International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-5, January 2020

Detection and Identification of Animals in Wild Life Sanctuaries using Convolutional Neural Network

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Abstract*: *Comprehensive, Precise and real time data regarding the position and characteristics of animals is necessary for safeguarding visitors inside a wildlife sanctuary. Investigations are made on the capability for automated, unambiguous and economical collection of data that are useful to perform rescue operations within the sanctuary because of the absence of other communicational sources. Web camera enables collection of photos relating to wildlife economically, conservatively as well as regularly. Extraction of information from such photos is costly, slow and requires human intervention. The proposed system demonstrates the automatic extraction of such data using Convolutional Neural Network (CNN). Deep CNN is trained for a set of images available in a wildlife dataset.

Keywords*: *Convolutional Neural Network, Web camera, Extraction.

I. INTRODUCTION

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. Placement of web-based cameras inside sanctuaries can help in tracing animals [1]. However, webcams have grown into an emerging tool for determining the animals [2] and estimate their habitat [3]. Since the number of images exceeds millions [4-6], extraction of information from webcam images is done conventionally with human intervention. Hence, they are slow and expensive for the experts to analyse them and most information are left unchanged.

Manuscript published on January 30, 2020.
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As webcams are becoming cheap and better, they are being utilized in major projects [6]. Variety of inexpensive data is made available by using automated technique for extracting information thus enabling ways for protective measures. The addressed work focuses on computer vision for extracting information about the presence of animals [7-10]. Such methods are risky when dealt by humans. Pictures obtained from webcams are often imperfect and certain pictures contain animals farther or so closer or only a portion of them are visible. Extraction of data is more difficult when the pictures are influenced by shadow, lighting and weather. Automated animal recognition systems improve the protection to the visitors of wildlife sanctuaries [1].

The proposed work establishes a machine learning technique called deep learning that creates tremendous revolutions in artificial intelligence in the current scenario particularly in computer vision [11]. Investigations are made on the efficiency of the deep learning technique for enabling various future researches by providing a way that is of low cost for providing information from webcam researches that are already in use [7-10]. The working of CNN requires large number of labelled images, materials for computation and newly available architecture of neural network. A lot of labelled images are combined with techniques of supercomputing and CNN for testing the wellness of automated extraction of information from webcams using deep learning. The outcome produces a system that enhances the capability of automated extraction of priceless information from webcam images. Certain systems utilise applications based on android for natural recognition [31].

The organization of the paper is structured as follows. Literature review on CNN is presented in Section 2. The proposed CNN based animal detection technique is explained under section 3. The performance of the proposed technique is evaluated and discussed in section 4. Section 5 concludes this paper.

II. RELATED WORK

The concept of deep learning [13] enables automated extraction of additional abstraction layers on computer systems. Based on the inspiration obtained from the visual cortex of mammals [14], every layer of the CNN extracts data from the parts of images obtained from the outcome of previous layer [12]. A soft-max function comprises the CNN last layer specially designed for the purpose of classification. For each class, the function produces an outcome that lies within 0 as well as 1 and the summation of the output of all classes is 1.

The outcomes obtained are elucidated as the projected possibility of CNN of pictures of particular classes as well as high possibilities are elucidated due to the confidentiality of CNN knowing that the particular image belongs to the particular class [15]. Several demanding issues such as machine translation (19,20), playing Atari games (23), image recognition (21,22) and speech recognition (16-18) has been tremendously improved using CNN.

Small sets of data (25, 26) can be detected using hand held characteristics (24). In contrast to this, essential characteristics can be automatically harnessed using CNN to detect animals as well as the technique can be applied on the largest set of data specifying wild animals [1]. Characteristics can be learned from data includes that by doing so performance can be improved (12,27); However, these characteristics are moved to certain other areas with limited sized datasets (28, 29); since they consume more time for designing characteristics manually. Hence a generalised algorithm which performs automated characteristic learning improves the performance of various kinds of data thereby enhancing the impact. An additional benefit of CNN lies in the fact that hand held characteristics can be added to them for improving performance if they are considered to be useful. (30). Hand held characteristics are harnessed on existing techniques for animal classification includes (8), where attempts are made to differentiate webcam recording that contain no animals (25) as well as the usage of support vector machine (14) for classification of images. They achieve an accuracy of 82%. However, such methods need cropping to be done manually that demands manual effort.

