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AN AUGMENTED CONVOLUTIONAL NEURAL NETWORK FOR TRAFFIC SIGN DETECTION

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Abstract

In today's world, majority of the accidents are occurring because of not obeying the traffic rules and signs. Majority of the cases is due to not following the traffic signs. Because of the low light or not having adequate knowledge of the signs. A solution for this problem is to detect the sign and its usage automatically. It can be achieved with the help of image processing techniques. Many researchers have proposed different algorithms for traffic sign detection. Maximum, it can classify six traffic signs. Hybrid feature extraction deep neural network is one of the existing techniques and it can able to classify six traffic signs with high accuracy of 98.97%. But, it requires high processing time to perform multiple operations. Hence, in this an augmented convolutional neural network is proposed to classify ten traffic signs. The proposed method uses Gabor filter and convolution neural network to extract features. Then, extracted features are trained and tested using convolution neural network. Due to the single stage processing, the proposed can reduce its computation time for feature extraction and able to classify ten classes of German dataset. The proposed method will be implementing using MATLAB in windows 10 environment. Its performance will be evaluating using accuracy against the existing techniques.

Keywords: Traffic sign detection, Gabor, Augmentation, CNN, Ten classes.

Introduction

He Yang isdeveloping a proposed system for traffic detection. Here they use convolution neural network (CNN) for object detection.CNN is used to extract the feature and detect the sign location. Then attention network module. Used to recognize the real state of traffic lights or signs. For the feature extraction here use artificial neural network this is based on retina Net. Here use many scale so, this system is superior when compared to other previously existing system. The main advantage of the system is, it is small object detection, performance of this multiscale is better than the performance of the other method.

Yiqiang Wu is developing a proposed algorithm for traffic detection at real time. Here they develop traffic sign object detection sign board with ultra-efficient. This system use to detect the small size objects.it ensures unlimited traffic sign classification for real time analysis. Here they define two module for classification that are RPM (region proposal module) and CM (classifier module). In architecture two level of detection are used that are one is focus location of the sign another one is focus traffic sign, for the better performance improved YOLOv3 is used in RPM. This system gives improved performance compared to other existing system.

HoanhNguyen isdeveloping a proposed algorithm based on light weight network then multilayer proposal network. For fast detection of traffic sign. Here deep learning based classification used as base network. . Negative samples mean false objects that are similar to true object it is hep to determine the real objects. Multi scale cascade R-CNN it is used for detect the small size objects. Small size traffic signals are difficult to detect for this purpose here use multi cascade R-CNN (random convolution neural network).multi scale attention is used for improve the accuracy of the detection. Sometime unfortunately we detect negative objects, that's shown like to real objects to solve this problem multi scale attention is used.in this algorithm give more accuracy and speed of detection is highly increased.

Khaledbayoudh proposed a system based on traffic signal detection this system also used in semantic road detection system, the main use of this system is advanced driver assistant system. For deep learning here use 2D and 3D convolution. In 2D convolution neural network 2D filter is applied to the input image. In 3D CNN three dimension (3D) filters is applied to input image.in 3D convolution here use 3D kernels slides at the input. Then here also use hybrid 2D and 3D CNN. Hybrid 3D mean it have multiple three dimension convolution. The accuracy of the system is 98.80%.

DomenTabemik is design a proposed system that is based on traffic sign recognition and detection for large scale. In this paper use mask-CNN this type of CNN is extension of R-CNN. Mask-CNN and R-CNN both is composed module. This type of convolution neural networks, require adaptation technique to adopt specific technique in traffic signal detection. Data augmentation is important for learn about the training set size.DFG is a is used to maintain the traffic sign dataset. The image is captured by the camera mounted vehicle, which is clearly detecting both urban and rural area. For this purpose here use this technique. Several different type of matrices are used here, finally performance of the system is improved from 93% to 95%.

