Reducing Frequent Killing of Elephants from train collisions using Machine Learning

CT Wijewantha[1], WPJ Premarathne[2], and WMKS Ilmini[3]
Faculty of Computing, General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka
[1] chamindutharaka@gmail.com

Abstract— *Elephant-human conflicts are a significant issue causing death and injury to elephants and humans. Elephants raiding human plants, unexpected human-elephant encounters as elephants cross their paths, elephants crossing railway lines are the major problems for these injuries. According to the report tabled in Department of Wild Life Conservation 279 elephant's deaths have been reported in the last year (2018). The proposed system helps to identify elephants in day time as well as night time. This paper presents design and implementation of Deep Learning and PIR sensor-based solution to detect elephants in day time as well as night time and send a message to the user with the correct distance between elephants and train. In the implementation of deep learning model transfer learning has been applied with InceptionV3 model. The deep learning model gained 99.13% of training accuracy, 98.98% of validation accuracy and 98.86% of test accuracy with 0.0001 learning rate, 0.9 momentum and 4300 training images*

Keywords— *Deep Learning, Transfer Learning, Elephant Tracking, PIR Fence*

I.Introduction

Elephant is considered as a national resource. But unfortunately, they are now in the category of most threaten animal in the world. Therefore, the actions need to be taken to protect them. In order to save their lives, from all of the above accidents the one that can be kept in control is the train collisions. Therefore, the government should act to reduce elephant deaths that are caused by the train collisions. The highest number of elephant-train conflicts were reported in Polonnaruwa, Eastern and Anuradhapura areas. The trains are more liable to meet accidents with elephants near jungle areas. Therefore, the railways near jungle areas need to be inspected by drones whenever a train passes by and capture images in that area.[3]

The main concern of this research is to automatically detect the elephants from the drone captured images and to give an alert to the train drivers through their smart phone by tracking the location of the elephant. As a result, the driver will be able to get the information about the distance between elephant and the train and will be able to control the speed of the train by not hitting the elephant.

Deep learning (DL) is part of a broader family of machine learning methods based on artificial neural networks. Learning can be supervised, semi-supervised or unsupervised. Artificial Neural Networks (ANNs) were influenced by the processing of data and the distribution in biological systems of communication nodes. There are different distinctions between ANNs and biological brains. In particular, neural networks tend to be static and symbolic, whereas most living organisms ' biological brains are dynamic (plastic) and analogous to advanced scientific learning of algorithms and models that computer systems use to perform a specific task without using explicit instructions, relying instead on patterns and inferences. Machine Learning seen as a subset of artificial intelligence. Machine learning is seen as an artificial intelligence subset. Machine learning algorithms build a sample data-based mathematical model, known as "training data," to make predictions or decisions without the task being explicitly programmed. Machine learning algorithms can be used in a wide range of fields and industries, such as email filtering in the government sector and computer vision, where it can develop an algorithm with specific instructions for the task.

Transfer Learning (TL) is a huge knowledge in machine learning that aimed on storing knowledge gained while solving one problem and put on it to a different but related problem. For example, knowledge gained while learning to recognize Elephants could apply when trying to recognize the difference between Elephants and other animals.

Automated system operations (ASO) is the set of software and hardware that permits computer systems, network devices, hardware devices or machines to work without any manual interference. ASOs allow computer systems to work without a human operator physically located at the site or place where the system is installed.

At present, number of automated detection systems are available on the web including Automated Elephant detection system (Neil k.shridan-2017) , Early warning system for potential train collisions (L.Jiang,C.Bai-gen 2016), Automatically identifying , counting , and describing wild animals in camera-trap images with deep learning (M.S Norouzzadeh 2018), Fast Human-Animal Detection (Hayder Yosif, Roland Kays, Zhihai He), Real-Time Human Detection and Tracking (swapnil V.Tathe and Sandipan

P.Narote) and Real Time multiple people detection using skin color , motion and appearance information (Sang Min Yoon, Hyunwoo Kim).

Convolutional Neural Networks (CNNs) are a type of Neural Networks that have established very effective in areas such as image recognition, identification and classification. CNNs have been successful in identifying faces, objects, human gestures and animals. The most fundamental advantage of a convolutional neural network is automatic feature extraction for the given task provided that the input can be represented as a tensor in which local elements are correlated with one another.

