Project Proposal Report

Enhancing Sustainable Crop Protection through Machine Learning-Driven Integrated Strategies

Project ID: TMP-2023-24-074

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June 2023

DECLARATION

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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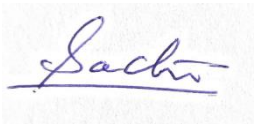
Signature : 

The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

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Signature of the supervisor Date

(Mr. Vishan Jayasinghearachchi)

ABSTRACT

Crop damage poses a significant challenge in Sri Lanka's agriculture. In the first half of 2022, Sri Lanka experienced substantial crop damage caused by wildlife. Approximately 144,989 metric tons of 28 crop varieties, along with 93 million coconuts, led to a loss of 30,215 million LKR ($87.5 million), as per recent calculations [1]. The toque macaque tops the list of crop raiders followed by wild boar, elephant, peacock, giant squirrel and porcupine with five types of crops most heavily damaged: coconuts, paddy, vegetables, corn and bananas[1]. This research focuses on pest control in agriculture, with a specific emphasis on addressing the issue of crop damage caused by Macaque Monkeys. This research aims to identifying macaque monkeys by their different sounds when they enter to the farm and give a signals to the cameras to confirmation process. For overall research aims to identify and confirm the macaque monkeys and develop a Mobile application. In this research component covers identification of presence of macaque monkeys using macaque monkey sounds and tree branches shaking sounds. Basically selected algorithms are used to classification and identification of macaques and Accuracy and performance will be evaluate and most suitable approach will be used to the classification.

Furthermore, Real time tracking the sounds by using few microphones that covers the farm and real time identification will be done.

Keywords: Macaque, crop damage, Sound classification, real time monitoring

Table of Contents

Table of Contents

1. INTRODUCTION

1.1 Background

In Sri Lanka, agricultural productivity faces a formidable obstacle due to crop damage. The initial half of 2022 witnessed notable agricultural losses attributed to wildlife incursion. Calculations indicate that around 144,989 metric tons of 28 diverse crops and 93 million coconuts were lost, accounting for a substantial financial setback of 30,215 million LKR ($87.5 million). The toque macaque tops the list of crop raiders followed by wild boar, elephant, peacock, giant squirrel and porcupine with five types of crops most heavily damaged: coconuts, paddy, vegetables, corn and bananas [1].

The Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI) says in the first quarter of this year, 320 complaints have been received regarding crop damage caused by wild animals. According to the report provided by HARTI in 2023, most crop damage among the reported incidents has been caused by the Macaque monkeys. The HARTI report has revealed that 200 million coconuts have been destroyed in the last year alone, especially in the coconut triangle [2].

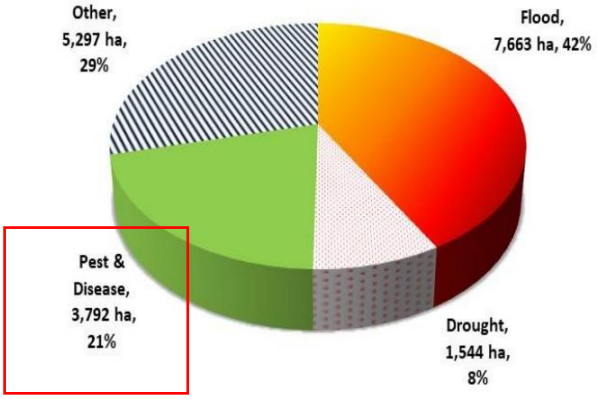


Figure1: Paddy:Crop Damage -2022-maha [2]

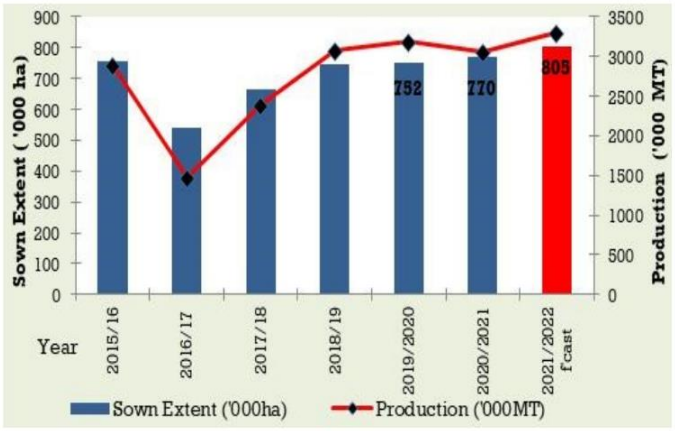


Figure2: Paddy: Trends of paddy sown extent and production in 2022 Maha session[2]