After analysis the above papers this system is proposed with improved performance and more accuracy. Now a day accidents are major problem for the reason of this accident is traffic and unpredictable traffic signs. Majority of the cases is due to not following the traffic signs. Because of the low light or not having adequate knowledge of the signs. A solution for this problem is to detect the sign and its usage automatically. It can be achieved with the help of image processing techniques. Many researchers have proposed different algorithms for traffic sign detection. Maximum, it can classify six traffic signs. Hybrid feature extraction deep neural network is one of the existing techniques and it can able to classify six traffic signs with high accuracy of 98.97%. But, it requires high processing time to perform multiple operations. Hence, in this an augmented convolutional neural network is proposed to classify ten traffic signs. The proposed method uses Gabor filter and convolution neural network to extract features. Then, extracted features are trained and tested using convolution neural network. Due to the single stage processing, the proposed can reduce its computation time for feature extraction and able to classify ten classes of German dataset. Gabor filter is used.

Literature review

WasifArmanHaque (2020) developed a system that purpose is recognizing the traffic signal. Here they use light weight convolution neural network. Orderly we give training to CNN, firstly we resize the input image because input image size is one of the important one. We want to recognize different image, different images have different size so, resizing is important. Next

process is augmentation. To fix the image in convolution neural network architecture we want to rotate or translate. These processes train the data. For this purpose data augmentation used here then next process are data learning and data experiments. To find the architecture and to solve the problem hyper parameter tuning technique is used.at the result it give high accuracy in GTSRB result accuracy level is 99.40%. In BTCS result it give 98.97 % accuracy.

Alexander Shustanov (2017), is develop a proposed algorithm using convolution neural network for traffic sign detection, now a days many images are analysis by using convolution neural networkbecause it give fast execution. The sign detection is solved by two techniques first technique is localization and second technique is subsequent.in traffic sign classification CNN is with (ANN) artificial neural network are used this approach is very popular one to solve pattern recognition problem.to evaluate the accuracy of the system here use two localization that are one is GTSRB and another one is GTSDB, this algorithm contain 9,987 images in dataset. Finally accuracy of the developed system is 99.94%.

YassminaSaadnaisdeveloping a paper that have concept about method of traffic sign detection and classification and it is over view. Driver assistance system is used to reduce the accident level, through it are automatic tasks. The main problem in automatic detection system is they don't know how to detect and recognize, recalling of the traffic signs from fixed image. Detection method have three technique that are learning-based, colour-based, and shape-based.in colour based section here apply segmentation for detect the region.it recognize specific colour of images.in shape based system it recognize the shape of the sign. For this analysis here use edge detection method.in learning based method used for solve the problem of lighting, size of HOG, distance etc.

Alvaro Across-Garcia (2018), is develop a proposed system for traffic sign detection that is evaluation is based on deep neural network. The main advantage of that system is it works with increased speed and memory consumption. In convolution neural network it have number of floating point operator and learnable parameters for the training of data here use Microsoft COCO dataset and the GTSDB is used for recognize the traffic signal. This system has high accuracy and high speed. Accuracy level is 78.83% running time is 21.48.

He Yang isdeveloping a proposed system for traffic detection. Here they use convolution neural network (CNN) for object detection.CNN is used to extract the feature and detect the sign location. Then attention network module. Used to recognize the real state of traffic lights or signs. For the feature extraction here use artificial neural network this is based on retina Net. Here use many scale so, this system is superior when compared to other previously existing system. The main advantage of the system is, it is small object detection, performance of this multiscale is better than the performance of the other method.

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AleksuAvramovic (2020) develop a system to detect traffic sign using parallelization and region focusing. For this method here use neural network classification. DFG traffic sign dataset have bench marking andtesting for proposed algorithm. In fast object detection technique here use convolution neural network, here use three YOLO architecture to detect number of objects are placed within single image.YOLO is fast and one stage detector it have able detect large scale images. The object detection is classified into two types. That is detection using fixed region (it give clear knowledge about the image) and detection using movable region (it not give clear detail about image). That result give better processing time accuracy compared to previous algorithm.

Dewi (2020) develop a proposed algorithm, for traffic sign recognition using convolution neural network pooling. Her use attention mechanism generally attention mechanism classified into two types that are hard attention, soft attention. Hard attention is predicted stochastically soft attention predicted deterministically. Soft attention adding important region in captured image this is focused by adding dimension with it. Convolution layers one of the important part in CNN.in convolution layer number of filters are used is one of the important consideration in CNN designing.in feature extracting process that location cause error.