This paper presents an improved version for detecting the elephants accurately and give the output to the user. The elephant detection system consists of 3 main identification methods; training the machine to identify the elephants through the dataset, motion and skin colour detection and PIR sensor method.

The rest of this paper is organized as follows. Section 2 describes overview of some existing Animal detection systems. Section 3 describes about the design and Implementation of the Elephant Detection System. Section 4 designs and implements the detection system for elephants. Then section 5 shows how the mechanism for the detection of elephants is in practice. Finally, the paper is finalized in section 6 with a note on further job.

II.LITERATURE REVIEW

In this chapter is first described shortly by the CNN and its image classification implementation. Visual recognition is a comparatively trivial job for humans, but due to complex and diverse picture characteristics it is still challenging for automated image recognition systems. Each object of concern can change an infinite number of distinct pictures, produced by varying positions, scales, views, backgrounds or lighting. Challenges become more severe in real-world issues such as the classification of wild animals from automatic trap cameras, where the majority of pictures captured are of incomplete quality as outlined in section 1. The thermal heat camera system and using Department of wild life conservation (DWCC) are inefficient and less accuracy and also these cameras very expensive.[4] If they bring DWLC people for train it also another cost for railway Department.

An assessment of the Human Elephant conflict in Sri Lanka (Charles santiapillai:, s wijayamohan) have mentioned human elephant conflict in Sri Lanka is not a modern problem. [6] It has been started since humans began to cultivate the areas that we previously occupied by AP That time electric fences were used by humans for prevent elephant from executing the forest fields but nowadays it is not successful. Some chosen systems for animal detection and their characteristics are discussed in the following.

A. Elephant AI system

A system was implemented to avoid human elephant conflict by identifying elephants using machine vision and alerting people and/or elephants to answer by Neil.k.sherdon. [5] According to this project, the system is capable to detect elephant and give an alert to villagers. With this project he has tried to identify elephants moving along their regular paths and tracking the elephants before they stray onto railway lines.

B. Early warning system

Early warning system for potential train collisions enhancing safety of highspeed trains [Liuz jiang, Ba-gen, Wang Jian] have mentioned about the concept of train collision early warning system. Presently the safety of railways was designed to be based on the Signalling Systems.[8] The automatically train detection system tried to introduced by them. This system also very valuable for us to early detection of elephants.

C. Automatically Identifying Animals

Automatically identifying, counting, and describing wild animals in camera trap images with deep learning. [Mohomed Sadegh Norouzza] have mentioned Motion sensor “Camera Traps” enable to collecting wild life pictures inexpensively.[11] And also, they have demonstrated this information can be automatically extracted by deep learning, and cutting-edge type of artificial intelligence. The system performed at an accuracy of 93.8% for identifying the animals clearly.

D. Early warning system

Fast Human-Animal Detection [Hayder Yosif, Roland Kays, Zhihai He] have proposed a system to detect human and animal coupling effective dynamic background modelling with the deep learning classification from highly cluttered camera trap images. [10] The use of the computer complexity by 14 times as a result it has outperformed existing other systems based on camera trap images

E. Real time human detection and tracking system

Real-Time Human Detection and Tracking [swapnil V.Tathe and Sandipan P.Narote] have proposed a system to real time human detection and tracker using a skin color based methods for face detection , YCbCr color model is used to detect skin regions, Mean shift algorithm and Kalman filter algorithm is used for tracking.[14] Finally they have mentioned the real time tracking requires faster computations and high power consumptions

F. Real time multiple people detection system

Real Time multiple people detection using skin color, motion and appearance information [Sang Min Yoon,

Hyunwoo Kim] have proposed a new method for detection of multiple people using robust skin color, background subtraction and human upper body appearance information.[15] Hausdorff distance is implemented for the image matching. They have mentioned algorithm can detect humans under several conditions such as skin color noise and complex backgrounds.

III.DESIGN AND IMPLEMENTATION

In this section briefly discussed about the design of the Elephant detection system.