In the village being studied, residents are dealing with a constant problem: pests that destroy their crops. Macaque monkeys are a big issue, causing direct damage to fruits, vegetables, grains, and flowers. They also trample plants and knock them down, making things worse and leading to farmers losing a lot of money. These crops are important for the farmers' income. The impact of these pests and diseases is serious. Farmers are struggling to protect their crops and make enough food. The money they lose because of the damage affects their lives and the whole

community's economy. So, it's important to find ways to solve these problems and help the village's farming stay strong. To address these issues different methods are tried by the farmers such as shooting, fearing the macaques and so on. But solutions should be addressed protect the crops as well as not harm the animals and taking care of the environment.

Figure 3, 4:macaque monkeys harm crops

By considering these facts smart solutions to get rid of macaque monkeys should be highly needed. In this research address to minimize the crop harm by macaque monkeys. Macaque monkeys move around in groups and can show up at farms anytime, causing harm. The challenge is that farmers can't always know when they're coming. Overall research address the identifying macaque monkeys real time, and confirm the presence of macaque monkeys in the farm and inform the farmers and chase the macaque monkeys away. This research component address , monitoring the sounds in the environment real time by using several sound sensors and identifying macaque monkeys by their voice and send a signals to the cameras to the further confirmation process. Mobile application is to be developed for the overall research and development and detection of the macaque monkeys are display in the mobile application with the date and time so that farmers can get more information about the macaque monkeys coming patterns and see if the solution to keep them away is working effectively.

1.2 Literature Survey

Macaque monkeys cause farm damage. To prevent losses, caused by macaque monkeys an IP camera-based warning system is proposed In order to identify the monkey accurately in the field, hybrid recognition mechanisms are used. The system can notify farmers when the monkey is near in the farmland, and then can make noise sounds to drive the monkey out[3]. This proposed system several cameras are used to take images. Real time monitoring is not done.

For identifying the presence of macaque monkeys sound recording are used in the proposed research. Among different environmental sounds macaque sounds should be identified.

L. G. C. Vithakshana and W. G. D. M. Samankula proposed IoT based animal classification system using convolutional neural network. They used six categories of animals. There are many classification techniques. Most commonly classifications are done using acoustically and visually. They used acoustical classification techniques. IoT based acoustic classification system was designed using Convolutional Neural Networks (CNN).The audio clips were preprocessed using the Mel frequency Cepstral Coefficient (MFCC). A CNN architecture based on TensorFlow was used for the training process. To train and test the network, 400 sound clips of two seconds, such that 40 per each ten animal species, which were gathered from online libraries and formatted using Audacity, were used. The network was trained by changing the different gradient descent optimizers and eventually obtained the confusion matrices for each . [4].

Convolutional Neural Networks (CNN or ConvNet) is a well-known deep learning algorithm. It was invented based on the natural visual perception mechanism of the living creatures. CNN is commonly used for the classification. The most basic building blocks of neural networks are called neurons. Apart from that on CNN, there are convolutional layers, pooling layers, activation functions such as Rectified Linear Unit (ReLu), and fully connected layers (dense layers) available. There also have some variations of neural networks, including CNN, Recurrent Neural Networks (RNN), Autoencoders, and so on [5].

Yeo, Al-Haddad, and Ng researched animal identification (ID) detection system based on animal voice pattern recognition algorithm. In their system, they used the Zero Cross Rate (ZCR), MFCC, and Dynamic Time Warping (DTW) joint algorithm for animal voice recognition. ZCR was used to detect the endpoint of given input voice data and remove the silenced voice. When there is an input voice signal, the initial step is to detect the beginning and ending point of the vocal signal. The reason of this process is to remove the silence sound such that the processing is only focusing on the main part of the sound. MFCC was used for feature extraction of the given audio data files. Finally, voice pattern recognition was done using the DTW algorithm. As their obtained results, the developed system has worked as expected. [6].

Grill and Schluter conducted a study to detect the presence of birds on Mel-scaled log-magnitude spectrograms in a given audio signal by using two CNN architectures, namely “bulbul” and “sparrow”. Both architectures were performed very similarly on test datasets. The “bulbul” system was performed slightly better in the development set. Eventually, they obtained an Area Under Curve (AUC) measure of 89% for the hidden

test set, which was higher than any other previous contestant. They concluded that any other further improvement might not need for this study [7].

