CONVOLUTION NEURAL NETWORK BASED ANIMAL DETECTION ALGORITHM FOR PARTIAL IMAGE

Dr. K. Paramasivam[1], S. Krishnaveni[2], S. Sowndarya[2] & E. Kavipriya[2]

[1]*Professor, EEE Department, Kumaraguru College of Technology, Coimbatore, TN, India..*

[2]*UG Scholars, EEE Department, Kumaraguru College of Technology, Coimbatore, TN, India.*

[1] *paramasivam.k.ece@kct.ac.in*

Abstract: *Animals entering the agricultural land near the forest areas destroy crops or even attack on people residing nearby villages. In this situation, punishment for animals is not remedial action. In order to save human beings, agriculture crops and animals, it is required to provide good solution using technology. Therefore there is a need of system which detects the presence of animal and gives warning about that in the view of security purpose. In this paper, deep convolution neural network based classification algorithm is devised to detect animals both in video and images. Proposed approach is a classification model based on different features and classifiers. The different features like color, gabor and LBP are extracted from the segmented animal images. Possibilities of fusing the features for improving the performance of the classification have also been explored. Classification of animals is accomplished using CNN and symbolic classifiers. Initially, features are extracted from images/frames using blink app pre-trained convolution neural network. Later the extracted features are fed into multi-class CNN classifier for the purpose of classification. CNN is constructed using sequence of layers like Convolutional, sub-sampling and fully connected Layer. Therefore the proposed algorithm is more suitable for classification and detection of animals from the camera pictures with different pose and partial image of animals. Algorithm is developed and implemented in raspberry pi embedded system using python coding. For validating the performance of the proposed algorithmic models and also due to non availability of a large bench marking related dataset, in this work, successful attempts to create an animal image dataset and an animal video dataset are also made. The proposed deep learning based animal classification models in terms of accuracy, precision, and time consumption are established and validated experimentally with the data set. Experimental results show that better detection accuracy is obtained for even partial image of animals. The proposed animal detection system therefore will be a great support to society to safe guard the agriculture, wild life and human being.*

Keywords: Animal classification, Image processing, Artificial Intelligence, Convolutional Neural Network, Deep learning, Embedded system, partial image

1. INTRODUCTION

Every year almost 100-300 humans and 40-50 elephants are killed during crop marauding in India. In spite of deforestation and violation of afforestation, the environment in forest areas are not conducive for native animals. Due to the pollution and environmental changes forest areas too not receiving normal rainfall in a year. This leads to unavailability of necessary food and water and hence many animals are coming out of forest. When wild animals such as elephant, tiger, lion leopard etc., damages to human life, agriculture crops, domestic animals life and infrastructure are inevitable. Directly or indirectly the changes in civilization and life style of human being are the main reasons for animals to come out of forest area. Unless animals are disturbed, they never touch human being.

Machine learning is one of the key application field in booming Artificial Intelligence (AI). Machine learning has feature able to learn and enhance the performance of the system using past experience. It does not require any specific programming to do so. Programming in machine learning concentrates on accessing data and learning by own using the data. It specifically uses information or data like illustrations, previous examples, direct experience, instructions etc. Specific and required pattern in data is identified to take better decisions for improvement of system in future. Automatic learning, avoidance of human intervention, performance improvement and appropriate adjustments in actions of system are the key features and characteristics of machine learning.

Deep learning is a subset of machine learning. Performance measure in many practical applications such as image recognition, sound recognition etc is greatly improved when deep learning is applied. Convolutional Neural Network(CNN) used in deep learning called deep neural networks is widely used in analysis of image processing. Need for pre-processing in CNN is comparatively less over the other image processing algorithms. Hence concept of CNN along with deep learning is more preferred for image classification applications. It finds variety of applications such as video and image recognition, image classification, medical image analysis, recommender systems and natural language processing.

Concept of animal detection is one of the emerging area in wild life environment issues. The problem can be solved by watching the activities and path ways of wild animals in forest and its surrounding area by using CNN based animal detection algorithms. This will be helpful to take appropriate actions by forest department and to safeguard the human being, agriculture crops against attack of animals. The technique will also to protect the wild animals in future.