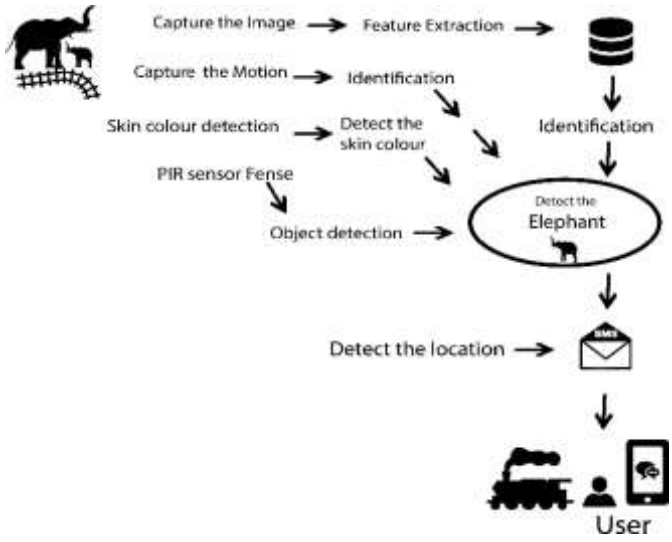

Figure 1. Overview of the existing Elephant detection system

The live camera of the system takes the live stream video and identifies the motion and also the differences of the present environment. During the day, when the lighting conditions are right, security camera works perfectly and are able to live observe high resolution video at full colour. However, when darkness sets in, surveillance cameras require a source of lighting. Infrared light is invisible to the human eye, but visible to the cameras.

Prior to extraction of highlights from a creature picture or edge, the locale comparing to a creature must be fragmented from its experience. Given a picture with the creature, the objective is to fragment out the creature locale which is the main district of our enthusiasm for it. In the second step, various highlights are picked to depict various properties of the creature. A few creatures are with high particular shapes, some have an unmistakable shading, some have unmistakable surface examples, and some are described by a mix of these properties. At long last removed highlights are utilized to arrange the creature. Division subdivides a picture into its constituent parts or article. Division procedure should stop when the object of intrigue has been segregated. Creatures are frequently encompassed by greenery, a shadow out of sight because of which the districts relating to the creature in the scene and the foundation may look fundamentally the same. In the identification part, it compared the captures of the elephants and the present dataset of the system. If the picture is showing more than 50 percent of equalities it recognise that animal is elephant.

Videos can be regarded as frames called stacks of images. The elephant detection system that compares distinct frames (photographs) to the first frame that should be static (originally no motions). By comparing the intensity value of each pixel, we compare two pictures.

In Grey frame the image is a bit blurred and we did so in gray scale because in gray images there is only one intensity value, whereas in RGB (Red, Green and Blue) image there are three intensity values. So, the intensity difference in the grayscale would be simple to calculate. Difference frame indicates the difference of first frame intensities to the present frame. The limit difference in intensity for a specific pixel is more than 50 in the threshold frame (in the elephant detection scheme) then that pixel will be white and that pixel will be black if the distinction is less than 50. In the color frame, the color images in the color frame can be seen along with the contours of green, red and purple around the moving objects.

PIR sensor detects a moving elephant from the sensor within about 10 m. As the actual detection range is between 5 m and 12 m, this is an average value. In essence, PIR sensors are made of a pyro-electric sensor that can detect levels of infrared radiation. For countless vital projects or objects to be discovered when a person has left or entered the region. PIR sensors are amazing, the control is flat and the effort is minimal. Here the elephant detection system has used PIR sensor fence to detect elephants in any weather condition.

IV.ANOTOMY OF ELEPHANT DETECTION SYSTEM

This section briefly discusses implantation of the Elephant detection system.

If the PIR sensor detects a moving elephant from the sensor within about 10 m, it will automatically turn on the camera and begin streaming. After detecting the object system can send the message to the user or nearest railway station through the radio frequency. After the signal received from the PIR sensor automatically open the camera. Then the elephant detection system is starting to compare the pictures of the database and present pictures that it is observing. If the system achieved more than 50 percent of accuracy it gives output with the name and the accuracy.

Figure 2. Flow chart of the existing Elephant detection system

The elephant detection system detects the elephants through the motion detection technique. The background of the system video stream is largely static and unchanging over consecutive frames of a video. Therefore, if the elephant detection system can model the background, the system monitors it for substantial changes. If there is a substantial change, the system can detect it as a motion, this change normally relevat to motion on the video of elephant detection system.

V.SYSTEM IN ACTION

This chapter discusses briefly how the Elephant Detection System operates. The detection system for elephants has been introduced as a python implementation and is capable of being very precise.

