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Vehicle Detection on Sanctuaries Using Spatially Distributed Convolutional Neural Network

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ABSTRACT

Nowadays, detection of vehicles from images captured using web camera is becoming an important focus in the research field of image processing. A common issue inside a wildlife sanctuary is that the possibility of vehicle moving in wrong way or getting into some problem is high. This work proposes an algorithm for detection of vehicles using CNN (Convolutional neural network) on the basis of SDP (spatially distributed pooling). Finite length feature vector is developed by sampling various sized behavioural pattern using SDP. Thus effect of detection can be improved by avoiding distortion of different sized images. Also, Normed slope (NS) method is proposed with more number of threshold as an algorithm for image pre-processing. Using NS, retains the object edge which might be disturbed in the infrastructure. Computational cost for extraction of candidate objects is lesser as only a limited candidate windows are generated. Results of experiments reveal that the SDP based CNN can work well on multiple sized input images thereby improving the effect of detection.

Keywords: Web Camera, Detecting vehicles, Spatially Distributed Pooling, convolution neural network.

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INTRODUCTION

Web cameras are being developed nowadays as light-weight, low cost devices. The images captured using such devices can be used to obtain data about remote sensing including, observation of traffic, observing agricultural land cover [1-6], archaeology [7-9], meteorology [10], monitoring volcanic regions [11] and monitoring forest fires [12]. In dense forest because of the absence of mobile network for communication, web cameras are mainly utilised for taking rescue measure. In a sanctuary, the issue of getting missed or being trapped is a major problem concerning the lives of individuals involved on it and hence the providing security is critical. In addition to this, there may arise issues like getting into improper way, malfunctioning of vehicle etc. The seriousness of such issues is at peak during night as well as morning because the possibility of getting injured by deadly animals is more at these times. Due to the absence for the medium of communication it becomes impossible to being helped at such situations. It is more difficult for monitoring every vehicle entering into a sanctuary as the number of visitors are high and it is critical for monitoring them in the mid of forests.

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These problems are not defined by the existing techniques and not enough security is provided and other measures regarding security are minimum. In this work, Webcam is the technology used to monitor vehicles replacing conventional techniques. Every region of the input image is scanned for discovering the exact position of vehicles. Hence a CNN system is proposed along with SDP for vehicle detection.

The organisation of the paper is as follows. Section 2 describes the brief review about the detection algorithms. The proposed methodology is explained under Section 3. The performance of the proposed method is examined and it is discussed in Section 4. The conclusion of the proposed work is given in section 5.

RELATED WORK

With the development in technologies in the sector of vehicle detection, methodologies that utilises Wireless Sensor Networks are common, where the scope of analysis of this part is high to certain extent. [13] has discussed about crisis control by means of wireless sensor network on the basis of multi-agent scheme, where it includes data collection, tracking, orientation for search and rescue, multi-agent system, and cooperative decision making as the prime objective. In this regard, restriction in the usage of multi-agent mode is enabled in software layer in order to enhance the performance of wireless sensor network based on co-operation between sensor nodes. [14] has employed thermal and humidity sensors to identify abnormal circumstances. Zigbee and Wi-Fi networks are used for the sensors in the clusters to connect to the corresponding cluster head and cluster head to send data to control room respectively.

Deployment issues of nodes are dealt using a low power and non-expensive wireless smoke alarm structure based optimization method suitable for household scenarios [15]. [16] has developed a smoldering methodology and ûaming phases, and have made known the correlation between diverse sensor combinations to identify the ideal sensor combination that provides higher accuracy. This wireless multi-sensor system also makes use of artiûcial neural network for better performance.

A contribution is made for recognising vehicle licence plate is proposed in [17]. The author detects the plate based on edge detecting mechanisms. Correspondingly the result of detection is applied on to the recognising section. False rate are reduced in [18] using nearest neighbour technique. Characteristic of colour is extracted by using Colour Index Local Auto-Correlations which is executed using the histogram of the input image.

In [19], an image processing system in terms of YCbCr is used to address the shortcomings of the normalized RGB method. It is preferred owing to its reduced complexity. [20] has presented a data mining and image processing based model, in which multi sensor wireless network is designed using IP cameras for ûre detection. IP cameras have to be placed straight to sensors and must be kept far above the ground level to acquire better view.

The existing techniques and algorithms fail to propose the detection of vehicles inside sanctuaries. Hence a system is proposed to detect vehicles inside sanctuaries using images from webcams. The system uses a CNN method along with SDP for training and training a set of images obtained inside sanctuaries.