In the Khamparia, Gupta, Nhu, Khanna, Pandey, and Tiwari study, they conducted a sound classification using CNN and Tensor Deep Stacking Network (TDSN). They used the spectrogram images of environmental sounds to train the convolutional neural network (CNN) and the tensor deep stacking network (TDSN). They used two datasets for our experiment: ESC-10 and ESC-50. Both systems were trained on these datasets, and the achieved accuracy was 77% and 49% in CNN and 56% in TDSN trained on the ESC-10. From this experiment, it is concluded that the proposed approach for sound classification using the spectrogram images of sounds can be efficiently used to develop the sound classification and recognition systems [8].

Ajibola Alim, S., & Khair Alang Rashid, N. study, investigated on different feature extraction algorithms for speech recognition, including Mel-frequency Cepstral Coefficient (MFCC), Linear Prediction Coefficients (LPC), Linear Prediction Cepstral Coefficients (LPCC), Line Spectral Frequencies (LSF), Discrete Wavelet Transform (DWT), and Perceptual Linear Prediction (PLP). Moreover, they concluded that none of the methods were superior to the other; the area of application would determine which method to select [9].

1.3 Research Gap

I could not be able to find the macaque monkey sound identification and classification research papers. I found various research papers that are used to classify the sounds. They used different algorithms and different techniques to classify the sounds.

Feature	Research 1 [4]	Research 2 [5]	Research 3 [6]	Research 4 [7]	Research 5 [8]	Proposed system
Mobile Application is developed	✓	✗	✗	✗	✗	✓
Compare selected algorithms and make a comparison. Accuracy , Performance,	✗	✗	✗	✗	✓	✓

Accuracy and performance						
Compare the give most suitable algorithm to this classification	✗	✗	✗	✗	✓	✓
Real time monitoring	✗	✗	✗	✗	✗	✓
Give preliminary output to the confirmation process	✗	✗	✗	✗	✗	✓
Use CNN	✓	✓	✗	✓	✓	✓

1.4 Research Problem

Macaque monkeys pose a challenge to farmers due to their tendency to move in groups and cause damage to crops. They knock down fruits, damage them, pick flowers, and break small branches, making it hard for farmers to predict their unpredictable patterns. This uncertainty results in farmers often discovering crop damage after the fact. In response, some farmers resort to aggressive methods like wearing masks and using intimidation or even shooting the monkeys. In this research smart solution is proposed to identify the macaque monkeys and chase them away. The problems are;

- ✓ How to identify the presence of macaque monkeys. What methods can be used to identify the presence of macaque monkeys ?

Simply we can tell using cameras their images can be get and can check whether they are in the farm. But the time that they presence cannot be predicted. They may appear any time in the day. So real time monitoring should be needed.

- ✓ When real time monitoring how to reduce the power consumption and how to guarantee the sustainability of the system ?

But getting video recordings from the cameras in real time are not feasible because they are power heavy. To address that issue two step verification process is proposed. By using several sound sensors sounds recording can be got. Real time monitoring can be done using the sound sensors and analyzing the audio recordings presence of macaques can be identified and then for the confirmation process cameras can be used.

2. OBJECTIVES

2.1 Main Objective

Main objective of this research is to develop a smart system to identify the macaque monkeys and analyzing the different environmental sounds in the farm and from them detect the presence of macaque monkeys anytime during the day using sound recordings taken from sound sensors.

Compare and contrasted the models that use to identification process. Propose most suitable model.

Main aim is to reduce the crop damage caused by the macaque monkeys.

2.2 Specific Objectives

- Using several sound sensors which are in different locations in the farm getting the sound recordings and save the in a storage
- Real time monitoring and analyzing the sound recordings identify whether monkeys are presence or not and give signals to the cameras if identified macaques are presence.
- Develop a mobile application which give the information about the detection of the macaque monkey presence with the date and time and maintain a history which aims to give more ideas to the farmers about patterns.
- Compare the models and give comparison and use most accurate and model to identification process. Propose most accurate model.

3. REQUIREMENTS

3.1 Functional Requirements

- Real time monitoring
- Classification the macaque sounds ad non- macaque sounds
- Give preliminary output in order to trigger the cameras to on

- Farmer should be able to see the log which the macaque monkeys presence in the farm
- Accuracy

3.2 Non- functional requirements

- Performance
- Maintainability
- Reliability
- Robustness

4. METHODOLOGY

This research's primary goal is identify the presence of macaque monkeys using sound records.