Now the Elephant detection system is capable to identify elephants accurately through the live video. System can identify elephant with 99 percent of accurate. According to performance of the developing elephant detection system is taken 6.28 Frames within one second.

Another characteristic of the Elephant detection system is capable of identifying more than 90 percent precision of various elephants. For the high accuracy results the system can increase the performance of the machine. The elephant detection system is capable to identify many elephants who are moving in the background.

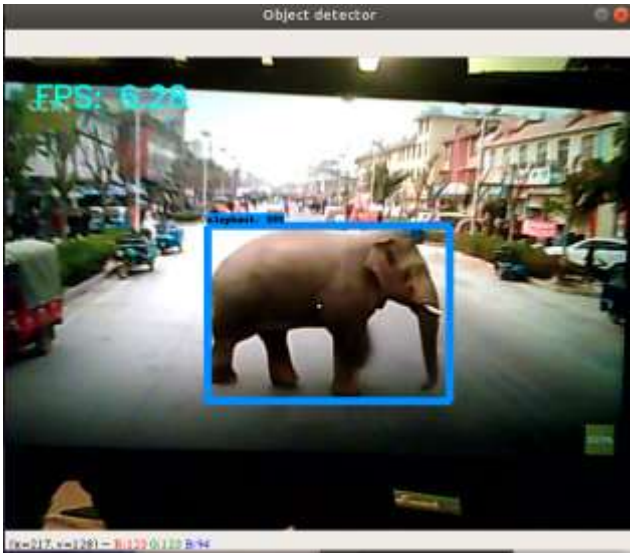

Figure 3. Single elephant detection from the live video stream

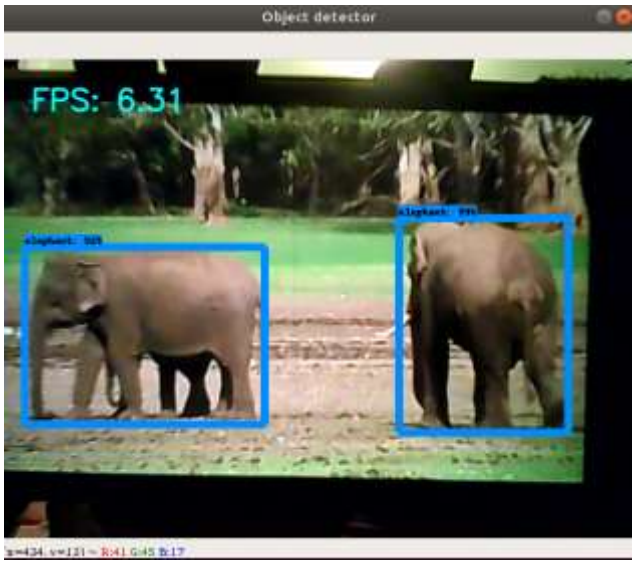

Figure 4. Multiple elephant detection

Night vision elephant identification is the best feature of the elephant detection system. Because during day time the camera can easily identified the elephants with more than 90 percent of accuracy. The elephant detection system already takes the grey scale images for the identification through the system.

Therefore, the elephant detection system is identifying elephants with more than 90 percent of accuracy and the 7.02 frames per second speed.
The system observed the several results through the live streaming in day time as well as night time.

Figure 5. Identify elephants at night time through the live video.

VI.CONCLUSION AND FURTHER WORKS

This article introduces the design and execution of the enhanced detection system for elephants. The Elephant detection system has been designed as an automated machine learning system and implemented through the python language. The Elephant detection system consists of 3 sub-systems namely Machine learning system, PIR fence system and Notion and skin colour detection system. The Elephant Detection System was set up as a python platform and tested effectively with the prototype setting and the actual environment.

Many researchers have done for early elephant detection system in other countries and even them also still not implemented as commercially. But in Sri Lanka elephant detection system through the Convolutional Neural Network have not yet been implemented. Most of these research works used image processing and Machine learning as the technology. For the process of this proposed system I used four main steps namely PIR Sensor fence, Motion detection, Skin colour detection and machine learning. This proposed system has used these techniques as well.

The system has provided the most accurate distance between elephant and the train. Analyse the information of elephant crossings and detect the most suitable time and time periods and finally give some alert to the drivers and implement the system to the rural areas can be considered as a further work of the research.

