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A Research Paper on Convolutional Neural Network (CNN) Theory based Automated Traffic and Road Sign Detection and Recognition System

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Abstract: ***India is a country with a dense road network and has a complex system to maintain road safety. As we all know that we have a complex traffic system in which we have more than 100 types of traffic symbols in it. While driving, it is tough to take care of all the symbols placed at the road end. Sometimes the driver does not know what that symbol says. In this system sometimes the driver misses the road signs because the attention of the driver is overdriving the vehicle safe which leads to an accident or issuing Challan.***
Sometimes the traffic signs don't notice by the driver. So all the drivers or the vehicle need a system which is capable to read and recognize the traffic symbol placed at the road end and the system must be capable of giving simple instruction to the driver. So that system can automatically detect which type of symbol is this and can notify the driver. The system must have a good accuracy rate, as well as the system, must have a very good speed of working. This system can also be used in driverless cars to notify the system about the road signals and hence the system can tackle all the symbols carefully.
Keywords: Traffic Sign, Machine Learning, Neural network, Detection, recognition, Traffic symbol

I. INTRODUCTION

With the quickening process of innovation and the growing of car proprietorship, road traffic safety has developed more and more central everywhere the world, expressly in the advanced countries. In fact, there are extensive volumes of people who lose their survives due to traffic accidents in each year and the yearly normal volume of such people aspects growing. [1] As an imperative element of intelligent transport system, unconventional driver support system of intellectual vehicles will alert the probable danger, help the chauffeur with navigation and supervision, and variety driving safer and easier. Examples of such a organization contain adaptive cruise controller, lane withdrawal threatening system, collision circumvention system, night vision, traffic sign acknowledgment, and so on [2].

Generally dialogue, imperative material nearby the traffic condition, existing to drivers, is regularly encoded as painterly signals alike traffic signs, traffic lights, road marks, etc. In positive environments, human visual discernment can be precious by various features such as exhaustion, drunk driving and driving tightness.

To growth road safety, an ADAS has to recognize this visual language, and permit the information to drivers by using unlike slants with traffic sign recognition (TSR) [3].

Normally, all the traffic warbles use violent colors so that they can be effortlessly noticed by the drivers driving on the roads. All of them are retained very unassuming in expression so that even the driver driving at a very respectable speed can effortlessly read them. It's compulsory for all the drivers to realize and shadow all the traffic signs. The traffic signals are used to tell the guidelines and boundaries over that road with the help of unpretentious and easy graphical symbols.

Most of the automated systems works using a forward facing camera hidden behind the rear view mirror. They identify certain road signs and scan the road ahead. Speed signs are read by most of the systems, but traffic sign recognition systems is more convenient in identifying other road signs like no overtaking zones.[4]

Despite the advantages of traffic sign recognition, there are drawbacks. For starters, in more rural areas it is fairly common to see a traffic sign which has been engulfed by a hedge. Which could mean you and your car plough into a 30mph zone way above the speed limit, endangering other motorists and pedestrians.

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A. Challenges for Traffic Sign Recognition

Developing an automatic TSDR system is a tough job as the environment is changing rapidly [5]. Reliability is one of the major concerns in TSDR system [6.7]. As color information is highly unreliable and shape can be changed due to different factors, so researchers tried to use the combination of color and shape information for the development of TSDR system.

Many new methods like MSER based HOG, The Karhunen-Loeve transform, Low Rank Matrix Recovery (LRMR) [8], Fuzzy c means (FCM) are the other machine learning algorithms introduced by the researchers[9] Still, for real time application an effective TSDR system needs to consider all the issues that can affect the system. The issues that needed to be considered while developing a TSDR system are Variable lighting condition, Fading and blurring effect, Affected visibility, Multiple appearances of sign, Motion artifacts, Chaotic background and viewing angle problem, Damaged and Partially obscured sign,

Unavailability of public database, Real-time application considering all the issues, a single stand-alone method cannot solve all the problems. Researchers have already developed various methods to minimize the effect of variable lightings, motion blur, damaged sign, fading and blurring problems. Using Eigen-gradients based oriented gradient maps and the Karhunen-Loeve transform is the latest method to minimize the effect of variable lighting. Other than that, Hough transformation, Adaptive thresholding and Adaptive shape analysis, Self-Organizing Map are also minimize the effect of lighting change.[10]

B. Problems and Issues

TSDR system development is a demanding and troublesome task. There are many causes taken into consideration that can make the process of TSDR not so great. Problems faced by each TSDR system is split into the following elements:

1) *Inconsistent Lighting Conditions* is one of the major problem in the development of a TSDR system. Different traffic signs have distinct colors which make them observable. This color information is sensitive to changes in lightning. Fig. 1 illustrates the effect of lighting on a green information and direction sign.