In this component, the proposed system that has the capability of

1) Real time record the environmental sounds.
2) Classify the macaque sounds and branch breaking sounds and other sounds using several models and give the decide the most accurate one.
3) Identify the macaque sounds and branch breaking sounds among other environmental sounds
4) Give preliminary output in order to give signals to cameras on to the confirmation process.
5) Maintain history of detection the macaque presence with other details line time and date.

Dataset

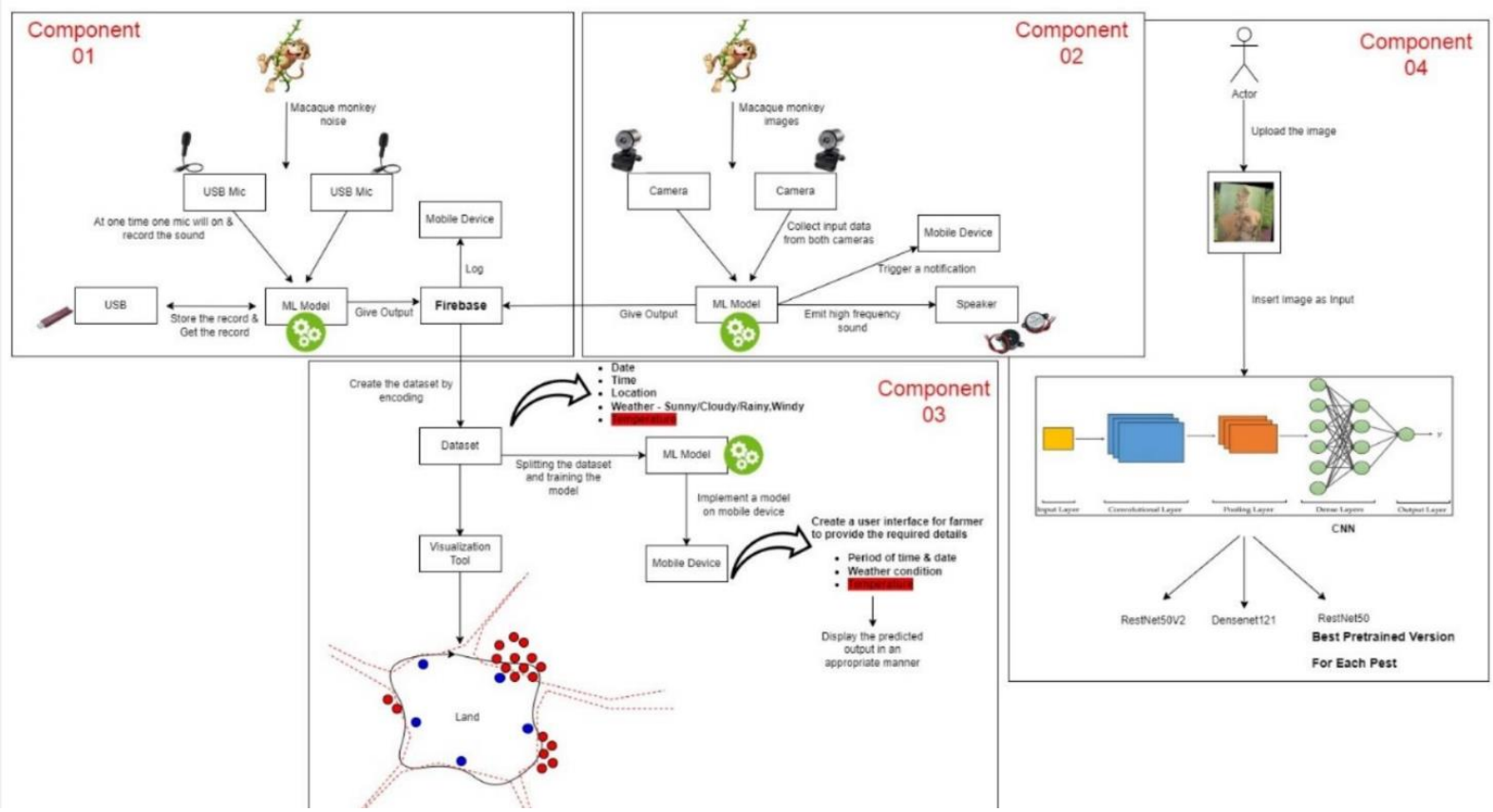
Macaque monkeys' communication sounds are different one another. Different macaque sound clips are collecting manually. Sound records are carrying out 3 to 5 seconds.