Recent researches work on harnessing CNN for classifying images obtained from webcam. (26) harness CNN for complete automation for identifying animals. However, the demonstration of such techniques are carried out on a dataset that includes 20,000 images and 20 classes, that is small sized than that explored here (26). Moreover, they are only 38% accurate that required more to be improved.

The proposed work performs detection of the presence of wild animals inside a wildlife sanctuary. It uses CNN for the classification and detection from images obtained from web camera. It is more helpful for performing rescue operations inside sanctuaries

III. PROPOSED METHOD

Different types of deep learning possess varied architecture. The difference occurs in the layer types they possess, number, size as well as the order of such layers. The proposed work tests nine types of non-conventional architectures for pointing out the one that performs well as well as for performing performance. Because of complexity in training multiple samples, a single model is trained at a time and also it is theoretically proved that training differently initialised model with similar architectural concept offers identical performance. Accuracy of classification process can be improved by using a combination of methods together simultaneously and predict their average performance. Once every stage of the entire models is trained, ensemble is made for the methods applied for training by computing the average based on their prediction.

When movement of an animal is found in the nearby location the camera is triggered and it captures a series of pictures. Every time when the camera is triggered, it is considered as a capture event. The dataset used by the proposed system includes a total capture event of 1.2 million mainly of 48 varieties of animals. A large number of volunteers work on images obtained from these datasets. It is found that, on considering the entire set of data, total classifications of 10.8 million ids recorded.

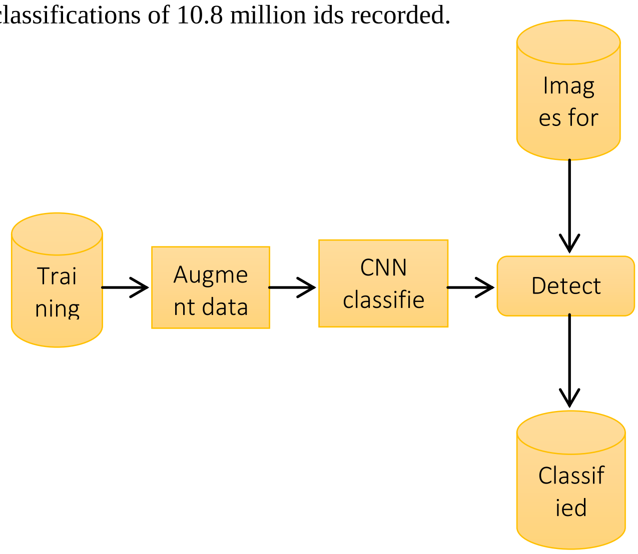

Figure 1: Block diagram of CNN for animal detection

This work concentrates on images that include a single type of animal, thereby removing images that contain more kinds of animal species in the entire set of data. Researches can be carried out in future by which the algorithm can be extended to deal with images containing multiple species of animals.

Convolutional Neural Network

CNN is a kind of neural network that proves itself to be effective around domains including classification as well as recognition of images. Identification of animals, objects and face is successfully carried out using CNN. The four major functions of CNN are Convolution, Non-linearity, pooling as well as classification. These functionalities are considered to be the fundamental blocks of each and every CNN architecture. Figure 2 depicts the architecture of the CNN used in the proposed system.

