Fish Guide Pro

”Mobile application to identify and provide details of freshwater fish in Sri Lanka”

Inspire love for learning

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Abstract

Fish Guide Pro is a mobile application that helps users identify freshwater fish in Sri Lanka, a country known for its rich biodiversity. The app is useful for various parties including researchers, students and nature lovers. To do this, MobileNet version 2, a model specifically designed for mobile devices, was used after studying several other models. There are 53 layers in MobileNet version 2 and hence its accuracy increases. The first step in fish identification was to collect data for five different fish species, which required taking nearly 800 photographs. The accuracy became 0.9983 after several rounds of testing. Also wireframe and mockup creation was done before creating user interface to increase user experience. The Fish Guide Pro app was developed using the Java programming language in Android Studio, making it efficient and user-friendly.

Acknowledgement

I would like to thank everyone who has helped me in this project from the beginning to the end. Especially under the guidance of Dr. Rajitha Navaratne, this application was successfully completed.

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Chapter 1

Introduction

1.1 Chapter Introduction

Fishes that are indigenous to Sri Lanka were examined and introduced here. The problem domain was identified and discussed along with its context. Afterwards, Fish Guide Pro was presented as a solution to the problem. A topic called "Research Objectives" covered both general and specific objectives. A Gantt chart presentation was used to outline the thesis.

1.2 A brief introduction to freshwater fish native to Sri Lanka

Sri Lanka, known as the pearl of the Indian Ocean, has a surface area of 65,610 square feet. The country's diverse biodiversity is one of the reasons for this title. Sri Lanka has various climatic conditions, flora, fauna, and fish in an area of 100 km. Fish can be found in both freshwater and saltwater. However, this project's primary focus is on freshwater fish, which are fish that live in rivers, ponds, lakes, and other inland water habitats. These fish can survive in different environments, and they come in different shapes, colors, and lifestyles. Freshwater fish have economic, cultural, and recreational value. Sri Lanka is home to both native and endemic fish species. Among the 95 freshwater fish species in the country, 52 are native, making up 41% of the total fish species. Sri Lanka is responsible for 70% of this value alone *Freshwater Fish in Sri Lanka - EDB Sri Lanka* 2023. However, some fish species in the region are in danger of extinction due to fish habitat destruction, water pollution, the introduction of non-native fish, climate change, and river fragmentation *One-third of freshwater fish face extinction and other freshwater fish facts — Stories — WWF* 2023. Researchers are continuously working to save these fish species. However, identifying some fish can be challenging since many fish share similar traits. The lack of diversity in the types of fish, the incorrect methods of obtaining fish data, and the conflicting information in some literature are contributing factors that make researching fish in Sri Lanka difficult.

1.3 The identified problem domain

Identifying the native fish of Sri Lanka has been a challenging task due to the vast diversity of fish species present in the country's freshwater ecosystem. The funding for this project is based on the need to preserve this diversity. Factors such as gender, age, and color play a significant role in how these fish species adapt to their environment. These factors make it challenging to observe and protect fish species that are on the brink of extinction. Additionally, there are other grant-related information that needs to be analyzed and taken into consideration.

- Species diversity - Since freshwater environments are home to many species of fish, some fish show similar characteristics due to shape, color and size and body markings that show considerable diversity. Because of this, it is difficult to identify hitherto undiscovered or rare (to be conserved) fishes.

- Similarities between species - Although fish of several species and families belong to the same ecosystem, similarities can be seen between them. It is a challenge for study groups because it is difficult to identify them with the naked eye.

- Hybridization - If a fish has undergone hybridization, it is quite difficult to identify the species or family of the fish. Also, new offspring with intermediate characteristics can be born and a new race can be born. It also makes it difficult to identify the fish correctly.

- Lack of identifying features - Another reason is that some fish do not have enough features to be easily recognized by the naked eye. This is an example of small and subtle features.

- Limited information and lack of available resources - If time is taken to identify fish and collect information, there will be a problem of efficiency and accuracy. Even on the Internet, information about some fish is minimal.

Identifying fish in freshwater environments is a challenging task due to multiple factors. "Fish Guide Pro" aims to lead the way in addressing this difficulty by providing a comprehensive guide to help find the specifics of the fish observed in streams, rivers, and other freshwater environments.

1.4 problem context

As mentioned earlier, Sri Lanka's rich biodiversity is a valuable asset to the country and plays a crucial role in the overall ecosystem. The presence of numerous streams, rivers, and ponds in the region facilitates the growth of various species of freshwater fish. These fish are nurtured and bred in institutions overseen by the National Aquaculture Development Authority (NAQDA). Additionally, the following points provide a better understanding of the issues discussed above.

- Identification Difficulties - Identifying and documenting freshwater fish is challenging due to their resemblance to each other, requiring special observations and tests for accurate identification.
- Conservation Concerns - Humans, along with various environmental and ecological factors, are putting fish species at risk of extinction. Even minor effects can have a significant impact on fish populations. Therefore, it is crucial to maintain a proper environmental balance to ensure the survival of these species.
- Current Fish Identification Methods - At present, identifying fish using traditional methods is mostly reliant on books and reference materials. This approach is highly inefficient and time-consuming. Furthermore, relying on print media means missing out on the latest information. A digital guide can help you obtain fish-related information quickly and easily.

- Technology as a Role - The traditional search, which was restricted to books, has been broadened by technology. This makes it a user-friendly and accurate data-collection tool for academics and observers who dislike books but enjoy fish.
- Data should be gathered from trusted sources. It is possible to accomplish so through government and private institutions, and both should be supported.
- Stakeholders and Users – helps students, researchers and observers involved in interdisciplinary training at the National Aquaculture Development Authority (NAQDA).

1.5 Fish Guide Pro as a Comprehensive Solution

Fish Guide Pro is a smartphone app created to help identify different fish species. It aims to provide a unique solution to the issue of identifying fish. Initially, the app will only recognize five local fish species: Bulat Hapaya, Damkolapitiya, Galpadiya, Kawaiya, and Talkossa. However, the number of fish species will increase over time according to future plans. The app uses a computer vision model called MobileNet to identify fish. Once the app detects a fish, it displays various information such as the fish's scientific name, genus, tribe, caste, available food, reproduction, distribution, living environment, and living area. This information is helpful for anyone who enjoys, investigates or studies local fish. The main goal of Fish Guide Pro is to offer quick and easy access to information about different fish species. Users can simply upload or take a picture of a fish, and MobileNet will identify the species and display the relevant information. The app is user-friendly and also easy to use, making it suitable for people of all ages.

1.6 Research objectives

The "Fish Guide Pro" project has a clear goal - to provide information about Sri Lanka's fish community to interested parties such as fish watchers and explorers. The project also has specific aims, objectives, and strategies in place to ensure that the application is efficient and effective.

1.6.1 General Objectives

The main objective of this project is to create a mobile application that can identify native freshwater fish in Sri Lanka and provide accurate information on each fish. The grant's goal is to support various institutions in Sri Lanka that are involved in fish research, development, and interest, including the National Aquaculture Development Authority (NAQDA) and private aquaculture development centers. By including specific details and traits of the fish they observe without external assistance, those involved in the aquaculture sector and freshwater fish research can obtain comprehensive and precise information. This program is expected to be a useful tool for further research on Sri Lanka's local freshwater fish resources, making access to extensive fish identification materials more accessible. It is particularly effective as it reduces reliance on others. The overall goal of this project is to make the program user-friendly for people of all ages, including young and elderly individuals, who use it.

1.6.2 Specific Objectives

When identifying objectives, a specific objective can be set, which can cover various areas such as deployment and data collection. Here are some of the objectives that can be pursued:

- Data Collection - A key feature of the application is its ability to collect data. The Dambulla Aquaculture Development Centre, managed by the National Aquaculture Development Authority (NAQDA), provided all the necessary information, including fish descriptions and photos, to train the model. The Aquaculture Development Centre is an excellent choice for several reasons. Using high-resolution photos to train the model could enhance the accuracy and reliability of the data collected.

- Creating a dataset for model training - Before training the model, a dataset must be created. This involves tasks such as labeling and removing unclear photos from previously collected images.

- Choosing the most appropriate machine learning models for the generated dataset - Several successful and effective machine learning models are available for this project, and one of them can be selected.

- Training the dataset using the chosen models - The goal is to train the model accurately and consistently. Training techniques are applied repeatedly to reduce errors.

- Examining similar applications - This helps in understanding what those applications have not achieved, making it easier to comprehend how the Fish Guide Pro software works and what adjustments are required.

- Creating and developing the application - This objective is listed under the general objective because the primary aim is to create a user-friendly application during the initial development. The program is useless if the user cannot navigate it easily, regardless of how clear the visuals are, how imaginative the data collection is, or how excellent the models used are. Thus, the creation objective occupies a high position.

- Integration - This involves integrating the mobile application and the trained models. The software combines the trained models to build a back-end API.

- Evaluating Performance - This objective aims to test and evaluate the application's performance thoroughly. It ensures that aspects such as speed, precision, robustness, etc. are taken care of through configuration techniques.

The aim is to create a high-quality application by achieving these specific objectives.

1.7 Gantt chart

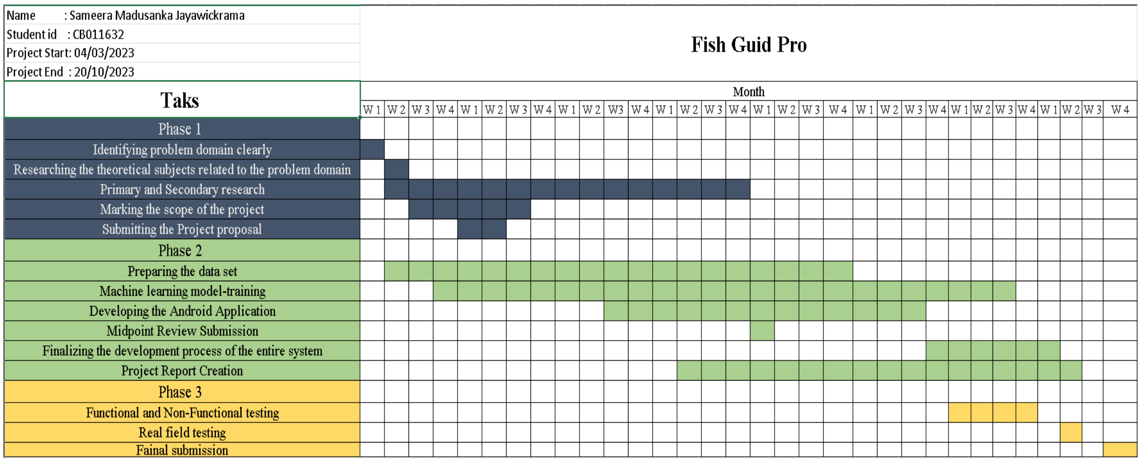

Figure 1.1: Gantt chart

1.8 Thesis outlines

chapter	**Chapter outline**
Interdiction	Elaborates the project problem domain, problem context, general and specific objective.s
Literature Review	Discusses the previous studies.
Requirements specification	Discusses Functional Requirements, Non-Functional Requirements, and Software Requirements.
Methodology	Intends to discuss in detail the entire development and methodology of the fish guide pro application.
Solution concept	The concept of solution is primarily discussed.
Implementation	Describes Hardware and Software requirements, Object Detection model Mobilenet and Mobilenet training process using illustrations.
Testing	Discusses how the application is tested.
Conclusion	Conclusion, limitations and future works are discussed.