Sounds that macaque monkey make when the breaking the branches are also collected with other environmental sound clips. Macaque sounds and branch breaking sounds are going to be clear using noise cancellation and they will be prepare more suitable to train the models.

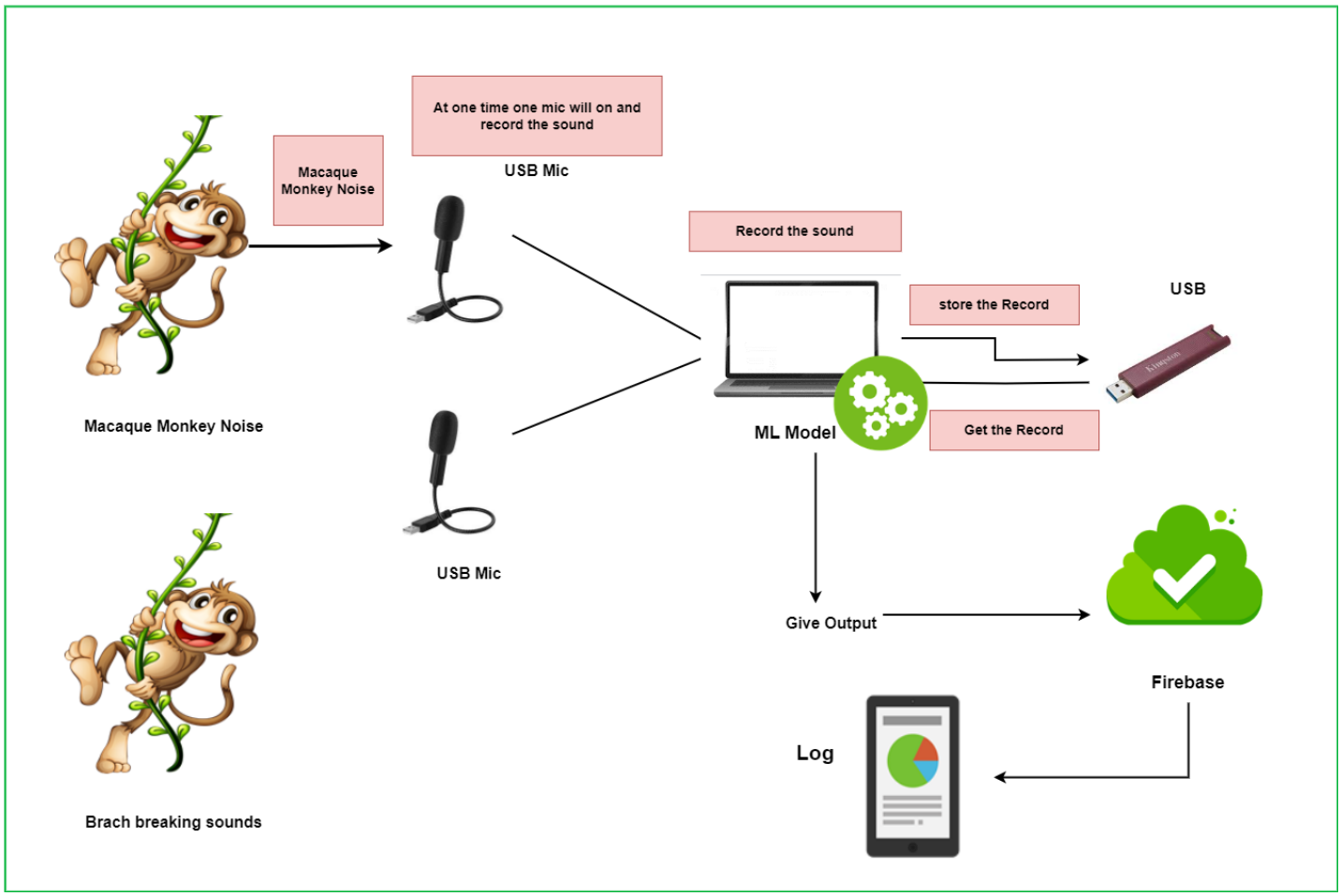
Algorithms

CNN , RNN etc. will be used to classify the macaque sounds and accuracy and performance will be evaluate and most suitable approach will be used to the system.