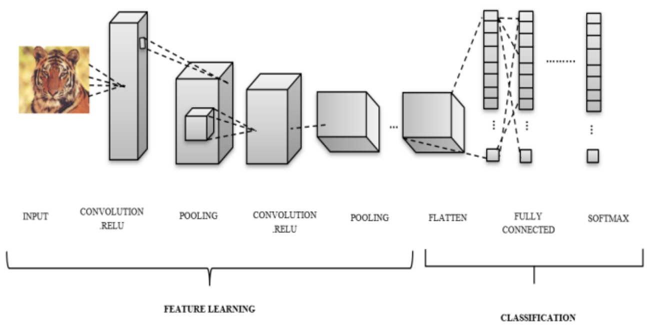

Figure 2: Architecture of CNN

On the event of max pooling, spatial neighbourhood is defined and the highest element is taken from the obtained feature map found inside the window.

In alternate to the selection of highest element, it is possible to extract the mean or the overall total of entire elements found in the window. Figure 3 shows the working of max pooling.

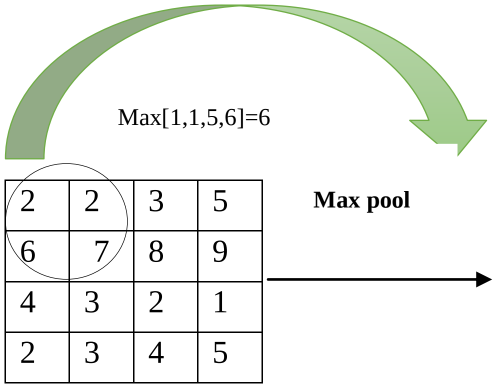

Figure 3: Max pooling

A loss may occur during the training phase which can be computed in various ways. The common methodology for computing loss function is mean squared error that is considered ½ times (actual - predicted) squared.

$$E_{total} = \sum \frac{1}{2}(target - output)^2$$

The loss occurred in the system can be rectified or mini missed by updating the weights. The weights are updated in order to obtain a change in the reverse direction of gradient.

$$w = w_i \eta \frac{dL}{dW}$$

Where, w indicates the weight, wi represents the initial weight and η, the rate of learning

It is found that about 75% of the images are classified under the class that does not contain an animal. Moreover, the entire set of data is considered to be of unbalanced because certain animals exist frequently in more images than the others. This imbalance is a major issue in the domain of machine learning as they rely heavily on classes that more number of examples. If the system is found to predict frequently available class, it is then applied to classify only those species in order to obtain high accuracy and eliminating the need to invest more to make the system learn rare class.

The overall capture events are labelled by the volunteer irrespective of single image. However, outcomes are reported for the label of overall capture event, the proposed work focuses on labelling of distinctive picture since it is simple for inferring labels for the capture event. Moreover, it is also noted that usage of distinctive image results in high accuracy since labelled examples are allowed to be trained more than thrice. The advantage of performing training on images help others perform similar projects that may be based on image but not on capture event.

IV. RESULTS AND DISCUSSION

Two-layered pipeline is found to outperform one-layered pipeline. The initial layer detects whether an image contains an animal. The second layer reports about the images with animals. In the dataset it is found that 75% images are identified to be without animals. Hence the automated system thus saves time and human work about 75% during the first layer. A method is trained to carry out the tasks of identifying images with animals and others without animals at the same time. The functionality of every task gets improved when a greater number of tasks is learned in parallel. For this every task requires their own method which means that tasks can be solved fast and are energy efficient and it is simple to save and transmit. These benefits become more effective when webcam is utilized for running neural network for determining images to be stored or transmitted.

Dataset

The proposed work concentrates on recognizing only a single species rather than more numbers from an image. Hence images that are labelled as pictures with multiple animal types as pointed out by humans are eliminated from both the train as well as test sets. The set of data utilized for test and train are obtained from the pictures that are marked by humans as images containing animals. When the test data set includes a greater number of similar images then the method memorizes such images and returns the result without performing the entire operation. Totally 301400 images are identified to be with animals. From this set a train set is established that includes 283000 images as well as three test set. The set marked by the volunteers include 17400 images. Data set includes pictures clicked both at day as well as night and this difference in time shows difference in their performance.

