

COMPUTER VISION BASED TRAFFIC SIGN SENSING FOR SMART TRANSPORT

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Abstract: The paper puts forward a real time traffic sign sensing (detection and recognition) frame work for enhancing the vehicles capability in order to have a save driving, path planning. The proposed method utilizes the capsules neural network that outperforms the convolutional neural network by eluding the necessities for the manual effort. The capsules network provides a better resistance for the spatial variance and the high reliability in the sensing of the traffic sign compared to the convolutional network. The evaluation of the capsule network with the Indian traffic data set shows a 15% higher accuracy when compared with the CNN and the RNN.

Keywords: Traffic Sign Detection and Recognition (TS-DR), Capsule Neural Network, CNN, Recurrent Neural Network, Intelligent Vehicle

1. INTRODUCTION

The extraordinary progress in the traffic on road, due to the increase in the number of vehicles every day has resulted with the increase in the road accidents, one of the primary causes leading a major number of accidents nowadays is the ignorance of the road signs by the drivers. Malik [7] in his paper he has tried to fix the problem of the increasing accidents by developing the automated system enabling the drivers to detect and recognize the road signs. So the traffic sign recognition plays a vital role in assisting the drivers on road by notifying them the traffic signs such as the U-turn, level crossing without barrier, traffic signal ahead etc. [10]. Though numerous of research works have been done in the area of computer vision and has led to significant improvements in the TS-DR and the recognition, the real time detection and the recognition of the traffic signal still remains a challenge due to the changing weather conditions etc. some of the difficulties in the recognition and the detection of the traffic sign are listed below.

1. Lightening conditions: the difference in the light in the day time and the night time.



2. Confusion in the Scenes: as some signs and the logos would resemble traffic symbols creating confusion to the drivers and the system that assist them. In many cases the traffic sign would be semi –hidden under a bush or the branches of the tree.
3. Similarities: The similarities in traffic signs.
4. Physical conditions: due to certain accidents the sign could be tilted or rotated rising difficulty in the identification of the signs. The fig .1 below shows the image of the traffic signs that cause challenges.

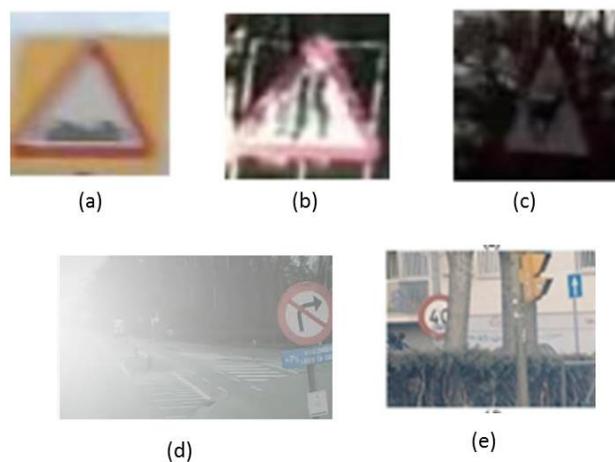


Fig.1 (a) sign blurred due to the lightening, (b) the Sign that is half hidden due to the shadow of the tree, (c) in the night time, (d) bad weather conditions, (e) hidden by the branches of the tree

So there is a necessity of the system with the high accuracy for the TS-DR for having a safe driving. The proposed process put forward an intelligent vehicle system that is enriched with the capability of detecting and recognizing the traffic signs under all weather conditions and the luminance. The proposed method utilizing the capsule a network ensures efficient and an improved traffic sign detection and the recognition method to elude the unwanted fatalities on road.

The rest of the paper is organized with the related work in the section 2, the details of the proposed work in the section 3, the

results evaluation in the section 4 and the conclusion in the section 5.