PROPOSED METHOD

Discovering objects in wider region image is required for detection of specified objects and crucial classifiers are used to deal with images. Segmentation of such images is carried out in order to decrease the image size to be applied into classifiers and for the extraction of candidate window with the expected outcome. Candidate objects are extracted rapidly depending on the binarised form of NS to attain candidate window consisting of expected outcomes**.**

Features of Normed Slope

Extracting candidate object using the binarised form of NS utilises general methods for detecting target to identify each vehicle in remotely sensed images captured on webcam. Objects related to vehicle has generally closed and independent boundary. With this regard, there exists difference in the NS of image obtained by windows to constant sizes. However doing this causes variations in the boundaries of the features of NS. Initially, the image for input is normalised into distinct size and then the NS is calculated for the adjusted image.

Outcome models for NS

64D NS is applied into classifiers as input based on the fact that human eyes perceive things prior to

recognition. The features are then scored using a SVM (support vector machine) with two stages inorder to obtain method for identification of vehicle found in image window.

Step 1: Linear SVM is used to learn the mass (m) of classifier. For finding generic object found in an image the size of window is predefined and quantized in view of scanning the image. Also scoring of window is carried out using a method.

$$w \in R\, x_1 = (m, g_1)\ l = (i, x, y)$$

Here score of confidence is represented by the term x_1, g_1 represents the features of NS, the size and position are indicated by l and i, (x, y) denotes the window coordinates.

Step 2: The mass v as well as t of classifiers of second level can be learnt using linear SVM. Depending on the scores of confidence obtained from the first step, a set of windows of size l are selected with the help of non-optimal suppression (NOS). Moreover, window of size 512x512 may not contain vehicles hence those windows are screened further.

$$z_l = v_i \,.\, x_l + t_i$$

Where, v_i, x_l and t_i represents the coefficients and biased variable of size i, and z_l represents the window score of second step. Window with maximum score is fed into the next step as input.

NS pre-processing

CNN is an algorithm that can be able to process the original images directly, because of its point to point construction. When the images from the web cameras are disturbed by the infrastructure, their features may be learnt by the neural network with noise. In order to solve such issues, NS algorithm is established for performing pre-processing on images. The framework of webcam image includes that allows to differentiate between vehicle and other objects. The gradients of colour images can be calculated using a differentiation operator ["1, 0, 1]. The edges of targets obtained from the NS algorithm are found to be more recognizable when compared with other conventional methods. However, if there exists changes in the background, or if it is found to be disturbed, the data obtained from NS is also difficult to be distinguished. This problem is solved by using multi-thresholds to retain the original information. After applying the multiple thresholding technique, the layout of cars are elevated, suppressing other objects.

CNN

The architecture of CNN in the proposed work includes four max-pool down sampling sheets, three totally-connected sheets and four convolutional sheets. A feature map equally weighed neurons is obtained as outcome from the CNN convolutional layer containing several convolutional kernels. Once the processing of neurons is done by ReLU activation function, resultant features provide better toughness. Reduction in dimensionality reduces the count of neuron and takes away high level features available.

Convolutional sheets and characteristic mapping

In a conventional CNN, initial four sheets include convolutional sheets, which are then moulded by max pool sheets. The pool sheets are considered as special convolutional sheets. Generally, sliding windows are adopted to work on image. Additionally, two final sheets are entirely connected and the final sheet utilises a SVM classifier to produce resultant image. As the entirely connected sheets need input to be fed as constant size, neural networks needs a fixed sized input image. However convolutional sheets accept images of variable size because of the presence of sliding filter on them.

SDP layers Also known as spatially distributed pooling, SDP is considered as an unique technique utilised in the applications of computer vision Images are separated into sheets based on the image precision and collects their characteristics. Before the advent of CNN, most classification and detection methods utilises SDP as a major feature. Processing of varied sized images is possible with neural network when SDP is integrated with pool mechanisms. The convolutional sheet of CNN generates an output image exactly as the size with which the image is given as input. The entirely connected sheets require input to be fed as constant sized vectors developed using pooling through BoW mechanism. However SDP is much better than BoW and retrieve data from non-global bins with the help of pooling.

RESULTS AND DISCUSSION

The images available in the Vehicle dataset are obtained by web cameras with a focal length of 50mm and 5616x3744 as resolution. Such images obtained undergo sampling at a interval of 13 cm and are stored in JPEG format. A total of 20 images are used, on which half are utilised for the purpose

of training and the remaining are utilised for testing. As a result of training, it is found that the training set of images contain 54 number of trucks and 3418 cars as samples of positivity. However test case reveals result of 5928 vehicles. The performance of the proposed CNN algorithm is measured in terms of RR, FAR and precision rate (PR) as a standard. Lesser the value of FAR, the lower the false detection of other objects in the infrastructure as vehicles, a greater PR value indicates that the number of vehicles are more. Whereas, vehicle detection is found to be high with higher value of RR. Hence the technique is aimed to have less FAR and high RR as well as PR as possible.