Fig.1 Effect of variable lighting conditions.

2) *Damaged Traffic Signs*, Damaged and slightly occluded traffic signs can render both the detection and the recognition stages faulty. Fig. 2 shows examples of damaged and partially occluded stop signs.



Fig. 2 Examples of damaged and partially obscured traffic signs.

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3) *Blurring and Fading Effects:* Radiance through rain or snow causes fading and blurring of traffic signs is another difficulty, these circumstances can lead to wrong detections, and reduce the success of a TSDR system.
4) *Motion Artifacts:* Images taken from a running vehicle may be subject to motion blur. Using a low resolution camera is also another reason for noisy or blurred images.
5) *Region Establishment:* There are different objects on the road that have characteristics similar to traffic signs. These objects can cause difficulties for the system while determining the exact location of the signs. For instance, advertising banners on the road can result in incomplete target region establishment (see Fig. 3).



Fig. 3 Presence of a banner on the left side of the road

6) *Poor Visibility:* The shadow coming from the headlights of other vehicles on the road can cause poor visibility. Other facts that may reduce the visibility are rain, snow, and fog. All of the aforementioned factors may negatively impact the performance of a TSDR system.[11]

II. PROBLEM DEFINITION

As nowadays we have a identical compound and appropriate traffic rheostat system in India which has several categories of Traffic Symbols in it. So, to help the driver we prerequisite a suitable system that can diagnose and pigeonhole the forthcoming traffic symbol. By this, the driver will be abetted in easy umpiring as well as if we are executing driverless cars then this progression is very imperative. The projected system will help to diminish the traffic difficulties in India as well as to diminish the number of bereavements due to road accidents. Let's converse the problematic which we'll be going to face while implementing the system.

A. The proposed system requirement have a upright camera eminence to capture the image so that prophecies can be made accurately. With an intensification in camera eminence, there is an intensification in the eminence of the image as well.
B. The proposed system wills prerequisite a bulky amount of dataset for the suitable training of the system. Whenever we requirement to accomplish high exactness then we prerequisite a huge volume of dataset for recovering and effective training of the model.
C. The proposed system is unswervingly associated with the protection of citizens and vehicles completed the road, so it must have respectable accurateness in estimate. The pronouncement of the projected organization will work as the particular assistant to the driver and at this stage; the wrong calculation can chief to accidents.
D. The proposed system must be good at performance in real-time so that it can be implemented. When we do everything for real life it obligation have a respectable presentation in real-time too.
E. The proposed system must have a speediness multiplication so that in real-time implementation the expectations can be completed at high speed.
F. The proposed system must have low commemoration drinking so that it will take less stowing. As when we are in the implementing chapter of the system then recollection is a big factor.
G. The anticipated system must be virtuous in supervision blur images because occasionally the dust is whichever over the camera or the symbol. So even then we requirement to envisage the symbol efficiently.

III. GOAL AND OBJECTIVE

To discover the traffic signs position and sign in natural scene images. To ascertain the region of interest (ROI) in which a traffic sign is identified and authenticate the sign after a large-scale search for candidates inside an image. The resolution of traffic sign recognition is to categorize the perceived traffic signs to their explicit sub-classes. To develop an efficient TSDR system using convolutional neural network based on Indian traffic sign dataset

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IV. METHODOLOGY

As the proposed system is designed to overcome off the problems and limitation came in all past works. So first let's have a look over the basic architecture of the system with an example so that we can easily the working. The architecture is further divided into four different phases as the requirements. Compared to the past system of recognition of Traffic symbols the proposed system has a very simple structure.