Table 1.1: Thesis outlines

Chapter 2

Literature review

2.1 Chapter Introduction

Solutions have been explored that are similar to the pre-prepared application and linked study paper, while also comparing them to previous applications. Additionally, we introduced the topic of Ichthyology and explained the model and fish species used to develop Fish Guide Pro. The discussion emphasized the importance of using a mobile application for identifying fish, rather than traditional methods.

2.2 An ichthyology from history to the present

When discussing fish, it is important to mention the field of Ichthyology. What exactly is Ichthyology? What is its history? What does it entail? What are its objectives and benefits? Let's delve into these questions. Ichthyology is the scientific study of fish, encompassing a range of sub-disciplines such as behaviorism, taxonomy, anatomy, and physiology. Essentially, it is the science of studying fish. Scientists study fish in various bodies of water, including rivers, ponds, lakes, and oceans, piecing together the puzzle of how fish relate to each other. To achieve this, they study the appearance of fish, identify their characteristics by examining their bones and muscle structure, observe their interactions and behavior with other fish, analyze their habitats and how they suit each species, and examine the internal anatomy of fish *What*

Is Ichthyology? 2023.

Ichthyology is the study of fish, and the name comes from two Greek words, ichthy and ixthu. The origins of this field of study date back to the Paleolithic era, around 40,000 years ago. In 335 B.C.E. and 322 B.C.E., the Greek philosopher Aristotle provided the first taxonomy of fish, describing 117 species of Mediterranean fish Vishnupriya, Nair, and Sangeetha 2022. Over time, researchers have continued to study fish with great attention, and by the late 19th century, many new species had been discovered and data on diversity had been gathered. This allowed for a clearer understanding of the relationships between fish species. In the middle of the 20th century, advances in oceanography and the development of new techniques and equipment, such as SCUBA, made it possible to study fish behavior underwater. This research uncovered many previously unknown facts about fish interactions, migration patterns, and habitats. Thanks to these advances, researchers were also able to maintain and breed fish in lakes for use in laboratory experiments, leading to studies in toxicology and parasitology. In addition to scientific research, ichthyology has an important role in recreation, with many fish kept for fishing. However, it is crucial for government agencies and laboratories to responsibly manage research and replication to protect fish conservation and wild fish breeding. Sri Lanka's National Aquaculture Development Authority (NAQDA) plays a significant role in this effort.

2.3 The need for a mobile application over traditional methods

Understanding the world of fish is a fascinating and complex task. The vast diversity of fishes makes them difficult to study, even for experienced observers and explorers. Identifying different types of fish can be particularly challenging when they belong to the same genus, tribe, and species. Fortunately, in our technological age, mobile phone applications have been developed to help overcome these challenges. These apps offer a simple and user-friendly interface, making them easily accessible to anyone with a mobile phone. With these tools, studying fishes has become more efficient and advanced. By enhancing the usability and functionality of these apps, users can gain deeper insights into the diversity, complexity, and wonder of the underwater world.

2.4 Detailed overview of selected freshwater fish for Fish guide pro and model

2.4.1 Freshwater fish

The information of the five fishes selected in the Fish Guide Pro application is discussed here. There, of course, scientific names are discussed, such as lifestyles and areas of distribution.

- "Bulat Hapaya" - The Black Ruby Barb, also known as Pethia nigrofasciata, is a tropical fish species that can survive in water with a pH level between 6.0 and 6.5. They prefer water with a dH level between 5 and 12, and a temperature range of 22°C to 26°C. They can be found in mountainous regions, canals connecting Kelani to the Nilwala Basin in Sri Lanka, and clean, chilly streams. The maximum length of this fish is around 6.7 cm, and they typically feed on debris and algae. They lay eggs in shallow water.

- "Dangkola Petiya" - This fish known by the scientific name Dawkinsia singhala is also known as Sri lanka Filamented Bard. It is also a fish of the family Cyprinidae and shows a body growth of about 7-8cm and is found in Yakwella, Ging Ganga basin, and wet, dry and intermediate zones. A large amount is also reported from Galle Matara and Kaluthera areas. It is also found in slow-flowing lakes or canals from fast-flowing rivers. It also lives in flocks of only 1 meter deep water. Algae and animal carcasses are taken as food.

- "Gal paandiya" - The fish species in question is Garra ceylonensis, commonly known as the stone sucker. This fish can be found in both dry and humid zones, with water pH ranging from 6.5 to 7.0 and dH ranging from 12 to 15. It thrives in tropical temperatures between 24 and 26 degrees and can grow up to 15 cm from its original 8 cm body length. Its primary source of food is algae.

- "Kavaiya" - Another fish species, known as the climbing perch and scientifically named Anabas testudineus, can grow up to 12.5 cm. It prefers tropical temperatures between 22 and 30 degrees and is often found in wetlands and canals. This fish has the unique ability to survive in unfavorable water environments and can hide in muck during dry seasons.

- "Thal kossa" - The Belontia signata, also known as the combtail, is an endangered fish species unique to Sri Lanka. It can grow from 10 to 18 cm and is found in still water bodies that contain gravel and pebbles. Its diet consists of decomposing aquatic organic materials and small aquatic creatures. Its eggs hatch in just two days, and it prefers tropical temperatures between 24 and 28 degrees.

2.4.2 Model

The Mobilenet is a 28-layer network that has been specifically developed for use in mobile and embedded devices. To reduce the computational cost of the model, the depth-wise separable convolution approach has been utilized. In traditional convolution, the entire input is processed in one go, but with Mobilenet's depth-wise separable convolution, the process is split into two parts. The computational cost of these parts is calculated using highly sophisticated methods. Here are a few examples.

$$DG^2 \cdot DK^2 + N \cdot DG^2 \cdot M$$

This essentially computes the normal form one.

$$\frac{M \cdot DG^2 \cdot DK^2 + N \cdot DG^2 \cdot M}{DK^2 \cdot M \cdot N \cdot DG^2 + N + 1}$$

This makes the total computational according to the depth-wise separable convolution while Calculating the cost.

MobileNetV2, also known as MobileNet Version 2, is the second evolution of MobileNet. It has 53 layers, which is significantly more than its predecessor, and includes a new layer module called Inverted Residuals with Linear Bottlenecks Sanjay and Ahmadinia 2019.

2.5 Related work with gap analysis

2.5.1 SuperFish Mobile Application

SuperFish is a new mobile application created by a team of instructors from the University of Mauritius, including Nadeem Nazurally, Somveer Kishnah, Sameerchand Pudaruth, Chandani Appadoo, and Fadil Chady. The application uses deep learning and image processing techniques to identify different species of fish simply by taking a picture of them. With 38 species of fish found in the coastline and lagoons of Mauritius, along with the estuaries and nearby reefs, the complete data set consists of 1520 photos, 40 of which are not of the same fish, to identify the fish using image processing techniques and deep learning. Of these images, 80% were used for training, 10% for validation, and 10% for testing.

All photos are first converted to grayscale format, and then Gaussian blur is applied to reduce image noise before eliminating the background and leaving only the fish. Several traits, including the fish's height, size, proportion of height to size, and tail shape, are derived from the separated fish. The performance of the fish data set was evaluated using SVMs, decision trees, KNN, neural networks, and random forests, with kNN and TensorFlow algorithms achieving 96% and 98% accuracy respectively. The aim is to increase the number of fish species in the data set, improve the quality of data, and remove any obstacles after proving the software's effectiveness Pudaruth et al. 2020.

It is worth noting that the images are blurred using Gaussian technique, and the fish's background is removed after reducing the noise in the photos. Although images without a background are more impactful, Gaussian blur substantially changes the image. Fine lines are not visible after the noise is removed, and the scales and fin folds of a fish are stripped of their sharp edges, leading to a loss of detail. Additionally, applying the same Gaussian blur to all of the photographs has an impact on the variety of the images. However, not all noise types are appropriate for this purpose*Gaussian Blur* 2023.

2.5.2 Mobile application built using a convolutional neural network based on YOLO

K. Priyankan and T. G. I. Fernando from the Department of Computer Science at the University of Jayawardapura in Sri Lanka have developed a mobile application that accurately identifies fish using YOLO and Convolutional Neural Networks. The study focused on 16 out of the 90 varieties of fish commonly consumed in Sri Lanka, using only 14,000 images of those fish. The application uses a convolutional neural network based on YOLO to recognize the fish in 3-20 seconds, depending on the internet speed and visual quality. Once identified, the application provides nutritional information, protein and mineral content, pricing, and cooking instructions for the selected fish species.

The data set for the Grant Reason application was gathered from fishermen, fish store owners, and the general public. Before creating the dataset, the researchers planned the image collection and size of the photographs that would be used. They found that an accurate dataset requires between 800 and 900 images of a single fish, and identified the locations where fish can be found. In total, the dataset included only 120 photos from one location, but the augmentation procedure produced 14400 additional images Priyankan and Fernando 2021.

The researchers chose YOLO because it uses only one CNN for classification and localization, instead of several. Their model achieved an accuracy of 77%. The technology has been designed to deliver accurate results. However, there are some ambiguities regarding the fish consumed by people, such as variations in cost, which fluctuates daily. Additionally, there are concerns about the quality of the data collection, as the dataset includes a substantial number of poor-quality images. Despite this, the application provides a useful resource for identifying fish and obtaining nutritional information.

2.5.3 (U-Net) and the image masking model built using convolutional neural net (CNN).

A piece of writing has been posted on the library website by C. David de Santana, Edgard Leonardo D'avila Panduro, Morgan Ruiz-Tafur, Alexander J. Robillard, Michael G. Trizna, Rebecca B. Dikow, and Jessica L. Deichmann, Wiley discussing the world's largest freshwater fish found in the Amazon forest. More than 2700 native fish species have been discovered so far, but classifying fish for scientific identification or genetic testing requires extensive training and knowledge. However, an image masking model has been developed using a convolutional neural network (CNN) and the U-Net to solve the issue. The model identifies 33 different species of fish with a 97.9% accuracy rate. The specialists gathered information from the Morona River valley in the Achuar district of Loreto, Peru, for the years 2018 and 2019. They used morphometric and meristic traits to determine which fishes they were looking at. They found 141 species from 89 fish families. The fish were captured on camera using a Nikon D3500 camera, but they could only use photos of 33 different fish species. To separate and distinguish fish and background, the researchers created a model utilizing U-Net during the first preprocessing stage. The classifier was developed using an Nvidia GeForce GPU and the Fast.ai module, which is a part of PyTorch *Application of a deep learning image classifier for identification of Amazonian fishes - Robillard - 2023 - Ecology and Evolution - Wiley Online Library* 2023.

The resnet-101 architecture is the basis for the model's construction. When creating the first data set to identify fishes, meristic and morphometric traits have been used. However, some of the drawbacks of meristic characteristics are evident. Meristic traits can differ even within a single species depending on a fish's age, sex, or habitat. Additionally, there are drawbacks to morphometric analysis. The dataset raises questions when age-related changes, environmental influences, species overlap, and measurement errors are present *Full article: Morphometric and meristic variations between non-reproductive and reproductive kutum females (Rutilus frisii kutum, Kamensky, 1901), in the southwest Caspian Sea* 2023.