2. RELATED WORKS

The related works brings out the details of the existing methodologies of the traffic sign detection. Some of the computer vision based methodologies are presented in the paper. The Houben, et al [1], in his paper takes into consideration the prominent approaches such as the linear classifier that depends on the HOG descriptor, violajones detector on the Haar features and the Hough transform and analysis the optimal method for the traffic sign classification. Cling back to same motive of detecting and recognizing the traffic sign and the De la Escalera et al [2] put forward a detection phase and the classification phase for the detection and the recognition of the traffic sign utilizing the genetic and the neural network and the Cheng et al [3], utilizes the method of the sparse Gabor filter and the support vector machines to detect and recognize the pedestrian. With the survey presented by the Mogelmose et al [4], we could gain the various stages inherent in the traffic sign detection such as the segmentation, feature extraction and final sign detection. Real time traffic detection is proposed by the Miura et al [5] utilizes the dual camera one equipped with the wide –angles and the other equipped with the telephoto lens , a processor with the image processing supported with the recognition algorithm to have the detections of the traffic signs at ease ,with high speed. The research proceeded by Chen, et al [6], also puts forward an real time traffic signal detection and recognition engaging the Haar wavelet features in the detection of the sign and the SURF in the recognition of the sign. Malik, et al [7], proposes an automatic detection of the traffic signs using the hough transform and the recognition employing three techniques SIFT, SURF and the BRISK, compares the three recognition techniques and enumerates the optimal method. He identifies the BRISK to be the most efficient among the three. Peker, et al [8], proposes robust traffic sign detection with the enhanced performance system that adapts to the real world by combining the traffic sign recognition and the digital maps. Măriuț et al [9], the three step algorithm for the automatic detection and the recognition of the signs using the HSV color space is proposed in the paper and the real time traffic sign recognition in three stages using the hog features and the machine learning approaches was proposed by Zaklouta et al [10], deep convolutional network utilizing the multitask trained CNN to have effective feature recognition and the detection. Was proposed by Qian, et al [11], Zhu et al [12], proposes the traffic recognition using the fully convolutional network and the deep convolutional network. Patrick et al [14], provides the survey of the different architecture the tools and the methodologies involved in the implementation of the capsule network. All the above mentioned methodologies failed in one or the way to provide the efficient sign recognition and the detection, even the RNN and the CNN were incapable of the recognizing the pose and the objects deformation and required a huge amount of training dataset. So the proposed method to develop an intelligent system with the capability of detecting and recognizing the sign associated with the traffic the capsule networks are utilized in order to have a higher accuracy and a speedy process. Vijayakumar, et al [15] presents the



“comparative study of the capsule networks in various applications”

3. PROPOSED WORK

The paper aims in framing recognition and the detection system for the traffic sign sensing using the color based segmentation [7] [6] and the detection using the Hough transform [7][1] followed by the classification using the capsule neural network [14] the fig.2 below is the general flow diagram representing the flow in the proposed process.