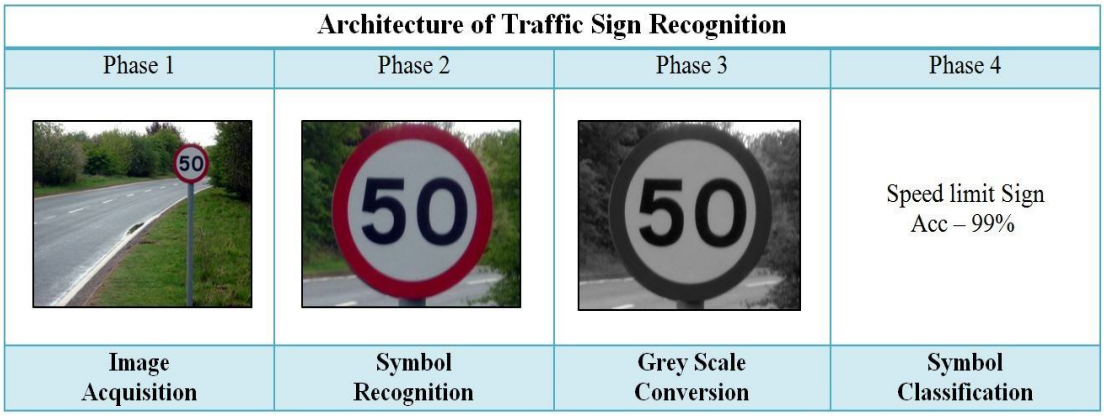


Fig.4 Architecture of traffic sign recognition system

A. TSDR using Convolutional Neural Network

CNN Convolutional Neural Network is a deep learning approach or we can say that it is a deep learning algorithm. Mostly the CNN performs the task of differentiating one image from the other. We can also say that CNN is used to classify images or to judge images as per the requirements. In deep these network assigns importance to different image aspects so that it can get a relation between the same images and able to differentiate the different one. We also called the CNN as ConvNet. The Proposed system has following layers in it.

1) *Image Acquisition:* As the word itself related to the creation of a digital image of a visual scene or it also means to collect a digital image. When we make anything in which the input is the image so the source of that image is a very big factor to take care of. So, in the proposed system, we are assuming that all the vehicles are totally equipped with cameras, so there the source of the image is the Camera. So the camera will capture the live recording and will send the information or will send the digital image to the system. So, this whole process is focused over giving input of the system and the image acquisition example.
2) *Symbol Recognition:* As in Fig. 4,we can see that we have an image of a road with a symbol in it. With the help of a camera placed over the car the image is captured. The digital image came from phase one is the image of the whole scenario. So, we need to frame out the symbol and this can be simply done with fetching the shape of the symbol. The symbols are mostly shaped in Round, Triangle, and square. So, with the help of many simple and predefined approaches, we can get the symbol. Our major focus is to speed up the classification problem. So, in this phase the image came from phase one will be processed and the output given is the image of the symbol.
3) *Grey Scale Conversion:* The CNN or ConvNet works best when any greyscale images are given for prediction. The unique part of the proposed system is we trained the system with the help of a grey scaled image database so that it can easily and rapidly classify the images. As when we convert a digital image into a greyscale image, we simply reduce the dimensions of the image. As in traffic signals, we have only two colors, so using them in greyscale doesn't create any bad impact over the system. By using the greyscale data, we reduced the dimension of the data and hence we increased the speed of processing the image. So, all over using a greyscale image in the case of traffic light system will have a proper positive impact over the proposed system.
4) *Symbol Classification:* As we are in the last phase of classifying the symbol. From the phase three, we got the greyscale image of the symbol, so in this phase, we just need to classify the image that which kind of traffic symbol is this. So when we trained CNN(Convolutional Neural Network) we used the greyscale image dataset so the model which is trained to classify needs a greyscale image in its input. This phase will give us the prediction of the symbol showing in the image. As when we trained CNN to avoid training, again and again, we dumped the model into a pickle file. The same pickle file is further used for prediction purposes. The pickle file is a very simple way to carry any model from one place to another as well we can simply use the model form this file just by importing the model, we don't need the same large space again and again. So, this is about the basic architecture of the proposed system.