2.5.4 Mobile-based Fish Quality Detection System

A team of researchers, including Suhadi, Prima Dina Atika, Sugiyatno, Ahmad Panogari, and Rahmadya Trias Handayanto, has developed a mobile-based fish quality detection system using the K-Nearest Neighbors Method. Their focus was on the Mujair, a type of freshwater fish commonly found in Indonesian rivers and ponds, which is less expensive and tastier than other fish available in the market. Since the fish needs to go through a lengthy storage process before consumption, its freshness is often doubtful. To address this issue, the team used the fish's eyes to determine its freshness through a mobile application. The K-Nearest Neighbor (K-NN) algorithm was used for this purpose, and the study included problem analysis, approach, mobile application development, and implementation. The team also measured the accuracy and outcome of the image processing method using standard methodology. The RGB function was used to study the fish's eyes, and the team provided equations for locating the K-NN algorithm in their research report. However, they claim that the algorithm's accuracy is only 90%. While K-NN is a simple algorithm, it has limitations when working with high-dimensional data, unlike Convolutional Neural Networks (CNN). CNN is a better option for tasks like image categorization due to its numerous layers. As the dataset grows, K-NN can become memory-intensive and computationally expensive *Mobile-based Fish Quality Detection System Using K-Nearest Neighbors Method — IEEE Conference Publication — IEEE Xplore* 2023.

K-Nearest Neighbors (KNN) is used here. When compared with Convolutional Neural Networks (CNN), a gap can be identified. KNN is a relatively simple algorithm. Therefore, there are some limitations in handling high-dimensional data. But because CNN has many layers, CNN is well suited for things like image classification. Also, KNN can become computationally expensive while increasing the size of the dataset and becoming memory intensive Rahmad, Rohadi, and Lusiana 2021.

2.5.5 WikiFish Mobile Application

In April 2022, Kholoud K. B. Elbatsh, Ibrahim Y. S. Sokar, and Shareef T. R. Rajab from Gaza University released a mobile fish identification app called WikiFish. The app uses deep convolutional neural networks to identify different species of fish found in the fish market. The researchers collected data from fish markets and aquaculture farms, and used 89 fish species to create a dataset of 2670 images. They then trained the dataset using the AlexNet model, which has an accuracy of 80% using RELU SOFTMAX as the primary network model. The WikiFish app is part of the SAMAKA fish market administration system, which aims to manage all fisheries in the Gaza Strip. The app can be used to identify unsuitable fish and toxic fish, which have increased in quantity in recent years. The researchers chose AlexNet because of its validated training and accuracy of over 90%, which is clinically approved. However, they note that AlexNet has several parameters, making it less suitable for smartphones and IoT devices with less storage space. The researchers suggest that MobileNet may be a better option for these devices, as it has been modified to use less storage space and battery life. Overall, the WikiFish app is a useful tool for identifying fish species in the Gaza Strip and other nations. It is part of a larger effort to manage all fisheries and ensure that only safe and suitable fish are sold in the market Elbatsh, Sokar, and Ragab 2022.

Both AlexNet and MobileNet are built on convolutional neural network (CNN) architecture. But they have some differences. Indeed, computer vision makes a significant contribution to the field and when compared with MobileNet, several disadvantages are apparent. AlexNet has a number of parameters. This makes it less suitable for connecting smartphones and IoT devices with limited storage capacity. But MobileNet is lightly tweaked to work on devices with storage and storage facilities without any issues. Also, AlexNet consumes more battery power compared to MobileNet Pujara 2021.

2.5.6 Dead fish detection using SSD MobileNet

Guangdong Ocean University conducted a test to identify dead fish using SSD-MobileNet. The test compared and discussed the SSD-MobileNet V1, V2 and V3 models for an embedded mobile application. Among them, V3 stood out as a real-time object identification method. It combines NetAdapt and NAS (Hardware Network Architecture Search) techniques, making it a new and unique approach to algorithm and network generation. There are two approaches for identifying items based on their observations. Single object detection methods, such as R-CNN, OLO and SSD (Single Shot MultiBox Detector), only detect one object at a time. On the other hand, SSD employs the pyramid feature-level approach of identification concurrently. Google has proposed a convolutional neural network, called MobileNet, that is highly effective for embedded systems. In their experiments with MobileNet V3, they demonstrated a 95% accuracy level when compared to V1 and V2 *An adaptive dead fish detection approach using SSD-MobileNet — IEEE Conference Publication — IEEE Xplore* 2023.

2.5.7 FiSDA Mobile Application

Gil Gabornes Dialogo, Larmie Santos Feliscuzo, and Elmer Asilo Maravillas from Eastern Samar State University in the Philippines have developed a unique mobile application called "FiSDA" for fish identification using convolutional neural networks. The application is now available for fish identification in the Gulf, targeting students and marine scientists as their main audience. They have effectively collected data by uploading 6918 pictures of 467 fish species. The top model out of the vast population of training models has an accuracy of 96.49%. The software starts by capturing a picture of the fish using the camera included in the smartphone app. The categorization model, based on a convolutional neural network developed and processed, recognizes the fish details displayed according to the original photograph Dialogo, Feliscuzo, and Maravillas 2021.

This is very similar to the Fish Guide Pro app, but the Convolutional Neural Network being trained is different. That is, they use an AlexNet based Convolutional Neural Network. But MobileNet Convolutional Neural Network is used for Fish Guide Pro because it does not take up much memory and uses minimal battery power.

Chapter 3

Requirements specification

3.1 Chapter introduction

Functional Requirements, Non-Functional Requirements, and Software Requirements are covered in this section . It also includes sub-topics such as image capture and processing, fish species identification, user interface design (UI/UX), and data storage.

3.2 Introduction to Requirements Specification

Sri Lanka boasts a rich cultural and heritage background with indigenous fish species playing a significant role. It is essential to protect and learn about these species. This chapter outlines the prerequisites for developing the Fish Guide Pro, a smartphone app designed to identify freshwater fish in Sri Lanka.

It also highlights the features, constraints, and expectations that guided the app's development process to cater to the demands of all interested parties in freshwater ichthyology.

Fish Guide Pro has been carefully crafted to ensure high-quality functionality and user satisfaction.

3.3 Functional Requirements

On the path to success in Fish Guide Pro, several requirements have been carefully studied. Of all, this is just a starting point. It offers an engaging user experience for curious explorers, observers, researchers, and conservationists.

3.3.1 Image Capture and Image Processing

The app captures images / allows users to upload and process existing photos. Users can photograph the fish in their natural habitat using the camera on their mobile device or an image from their gallery. Once a photo is taken, the app's MobileNet-powered model recognizes the fish and displays its detailed information on the device's screen.

3.3.2 Fish Species Identification

The app currently features five fish species discussed in Chapter 2 and uses a MobileNet-powered model to provide speedy results. This model recognizes the fish and behaves as though it has been trained. All of the information about the specific fish is displayed on the device's screen.

3.3.3 User Interface Design (UI UX)

Fish Guide Pro acts as a gateway to the world of freshwater fish in Sri Lanka, and it should be user-friendly and easily accessible. The app's design, from the logo to the final user experience, is straightforward. It is especially useful for students interning at organizations like NAQDA, who need to access it frequently.

3.3.4 Data Storage

The fish species data is stored in a separate database to avoid bloating the app's size. The app features a registration and login system that utilizes Google Firebase to keep users' data private.

3.4 Non-Functional Requirements

Functional requirements describe the tasks the application must perform. In contrast, non-functional requirements specify how effectively it should execute those tasks. Non-functional requirements evaluate the application's characteristics and efficiency. Their goal is to provide the user with a seamless experience without any unexpected interruptions.

- Usability - The nature of the usage and the possibility of usage are considered. Everything should be not only user-friendly but also responsive. Everything should be arranged with clear buttons and words.
- Performance - This is discussed in terms of application speed. A quick response is expected from every action taken by the user.
- Compatibility - Considers using the application without conflicting with the same system. And it should work properly on all devices from smartphones to tablets.
- Reliability - The focus here is on managing existing or future errors in the application, accurately identifying fish species and providing information.
- Scalability - Could be scaled up as the number of users increases and measures taken in the future to increase the number of fish currently being used.
- Security - User data is stored here. it looks at their security and application security. User data must remain confidential.

The standard of quality functionality and deployment is defined by adequately addressing these stated non-functional requirements. The major goal here is not only to detect fish peculiarities but also to satisfy the user.

3.5 Software Requirements

Fish guide pro is intended to have a high user volume. It is currently only available for Android operating systems. Essentially, it was designed to work on Android 7 and above operating systems because smartphones running lower operating systems than Android 7 are now less popular.

- Operating System Compatibility - This addresses the issues discussed above. The range of operating systems is considered here.
- Internet Connectivity - Discusses the connectivity through the Internet. The application must be connected to the Internet while running.
- Permissions - This app only uses gallery and camera. Therefore, permissions must be given by the user to access them.

As an example, updates and device compatibility can be mentioned here. In essence, software requirements are intended to improve user access and application performance.

Chapter 4

Methodology

4.1 Chapter introduction

This chapter will provide a comprehensive overview of the development and methods used in creating "Fish Guide Pro". It will delve into the problems and difficulties faced by individuals involved in fish identification, as well as explain the concept behind Fish Guide Pro, which was developed as a feasibility study to minimize issues in identifying fish. Additionally, Abijanana Madyastanwala from the National Aquaculture Development Authority (NAQDA) highlights that students who have completed internships and have a passion for local fish will benefit from using this application. The quality of the application is also closely monitored over a set period of time to ensure the optimization of the quality process.

4.2 Validate the problem and verify the information

Before developing a fish detection smartphone application specific to Sri Lanka, a detailed investigation of the surroundings was conducted. The process was challenging, as highlighted in Chapter 1. Mr. A. R. Mudalige, a fish genetics specialist at the Dabulla branch of the Fisheries Ministry's National Aquaculture Development Authority (NAQDA), confirmed the difficulties faced in training students who come to their Authority to identify and learn about fish, and to participate in the internship program. Due to limited human resources, teaching the kids about fish separately from the occasional students was a challenging assignment. Additionally, academics and observers interested in fish investigated the issues in identifying fish. Although the hurdles differed by location, they all boiled down to the same difficulty. Based on these problems, the idea of developing a mobile application using new image detection technology arose, and a large-scale study was required to find a solution. After that, the background for the application was produced, and it was determined that it was reasonable to examine the operation of the mobile application using only 5 varieties of fish.

A Google survey was also conducted to identify the fish. Based on the verified and understood data and information of Google survey, many decisions were made about the effectiveness of Fish guide pro. And it was recognized as an essential application for all those interested in fish.Based on the information received in the Google survey, more attention was paid to the following while making the decision.