Overall system diagram



Individual System Diagram



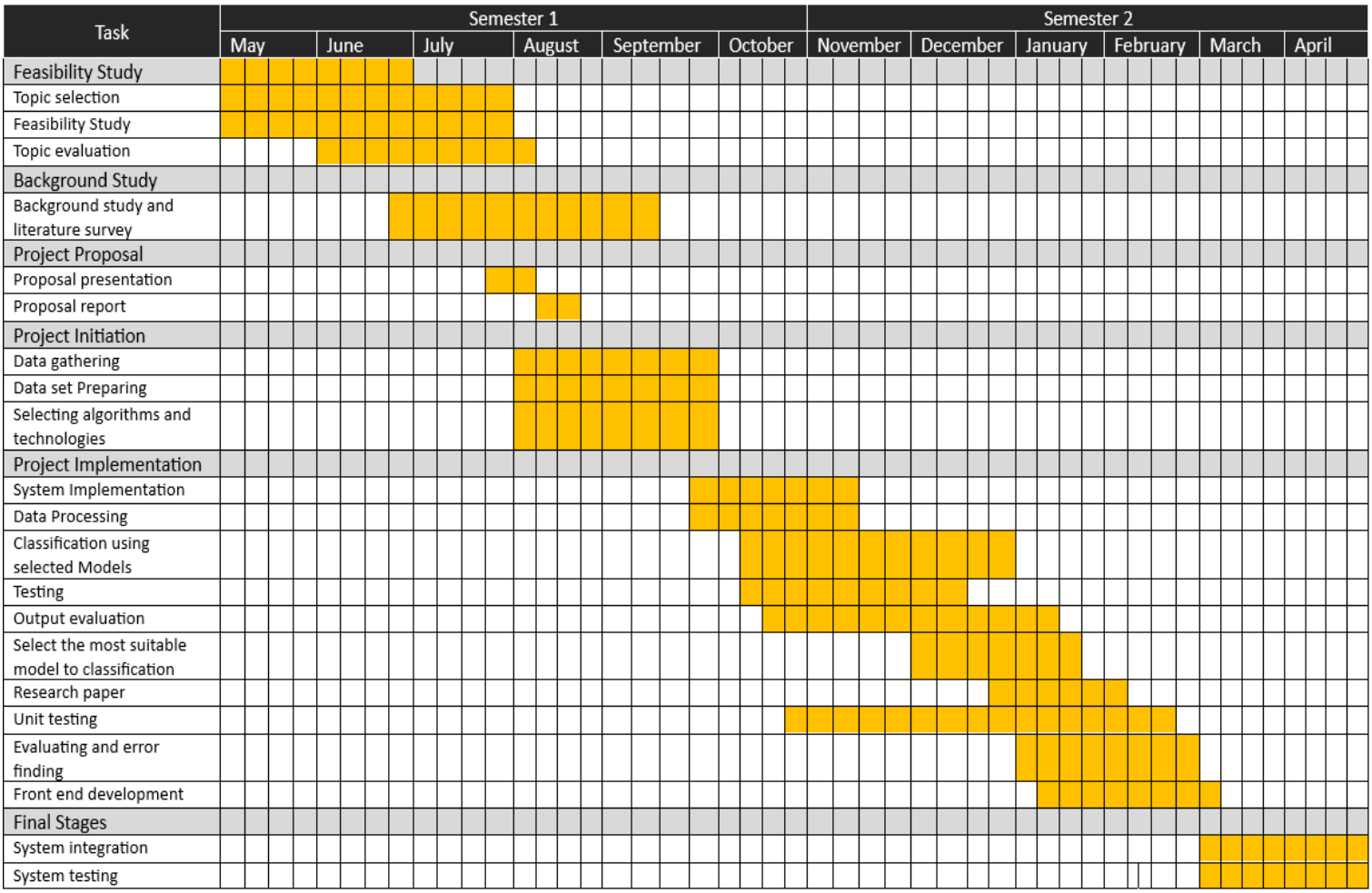
When macaque monkeys enter to the farm, they often emit distinct sounds. By using sound sensors, sounds are going to be recorded. There may be used several sound sensors that covers the farm. These sensors collectively cover the entire area, ensuring that any monkey-generated sounds are captured. Each sensor operates sequentially. Recorded audio snippets are temporarily stored in a local storage system, allowing for subsequent analysis and classification. To achieve this, a sophisticated sound classification mechanism is employed. This mechanism is trained to differentiate the specific vocalizations and noises produced by macaque monkeys from background sounds. This classification can involve machine learning techniques that learn from a dataset of known monkey sounds. Once the classification is performed, the outcomes are recorded. Each detection instance is tagged with a date-time stamp to provide a clear timeline of monkey activity. These records are then securely uploaded to cloud storage, ensuring data accessibility and preventing loss even if local storage is compromised.