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V. EXPERIMENTAL RESULT

1) *Software Environment*: Windows 10 64-bit operating system, JetBrains PyCharm 2019.1.1, TensorFlow 1.13.1, Python 3.7.0 64-bit.
2) *Hardware Environment*: Intel (R) Core (TM) i5-6500 CPU@3.20GHz processor, 8.00 GB memory, 2 TB mechanical hard disk.

A. Implementation and Evaluation

This dissertation uses the German Traffic Sign Recognition Benchmark (GTSRB) which is taken from the online data source kaggle. https://www.kaggle.com/meowmeowmeowmeowmeow/gtsrb-german-traffic-sign. The internal traffic signs are collected from the real road traffic environment in Germany, and it has become a common traffic sign dataset used by experts and scholars in computer vision, self-driving and other fields. The GTSRB comprises 51,839 images, which are divided into training and testing sets. A total of 39,209 and 12,630 Images are provided in the training and testing sets, accounting for approximately 75% and 25% of the whole, respectively. Each image contains only one traffic sign, which is not necessarily located in the center of the image. The image size is unequal; the maximum and smallest images are 250 X250 and 15 X 15 pixels, respectively. [12]

The proposed system is tested over 100 sample RGB color images of 16 different kinds of traffic symbol whose resolution is 32 X 32. We had plotted histogram over individual category. The graphs are named as per the category over which the graph is plotted Example: “Accuracy Graph of Bicycles crossing Symbol.png” This file shows the histogram of the accuracies came when we tested 100 sales of “Bicycles crossing” symbol.

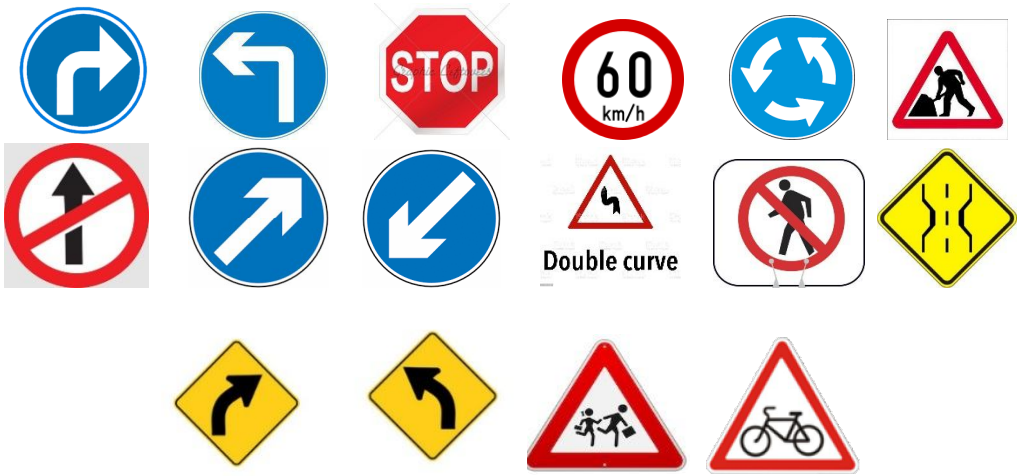


Fig. 5 16 different kinds of Traffic Symbols

- *Accuracy:* The accuracy of the algorithmic program provides the estimation concerning accurately identifying the teams of information. Thus, that's a necessary parameter for any information analysis algorithmic program. This parameter may be evaluated victimization the subsequent formula.

$$\text{Accuracy} = \frac{\text{Correctly identified samples}}{\text{Total samples}} \times 100$$

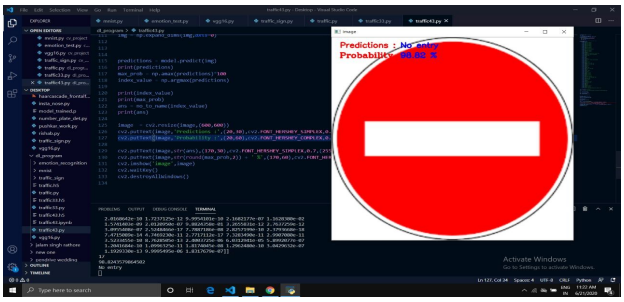


Fig. 6 Implementation Screenshot 1

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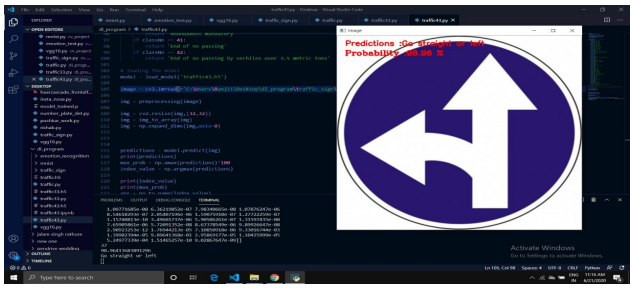