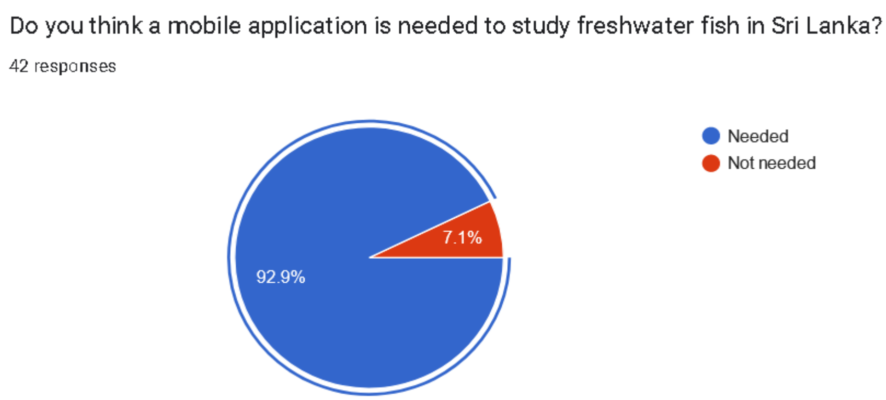

Figure 4.1: The need of a application

42 people from different ranks and different occupations participated in the table and 39 of them 92.9% said that an application is needed for identification of fresh water fishes in Sri Lanka.

By observing how they search for information about fish, more people are searching Google. But here the information is given in relation to searching for known fish.

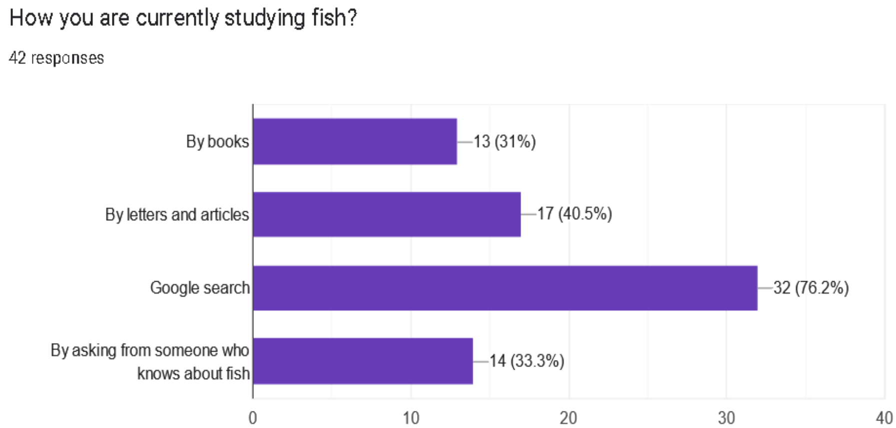

Figure 4.2: The searching type of a fish details

4.3 Literature Review

The literature review is an essential step that significantly impacts the development and effectiveness of Fish Guide Pro, a mobile app for identifying Sri Lankan freshwater fish. The review covers various research processes, including an introduction to Ichthyology and its goals, advantages, and how it works. Additionally, the review discusses the model used in the app and compares the five fish species included in Fish Guide Pro “bulath hapaya”, “Kavaiya”, “thalkossa”, “ dankola pethiya” and “gal paadiya”. The literature review also analyzes several previously developed apps for identifying fish, such as SuperFish, WikiFish, and FiSDA. It explores the quality of fish consumed by humans and convolutional neural net inputs. The literature review is a result of a thorough examination of academic databases, industry reports, and other appropriate materials. The search terms and keywords were carefully aligned, and only high-quality data was collected from recognized academic sources such as Google Scholar and IEEE Xplore. The review also includes report books and guides.

4.4 Process of Data and Information Collection

The data and information provided here are crucial factors that impact the operation of the Fish Guide Pro application. A data analysis is performed to ensure that accurate information is delivered, based on the data's correct behavior. Therefore, it is essential to collect data meticulously and ensure that the data is scientific. It is important to note that data collection and information collection are discussed separately.

4.5 Data collection, Data set Creation information gathering

Before creating a dataset, it's essential to have a source of data. Several websites like Kaggle were explored to find datasets related to fish in Sri Lanka for Fish Guide Pro, but unfortunately, none was found. Therefore, the next option was to generate a dataset. The National Aquaculture Development Authority (NAQDA) in Dambulla was chosen to provide the data, which consisted of fish photographs. NAQDA saved a vast collection of local fish, making it a suitable choice. A letter signed by Mrs. Nirosha Perera was sent to the ministry of fisheries requesting permission to obtain the data. The ministry then obtained authorization from NAQDA's Dambulla branch.. The acquisition of data took place within a legal framework.

During NAQDA's first field outings, the objective was to collect data by photographing the fish. It was crucial to learn how to identify and capture images of the fish included in the data set. Additionally, the quality of the photographs taken using cameras or smartphones needed to be enhanced. To prevent loss or damage of data, duplicate copies were saved at multiple points during the second field trip. In total, around 800 photos were collected, and image visibility and sharpness were improved as required.

As fish specialists, they provided and discussed more accurate information on the chosen fish, which was then confirmed as true.

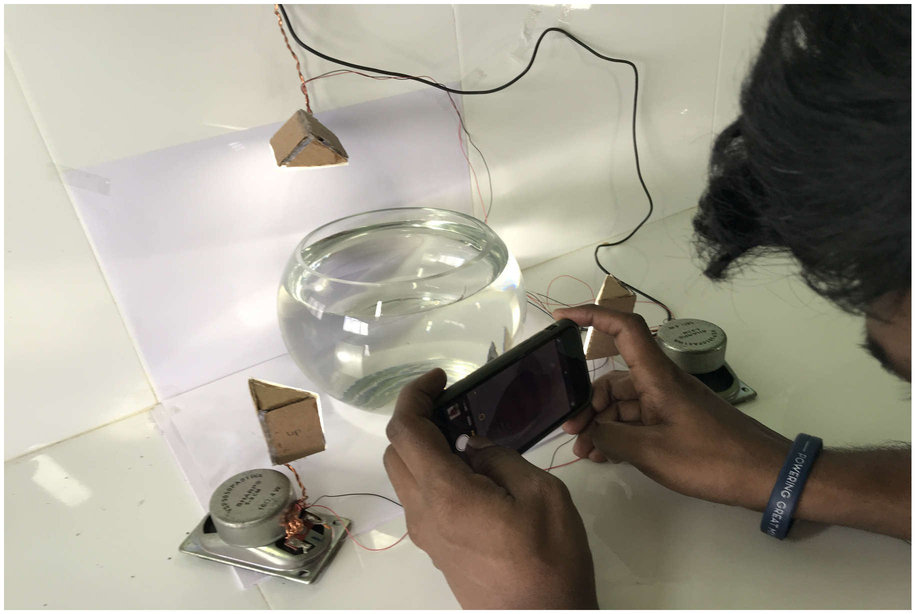

Figure 4.3: Taking pictures to create the deta set

Figure 4.4: Taking pictures to create the deta set

4.6 Solution Concept

During this ongoing study of Sri Lanka's freshwater fish, one of the main challenges is to come up with a solution concept. In order to achieve this, more detailed research and exploration of UML and wireframe diagrams were conducted using the previously learned UML and wireframe diagrams.

Firstly, the Fish Guide Pro application was examined using UML diagrams. Different diagrams were utilized to emphasize and demonstrate the concept and capabilities provided in Fish Guide Pro. Examples of these diagrams include High-Level Component Diagram, Use Case Diagram, Activity Diagram, and Sequence Diagram. These UML diagrams were very helpful in portraying the primary features and interactions between users when using Fish Guide Pro. They also reflected the interactions that occur within the application.

In addition to the UML diagrams depicting the interactions in Fish Guide Pro, a thorough examination of the wireframes for the interfaces was carried out. The user interface was designed with great attention to detail, ensuring that the application does not negatively impact the user's experience. Wireframe software was used to create wireframes for numerous app screens, including those with buttons, photos, navigation components, and card views. It is not an easy task to create these wireframes, and a large study was also conducted in this regard.

Finally, the development of Fish Guide Pro was initiated after studying the UML diagrams and wireframes.

All types of diagrams and wireframes are covered in Chapter 5 of the study.

4.7 Implementation

Efficiently deploying Fish Guide Pro involves considering several variables, such as hardware and software requirements, an Object Detection model, and the development of an Android application. The ultimate goal was to create a user-friendly application that displays the journey from conception to completion. The first step was to research and study the necessary software and hardware. All the required software to correctly implement Fish Guide Pro was reviewed. For coding the app, Android Studio was the best solution (IDE). Additionally, technologies like Draw io, Figma, Adobe Photoshop, and Adobe Illustrator contributed in some way to the construction of interfaces.

When discussing the hardware used to develop this application, it is important to note that an Acer Nitro 5 laptop was utilized. This allowed for a smooth and seamless experience while operating the application. Despite Android Studio providing a virtual device (mobile phone) to run the application, a physical mobile phone was preferred due to the application's use of the camera and gallery, which caused performance issues on the virtual device.

In regards to selecting the appropriate model, it was a challenging task. After reviewing numerous pre-trained models, including VGG (Visual Geometry Group) Networks, ResNet (Residual Network), YOLO (You Only Look Once) and DenseNet, it was determined that MobileNetV2 was the best option for mobile applications.

Fortunately, there were no significant hardware-related issues encountered during the development process. However, there were some software-related issues that had to be resolved before Fish Guide Pro could be successfully implemented.

Chapter 5

Solution Concept

5.1 Chapter introduction

The concept of solution is emphasized here. There, High Level Component Diagrams, Sequence Diagrams, Activity Diagrams, and Use Case Diagrams are used extensively to represent the solution concept.

5.2 High-Level Component Diagram

A High-Level Component Diagram is an effective tool for understanding the interaction of the input and illustrating the complete action sequence for acquiring clear knowledge and detailed analysis. This structure is used at a high level to identify user images, where the functional units represent the grant modules and other related modules. Below is the High-Level Component Diagram for Fish Guide Pro which describes the complete process along with the mobile phone.

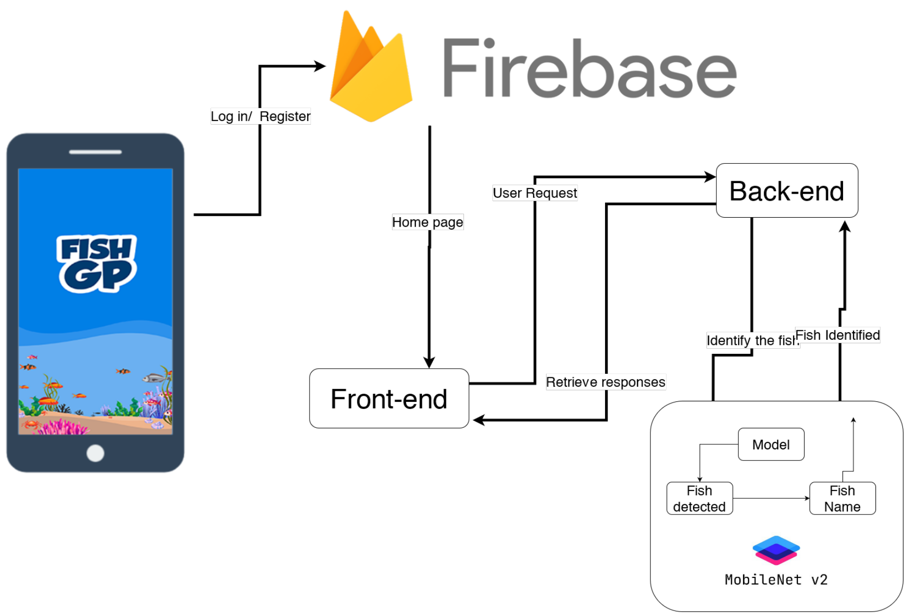

Figure 5.1: High-Level Component Diagram

5.3 Use Case Diagram

The term UML stands for Unified Modeling Language. Its primary purpose is to capture the requirements of a system and its behavior. These diagrams are useful in understanding the system as a whole and its interactions with users. However, they do not show the internal processes and practices of the system's critical components. Use-case diagrams can be used in the early stages of a project such as the requirements gathering phase, as well as during the analysis and design phases *IBM Documentation* 2021.

