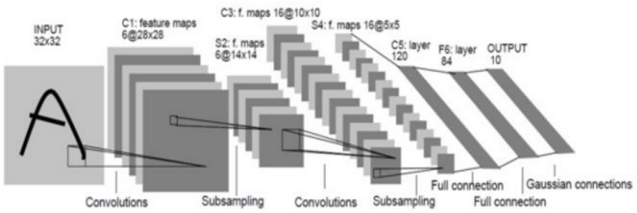

Figure 3. LeNet Structure.

In this paper, we used a modified LeNet. We utilized 32x32 3D image as an input image and 5x5, 5x5, 5x5 size of kernel for convolution layer. Sub-sampling layer proceeds sub-sampling and max pooling out of 2x2 sized receptive field. Within convolution layer and fully-connected layer, ReLU[10] is used as activation function. Lastly, by using Softmax in fully-connected layer, it is classified into 8 classes of output.

III. EXPERIMENTS

The GTSDB [11] has 43 classes of traffic signs. The training dataset contains 39,209 training images in 43 classes and the test data set contains 12,630 test images. This image is composed of various resolution from 15x15 pixel to 180x180 pixel. Data of GTSRB includes many other traffic signs other than speed-limit sign so we used 8 classes that correspond to speed-limit sign, 20, 30, 50, 60, 70, 80, 100, and 120. So the data set of speed-limit sign is comprised of 12,450 for learning or training purpose and 1000 for testing.

Figure 4. GTSDB Dataset.

By utilizing the above image of speed-limit sign, we will apply data augmentation method of ImageNet [10]. ImageNet proceeds with PCA on the RGB pixel of input image, multiplies the random variable that has an average of 0 and standard deviation of 0.1, and adds the original pixel value to increase the number of training data by acquiring various input images.

IV. CONCLUSIONS

This study purposed an efficient method for recognizing speed-limit sign using Hough transform features and existing deep learning algorithm CNN. The experimental results confirmed that this approach has a high performance. Currently, our research used simple LeNet structure. In the future research, we will modify the size of layer and Kernel and compare it with existing machine learning.

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