Fig. 7 Implementation Screenshot 2

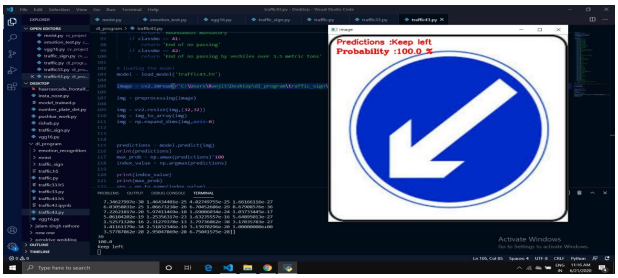


Fig. 8 Implementation Screenshot 3

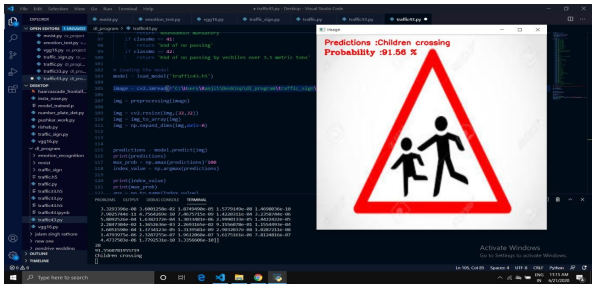


Fig. 9 Implementation Screenshot 4

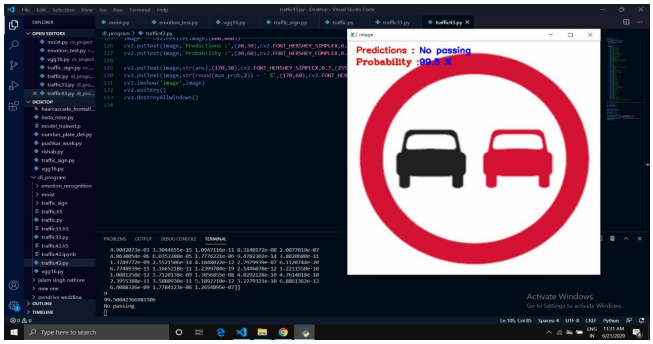


Fig. 10 Implementation Screenshot 5

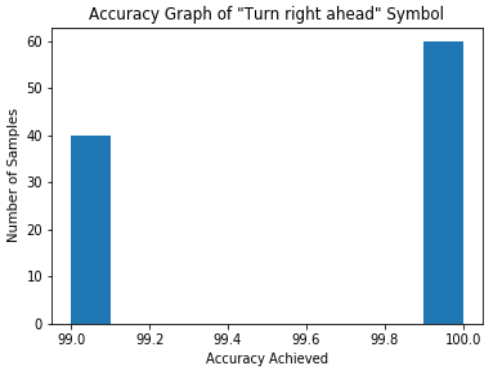
B. Result Analysis

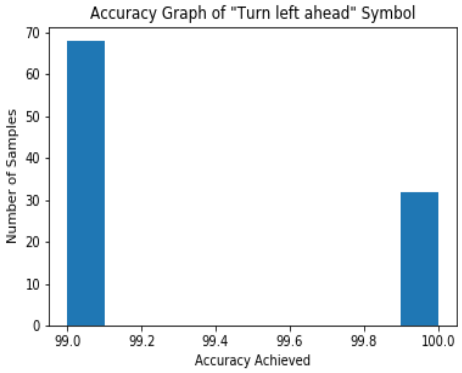
Here all the graphs are plotted in Histograms of Accuracy. On the proposed work we have implemented a model for the prediction of Traffic Symbols from an image. So for the testing purpose what we have done is we had passed 100 to 105 images of 16 Different types of traffic symbols. When we want to test the model what we need to do is pass different images and compare the results with the actual values. So for this, we have tested the model by passing all those 100 to 105 images of all 16 types of Traffic Symbols. The x-axis of histogram represents the accuracy achieved and y-axis represents the no. of sample tested. In these histograms, the bar length denotes which accuracy range is getting maximum hits. This means when we tested the model then all the symbols are predicted accurate but have the following accuracy. So with that accuracy, we have represented them in the histogram to have a pictorial form.