In order to find solution for this, technology is used carefully not to punish the animals when they come out of forest. In this paper, deep convolution neural network based animal detection method is experimented with large number of data set and implemented in raspberry pi to develop embedded system.

Content of this paper is with literature survey in section 2, proposed method in section 3, implementation & results in section 4 and conclusion in section5. References are added at last.

2. Literature Survey

Literature finds variety of animal detection techniques using image processing which involves several processes to carry out the complete algorithm. Such processes are data acquisition, segmentation, feature extraction, representation and matching process. Many segmentation techniques such as thresholding based methods, region splitting and merging methods (Ning J et al., 2009), Edge based methods (Senthilkumaran et al., 2009), Pixel labeling method, and Graph-based methods (Ning et al., 2010) are seen in the published sites. Extraction of suitable features will definitely enhance the performance of the system (Bai X et al,, 2009). Usually animals can be discriminated using color, shape and texture features (Matuska S et al., 2014) and some of them with the combination (Patra B et al., 2015).

In this case, the problem of classification becomes a statistical decision theory, a subject that has many applications to pattern classification (Wang X et al., 2014) used support vector machine to classify the animals. (Matuska et al., 2014) used both support vector machine and nearest neighbor for classification of animals. RFID collars are used to track the animals using GPS technology (Kim, Kim, & Park, 2010). Computer vision based approaches are also used to track animals by extracting features like color, shape and texture and (Zeppelzauer, 2013). CNN based method also proposed and compared with few existing methods(Tibor Trnovszky et al, 2017). Image processing based animal tracking system was developed using video signals (Manohar N et al, 2018) in which segmentation, feature extraction and mean-shift algorithms are used for detection and tracking purpose.

Most of the above methods are suitable when the camera pictures reflect the animal image in specified pose and orientation. But naturally it is not possible and the images are with animals in various pose, partial image of animals, shadows, complex background etc. Hence the proposed CNN based animal detection

algorithm focusses on classification of images with animal in different pose and partial image.

3. Proposed Method

In this method, deep convolution neural network based classification algorithm is devised to detect animals both in video and images. Proposed approach is a classification model based on different features and classifiers. The different features like color, gabor and LBP are extracted from the segmented animal images. Possibilities of fusing the features for improving the performance of the classification have also been explored. Classification of animals is accomplished using CNN and symbolic classifiers. Initially, features are extracted from images/frames using blink app pre-trained convolution neural network. Later the extracted features are fed into multi-class CNN classifier for the purpose of classification. CNN is constructed using sequence of layers like Convolutional, sub-sampling and fully connected Layer.

Block diagram shown in figure 1 describes the overall working of animal detection technique using neural network based image processing in hardware system.

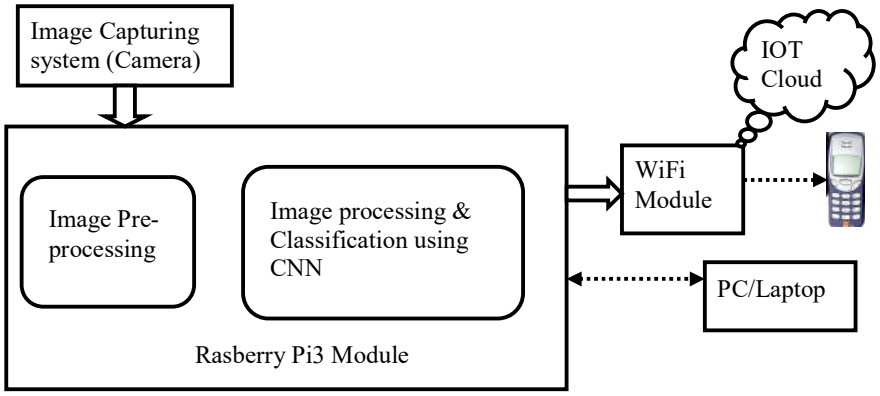

Figure 1. Block diagram of animal detection system

3.1. Image Capturing System

High resolution video camera is used for capturing the image of animals in the background of nature. Both image and video pictures are able to capture and send the signals to the hardware system. Specifications and features of the camera are 1). 16MP interpolated Resolution 2).High quality CMOS sensor 3). Clear, sharp still picture & motion video 4).Support external microphone 5). Auto white balance & exposure 6). Adjustable lens 7). 640×480; 352×288; 320×240; 176×144; 160×120; image resolution Frame rate upto 30 Fps 8). AC power frequency: 50Hz, 60Hz 9). Focus distance: 4cm~infinity and 10). USB 2.0 I/O interface.