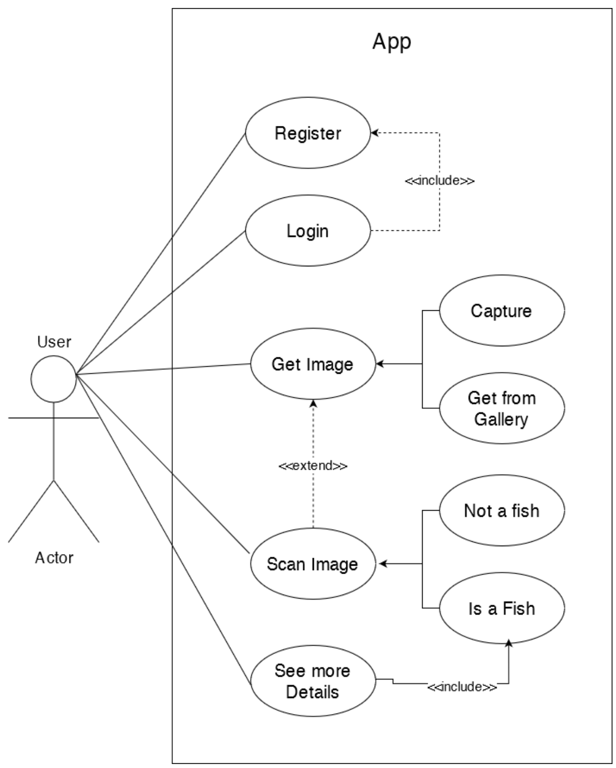

Figure 5.2: Use Case Diagram

5.4 Sequence diagram

A sequence diagram is the exchange of action messages related to each activity in the system and the preparation of a Unified Modeling Language (UML) diagram for the sequence of those messages. A sequence diagram has groups of objects that are connected to each other by life-lines *IBM Documentation* 2021.

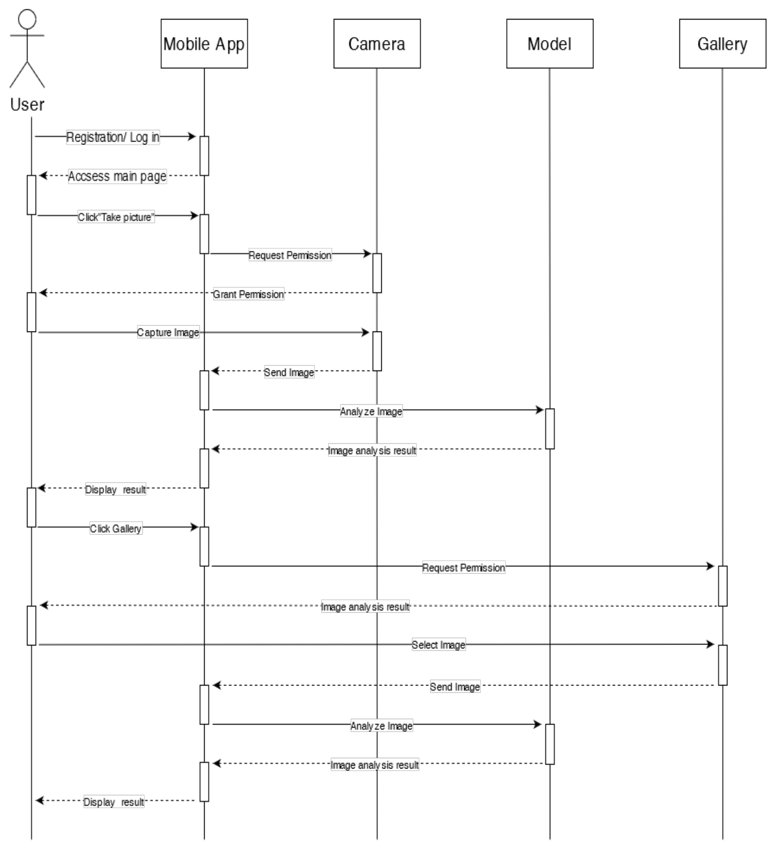

Figure 5.3: Sequence diagram

5.5 Activity diagram

Activity diagram is another diagram type available in UML Diagram. What happens here is a flow that shows the flow from one activity to another in an overall process. Here the flow of data can be shown in the order in which they occur. The activity diagram of two activities taking place in Fish Guide Pro is given below *MobileNet-v2 convolutional neural network - MATLAB mobilenetv2* 2023.

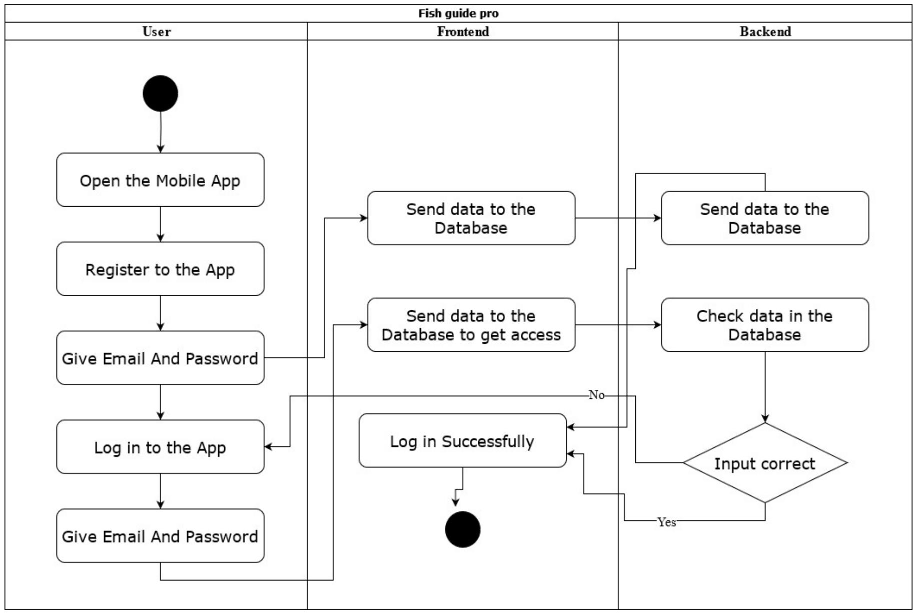

Figure 5.4: login

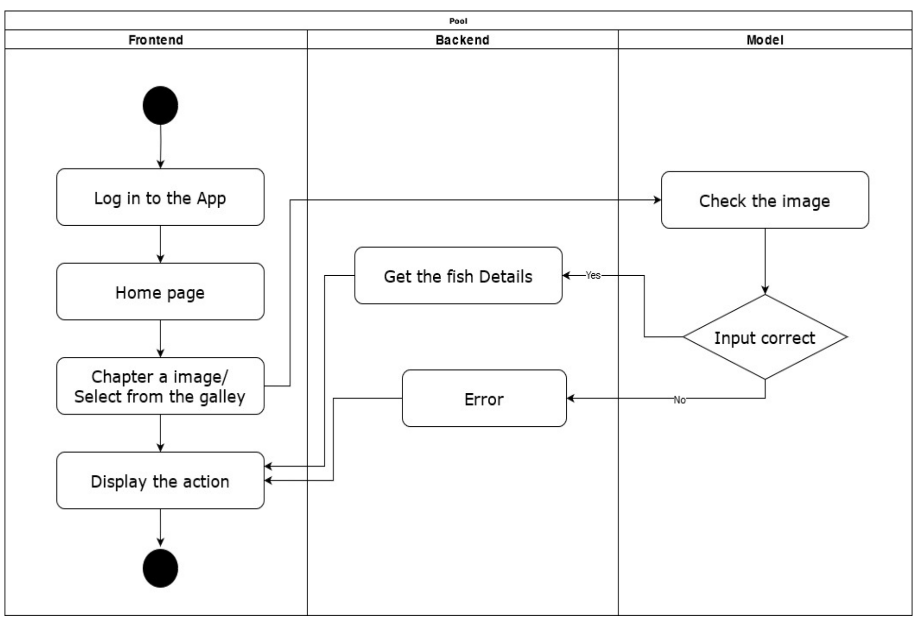

Figure 5.5: fish detection

5.6 Wireframe

In the past, the appearance of a website, mobile application, or any system was not considered important and more focus was placed on its functionality. However, nowadays, equal attention should be given to both the interface and functionality of the system. This serves as a preliminary version of the system that is expected to be developed. It helps in conveying the structure of the system to stakeholders and other individuals involved in the project.

5.6.1 Splash Screen

The splash screen is the initial screen that appears in most applications. It serves a specific purpose - to load data for the screens that come after it. This data is circulated between different applications, and the range and volume of data determines how long the splash screen will be displayed. The splash screen typically covers the entire screen for a few seconds before moving on to the next screen.

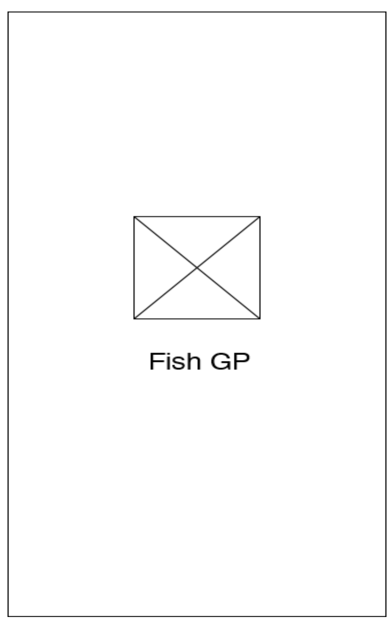

Figure 5.6: Wireframe of Splash Screen

5.6.2 Registration screen

The application's registration page can be found here. In general, registration is accomplished by obtaining an email address and a password.

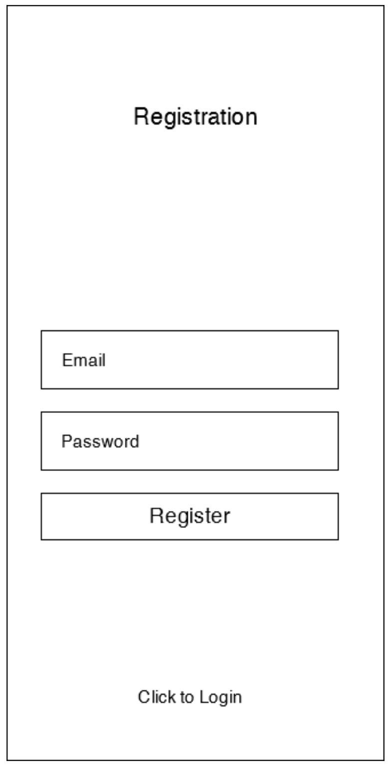

Figure 5.7: Wireframe of registration screen

5.6.3 Login screen

After the registration, it will return to the login page, where the user can log in by giving the email address and the password the user provided during registration.