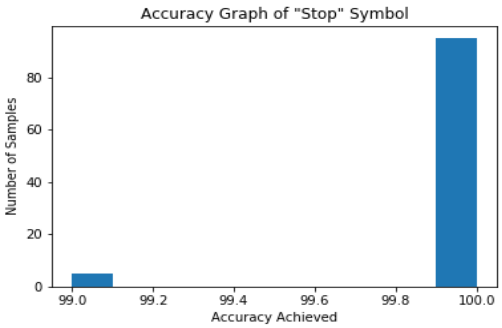
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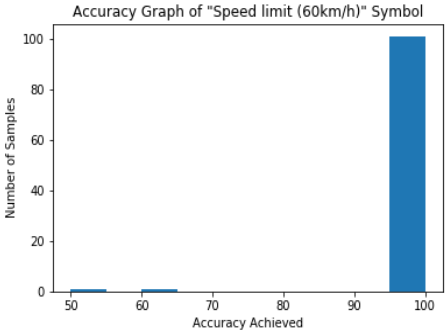
1) Accuracy Analysis

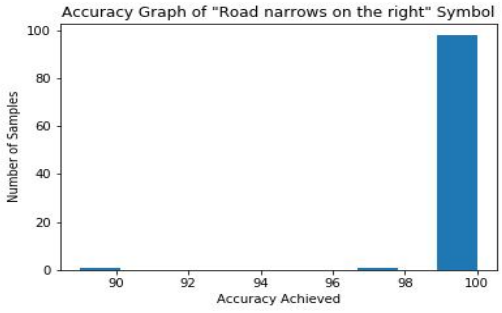
Here we have taken 102 samples for testing the accuracy

