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B.Sc. (Hons). Computer Science and Software Engineering

University of Bedfordshire

**REFLECTIVE REPORT**   
For   
**An Artificial Intelligence-based Human Elephant Conflict Mitigation System**

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# 1. Introduction

This reflective chapter provides a comprehensive project overview, encompassing the design, development, and testing phases. The report aims to reflect on the challenges encountered during the project critically, the personal growth and development achieved through the experience, and the valuable lessons learned throughout the process. The report also evaluates the project's success and offers practical recommendations for future work. The report underscores the significance of reflection in fostering personal and professional growth and the role of reflective practices in shaping and enhancing professional development. Overall, this reflective report is expected to provide valuable insights into the experience of working on the project and highlight the importance of reflection in achieving personal and professional growth.

## Project Background

The purpose of this project is to build a solution for the human-elephant conflict problem; Human-elephant conflict is the biggest problem in elephant-range countries, including Sri Lanka. Over the past decade, thousands of reported cases of human-elephant conflicts in Sri Lanka have resulted in human deaths, property damage, and the intentional killing of hundreds of elephants annually. Protecting the endangered species of elephants in Sri Lanka is a critical responsibility for the country. Despite various management strategies developed to mitigate this conflict, there still needs to be a solid solution, and many current solutions are only at the prototype level. This project aims to propose a sustainable solution to this problem by developing an artificial intelligence-based system for detecting elephants and providing early warnings to nearby villages; by automating the process currently carried out manually by human monitors, this system could significantly reduce human-elephant conflicts in Sri Lanka.

## Motivation

I have been working on the human-elephant project for almost two years; I naturally have the motivation to solve this problem; first, I built a sensor-based prototype for this problem two years ago. The ultimate reason behind my eagerness to address this problem is that there is an emotional story about it; I lost my friend in a human-elephant accident during school time; my friend is from a rural area of Sri Lanka called “Koduvamadu,” where a lot of elephants are there, still, we lose many properties and lives because of this problem, earlier, I read more research papers about this issue, I did some essential works on this using traditional methodologies such as sensor-based, size-based detection, etc., But, this time, I am going to use deep learning technology, This whole idea came one day when I was traveling to Colombo from Batticaloa at night on the bus; our bus was broken down in a jungle, I was sitting inside the bus, and I noticed that there were some humans near the paddy field area and watching for elephants, they make shouting when they see elephants. I realized that we could convert this manual task to a digital one; why don’t we build an AI camera that watches for elephants and gives alerts? That would be super-efficient; this is how this idea was born.

## Overview

This report contains four chapters; the first chapter explains my self-management procedures, such as how I managed time and tasks and solved some critical management issues that arrived during the research and development period. The second chapter covers the reflection on this project, the challenges I faced, how I overcame those blockers, and the solutions I used to tackle those. The third chapter contains information about the research progress and discusses current progress, future works, and limitations; The final chapter is about the thesis report content, which explains the structure and the documentation flows.

# 2. Self-Management

## 2.1 Introduction

During the development of this research, self-management was the focal point; I used many techniques and tools to manage my time, tasks, data, documents, and source code; I firmly believe my self-discipline and management skills helped me a lot in this journey to prioritize and, well-organized the research’ tasks and, procedures to obtain the high quality and usability outcome.

## 2.1.1 Time Management

As for time management best practices, I used many methods and tools, such as the Gantt chart, for planning and scheduling projects using “MS Excel tool”; Time tracking to estimate the amount of time spent on a particular task to prioritize future work using an online tool named “Clockify”; I setup milestones to complete specific tasks by a certain date to reduce the time spent on non-critical activities; Pomodoro technique was used improve the effectiveness of time management to divide tasks into sub-tasks using “Focus Booster” tool, and I also use time-blocking method to block my schedules using “Google Calendar.”

## 2.1.2 Task Management

As for task management best practices, I used “Trello Board” to manage tickets and task lists; as a prioritizing method, the Eisenhower Priority Matrix was used during the development stage of this research; I usually break down an enormous task into smaller pieces to make them more manageable, I prioritize task based on how important and urgent using High, Medium, Low keywords, this clearly defines the priority of a task. It helps me to maintain a task list more efficiently and effectively.

## 2.1.3 Data Management

As a cloud storage, I use “Google Drive” to maintain research-related documents and files; I consciously manage my data effectively; I create directories with a straightforward naming convention; I use “kebab-case” naming rules when it comes to naming files and folders. I used a system of folders and subfolders to organize my data, each folder representing a specific aspect of my research; since I use Google Drive, all my data is secure, and I don’t need to worry about backing up because Google Drive will handle those things, As a documentation tool I use “Microsoft Office.” Where I use “MS Word” to write research-related documents.