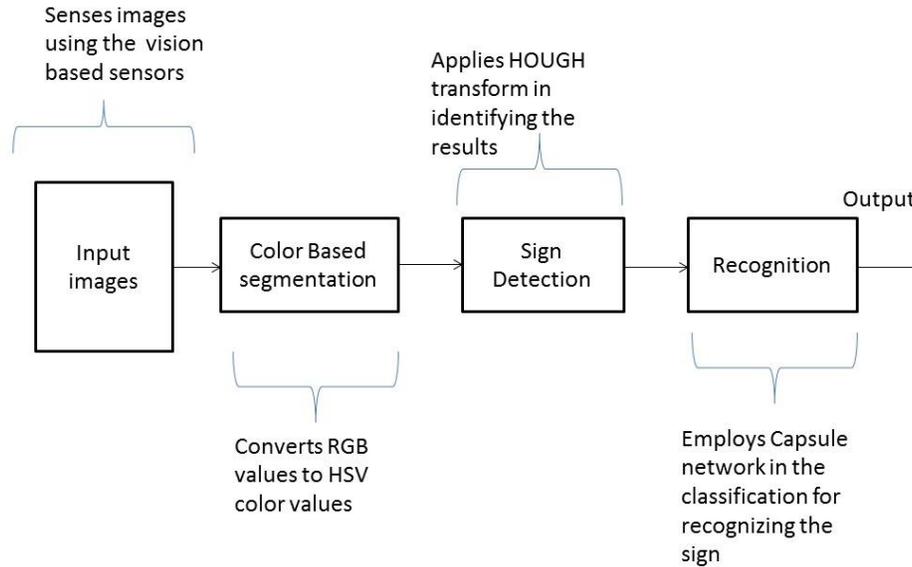


Fig .2 Proposed Flows in the TS-DR

The input images are acquired using the passive vision based image sensors to capture the images. The vision based sensors are more advantageous compared to the laser and the radar sensors. The vision based image sensors capture the images without any alteration to the road infrastructure. The vision based sensors are capable of providing a fast scanning and a moderate robustness compared to the radar and the laser sensors. The scanned images are subjected to the color based segmentation that converts the red, green and the blue values to the hue, saturation and values. The following equation (1) shows the transformation of the red, green and the blue values to the hue, saturation and

values

$$V = \text{Maximum}(R, G, B)$$

$$S = \begin{cases} \frac{[V - \text{Minimum}(RGB)]255}{V} & \text{if } V \neq 0 \\ 0 & \text{other wise} \end{cases}$$

$$H = \begin{cases} \frac{(-B + G)60}{s} & \text{if } V = R \\ 180 + \frac{(-B + G)60}{s} & \text{if } V = G \\ 240 + \frac{(-G + R)60}{s}, & \text{if } V = B \end{cases}$$

$$H = H + 360, \text{if } H < 0 \quad (1)$$

The color quantization for the Red values is acquired with the saturation < 0.2 , and hue $0 < H < 10$, $320 < H < 360$, for the blue values the saturation is less than $.2$ and the hue = $200 < H < 270$, the green values the saturation is $< .2$ and the hue = $20 < H < 100$. The completion of the color segmentation enables the framing of the enclosing rectangles by connecting the pixels that were detected. From the enclosing rectangles framed the smaller pixels lesser than the $.5$ is removed as the noise and the rest of the pixels are considered for the traffic sign identification.

The Hough transform is utilized in the proposed model to differentiate the road signs from the other objects that are included in the image. Being a prominent method for identify the boundaries and the curves that are in an image. The Hough transform transforms the Cartesian points to the parameter points and detects the lines and the other geometric spaces. The Hough transform is employed in the proposed model to identify the traffic signal alone and elude the other objects in the image. If an image is detected with the fully connected lines in case of a circle and the four connected lines in case of rectangle and three in case triangle and six in case of hexagon etc. it is contained otherwise castoff. The image detected is saved as the traffic sign.

Later this subjected to the capsule neural network for the classification that proceeds with two strides first training and then classifying. The capsule neural network [14] is initially trained with the images of the Indian road sign that is acquired from the images captured randomly by a travel taken around a metro city in India. The



preprocessing step removes the repeated images and utilizes them for training, the feature extraction using the color segmentation +Hough transform extracts the features for the traffic sign for training. The capsule neural networks are comprised of multiple layers with the initial layer the primary capsules that receives an input and makes effort in determining the pose of the particular pattern. The output is sent to the correct parent in the layer using the dynamic routing. The output of the traffic sign is evaluated by enumerating the predicted vectors at the output for all the traffic sign capsule pairs and implementing the routing by agreement algorithm.

The traffic sign capsules of layers comprised of 43 capsules for the Indian traffic sign at a size of 32each was utilized in the Caps Net. The each capsule in the initial layer assumes the corresponding weight and the vectors at the output for all the capsules that are in the second layer. The reconstruction of the input traffic sign by tuning of the output vector obtained, ensures the network to preserve the information of the traffic sign reconstruction throughout the network thereby eluding the over fitting of the information and helping in the perfect induction of the traffic signs.