Hoanh Nguyen (2020), is developed a proposed algorithm based on light weight network then multilayer proposal network. For fast detection of traffic sign. Here deep learning based classification used as base network. . Negative samples mean false objects that are similar to true object it is hep to determine the real objects multi scale cascade R-CNN it is used for detect the small size objects. Small size traffic signals are difficult to detect for this purpose here use multi cascade R-CNN (random convolution neural network).multi scale attention is used for improve the accuracy of the detection. Sometime unfortunately we detect negative objects, that's shown like to real objects to solve this problem multi scale attention is used.in this algorithm give more accuracy and speed of detection is highly increased.

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Jianming Zhang (2020) is develop proposed system for traffic light detection, firstly here take some of the random sample for data mining. That mining process is used for negative samples it is hard to detect negative samples. Negative samples mean false objects that are similar to

true object it is hep to determine the real objects multi scale cascade R-CNN it is used for detect the small size objects. Small size traffic signals are difficult to detect for this purpose here use multi cascade R-CNN (random convolution neural network).multi scale attention is used for improve the accuracy of the detection. Sometime unfortunately we detect negative objects, that's shown like to real objects to solve this problem multi scale attention is used.in this algorithm give more accuracy.

Linxiu Wu (2019) is developed a proposed algorithm that is based on faster R-CNN that system purpose is traffic sign detection. In autonomous vehicle vital sub system is traffic sign recognition system. Traffic detection based on two domains that are one is based on sign colour and another one is based on shape of the sign. The faster R-CNN is one of the universal targeted algorithm.in this method here take 900 images in data set with 600 training images and 300 images for test this system detect 20 types of objects which include human trees animals ,signs it give good accuracy.

Jun Hochung (2020) is develop a proposed system for traffic light detection using convolution pooling neural network. Her use attention mechanism generally attention mechanism classified into two types that are hard attention, soft attention. Hard attention is predicted stochastically soft attention predicted deterministically. Soft attention adding important region in captured image this is focused by adding dimension with it. Convolution layers one of the important part in CNN.in convolution layer number of filters are used is one of the important consideration in CNN designing.in feature extracting process that location cause error. To solve this problem convolution pooling layer is used here classification layer is completely connected with softmax layer.

Existing system

The traffic sign detection is one of the important technologies in our daily life. Now a day much more accidents are occurred day by day to reduce this problem this system is very important. That traffic sign detection system help to impaired persons and invisible persons. Before propose the new system we analysis the previously proposed system here use Here they use light weight convolution neural network. Orderly they give training to CNN, firstly we resize the input image because input image size is one of the important one. To recognize different image, different images have different size so, resizing is important method that is used in this algorithm. Next process is augmentation. To fix the image in convolution neural network architecture here use rotates or translates. This process trains the data. For this purpose data augmentation used here then next process are data learning and data experiments. To find the architecture and to solve the problem hyper parameter tuning technique is used.at the result it give high accuracy. But performance of the system takes more time.

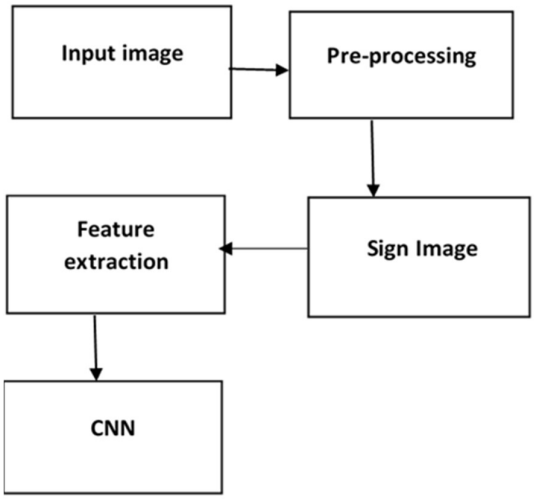
To solve this problem here we propose a new algorithm that is also use convolution neural network (CNN) classification. This neural network is reduce the training time of feature extraction.in existing system we have test limited number of data's only. These problems are solved in proposed system. Brief explanation about the proposed system is discussed below.