## 2.1.4 Source Code Management

I have to manage a large amount of source code in this research; I use “Git/GitHub” as a version control and source code management platform to drive the development of this research; I make regular commits to track changes to my codebase. I also use branches to work on new features or bug fixes, which helped me to organize my work and avoid merge conflicts; I use “Conventional Commits” for Git commit messages to document the codebase, and I use “README.MD” to write the system dependencies, libraries, installation, debug guides as a system information document, for coding alignment, I use constant identifier names such as “snake\_case” for variable names, “PascalCase” for function names, I use “VSCode” as a text editor with coding extensions and Boilerplates.

## 2.1.5 Gained Experience

Through my research, I gained experience in self-management, including time, task, data, and source code management. I used tools like the Gantt chart, time tracking, and the Pomodoro technique to manage my time, while the Eisenhower Priority Matrix and task breakdown helped me manage tasks efficiently. Google Drive was used for data management and Git/GitHub for source code management. My experience in self-management allowed me to prioritize and organize tasks, maintain quality outcomes, and streamline my workflow.

# 3. Reflection

## 3.1 Introduction

During the development of my research, I encountered numerous challenges and issues that impacted different stages of the process, including requirement gathering, dataset preparation, artifact design, research, development, and documentation. Each step presented unique challenges, and I had to exercise creativity, innovation, and problem-solving skills to navigate them successfully. In this reflection, I will discuss the challenges I faced during each stage of the development process and how I overcame them to accomplish my research objectives.

## 3.2 Requirement Gathering

**Task:** Gather information on human-elephant conflict by identifying parties involved, reading research papers, interviewing farmers and village people, and defining project goals and technical requirements.

**Issues:** Difficulty in identifying all parties, incomplete and biased information, the challenge in conducting questionnaires for uneducated farmers/village people, the need to travel far to collect stories, limited access to relevant research papers, and difficulty in choosing the most appropriate tools.

**Solution:** To address the challenges in gathering information on the human-elephant conflict issue, I conducted online research and collected data from existing databases, websites, and social media platforms. I also participated in community events to interact with locals and understand their concerns and issues. Furthermore, I thoroughly searched online databases and academic journals and contacted field experts to request information or insights. I used face-to-face interviews and observation methods to overcome the challenge of conducting questionnaires for uneducated farmers/village people. Additionally, I ran a cost-benefit analysis to determine the most appropriate and feasible solutions.

## 3.3 Dataset Preparation

**Task:** The first task is to gather many daytime images of elephants, which are crucial for training a daytime model. The second task is obtaining many nighttime pictures of elephants, which is essential for preparing a nighttime model. After gathering the images, the next task is to label and annotate them, which is time-consuming. Finally, it is necessary to delete inappropriate images from the dataset, such as low-quality or irrelevant images, to ensure that only valuable data is used to train the models. These tasks require careful planning and execution to produce a high-quality dataset that can be used to develop accurate and reliable models.

**Issues:** I encountered numerous challenges and problems while preparing the dataset. One significant problem was the large number of images, which made it difficult to annotate all of them manually. Another problem was the need for many daytime and nighttime images of elephants to train separate models for each condition, such as daytime models and nighttime models. Additionally, the labeling and annotation progress of elephant images required a significant amount of time and effort. Finally, it was necessary to delete inappropriate images from the dataset to ensure that only relevant and valuable data was used to train the models that provide better accuracy.

**Solution:** I employed several solutions to address the challenges encountered while preparing the dataset. I extracted frames from more than 150 discovery videos to obtain more images of elephants; I produced more than 150,000 images from those discovery videos. However, it was difficult to label all of them manually, so I utilized an online tool called "RoboFlow" to automate the annotation process. In addition, I used a Python script to convert the 150,000 daytime images into nighttime images by adjusting the brightness and color correction to create a nighttime dataset of elephants. These solutions allowed me to acquire more images for the project while reducing the time and effort needed for annotation. Finally, I established strict criteria for deleting inappropriate images, ensuring that only relevant and valuable data was used to train the models.

## 3.4 Artifact Designing

**Task:** During the designing period of the artifact, I had many challenges in choosing the suitable methods, techniques, and tools to carry out the project; I had so many tasks, such as defining the proper strategy to solve the human-elephant conflicts in Sri Lanka, what are the technical tools to implement the selected design, these are primary task during the artifact designing phrase. Moreover, I also had to plan the strategy precisely to provide a better solution for this problem.

**Issue:** As issues, I faced so much confusion in selecting the correct methodology; I was also confused about whether the AI approach can be the right one for this problem because my literature review ends up my mind with so many options to choose from, then I mixed those solutions to create a better artifact with so many backend features, another problem is, according to the interviews with farmers and villages people, I gained so many manual techniques that they used to block elephants entering their villages, such as giant crackers sound, fire those methods are complicated for me to build since the project has to be involved with electronic a lot, and it needs many resources, and especially it times more time and more people, then after I found a solution to block elephants intelligently, I had a problem on choosing technology stack the artifact I designed.

