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Early warning system for human-elephant conflict in Sri Lanka

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ABSTRACT

Elephants are essential indicators in an ecosystem. Human-elephant conflict (HEC) arises when elephants move to human livelihood. HEC is one of the significant problems in Sri Lanka. A variety of technologies have been developed to mitigate HEC. However, existing strategies are designed only to protect humans and their harvest from elephants. The proposed model identifies elephants before they invade villages. Therefore, save human lives, their property, and elephants. The model is built in combination with image preprocessing techniques and a convolutional neural network to detect the elephants. The model has achieved over 98.1% of accuracy with the test set. A trained model and classifier algorithm are applied to detect elephants in the video. After detecting elephants, a message is sent to relevant parties, and the 'bee sound' is emitted. The developed model will further be improved to detect elephants in motion video and to apply the Internet of Things to HEC.

Keywords: Classifier, Convolutional Neural Network, Internet of Things.

INTRODUCTION

Human-elephant conflict (HEC) is the major problem in the forest border in Sri Lanka. The impact of HEC is a major issue. One of the main reasons for HEC is the lack of sufficient forests for elephants. Many reasons are caused by to increase of HEC in Sri Lanka However, the number of injuries and deaths of humans and elephants is increasing day by day. Because of the harmful techniques are used by humans to get rid of elephants. During the last 12 years, the reported number of elephants killed count is 1464 elephants, and 672 humans were killed in Sri Lanka. Department of Wildlife Conservation in Sri Lanka have reported that 318 elephants were killed in 2020. However, in Sri Lanka, only a few techniques are used to mitigate HEC. Various technologies are being used in the world, both traditional and highly sophisticated techniques to reduce HEC. Such as detected through the sound produced by elephants (Sureshkumar et al., 2020), wireless sensor network (Ashwiny and Karthikeyan, 2016), and image processing. In addition, deep learning boundary sense architecture within wireless sensor networks (Dhanaraj and Sangaiah, 2018), automated unsupervised elephant image detection system (Sugumar and Jayaparvathy, 2014) are used to detect the elephants. However, many solutions are mainly focused on the problem after elephants invaded the villages. That means only focused on saving human lives from elephant attacks.

Moreover, most farmers try to save their crops from elephant attacks. Therefore, electric fences have been constructed around the village. Some systems are used high volume frequency sounds in the daytime and high-frequency light at nighttime for repelling. High volume frequency sounds can cause an elephant to die of a heart attack, and the light issued at night can damage other animals. Sometimes the responsible people do not get a message until the electric fence is damaged. At present, the system used in Sri Lanka does not use technologies like Machine learning, IoT, and cloud-based technologies as a solution to HEC.

The proposed solution has included the capabilities which ultimately overcome the limitations of traditional and existing solutions. In the first phases, captured the images in real-time mode and processed them with the help of a machine learning algorithm. The elephant detection from images is carried out using a convolutional neural network (CNN) architecture with the sequential mode. This research is mainly discussed how to build efficient algorithms to detect objects. In this research, machine learning techniques are used to train a created model to detect elephants. After detecting elephants, the bee sound is being broadcasted as a counter elephant action. Therefore, it is easier to keep the elephants away from the electric fence and minimise the damage to the elephants. This also minimises maintenance for electric fences, minimises environmental damage, and protects elephants from death and injury. Finally, the alert mechanism is used after detecting elephants. Therefore, it will be easy to notify forest officials and help people save their property and lives near the forest boundary. This paper has discussed the benefits of using deep learning to provide an effective solution for human-elephant detection in Sri Lanka.

METHODOLOGY

Identifying elephants near the forest boundary is the primary aim of this research. To accomplish that, the proposed solution-focused to detect elephants is by using a Neural Network. The process of this research is as shown in Figure 1. The problem is identified and gathered information has been analysed. Existing and new technologies, drawbacks of the existing system are discussed in the problem identify the state. Then, the dataset is gathered. The study used 1500 images with 1000 images of elephants. The dataset consists of elephant images in different kinds of angles and different lighting conditions (low-light and high-illumination). The collected dataset

has been organised and analysed. The next step is, collected the data are divided them into different types of datasets. There are training datasets, test datasets, and validation datasets. Data is preprocessed, including outlier detection, missing value treatments, and removing unwanted or noisy data from the elephant dataset. Dataset is converted to double grayscale. Moreover, grayscale images are resized (112×112) using *Keras* and *TensorFlow* in the data preprocessing state.