A dedicated mobile application serves as the interface for farmers to access the information. The app provides real-time updates on detected macaque intrusions, complete with timestamps

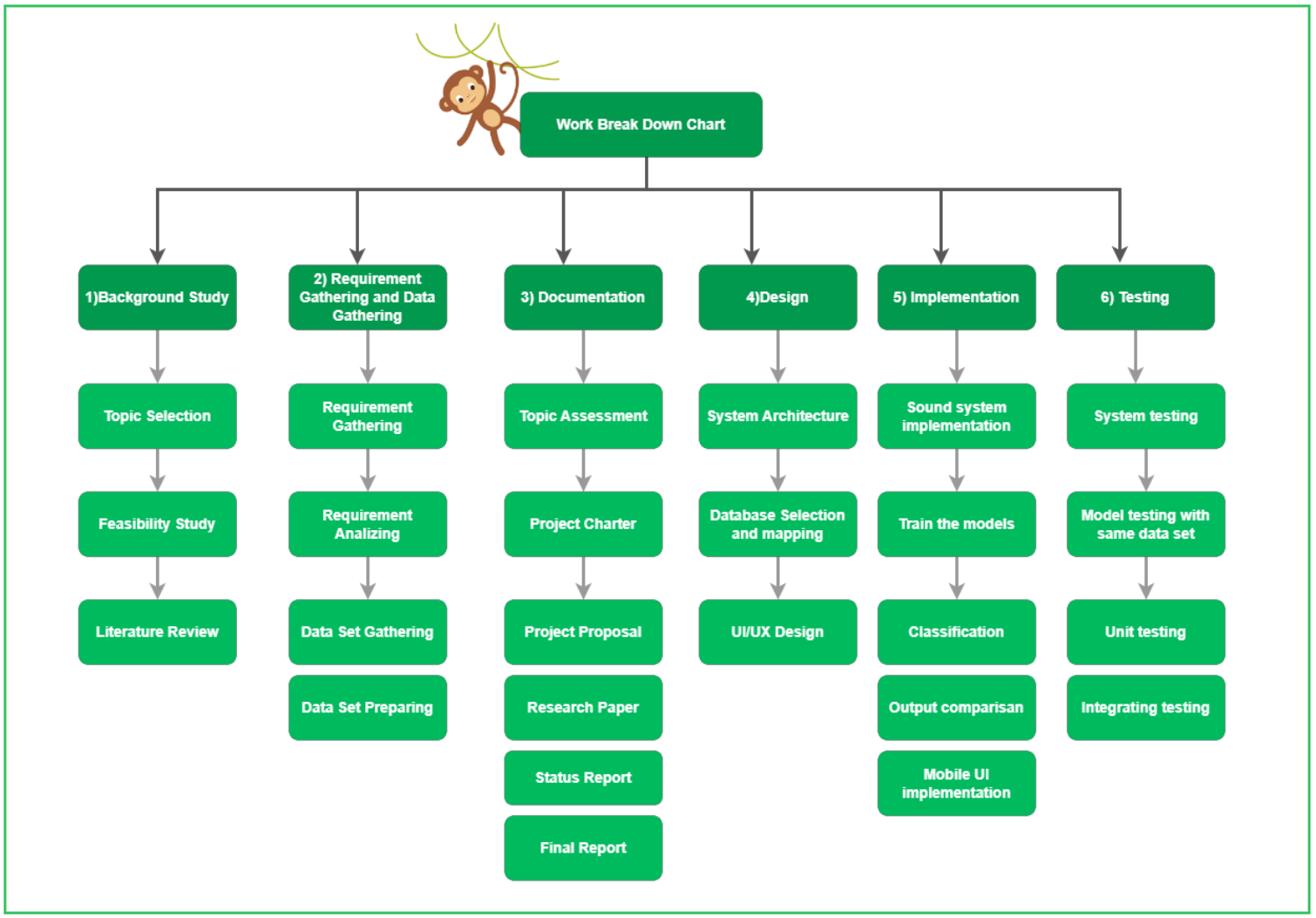
and the corresponding farm locations. This historical record of identified macaque occurrences aids farmers in understanding patterns.