3.2. Image Processing System

The captured signals from the camera are processed in given sequence to detect the type of animals. Output signal from the camera is not suitable to process and hence the signals are allowed to pass through pre-processing system. Then the image signals are processed in deep convolution neural network based algorithm residing in raspberry pi hardware system.

3.2.1. Convolutional neural network:

The architecture of convolutional neural network for animal detection is shown in figure 2. The CNN is same as in architecture of original Le Net (Convolutional Neural Network in Python) and classifies the given picture into various categories. Perceptron machine learning logic is used in CNN with supervised learning mode for analysis of data. Further CNN is mainly constructed by using three layers a) Convolutional b) sub-sampling and c) fully connected layer.

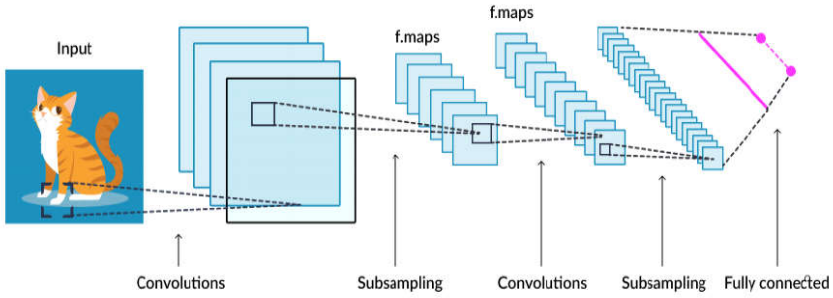

Figure 2. Architecture of convolutional neural network for animal detection

Convolutional Layer:

The Convolution layer is used as first layer of CNN made up of learnable filters placed spatially along width and height of input layer.

Convolution is processed by sliding every filter across height and width of the input volume and calculate dot product of filter coefficient and input at any position. While doing so for entire input volume, two dimensional activation amp is generated which is response from the filter at each position. Intuitively, a separate 2D activation map will be generated for each filter. At the end, all the entire activation map are put together and considered as the output of convolution layer.

Pooling Layer:

Pooling layers are helpful to decrease the quantity of parameters when the size of image is huge. Max pooling is applied where the greatest element is considered from the feature map. Dimension of the image is reduced by down sampling technique. Usually filter size of 2x2 is applied for pooling over both height and width and dimension is reduced by 75% while 25% is retained.

Fully connected layer:

Fully Connected Layers are specific type of hidden layer which must be used within the CNN. This is used to combine the features into more attributes that predict the output more accurately. In fully connected layer all the neurons are connected with previous layer. This is similar to conventional neural network. Matrix multiplication is applied to determine the activation of neurons.

3.3. Rasberry Pi3

The Raspberry Pi is a low cost, small sized computer that plugs into a computer monitor, and uses a standard keyboard and mouse. And it contains Broadcom BCM2837 64bit ARMv7 Quad Core Processor powered Single Board Computer running at 1.2GHz. Typical board with its interfacing device is shown in figure 3.