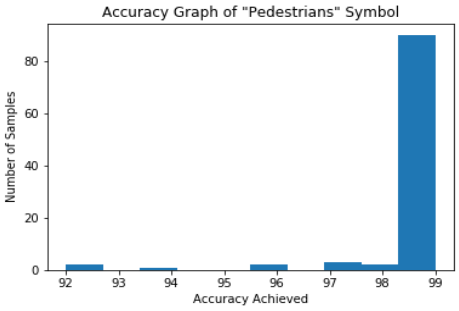


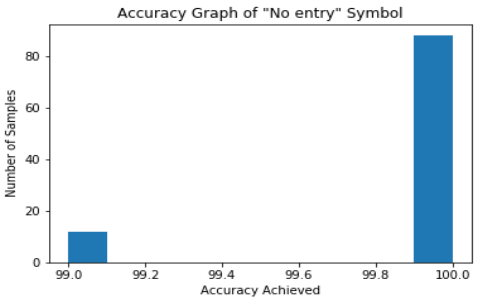


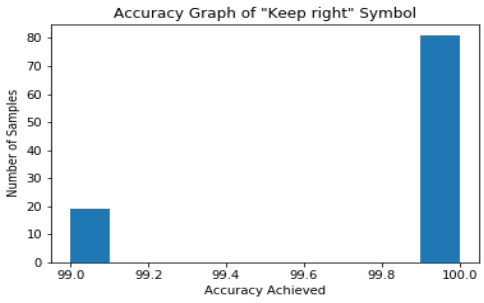


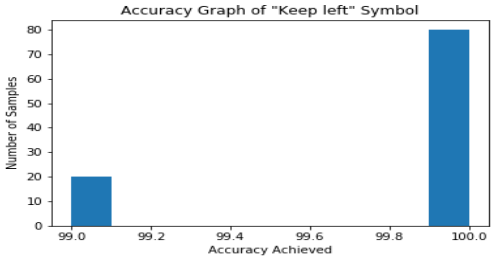


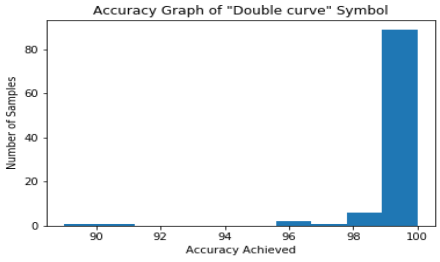












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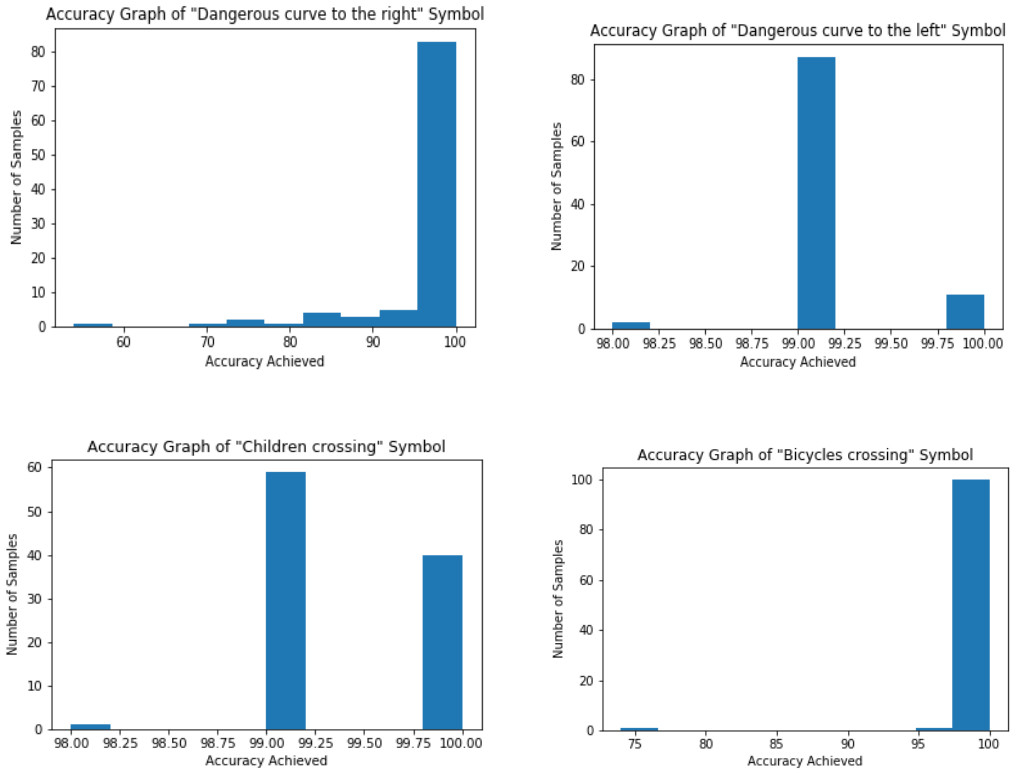


Fig. 11 Accuracy Analysis

VI CONCLUSIONS

This thesis illustrates a new detection and recognition algorithm in the context of Indian road signs using convolutional neural network approach in the illumination grayscale image and artificial neural network classifier trained by robust ConvNet. The grayscale image is chosen because grayscale doesn't create any bad impact over the system. By using the grayscale data we reduced the dimension of the data and hence we increased the speed of processing the image. So all over using a gray scale image in the case of traffic light system will have a proper positive impact over the proposed system. In this proposed system we use pickle file model which we dumped during the processing and this file also used to save the trained model in a file so that we don't need to train the model again and again. The segmentation results illustrate that it is robust in different illumination conditions. A precise road sign recognition system with greater accuracy is very crucial to contribute more safety and efficiency. In this regard, the experimental results represent that this system carries significant classification rate. The proposed model it is evident that the overall correct classification rate of the CNN classifier using ConvNet and pickle file model is about 99 %. In addition, a comparison is drawn among the state of the art classifier where the CNN outperforms in all scenarios.