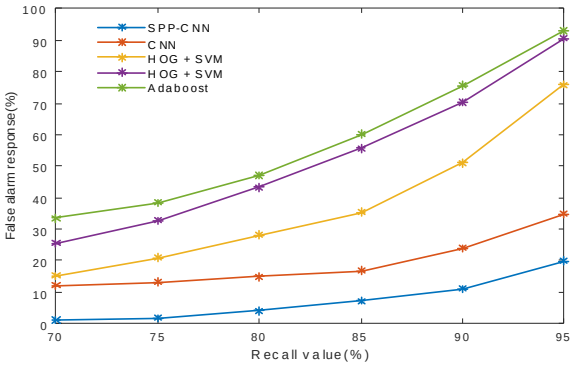

Figure 1: FAR and RR of detecting vehicles

Table-1: Vehicle detecting FAR and RR

Recall value(%)	False alarm response			
	SPP-CNN	CNN	HOG+SVM	Adaboost
70	0	11	15	33
75	1	12	21	38
80	3	14	28	47
85	7	17	35	60
90	11	24	51	76
95	20	35	76	93

The proposed work designs CNN for detecting vehicle, including four convolutional sheets and 4 pool sheets arranged in a series. The inputs fed into the network are obtained from NS with multi thresholding technique of thresholds 40 as well as 130. Moreover, the thresholds of the original image are also found to be identical. Consider an image of size 64x64 as input to CNN. The convolutional sheet measures it as 7x7 and generates feature patterns of size 58x58. Each convolutional sheets produces different number of feature patterns with varying size.

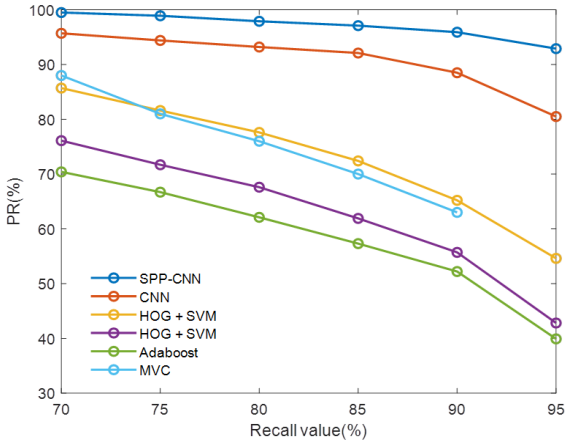

Figure 2: PR and RR for detecting vehicle

Table-2: PR and RR values

Recall value(%)	PR (%)				
	SPP-CNN	CNN	HOG+CNN	Adaboost	MVC
70	85.26	95.82	99.26	70	88.25
75	81.82	94.6	99.25	67	81
80	77.89	93.86	98.28	62	76.20
85	73.22	92.88	98.3	57.7	70.18
90	66.10	89.19	97	52.5	63.43
95	55.04	81.58	94.3	40.32	-

The rate of vehicle detection is found to be better when compared with those of the conventional algorithms containing SVM+LBP, SVM+HOG, MVC, Adaboost and conventional CNN. When RR is specified as 96%, the rate of detection of vehicle is shown as 93.9% and rate of miss prediction is found to be around 20%.

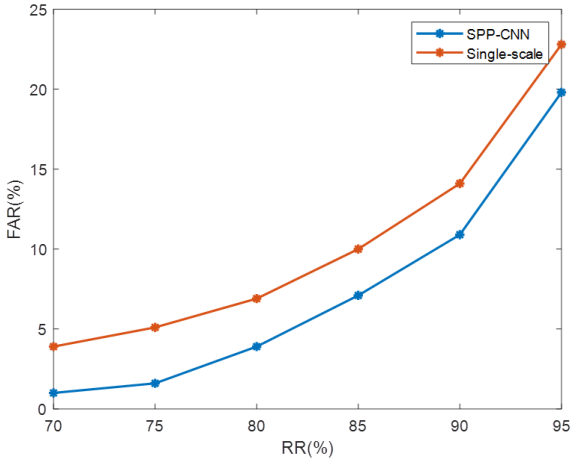

Figure 3: FAR and RR for detecting vehicle using image of single scale

Table-3: FAR and RR

RR(%)	FAR(%)	
	SPP-CNN	Single-scan
70	0.8	3.76
75	1.23	4.90
80	3.70	6.42
85	6.72	9.64
90	10.60	13.79
95	19.36	2.46

CONCLUSION

Detection of vehicles from images captured using web camera has emerged into a promising technology used nowadays. However existing methods fail to detect vehicles exactly in the view of protection. CNN method is used along with SDP in the proposed method for vehicle detection in wildlife sanctuaries. Multi-scale NS is used as a pre-processing technique for filtering the images. Filtering is done inorder to reduce noise present in images to be fed into the classifiers. From the simulation results it is observed that the proposed CNN method outperforms the existing methodologies in terms of detecting the vehicles in images captured by web cams inside wildlife sanctuaries. The performance is measured in terms of FAR, PR and RR. In the future this work can be extended to detect the presence of animals inside sanctuaries.

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