Proposed system

The proposed system can be achieved with the help of image processing techniques. Many researchers have proposed different algorithms for traffic sign detection. Maximum, it can classify six traffic signs. Hybrid feature extraction deep neural network is one of the existing

technique and it can able to classify six traffic signs with high accuracy of 98.97%. But, it requires high processing time to perform multiple operations. Hence, in this an augmented convolutional neural network is proposed to classify ten traffic signs. The proposed method uses Gabor filter and convolution neural network to extract features. Then, extracted features are trained and tested using convolution neural network. Due to the single stage processing, the proposed can reduce its computation time for feature extraction and able to classify ten classes of German dataset. The proposed method will be implementing using MATLAB in windows 10 environment. Its performance will be evaluating using accuracy against the existing techniques. Input image is taken by the camera that is mounted on vehicle at the input image recognize the sign then detect the sign then the detected image is converted into grayscale image, resizer is used for set correct pixel value, Otsu thresholding is used to detect the sign and it is shape, Gabor filter is used for texture analysis, and CNN is used for classification process. The block diagram of the proposed system is given below and working of each block is explained in below.

Block diagram



Input image

A camera is mounted on front part of the vehicle, that camera catch up the input traffic sign image. After catch up the input image it will compared to dataset. If the data is matched It will go next process otherwise the process is not continued. Data set is already having some collective traffic sign images. Input image is coloured image all coloured images are have RGB format, To analysis input image this format is very difficult further process are followed to get easy analysis. Here we use German data set for classification, this data set have 43 data set about traffic sign. We aim to classify 10 data set previously 6 datasets are classified in existing method. In this system feature extraction method, here use Gabor filter and GTSRB system is used to measure performance of the system. Here we take 210 images in class 1, 2250 images in class to 1410 images in class 3, 1980 images in class 4, 1860 images in class 5, 420 images in class 6, 1440 images in class 7, 1410 images in class 8, 780 images in class 9, 270 images in class 10 totally 12030 images used in our proposed system. 70 % used for training and 15% used for testing remaining 15% used for validity.

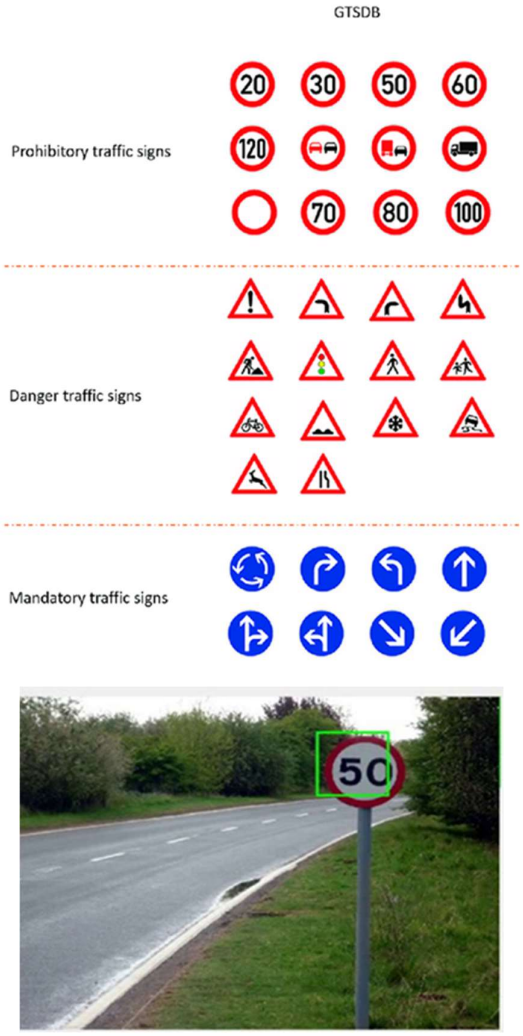


Figure 1. Input image

Pre-processing

Pre-processing is one of the important task in traffic sign detection pre-processing process is apply before feature extraction. Here pre-processing consist of three stages

- Gray scale converter
- Image resizer
- Otsu thresholding

Gray scale converting is used for convert RGB image into single value image. Then the resizer is used to resize the image pixel values. Otsuthreshold is used to get binary output.

Gray scale

Now a day digital photo graphic popular one, computer based images are have many values this complex to process for this reason. Convert that image into single value image that process is called gray scale conversion.

Figure2. Grayscale image

Gray scale is process of converting RGB image into black and white images. The input images are normally in the form of RGB it have more values it will convert to black and white it have single value for this reason we use gray scale converter. The colorimetric is used to calculate the gray scale value, gamma compressed function is used for this conversion, and to remove conversion use gamma expansion. This method is applicable for multiple images. Formula for gray scale conversion is shown in figure.