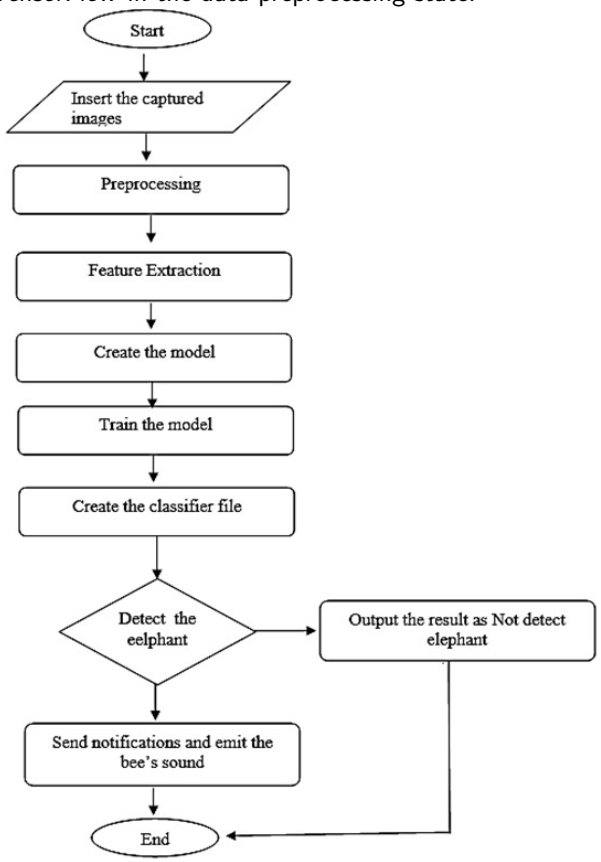

Figure 1: The flow chart of methodology

After preprocessing, a proper algorithm was selected for the model. CNN architecture with the sequential model is used as an algorithm implemented in Python3 with *Keras* libraries, including *TensorFlow*. The model has been used classification algorithms in Supervised Machine Learning. The output variable is categorical; there are two classes, such as within elephants and without elephants. The proposed model combined with the image preprocessing and CNN executed on the training dataset. The CNN architecture is applied to identify essential features from the training dataset. The architecture included convolutional layers and a max-pooling, fully connected layer with a dropout of 50%, indicating filter sizes like 64 and 128 for layers. The expected result depended on the architecture, and the model's accuracy is evaluated by providing the test set. The training dataset is used to determine accurately predict the output of the model. After creating the model, a model is trained. Finally, the accuracy and loss of both accuracy and test are evaluated and displayed. Prediction is another step in this experiment. Prediction of the trained model is displayed by using the *Keras* method. After predicting, the *Haarcascade* file is built using that is used to detect objects in an image and video. Images of elephants and without elephants are used to train the classifier using Python 3 with *Keras*.

Here, the XML file is generated as output. Live webcam object detection is the next step. Created *haarcascade.xml* file and trained model are combined to detect the elephant in an image or video. If the detect elephant, the system will provide an alert to the relevant parties. This research has been used the message gateway to received notifications. After object detection, send a notification to relevant persons, and the microcontroller audio device starts to provide bees' sound to the elephants. Here, Twilio's SMS API has been used to notify relevant responsible people. After detecting the elephant, Twilio's SMS API is provided messages to responsible parties. Finally, bee sound was provided.

Results and discussions

This research discusses the most suitable deep-learning model for real-time object detection and recognition. Research is determined on the neural network systems for avoiding HEC in Sri Lanka. Created model is presented with better accuracy compared to other models. The performance of the proposed model is evaluated using a test set. An experiment has been carried out to evaluate the classification performance of the CNN algorithm. In results, validation loss (26.7%) is decreased, validation accuracy (98.1%) is increased. Loss and Accuracy of both training and validation are visualised in Figure 2.

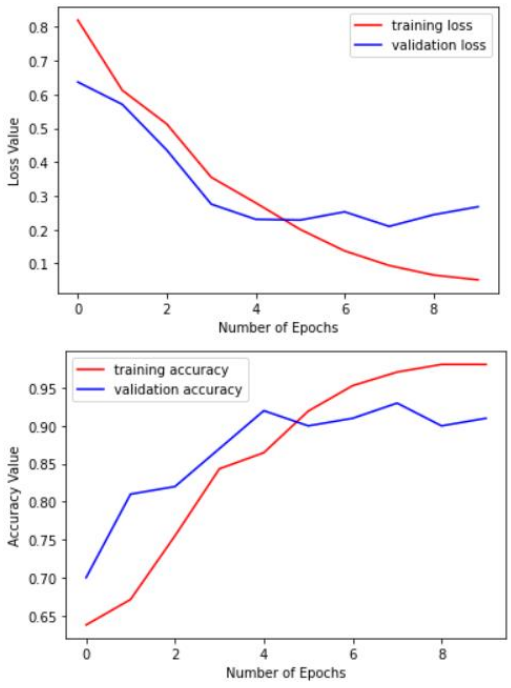

Figure 2: Accuracy and loss of the model

Accuracy and loss of both validation and test dataset are affected to final output. Then, real-time object detection is implemented using a trained model and *haarcascade* file. Then, elephants are detected in a live webcam based on the result of the created model and trained classifier. In an experiment, the best accuracy and loss are mainly affected to object detections. Likewise, a message is received by villagers and responsible parties after detecting elephants in the forest border. Likewise, the microcontroller audio devices are started to provide bee sound to the elephants. It is a reason to keep elephants away from the electric fence, minimise maintenance for electric fences, and minimise environmental damage. The main state is, this research has been provided with the solution to human conflict mitigation in Sri Lanka.

CONCLUSION

This research has experimented with using deep learning techniques within the CNN model for performing for detecting elephants. This research has provided a background to understand image preprocessing concepts, neural networks, convolution neural networks and elephant recognition in live webcam. This paper puts forward; we have used 1500 images to train the model and 1000 data images to test the model. CNN model has been used to accomplish this object in this research. After evaluating, accuracy was 98.1%; after obtaining the best accuracy, live object detection has been tested. The responsible parties receive messages after detecting the elephant. In future research, we have planned to apply this solution to motion cameras and the Internet of Things to detect elephants and provide the best solution for the human-elephant conflict in Sri Lanka.

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