Detect images with animals

The task of detecting images with animals can be carried out by getting an image input. The output may any of the two forms either the picture contains an animal or not. A sum of nine set of neural network method is trained. Since 75% images obtained from the dataset are found to be without any animal, the stability among the images with and without animals can be obtained by considering 25% images with animals and 765000 images with animals selected at random. The finalized set of data is then divided into train as well as test sets.

The set of data allotted for training includes 1.3 million images as well as testing includes 100000 images. The selected dataset does not contain labels for each event, labels are assigned to every image in the event. Each architecture applied obtained more than 95% accurate. Figure 4 represents the images that are captured by webcam inside wild life sanctuary. The image is processed using CNN algorithm to detect the presence of wild animal.

Figure 4: Animal detected images

The blue coloured solid line in Figure 5 presents accuracy in recognition using PCA algorithm. The red colour presents reliability of using LDA algorithm. The other plot of the figure illustrates the results of experiment obtained from the proposed CNN method

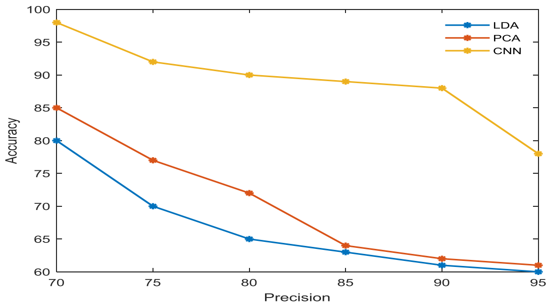

Figure 5: Animal recognition rate using PCA and LDA

Precision	Recognition accuracy		
	LDA	PCA	CNN
70	80.15	85	98.28
75	70	77.03	92.03
80	64.84	72.18	90.15
85	62.81	64.06	89.21
90	60.93	62.18	88.12
95	60.15	61.09	78.28

Table 1: Precision with varied accuracy in recognition

The overall precision of LBPH algorithm is depicted in red coloured plot of figure 6. The experimental results obtained using SVM are described in the green plot of the figure. The other plot describes the overall recognition accuracy of the proposed CNN method.

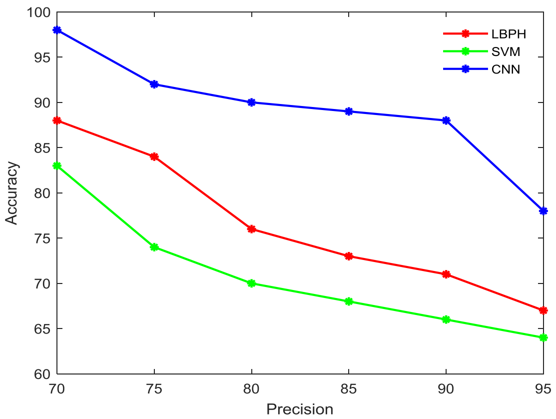

Figure 6: Animal recognition rate using LBPH and SVM

Table 2: Accuracy with respect to precision

Precision	Overall accuracy		
	SVM	LBPH	CNN
70	83	88	98
75	74	84	92
80	70	76	90
85	68	73	89
90	66	71	88
95	64	67	78

V. CONCLUSION

The capability of the computer vision techniques known as CNN are tested for automatic extraction of data from images obtained from the largest wildlife dataset. Initially the performance of CNN on the dataset is shown. The usage of CNN saves a lot of time for the biological researchers as well as volunteers since they perform labelling of image. In case of animal identification, the proposed work saves nearly 99% of human labor and 96% in case of human volunteer. Such considerable quantity of manual labor is transferred to other projects related to the field of science as well as extracting knowledge that are practicable for webcam projects which is unable to allot large number of manual volunteers. Automated extracting of data thereby drastically decreases the amount of cost required for gathering precious data obtained from wildlife sanctuaries and hence enables, improves and catalysis major future researches related to conservation of wildlife.

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