4. RESULTS AND DISCUSSION

The proposed frame work is evaluated with the test data set of 10350 images and the accuracy of the model is enumerated. The proposed method employing the capsules networks prove to be more efficient than the usage of the SURF, SIFT and the BRISK when comparing their accuracy with the capsule network. The capsule network is more efficient than the convolutional neural network, as the Caps Net is capable of identifying the pose and spatial variance more effectively than the CNN's. The evaluation of the all the five models with the training dataset of the 10350 training set images prove the competence of the proposed frame work in terms of accuracy compared to the SURF,SIFT,BRISK and the CNN. The equation (2) below shows the formula for the accuracy

$$Accuracy = \frac{\sum I_{TS}}{T_{TS}} \quad (2)$$

Where the I_{TS} is the detected traffic signs and the T_{TS} the total number of traffic signs that were subjected for testing.



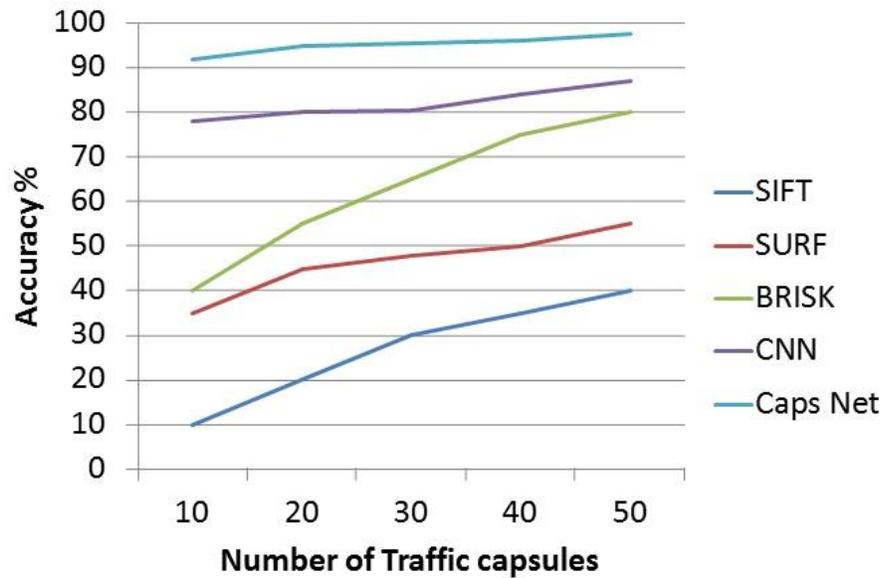


Fig.3 Accuracy

The fig.3 above shows the accuracy achieved by the SURF, SIFT, BRISK, CNN and the Caps Net, from the results obtained it is clear that the capsule neural network shows a 15% higher accuracy compared to the CNN, and the 20%-30% higher accuracy compared to the SURF, SIFT and the BRISK classifiers. So the capsule neural network encompassed with the capsules (group of ANN) performing more complex functions on the input shows a better performance compared to the other methodologies with the increased reliability and perfect classification and the recognition of the traffic signs even with the images that are blurring, rotated and distorted.

5. CONCLUSION

The paper proposing the frame work to enhance the capability of the TS-DR in the vehicle utilizes the capsule neural network for the acknowledgment of the traffic signal with the identification being performed using the color based segmentation and the Hough transform. The proposed frame work is trained with the Indian traffic sign data set acquired by capturing images randomly on a travel through a metro city in India. The evaluation of the testing dataset with the evaluation of the Caps Net and the other prevailing method prove that the color segmentation+ Hough transform +Caps Net based frame work for traffic sign sensing shows an improved accuracy and reliability

compared to the existing methods. The implementation of the proposed frame for the enhancing the vision capability of the vehicles is to be continued in the future.

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