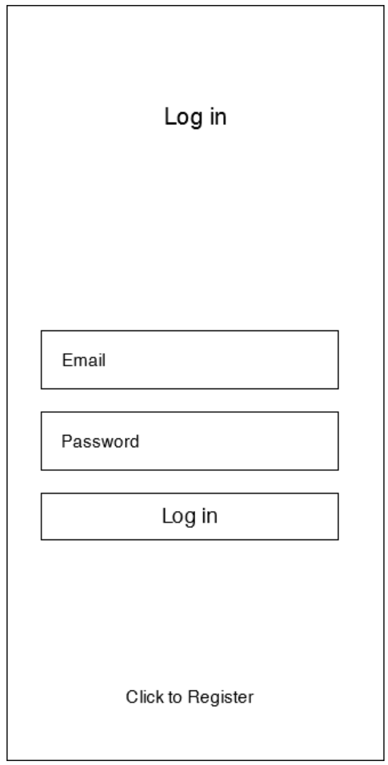

Figure 5.8: Wireframe of log in screen

5.6.4 Home screen(main screen)

The user will be directed to the homepage after logging in. The user can then provide an image of a fish via the camera or the gallery, which will be identified.

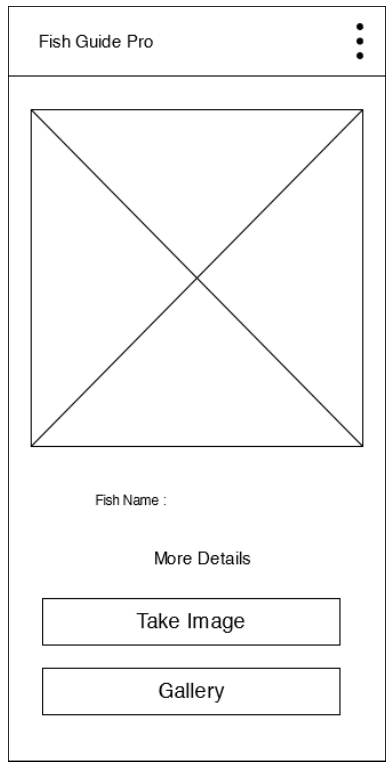

Figure 5.9: Wireframe of home screen

5.6.5 Details screen

This page can be accessed by the user by clicking 'more details' on the main page. If there is a fish in the selected image, the information on that fish will be provided here.

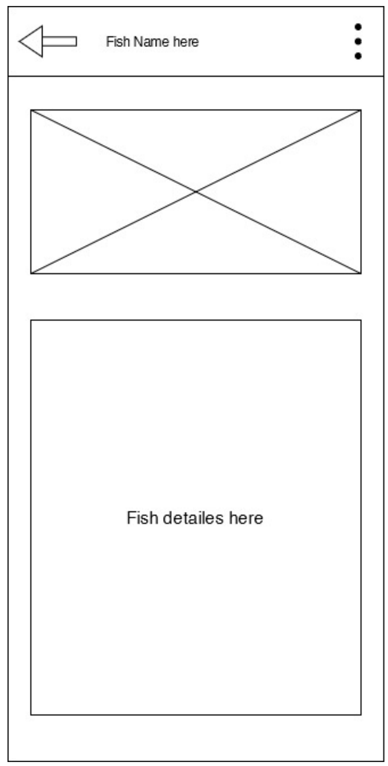

Figure 5.10: Wireframe of details screen

5.7 Figma design

Figma is a web-based application that is used for designing user interfaces and user experiences for websites, mobile apps, and other digital products. This is a popular tool among designers and creators. Figma is Cloud-Based and it also includes Design Systems, Plugins, Vector Editing, and other capabilities.

The Figma design for Fish Guide Pro is as follows. This creation has also been added to the Fish Guide Pro's actual mobile application. This Figma design was heavily influenced by the previously mentioned Wireframes.

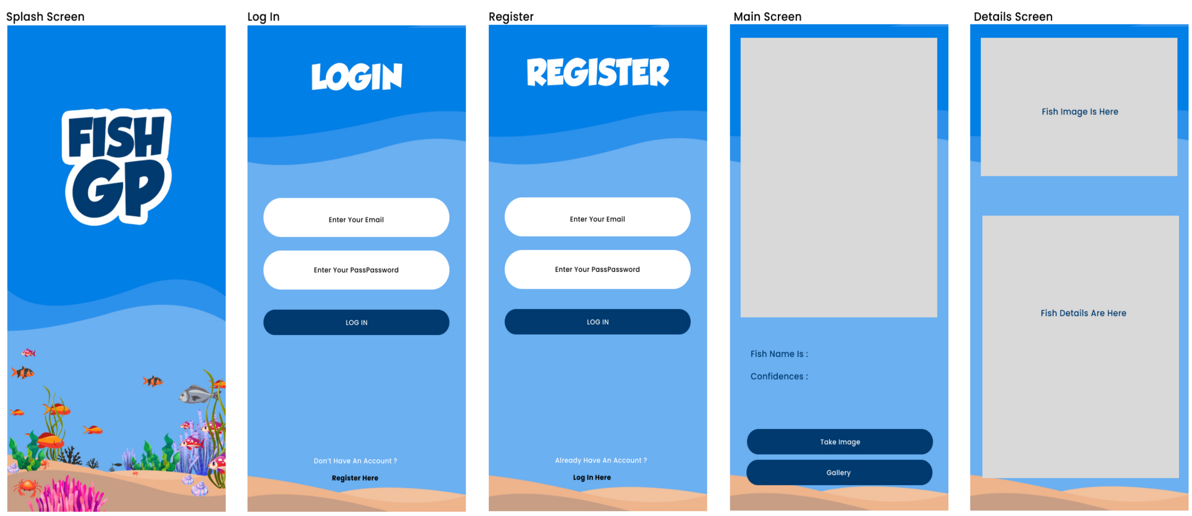

Figure 5.11: figma design

Chapter 6

Implementation

6.1 Chapter introduction

Here is a description of the Hardware and Software requirements, the Object Detection model Mobilenet, and the Mobilenet training process with pictures.

6.2 Hardware and Software Requirements

Advancements in software, hardware, and development tools have a direct impact on deployment effectiveness and quality performance. Therefore, it is crucial to carefully select the appropriate tools.

6.2.1 Software Environment

- Android Studio - To develop Android applications, developers use Android Studio as the official Integrated Development Environment (IDE). The builds are based on Gradle. Android Studio supports developing applications for all Android devices, and developers can use Java or Kotlin to build Android applications. Fish Guide Pro uses Java for its development.

- Jupyter Notebook - This web application is open-source and uses Python to train and support the Fish Guide Pro model.

6.2.2 Hardware Environment

While creating the application on Android Studio, a virtual device was provided, but to get the right touch and feel, the builds were done externally using an Android mobile phone.

6.3 Object Detection model

6.3.1 Mobilenet

MobileNetV2 was selected as the image training model for Fish Guide Pro after researching several pre-trained models, including VGG (Visual Geometry Group) Networks, ResNet (Residual Network), YOLO (You Only Look Once), and DenseNet. Its suitability for mobile applications, due to its efficient architecture and lighter weight than other models, made it the ideal choice. MobileNet is also widely used in mobile and embedded devices This convolutional neural network has 53 layers and provides more than one million photos from the ImageNet database under a wide range of 1000-item categories. Because the photos are from a wider spectrum, the output is frequently more accurate. The images featured are 224-by-224.

There are three versions of MobileNet: version1, version2, and version3. Version1 has 4.24 million parameters, while version2 has 3.47 million parameters and is almost twice as fast as the V1 model. Because mobile devices have limited memory, MobileNetV2 works efficiently in that limited memory **noauthor˙comparison˙nodate**.

The implementation of these machine-learning models utilized several techniques, including TensorFlow, Keras, OpenCV, and NumPy.

6.4 Mobilenet training process

During the training and testing of MobileNetV2 with fish images for Fish Guide Pro, a consistently high level of accuracy was maintained. Initially, the model was overfitted several times, but after error correction, the desired results were achieved.

6.4.1 Importing required packages and libraries

To ensure efficient and standardized coding, several packages and libraries including TensorFlow and Keras were imported which made redundancy and reuse code avoidable.

```
import tensorflow as tf
from tensorflow.keras import models, layers
import matplotlib.pyplot as plt
from IPython.display import HTML

import numpy as np
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.layers import Dense, Activation, Flatten, BatchNormalization, Conv2D, MaxPool2D,Dropout
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.metrics import categorical_crossentropy
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.preprocessing import image
from tensorflow.keras.models import Model
from tensorflow.keras.applications import imagenet_utils
from sklearn.metrics import confusion_matrix
from tensorflow.keras.optimizers import Adam
import itertools
import os
import shutil
import random
import matplotlib.pyplot as plt
%matplotlib inline
from tensorflow.keras.models import Sequential

import cv2
```

Figure 6.1: Importing required packages and libraries

6.4.2 Dataset Splitting

A third-party package called split-folders using the "pip install split-folders" command was installed . This package made the process of splitting folders much easier. Using split folders, the data was split into 80% for training, 10% for validation, and 10% for testing.

```
!pip install split-folders
Requirement already satisfied: split-folders in d:\appz\anaconda\lib\site-packages (0.5.1)

import splitfolders


input_folder = r"C:\Users\Sameera maduSanka\Downloads\fish GP model1911-2\copy"
output_folder = r"C:\Users\Sameera maduSanka\Downloads\fish GP model1911-2\dataSet"


splitfolders.ratio(input_folder, output=output_folder, seed=42, ratio=(0.8, 0.1, 0.1))
Copying files: 1471 files [00:12, 121.99 files/s]
```

Figure 6.2: Dataset Splitting

6.4.3 MobileNet v2 Importing

MobileNet v2 Import is provided here. It is done by TensorFlow through Python.

```
import tensorflow as tf

mobile_net_v2 = tf.keras.applications.MobileNetV2()
```

Figure 6.3: MobileNet v2 Importing

6.4.4 View a brief summary

Provides information about the model's architecture and a rough idea of the architecture of MobileNet v2.

```
mobile_net_v2.summary()

 Conv_1 (Conv2D)            (None, 7, 7, 1280)        409600    ['block_16_project_BN[0][0]']

 Conv_1_bn (BatchNormalizat  (None, 7, 7, 1280)       5120      ['Conv_1[0][0]']
 ion)

 out_relu (ReLU)            (None, 7, 7, 1280)        0         ['Conv_1_bn[0][0]']

 global_average_pooling2d (  (None, 1280)             0         ['out_relu[0][0]']
 GlobalAveragePooling2D)

 predictions (Dense)        (None, 1000)              1281000   ['global_average_pooling2d[0][
                                                                 0]']

==================================================================================================
Total params: 3538984 (13.50 MB)
Trainable params: 3504872 (13.37 MB)
Non-trainable params: 34112 (133.25 KB)
__________________________________________________________________________________________________
```