**Solutions:** As solutions for the issues that I mentioned above, to make confident that AI is the right solution, I explored my literature review and merged possible methods to form an AI-based solution with more backend features; Next, the biggest problem is with having a feature that is blocking elephants, to block elephants from entering villages, I chose a technique that is about playing artificial sounds effects of bees, there is a proven study that elephants are afraid of buzzing bees sounds, I used this method to sort out that challenge. Then after designing the artifact, I needed to choose the right technology stack; that was a serious issue because I ended up with so many tools; after thoroughly researching technological tools, I decided on the best tools to build the project; I chose Python as a primary programming language along with deep learning frameworks, I choose MERN to build the backend.

## 3.5 Development and Implementation

**Task:** During the development and implementation period, there are a lot of tasks, which can be divided into building the monitoring system and building the backend system; the monitoring system is more into AI stuff such as training AI models, sending early warning messages, detecting elephants, and the backend system is about managing the data that are sent by the monitoring system such elephant detection information time, date.

**Issue:** Some issues came across when building this backend and monitoring system; the first one is the building UI for the monitoring system; I chose PyQt for the user interface development of the monitoring system, but as long as the development goes, PyQt was not a good choice since it was unable to handle async/threaded programming methodologies, UI was stuck when there is a function executing in another thread and same as we are unable to access the UI elements from another thread, there are many issues on the monitoring part, another problem I faced during the training process of AI models, it needs high processing GPU, training failed because of a large batch size of images sent to the neural network at once, then as useful while coding, I encountered numerous amounts of errors and bugs.

**Solution:** As solutions for the issues that I encountered during the development and implementation process, I sorted out all of them in a more excellent way; the first issue is about the UI framework PyQt; As soon I get to know that it wasn’t suitable for asynchronous programming, I changed the UI framework to Tkinter, because Tkinter handles async programming in a nicer way, and also I used Tkinter Bootstrap to design the UI a bit to make it more good looking; and the second problem is about the training data size that is sent to the neural network during the model training process, it fails because of the batch size, then I reduced the batch to match with my computer hardware specification, so like this I faced a lot of errors and bugs, this is usual in programming, I solved all of them with the help of internet.

# 4. Research Progress

## 4.1 Introduction

This chapter reviews current research progress, such as limitations and future works; the primary scope of this chapter is to give the current state of the study. It presents an overview of the subject, highlighting significant findings in the field and discussing the challenges and opportunities. It aims to provide readers with a clear understanding of the current state of research and the direction of future investigations.

## 4.1 Current Progress

Currently, 60% of the research work is done. The development stage is ongoing; the dataset preparation of the elephant model is completed, and produced two kinds of datasets, daytime, and nighttime, which consist of 15000 images of elephants in each; the model training is also completed. I also implemented the early warning email-sending functionality, and the playing artificial sounds effects of the buzzing bees function are also built; Next step is all about building the backend system that can be used to analyze the captured data. Appendix "A" provides a comprehensive overview of the current progress of the system's layout.

## 4.2 Future Works (To be Completed)

40% of the research works are pending; Those are critical tasks on the backend system. The automatic testing script must be made to test the system; some critical works are pending in the backend site; I also need to make some changes to the monitoring system to integrate both systems to function together, and the FTP connection between the monitoring system and the backend system needs to be implemented to send captured elephant images to the backend system, like that there are many configuration works are out there when it comes to the system level. Some documentation works are also pending, such as the thesis report, and this system guide and documentation need to be prepared.

# 5. Detailed Content of Thesis Report

## 5.1 Introduction

The chapter provides an in-depth analysis of the final thesis report content; The thesis report covers various aspects of the project, including its background, objectives, methodology, data collection and analysis, results, and conclusions.

## 5.2 Thesis Report Content Structure

* **Title Page:** *Contains logo of UoB, module name, student name, ID, and submission date.*
* **Abstract:** *Contains the overview of the entire thesis.*
* **Acknowledgment:** *Contains**Brief statement of vote of thanks.*
* **Table of Contents:** *Contains**contents & structure.*
* **List of Tables:** *Contains*a*list of table information.*
* **List of Figures:** *Contains*figures, diagrams, and illustrations information.
* **Keywords:** *Contains abbreviations of long words used in this thesis.*

**Chapter: 01 Introduction:** *Explains the basic details of the research to get started.*

* Project Background
* Project Aim and Objectives
* Project Framework
* Description of Artefact
* Development of Artefact