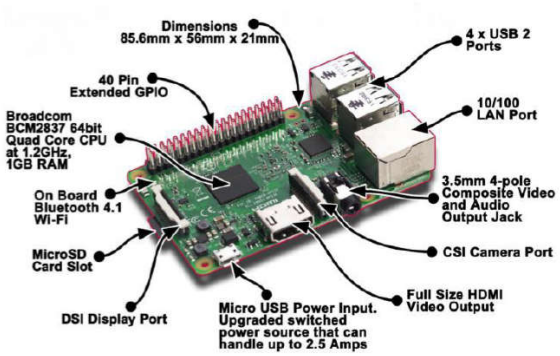

Figure 3. Rasberry Pi3 board

3.3.1. VNC VIEWER

Virtual Network Computing (VNC) is a graphical desktop sharing system that allows to remotely control the desktop interface of one computer (running VNC server) from another computer or mobile device (running VNC server). The desktop of the raspberry pi can be viewed and accessed in a window on your computer or mobile device. Raspberry pi can be completely controlled through this tool. There are two ways to connect to raspberry pi either in direct connection or cloud connection.

3.3.2. BLYNK APP

Blynk is a new platform that allows to quickly build interfaces for controlling and monitoring hardware boards like Arduino and Raspberry Pi from iOS or Android device over the Internet. After downloading the Blynk app, you can create a project dashboard and arrange buttons, sliders, graphs, and other widgets onto the screen. Using the widgets, one can turn pins on and off or display data from sensors.

4. Implementation and Results

The proposed animal detection algorithm is developed using convolutional neural network and implemented using raspberry pi embedded system. Python coding is used to develop the algorithm and programmed the microcontroller of raspberry pi. Algorithm is executing in two phases as training and testing to detect the animals. Training is carried out using large data set containing 13412 images classified through 6 cases for different animals. Data set and its cases are given in table 1. Training column shows that number of images used for training for each case and Validate coloumn shows the number of images tested successfully for detection.

Table 1. Data set images for training and Testing

IMAGE DATA SET	TRAINING	VALIDATION
SPIDER	3786	944
SQUIRREL	1451	318
HORSE	2200	370
ELEPHANT	1129	202
CHICKEN	3001	467
BUTTERFLY	1845	248
TOTAL	**13412**	**2549**

Since the resolutions of data set images are high and required resolution for CNN is low, the images are resized to minimize the dimension. Resized images are used for training and testing phase of algorithm.

Overall procedure for animal detection is given below:

1. The image is captured using the web camera.
2. The captured image is processed using the python coding which is residing in the microcontroller of Rasberry Pi3 hardware board.
3. The captured image is checked for various features of objects that match with any animal of trained data set.
4. Then it detects and classifies the animal which has been captured by the web camera.
5. Algorithm calculates the accuracy in percentage based on number of matched objects.
6. If the accuracy of detected animal is above 45% the alert signal will be sent to the registered user through the BLYNK APP.

Experimental set up using Rasberry pi3 board, web camera and system with VNC viewer is shown in figure 4. Figure shows web camera is connected to raspberry pi board which is connected with laptop. Data set images can be provided directly from laptop or through camera. In order to have practical situation, the image is shown in mobile display which is captured by camera and input to raspberry board. Elephant image given in the data set shows completely visible but the due to camera focusing partial image only captured and input to the controller for image processing. Result shows 80% of features of elephant are matching and hence confirmed as elephant.