Figure 6.4: View a brief summary

6.4.5 Removing the last dense layer

```
import tensorflow as tf
from tensorflow.keras.applications import MobileNetV2
mobile_net_v2 = MobileNetV2(weights='imagenet', include_top=True)


new_model = tf.keras.Model(inputs=mobile_net_v2.input, outputs=mobile_net_v2.layers[-2].output)


new_model.summary()
```

```
 block_16_project_BN (Batch  (None, 7, 7, 320)         1280      ['block_16_project[0][0]']
 Normalization)

 Conv_1 (Conv2D)             (None, 7, 7, 1280)        409600    ['block_16_project_BN[0][0]']

 Conv_1_bn (BatchNormalizat  (None, 7, 7, 1280)        5120      ['Conv_1[0][0]']
 ion)

 out_relu (ReLU)             (None, 7, 7, 1280)        0         ['Conv_1_bn[0][0]']

 global_average_pooling2d_1  (None, 1280)              0         ['out_relu[0][0]']
  (GlobalAveragePooling2D)

==================================================================================================
Total params: 2257984 (8.61 MB)
Trainable params: 2223872 (8.48 MB)
Non-trainable params: 34112 (133.25 KB)
__________________________________________________________________________________________________
```

Figure 6.5: Removing the last dense layer

6.4.6 Adding new dense layer

```
num_classes = 6
new_last_layer = tf.keras.layers.Dense(num_classes, activation='softmax')(new_model.output)

# Create the final model with the new last layer
final_model = tf.keras.Model(inputs=new_model.input, outputs=new_last_layer)

# Print the summary of the final model
final_model.summary()
```

```
 Conv_1 (Conv2D)             (None, 7, 7, 1280)        409600    ['block_16_project_BN[0][0]']

 Conv_1_bn (BatchNormalizat  (None, 7, 7, 1280)        5120      ['Conv_1[0][0]']
 ion)

 out_relu (ReLU)             (None, 7, 7, 1280)        0         ['Conv_1_bn[0][0]']

 global_average_pooling2d_1  (None, 1280)              0         ['out_relu[0][0]']
  (GlobalAveragePooling2D)

 dense (Dense)               (None, 6)                 7686      ['global_average_pooling2d_1[0
                                                                 ][0]']

==================================================================================================
Total params: 2265670 (8.64 MB)
Trainable params: 2231558 (8.51 MB)
Non-trainable params: 34112 (133.25 KB)
__________________________________________________________________________________________________
```

Figure 6.6: Adding new dense layer

6.4.7 Training the model

To train the model, the following command is used. To resolve the lack of proper resolution from the previous training, the 10 epochs were smoothed. Additionally, an accuracy of 0.9983 was achieved at the end of the 10 epochs.

```
history=final_model.fit(x=train_batches,
            steps_per_epoch=len(train_batches),
            validation_data=valid_batches,
            validation_steps=len(valid_batches),
            epochs=10,
            verbose=2
)
```

```
Epoch 1/10
118/118 - 172s - loss: 0.3868 - accuracy: 0.8798 - val_loss: 0.2211 - val_accuracy: 0.9583 - 172s/epoch - 1s/step
Epoch 2/10
118/118 - 137s - loss: 0.0647 - accuracy: 0.9821 - val_loss: 0.2134 - val_accuracy: 0.9306 - 137s/epoch - 1s/step
Epoch 3/10
118/118 - 134s - loss: 0.0373 - accuracy: 0.9932 - val_loss: 0.1599 - val_accuracy: 0.9514 - 134s/epoch - 1s/step
Epoch 4/10
118/118 - 132s - loss: 0.0407 - accuracy: 0.9872 - val_loss: 0.2163 - val_accuracy: 0.9306 - 132s/epoch - 1s/step
Epoch 5/10
118/118 - 135s - loss: 0.0156 - accuracy: 0.9983 - val_loss: 0.0528 - val_accuracy: 0.9931 - 135s/epoch - 1s/step
Epoch 6/10
118/118 - 135s - loss: 0.0167 - accuracy: 0.9949 - val_loss: 0.0561 - val_accuracy: 0.9861 - 135s/epoch - 1s/step
Epoch 7/10
118/118 - 136s - loss: 0.0150 - accuracy: 0.9974 - val_loss: 0.0394 - val_accuracy: 0.9931 - 136s/epoch - 1s/step
Epoch 8/10
118/118 - 134s - loss: 0.0098 - accuracy: 0.9991 - val_loss: 0.0240 - val_accuracy: 0.9931 - 134s/epoch - 1s/step
Epoch 9/10
118/118 - 135s - loss: 0.0192 - accuracy: 0.9949 - val_loss: 0.0067 - val_accuracy: 1.0000 - 135s/epoch - 1s/step
Epoch 10/10
118/118 - 143s - loss: 0.0182 - accuracy: 0.9983 - val_loss: 0.0122 - val_accuracy: 1.0000 - 143s/epoch - 1s/step
```