5. DESCRIPTION OF PERSONAL AND FACILITIES

5.1 Gantt Chart



5.2 Work Breakdown Chart



Figures

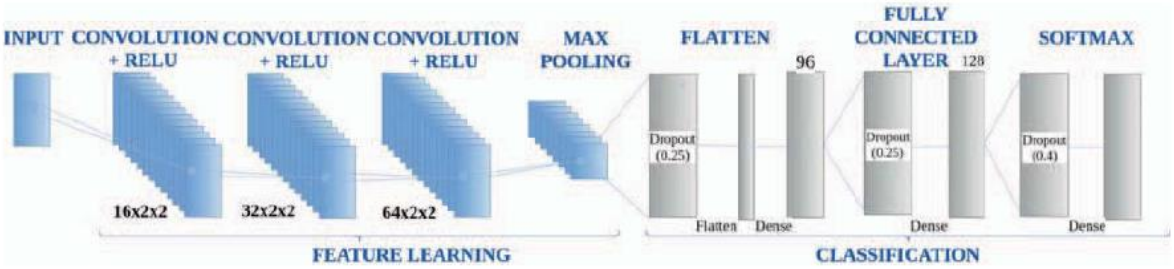


Fig. 1. CNN Architecture

Figure 5:CNN architecture [6]

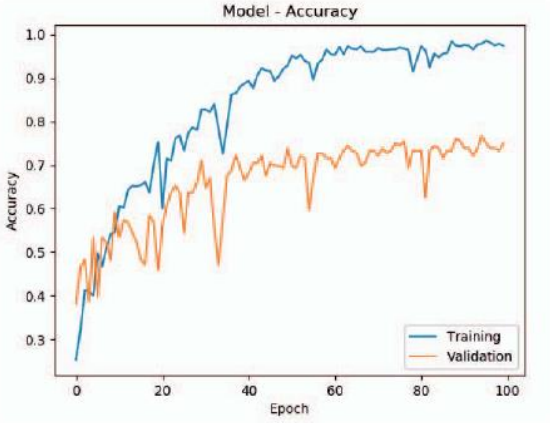


Fig. 2. Nadam Epoch - Accuracy Chart

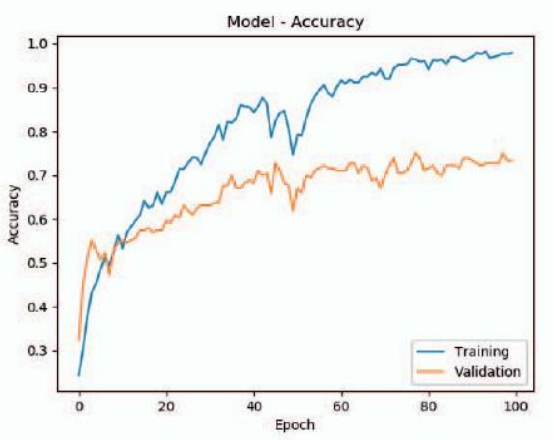


Fig. 4. Adam Epoch - Accuracy Chart

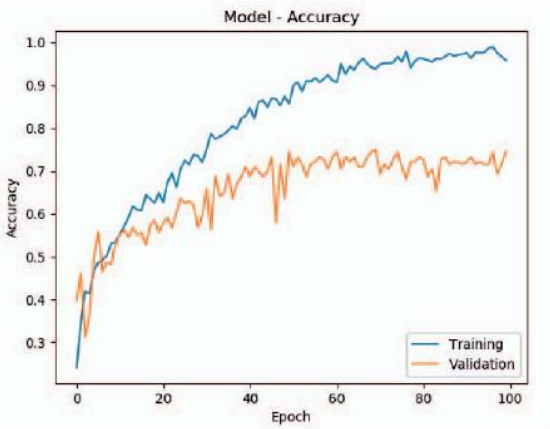


Fig. 3. Adadelta Epoch - Accuracy Chart

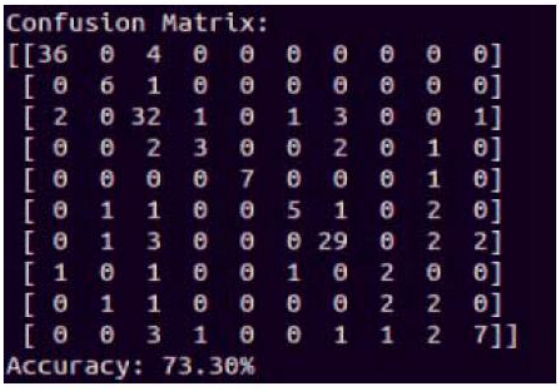


Fig. 5. Adam Optimizer Confusion Matrix

Figure 6:Accuracy charts [6]

6. REFERENCES

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