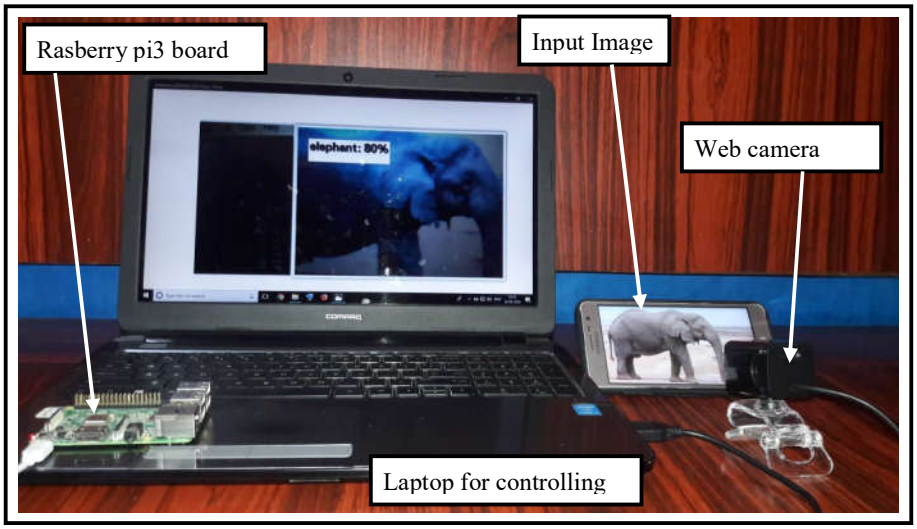

Figure 4. Experimental set up of animal detection system using Rasberry Pi

After training of data set images using training algorithm, different animal images are provided to the testing algorithm to validate the working of algorithm. Results shows that all the animals are detected correctly and displays set of accuracy results in percentage for each animal image. Set represents number of segmented objects of given image and each result shows amount of pixels matched with segmented images of data set used for training algorithm.

Typical results are illustrated in the following figure 5 with elephant image. The image shown here is maximum part of elephant except tail end. Figure 6 shows the screen shot from results(accuracy) of test algorithm in percentage. It shows for different segmented objects of image and their matching accuracy in percentage. The accuracy varies from 53% to 81% for elephant. The maximum value 81% and hence the given image is detected as elephant. This is displayed as final output of detection algorithm

which is shown as screen shot in figure 7. Figure 6 also shows one of the object is detected as dog with 67% accuracy. As the number of such object is only one out of many elephants, the result for dog is discarded and not considered for final detection.

Two more test images of elephant are also provided to the algorithm as given in figure 8(a) and (b) which are partial image with tail end of elephant. These two types of partial images are obtained by focusing the camera accordingly. Accuracy results are also given in the corresponding image of figure 8 as 49% and 47% respectively. Since these two images are part of elephant, the accuracy result is very much reduced when compared with image shown is figure 5 which is almost complete picture of elephant whose accuracy is 81%. Image (a) shows more portion of tail end of elephant than that of image (b) and hence accuracy of image(a) is slightly greater than that of image(b).

Above results shows that the proposed convolution neural network based animal detection algorithm works satisfactorily for different animals and results are verified large image data set.

Figure 5. Test Image of elephant and its accuracy

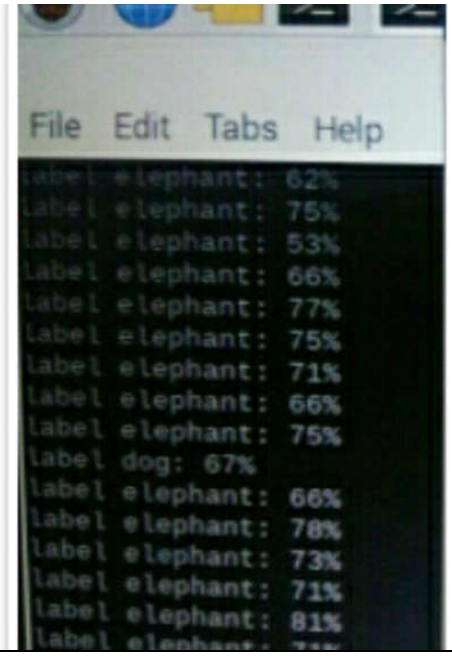

Figure 6. Test Image of elephant and its accuracy

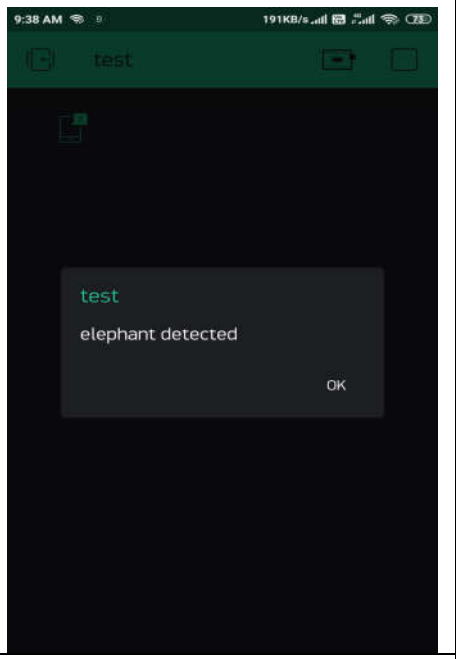

Figure 7. Screen shot of final result of Testing algorithm

(a)