Gray = (R * 0.3 + G * 0.59 + B * 0.11)	**[1]**

Maximum decomposition:

Gray = max (R , G , B)

Minimum decomposition:

Gray = min (R , G , B)

4.3.3. Resizer

Resizer is used for to fix the image pixel valueresizing is important process, when resizing the image un necessary part from images are deleted.

Otsu thresholding

In threshold algorithm firstly, the input image is convert into grayscale image then applying threshold at the output we get binary image. The pixel of the input image is greater than the threshold saturation value the respective output is marked white colour that is foreground colour. The pixel of the input image is lesser than threshold saturation value then the respective output is marked black that is background colour.

Figure3.otsu thresholding image

In Otsuthreshold process obtain the input image pixel and compute threshold saturation value, compare the image pixel value with threshold saturation value if the saturation is high white in those region and black colours for opposite case.

Figure4.background image

$\sigma_s^2(T) = s1(T)\ \sigma_1^2(T) + s2(T)$	[2]

Where σ_s – weighted variance

σ_1, σ_2 - probabilities

T – threshold

$s1(T) = \sum_{k=1}^{T} p\ (k)$	[3]
$s2(T) = \sum_{k=T+1}^{l} p\ (k)$	[4]

theprobality for gray level

l – maximum pixel value

$p\ (k) = N_k / N$	[5]

N – number of images

To get total variance

$\sigma_t^2 = \sigma_p^2(T) + \sigma_q^2(T)$	[6]

Feature extraction

Feature extraction is a technique used to additionally adding features in system.it give group of process to improve performance of the system, and it remove raw data's. In this method it collect group of data for feature extraction and manage more process at a time.

figure

Figure 5.german traffic sign data base

In this system in feature extraction we use Gabor filter and convolution neural networks are used.

Gabor filter

The Gabor filter is named by Dennis Gabor it is one of the linear filter it is used for texture analysis if we need any specific frequency in image to analysis this region use this filter. This filter is used to find out the appropriate for texture representation. 2 dimension Gabor filter is designed by Gaussian kernel function. This is modulated from sinusoidal plane wave. Frequency and orientation of of the Gabor filter similar to human vision system.

the below equation denotes gabor filter feature extraction.

$G_{a,b,f,\theta}(X,Y) = \text{Exp}(-\frac{(X-a)^2}{\alpha^2} - \frac{(Y-b)^2}{\beta^2})$	**[7]**

$Exp(i2\pi f((X-a)\cos\theta + (Y-b)\sin\theta$	**[8]**

General expression for gabor filter

$G(X,Y) = \text{Exp}\left(-\frac{X^{t^2}}{2\sigma X^2}\right) Exp\left(\frac{-Y^{t^2}}{2\sigma Y^2}\right) \cos\left(\frac{2\pi X^{t^2}}{\lambda} + \phi\right)$	**[9]**

Convolution Neural Network (CNN)

Convolution neural network employs convolution mathematical operation.it consist of both input and output layer.in this network input shape based on it is height and width and channels. Here use general matrix multiplication minimum one layer of their.this process extract the main feature of the corresponding image and give best objective.some convolution products are used here that sre padding and stride.

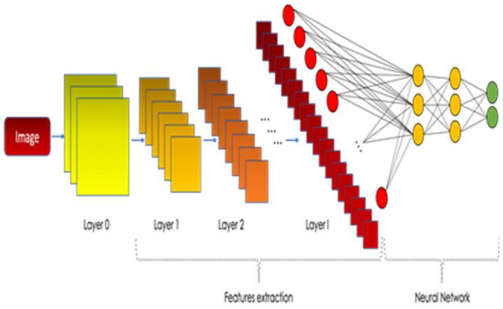


Figure 6. CNN process

Image can be representing in mathematical form as a tensor in given dimension.