**Chapter: 02 Literature Review:** *Explains previous studies and root causes of the problem.*

* Introduction
* Elephants in Sri Lanka
* Elephant Tourism in Sri Lanka
* Human-Elephants Conflicts
* Elephants and Farmers' Struggles
* Villagers’ Traditional Method
* Existing Solutions
* Technology Solutions
* Artificial Intelligence
* Computer Vision Technology
* Conclusion

**Chapter: 03 Methodology:** *Explains research techniques and methods.*

* Introduction
* Selection of Subjects
* Collection of Data
* Analysis of Data
* Design and Implementation

**Chapter: 04 Results and Discussions:** *Explains findings and research outcomes.*

* Introduction
* Description of Findings
* Evaluation
* Testing
* Summary

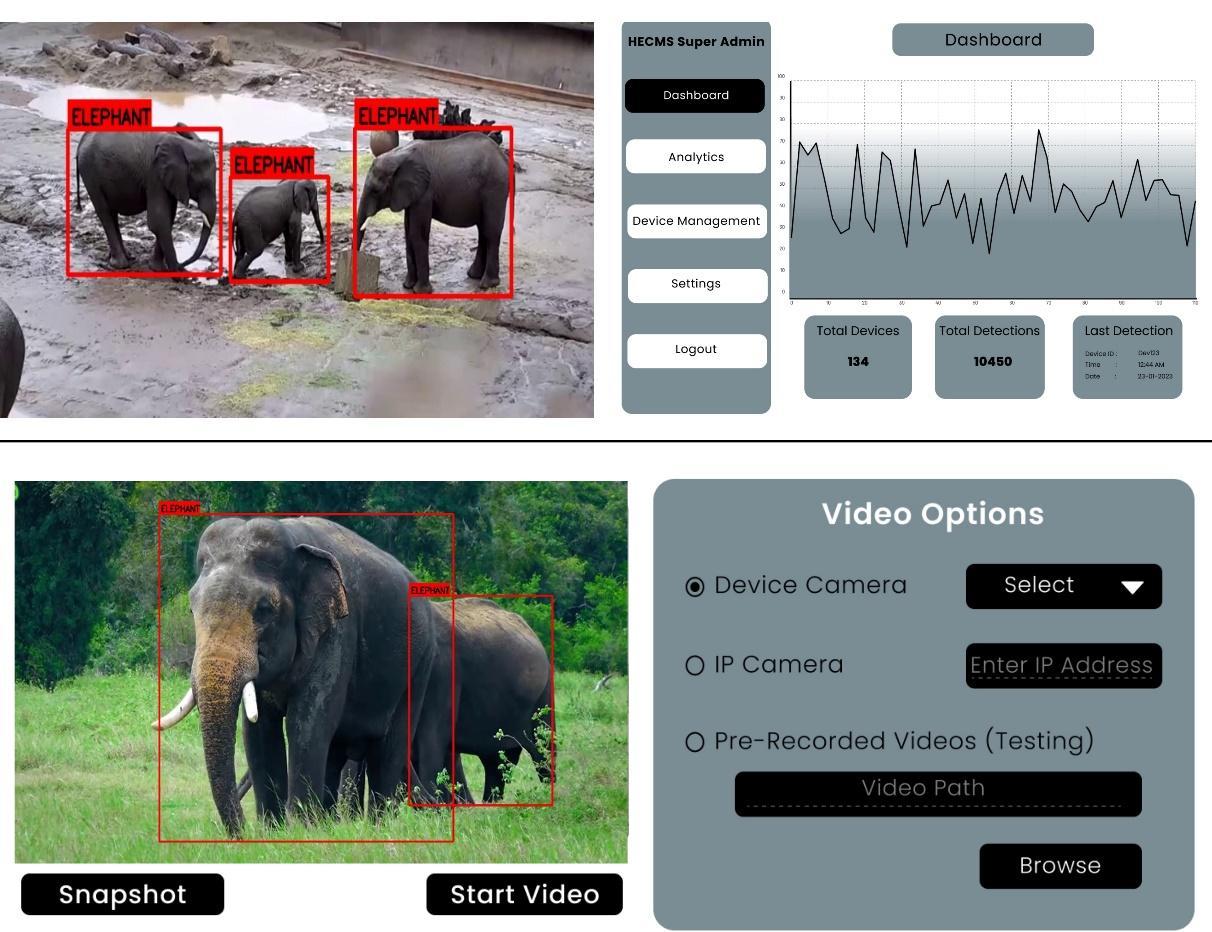
**Chapter: 05 Conclusion:** *Explains the summary of the research.*

* Future Work
* Limitations
* Recommendations
* Personal thoughts
* Final thoughts

**References:** *Contains sources and citations referred to in the thesis.*

**Appendices:** *Contains supplementary materials.*

# Appendix A: System Demo Layout



Graphical user interface, application

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