(b)

Figure 8. Test Images of partial elephant and its accuracy

5. Conclusion:

Convolution neural network based image processing algorithm is developed to detect the type animal shown in the input image. CNN is able to classify the input image into categories. CNN is a specific type of artificial neural network that uses perceptron's, a machine learning unit algorithm, for supervised learning, to analyze data. A simple CNN is a sequence of layers and mainly uses Convolutional Layer, Pooling or sub-sampling Layer, and Fully-Connected Layer. Stacking of these layers gives full Convolutional neural network architecture. Algorithm is developed for training of data set images and testing of input images. More number of data set images are used for training to give better results. Testing algorithm is validated using set of input images and all are correctly detected. Algorithm is successfully tested for partial image of animals which is captured mostly in camera used for animal detection purpose. Detection algorithm is implemented in embedded hardware system Rasberry Pi using python programming with set of interfacing devices. VNC tool is used to control the raspberry pi board and BLYNK APP is used to create front end tool to operate the detection system in user friendly mode. The system is embedded with WiFi logic to connect IOT cloud and to provide alert mechanism upon detection of animals. Necessary data related to animal detection can be stored in cloud to improve the system with data analytics. No doubt the detection system is very much helpful to the society to safeguard human beings, animals and agriculture lands of our Nation and world.

REFERENCES

[1] Bai, X., Liu, W., & Tu, Z., "Integrating contour and skeleton for shape classification", IEEE 12th International Conference on In Computer Vision Workshops (ICCV Workshops), ***(2009)****, pp. 360-367.*

[2] Kim, S.-H., Kim, D.-H., & Park, H.-D. "Animal situation tracking service using RFID, GPS, and sensors". Second International Conference on In Computer and Network Technology (ICCNT), ***(2010****), pp. 153-156.*

[3] Manohar N, Y. H. Sharath Kumar, G. Hemantha Kumar. "An Approach for the Development of Animal Tracking System", International Journal of Computer Vision and Image Processing, ***(2018).***

[4] Matuska, S., Hudec, R., Kamencay, P., Benco, M., & Zachariasova, M. "Classification of wild animals based on SVM and local descriptors", AASRI Procedia, 9, ***(2014),*** *pp.25-30.*

[5] Ning, J., Zhang, L., Zhang, D., & Wu, C. "Robust object tracking using joint color-texture histogram", International Journal of Pattern Recognition and Artificial Intelligence, 23(07), ***(2009)****, pp.1245-1263.*

[6] Ning, J., Zhang, L., Zhang, D., & Wu, C. "Interactive image segmentation by maximal similarity based region merging", Pattern Recognition, 43(2), ***(2010),*** *pp.445-456.*

[7] Patra, B. K., Launonen, R., Ollikainen, V., & Nandi, S. "A new similarity measure using Bhattacharyya coefficient for collaborative filtering in sparse data", Knowledge-Based Systems, 82, ***(2015),*** *pp.163-177.*

[8] Senthilkumaran, N., & Rajesh, R. "Edge detection techniques for image segmentation–a survey of soft computing approaches", International Journal of Recent Trends in Engineering, 1(2), ***(2009)****, pp.250- 254.*

[9] Tibor Trnovszky, Patrik Kamencay, Richard Orjesek, Miroslav Benco, Peter Sykora. "Animal Recognition System Based on Convolutional Neural Network", Advances in Electrical and Electronic Engineering, ***(2017).***

[10] Wang, X., Feng, B., Bai, X., Liu, W., & Latecki, L.J. "Bag of contour fragments for robust shape classification", Pattern Recognition, 47(6), ***(2014)****, pp. 2116-2125.*

[11] Zeppelzauer, M. "Automated detection of elephants in wildlife video", EURASIP Journal on Image and Video Processing, (1), 46, ***(2013)****.*