$Dim(img) = (s_H , s_w , s_c)$	[10]

sH -size of the hight
sw – size of width
sc – size of channels
dimension of the filter is

$Dim(Fltr) = (F , F , s_c)$	[11]

$conv(P,Q)x,y = \sum_{j=1}^{sH} \sum_{k=1}^{sW} \sum_{l=1}^{sC} P\ (j,k,l)Q(x+j-1, y+k-1, l)$	[12]

Experimental Result

In autonomous driving system traffic sign detection is one of the important process to guide the vehicle. Traffic light detection is very challenging process because identification of the small object of traffic sign and low quality of video light is more complex. In this system feature extraction method, here use Gabor filter and GTSRB system is used to measure performance of the system. This proposed system is tested by MATLAB window 10, this system consist of i7 processor and 500GB hard disk with 16GB RAM. This algorithm is tested by using 2 class, 6 class and 10 class of traffic sign detection.

Performance Analysis

In this proposed system the feature extraction method is analysed by accuracy, sensitivity, specificity, F- measure.

In previously existing system is classified by various classifier those are RF, MSVM, DNN.here the classifiers are analysed 2 type and 6type and 10 type of classes performance are investigated.

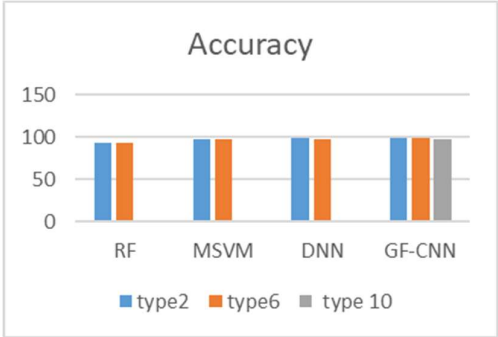


Figure 7

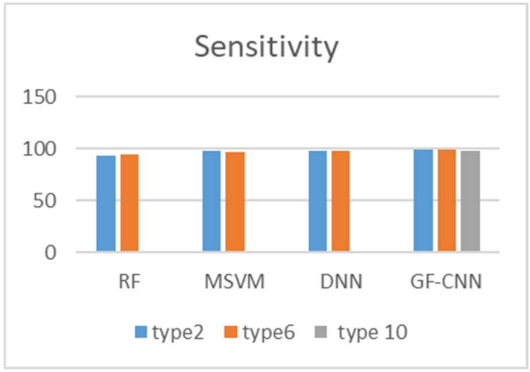


Figure 8

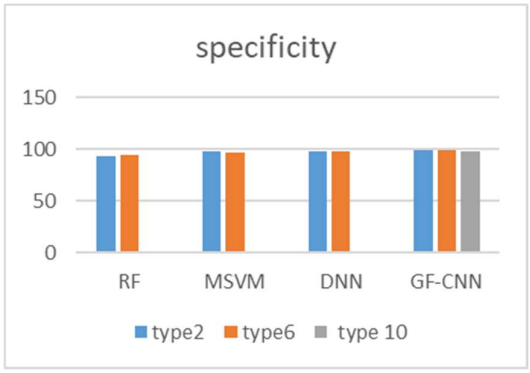


Figure 9

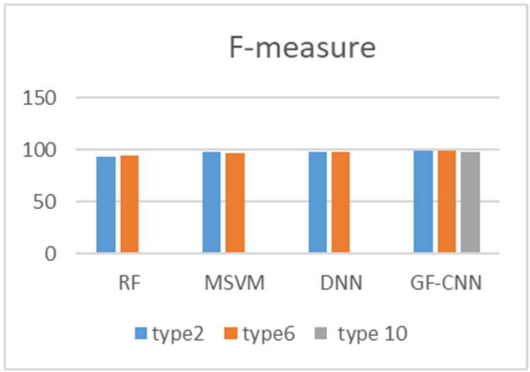


Figure 10

Comparative Analysis

method	2 classes	6 classes	10 classes
CNN	99.53	-	-
RF	-	97.53	-
DNN	99.75	98.97	-
Gabor filter with CNN	**99.85**	99.00	98.97

In this proposed method gabor filter and CNN feature extraction is give high accuracy when compared to class 2 and class 6. The achieved accuracy is 98.97% in class 10.

Conclusion

In this proposed method in autonomous driving system traffic sign detection is one of the important processes to guide the vehicle. Traffic light detection is very challenging process because identification of the small object of traffic sign and low quality of video light is more complex. In this proposed method gabor filter and CNN feature extraction is give high accuracy when compared to class 2 and class 6. The achieved accuracy is 98.97% in class 10.
This system give classification for 10 classes.so performance is increased. Response time is reduced so speed of the execution is increased.

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