VII FUTURE WORK

The proposed system offers better accuracy for the detection and recognition of traffic sign but this system recognizes only few road traffic sign so in future work, we determined to take into account a number of contests for further enhancement of the proposed system. In this regard we are planning to address the subsequent issues:

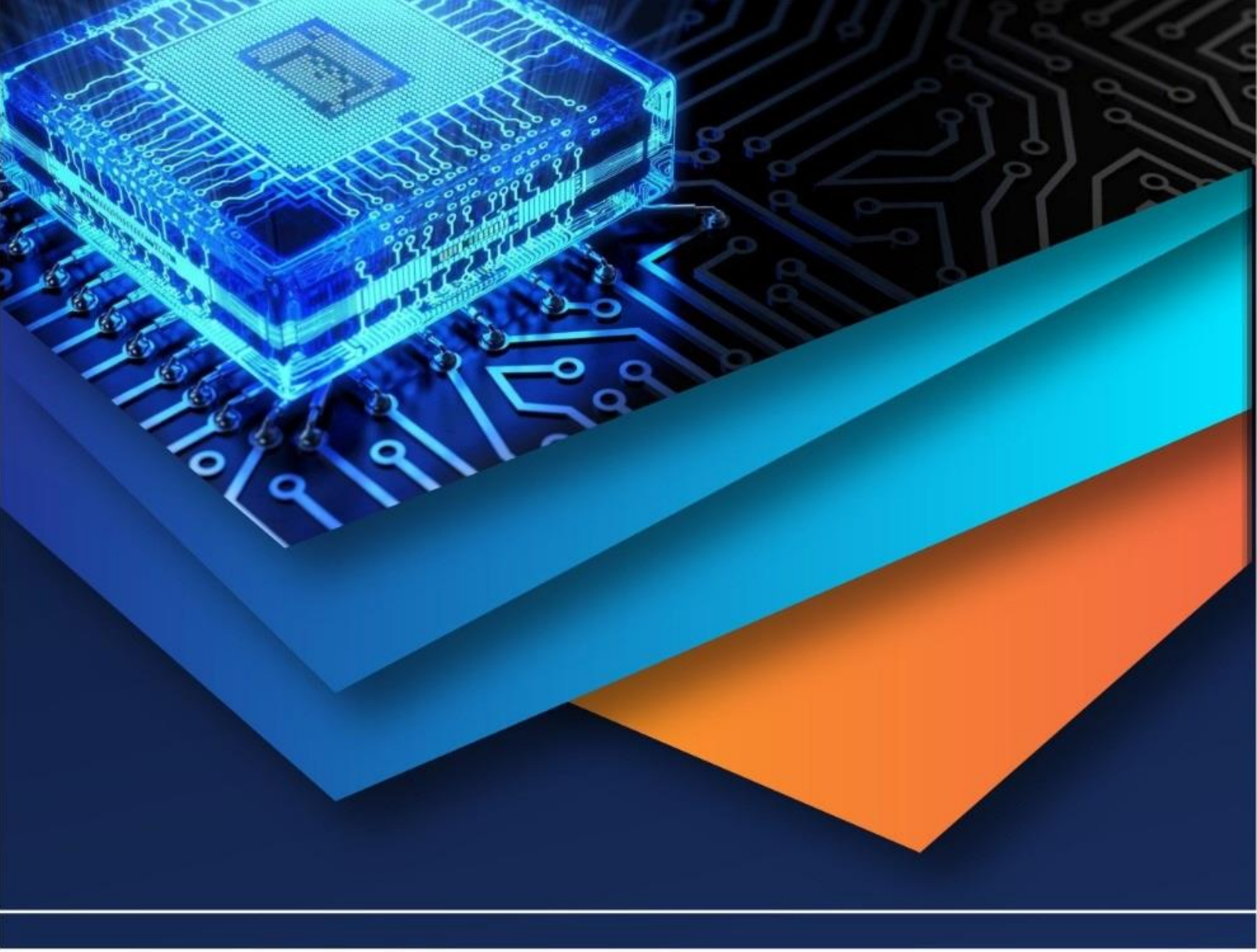
A. To identify all sorts of road signs
B. To identify array of road signs on the sight
C. To identify signs when images are taken under night brilliance
D. To proliferate the data set and
E. To develop this proposed for the real time application

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