As a further development I thought to develop the system to identify any object or human being that are going to cross the railway lines. With this technique I want to totally stopped the deaths that are occur because of the train collisions.

And also, I hope to develop a system to make a communication between driver and the system through the radio frequencies. Because we cannot find any mobile connections in the high rural areas and also huge forests. So, this technique also will be very use full to reduce elephants and also other animals' deaths.

ACKNOWLEDGEMENT

I would like to extend my gratitude towards to all my supervisors and colleagues who supported me to make this project successful.

REFERENCES

Sandra Binns, "Human-Elephant Conflict, Sri Lanka," International Elephant Foundation. .

D. Mudalige, "Deaths increasing due to human, elephant conflict," Daily News. [Online]. Available: http://www.dailynews.lk/2017/10/25/local/132377/deaths-increasing-due-human-elephant-conflict. [Accessed: 07-Feb-2019].

A. Press, "Sri Lanka elephant survey puts population at 5,879," The Guardian, 02-Sep-2011.

(first), "Department of Wildlife Conservation – 'Conservation of Wildlife Heritage for Present & Future Generation.'"

"Elephant AI." [Online]. Available: https://hackaay.io/project/20448-elephant-ai. [Accessed: 07-Feb-2019].

Charles Santiapillai,Ganga Bandara, "(PDF) An assessment of the human-elephant conflict in Sri Lanka," ResearchGate. [Online]. Available: https://www.researchgate.net/publication/228352008_An_assessment_of_the_human–Elephant Conflict in Africa," Hum. Dimens. Wildl., vol. 9, no. 4, pp. 271–278, Dec. 2004.

L. Jiang, C. Bai-gen, and W. Jian, "Early warning system for potential train collisions: Enhancing safety levels of high-speed trains," Proc. Inst. Mech. Eng. Part F J. Rail Rapid Transit, vol. 230, no. 1, pp. 295–312, Jan. 2016.

Tianmei Guo,Jiwen Dong, "Simple convolutional neural network on image classification," ResearchGate. [Online]. Available: https://www.researchgate.net/publication/320649477_Simple_convolutional_neural_network_on_image_classification. [Accessed: 07-Feb-2019].

"Fast human-animal detection from highly cluttered camera-trap images using joint background modeling and deep learning classification | Request PDF,"

ResearchGate. [Online]. Available: https://www.researchgate.net/publication /320088860_Fast_human-animal_detection _from_highly_cluttered_camera-trap_images_using_joint_background _modeling_and_deep_learning_classification. [Accessed: 07-Feb-2019].

M. S. Norouzzadeh et al., "Automatically identifying, counting, and describing wild animals in camera-trap images with deep learning," Proc. Natl. Acad. Sci., vol. 115, no. 25, pp. E5716–E5725, Jun. 2018.

Hung Nguyen,Sarah J. Maclagan,Tu Dinh Nguyen, "(PDF) Animal Recognition and Identification with Deep Convolutional Neural Networks for Automated Wildlife Monitoring," ResearchGate. [Online]. Available: https://www.researchgate.net/ publication/319392368_Animal_Recognition_ and_Identification_with_Deep_Convolutional _Neural_Networks_for_Automated_Wildlife _Monitoring. [Accessed: 07-Feb-2019].

S. Sladojevic, M. Arsenovic, A. Anderla, D. Culibrk, and D. Stefanovic, "Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification," Computational Intelligence and Neuroscience, 2016. [Online]. Available: https://www.hindawi.com/journals /cin/2016/3289801/abs/. [Accessed: 07-Feb-2019].

S. Lawrence, C. L. Giles, A. C. Tsoi, and A. D. Back, "Face recognition: a convolutional neural-network approach," IEEE Trans. Neural Netw., vol. 8, no. 1, pp. 98–113, 1997.

S. M. Yoon and H. Kim, "Real-time multiple people detection using skin color, motion and appearance information," in RO-MAN 2004. 13th IEEE International Workshop on Robot and Human Interactive Communication (IEEE Catalog No.04TH8759), 2004, pp. 331–334.

L. Jiang, C. Bai-gen, and W. Jian, "Early warning system for potential train collisions: Enhancing safety levels of high-speed trains," Proc. Inst. Mech. Eng. Part F J. Rail Rapid Transit, vol. 230, no. 1, pp. 295–312, Jan. 2016.