Figure 6.7: Training the model

6.4.8 Training and Validation Loss

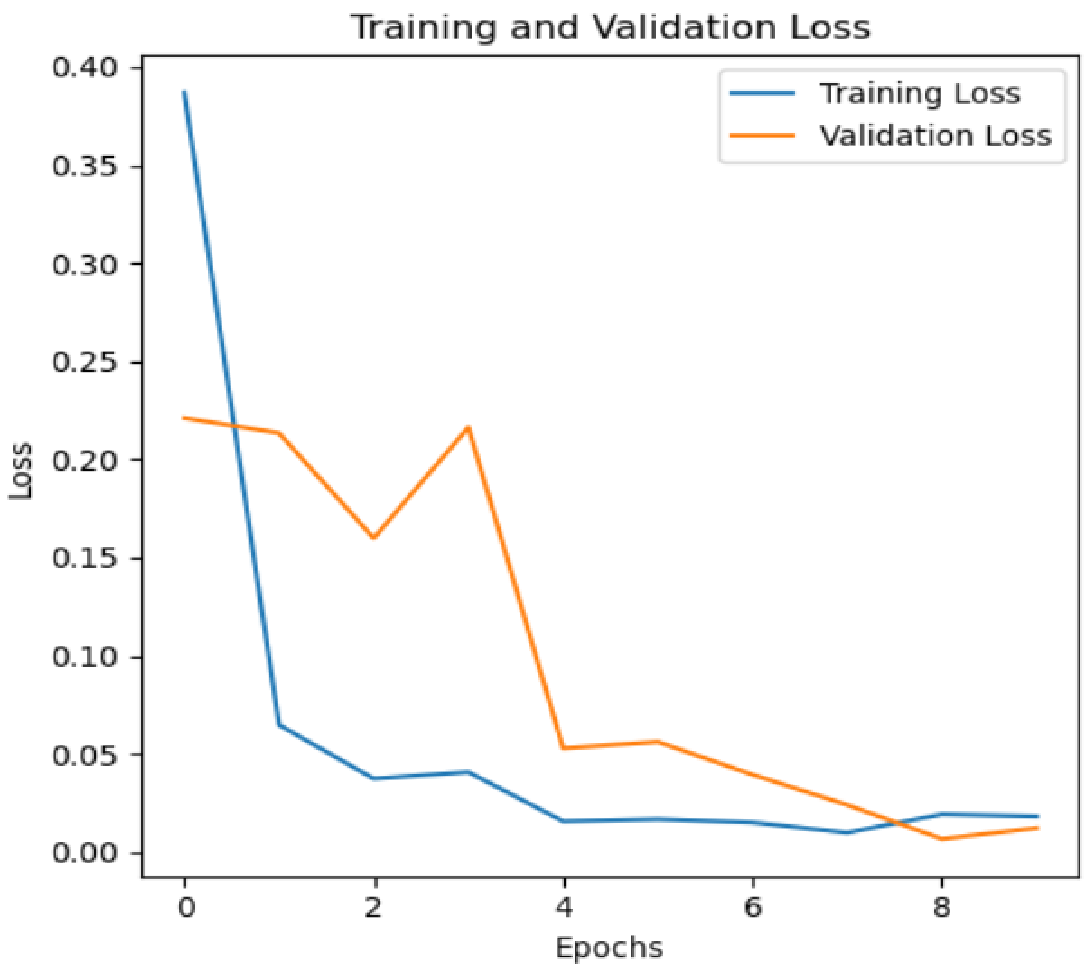

Figure 6.8: Training and Validation Loss

6.4.9 Training and Validation Accuracy

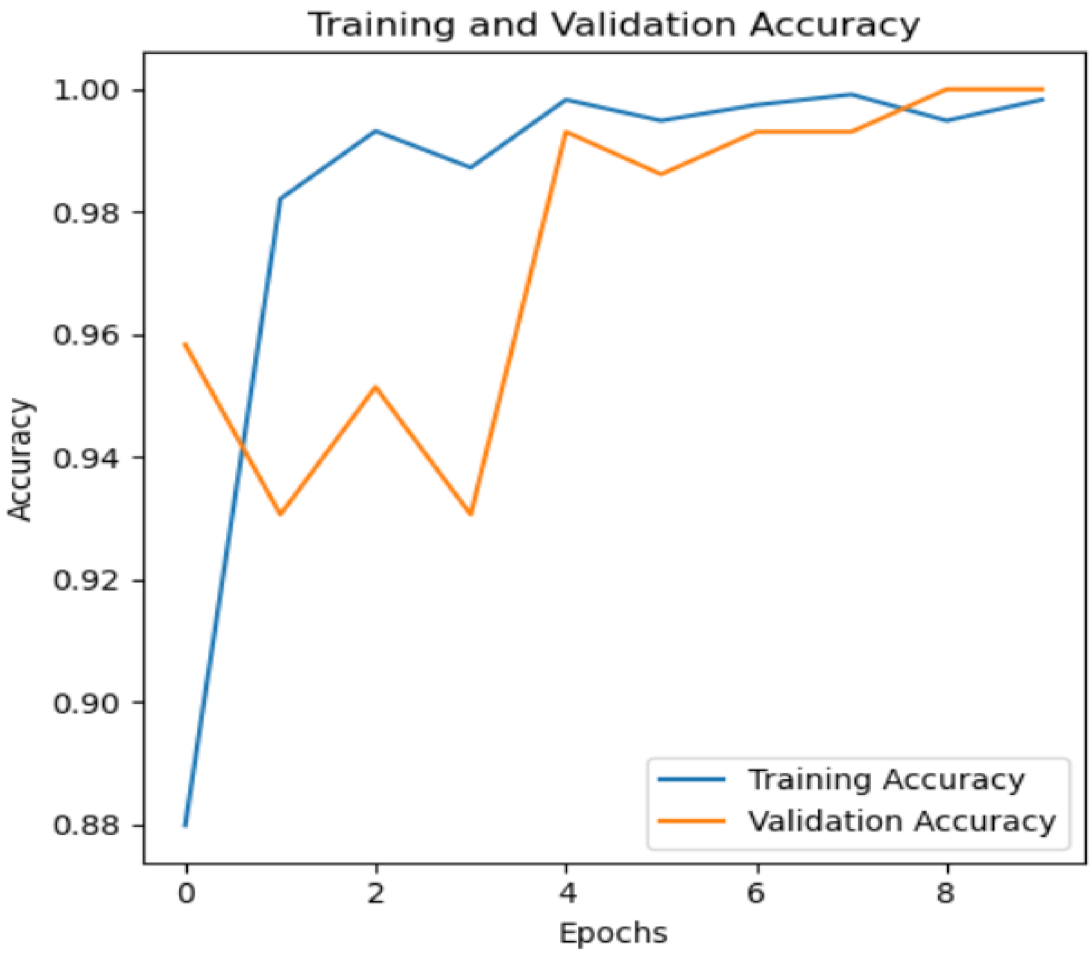

Figure 6.9: Training and Validation Accuracy

6.4.10 Confusion Matrix

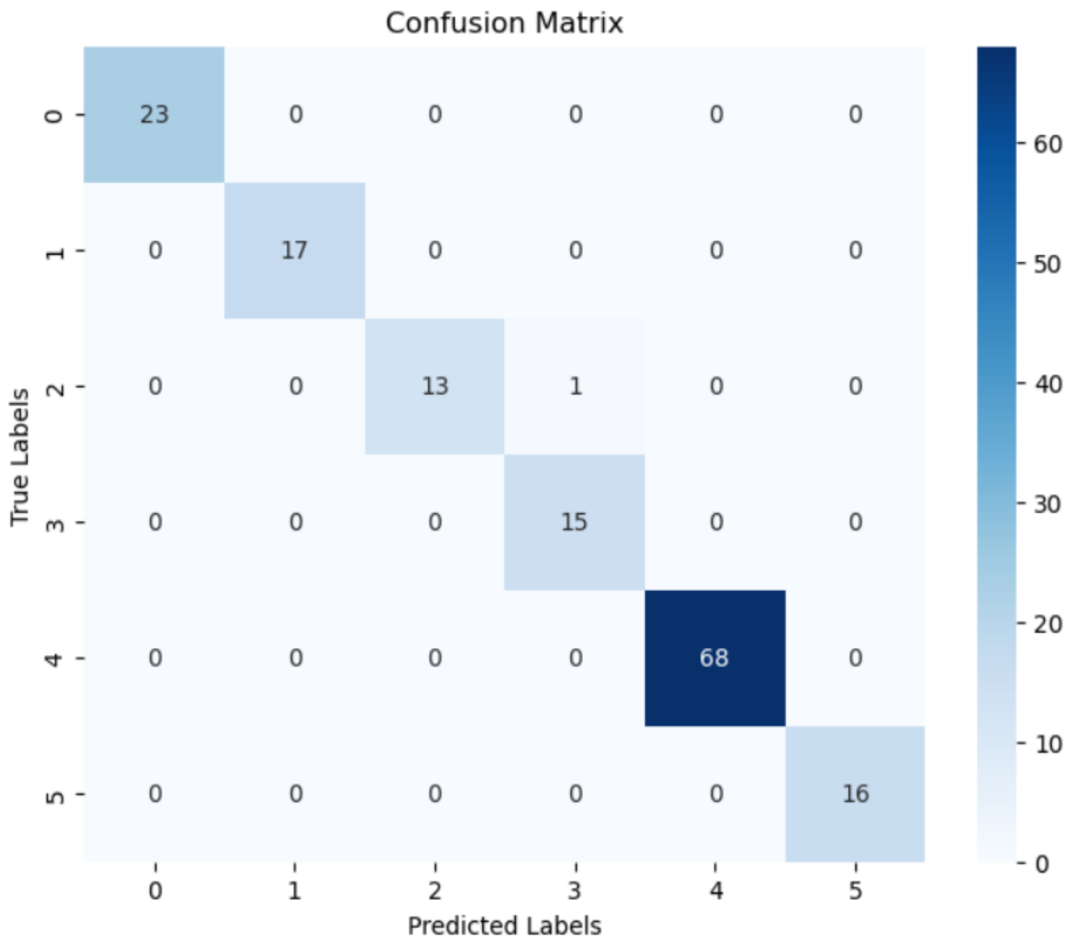

Figure 6.10: Confusion Matrix

6.5 Android studio application development

First of all, we consider how to create and design the Fish Guide Pro application together with Android Studio.

6.5.1 Androids studio interface design based on Figma design

Shown here are the Androids studio interfaces related to creative layouts made in combined with Figma. As mentioned earlier, all this is the increase the experience of the user.

Figure 6.11: Splash Screen

6.5.2 Functionalities of the application

Figure 6.12: Register page

Figure 6.13: Log in page

Figure 6.14: Home Page

Registration

The application's initial step is to allow the user to create an account, that is registration. The application cannot be used unless the user registers himself/herself. To register, the user needs to enter a valid email address and create a new password and that data will be saved in the Firebase database. The "isNetworkAvailable()" command is used to check the internet connection of the mobile phone.

```java
buttonReg.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        progressBar.setVisibility(View.VISIBLE);
        String email,password;
        email = String.valueOf(editTextEmail.getText());
        password = String.valueOf(editTextPassword.getText());

        if (TextUtils.isEmpty(email)){
            Toast.makeText( context: register.this,  text: "Enter Email", Toast.LENGTH_SHORT).show();
            return;
        }
        if (TextUtils.isEmpty(password)){
            Toast.makeText( context: register.this,  text: "Enter Password", Toast.LENGTH_SHORT).show();
            return;
        }
        //check the internet connection
        if (isNetworkAvailable()) {
        mAuth.createUserWithEmailAndPassword(email, password)
                .addOnCompleteListener(new OnCompleteListener<AuthResult>() {
                    @Override
                    public void onComplete(@NonNull Task<AuthResult> task) {
                        progressBar.setVisibility(View.GONE);
                        if (task.isSuccessful()) {
                            Toast.makeText( context: register.this,  text: "Account Created.", Toast.LENGTH_SHORT).show();
                            Intent intent = new Intent(getApplicationContext(),login.class);
                            startActivity(intent);
                            finish();

                        } else {
                            // If sign in fails, display a message to the user.

                            Toast.makeText( context: register.this,  text: "Authentication failed.",
                                    Toast.LENGTH_SHORT).show();
                        }
                    }
                });
        } else {
            progressBar.setVisibility(View.GONE);
            Toast.makeText( context: register.this,  text: "No internet connection. Please check your network settings.",
                    Toast.LENGTH_SHORT).show();
        }
    }
});
```

Figure 6.15: The code of registration

Login

The second part of the application is to simply login to the account created by the user. The user can return to the home page by retyping the e-mail address and the password the user submitted during the registration. The internet connection of the mobile phone is tested here as well.

```
buttonlogin.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        progressBar.setVisibility(View.VISIBLE);
        String email,password;
        email = String.valueOf(editTextEmail.getText());
        password = String.valueOf(editTextPassword.getText());

        if (TextUtils.isEmpty(email)){
            Toast.makeText( context: login.this,  text: "Enter Email", Toast.LENGTH_SHORT).show();
            return;
        }
        if (TextUtils.isEmpty(password)){
            Toast.makeText( context: login.this,  text: "Enter Password", Toast.LENGTH_SHORT).show();
            return;
        }
        // check the internet Connection
        if (isNetworkAvailable()) {
            mAuth.signInWithEmailAndPassword(email, password)
                    .addOnCompleteListener(new OnCompleteListener<AuthResult>() {
                        @Override
                        public void onComplete(@NonNull Task<AuthResult> task) {
                            progressBar.setVisibility(View.GONE);
                            if (task.isSuccessful()) {
                                // Sign in success, update UI with the signed-in user's information
                                Toast.makeText( context: login.this,  text: "Login success.", Toast.LENGTH_SHORT).show();
                                Intent intent = new Intent(getApplicationContext(), MainActivity.class);
                                startActivity(intent);
                                finish();
                            } else {
                                // If sign-in fails, display a message to the user.
                                Toast.makeText( context: login.this,  text: "Authentication failed.",
                                        Toast.LENGTH_SHORT).show();
                            }
                        }
                    });
        } else {
            progressBar.setVisibility(View.GONE);
            Toast.makeText( context: login.this,  text: "No internet connection. Please check your network settings.",
                    Toast.LENGTH_SHORT).show();
        }
    }
});
```

Figure 6.16: The code of log in

Take image

This area is critical to the application because this is the function that gains access to the camera. An image is then captured and transmitted to the integrated model for prediction. The application requests permission to access the camera the first time it is used.

```
camera.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {
        //launch camera if we have permission
        if (checkSelfPermission(android.Manifest.permission.CAMERA) == PackageManager.PERMISSION_GRANTED) {
            Intent cameraIntent = new Intent(MediaStore.ACTION_IMAGE_CAPTURE);
            startActivityForResult(cameraIntent, requestCode: 3);
        } else {
            //request camera permission if we don't have
            requestPermissions(new String[]{Manifest.permission.CAMERA}, requestCode: 100);
        }
    }
});
```

Figure 6.17: The code of Take image

Gallery

This Code, like the previous one, uses a unique approach to obtaining the image via the gallery. It is then sent to the model in the same manner as it was done in the camera.

```
gallery.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {
        Intent cameraIntent=new Intent(Intent.ACTION_PICK,MediaStore.Images.Media.EXTERNAL_CONTENT_URI);
        startActivityForResult(cameraIntent, requestCode: 1);
    }
});
```

Figure 6.18: The code of Gallery

Classified by image

In order to identify, the model takes images from the camera or gallery. The code in this section turns the bitmap image into a surrounding image. If the trained model has an image, it will be recognized and the fish's name will be displayed; otherwise, it will be displayed as an 'invalid object'.

```java
public void classifyImage(Bitmap image){
    try {
        FinalModelNew model =    FinalModelNew.newInstance(getApplicationContext());
        // Creates inputs for reference.
        TensorBuffer inputFeature0 = TensorBuffer.createFixedSize(new int[]{1, 224, 224, 3}, DataType.FLOAT32);
        ByteBuffer byteBuffer = ByteBuffer.allocateDirect(4 * imageSize * imageSize * 3);
        byteBuffer.order(ByteOrder.nativeOrder());
        // get 1D array of 224 * 224 pixels in image
        int [] intValues = new int[imageSize * imageSize];
        image.getPixels(intValues, 0, image.getWidth(), 0, 0, image.getWidth(), image.getHeight());
        // iterate over pixels and extract R, G, and B values. Add to bytebuffer.
        int pixel = 0;
        for(int i = 0; i < imageSize; i++){
            for(int j = 0; j < imageSize; j++){
                int val = intValues[pixel++]; // RGB
                byteBuffer.putFloat(((val >> 16) & 0xFF) * (1.f / 255.f));
                byteBuffer.putFloat(((val >> 8) & 0xFF) * (1.f / 255.f));
                byteBuffer.putFloat((val & 0xFF) * (1.f / 255.f));
            }
        }
        //newly add missing code
        inputFeature0.loadBuffer(byteBuffer);
        // Runs model inference and gets result.
        FinalModelNew.Outputs outputs = model.process(inputFeature0);
        TensorBuffer outputFeature0 = outputs.getOutputFeature0AsTensorBuffer();
        float[] confidences = outputFeature0.getFloatArray();
        // find the index of the class with the biggest confidence.
        int maxPos = 0;
        float maxConfidence = 0;
        for(int i = 0; i < confidences.length; i++){
            if(confidences[i] > maxConfidence){
                maxConfidence = confidences[i];
                maxPos = i;
            }
        }
        String[] classes={"bulath hapaya","damkolapethiya","galpadiya","kawaiya", "others","thalkossa (belontia signat )"};
        String maxConfidenceString = String.format("%s: %.1f%%", classes[maxPos], maxConfidence * 100);
        //float confidenceValue = Float.parseFloat(maxConfidenceString.split(":")[1].trim().replace("%", ""));
        if (classes[maxPos].equals("others")) {
            result.setText("Invalid object");
            confidenceRate.setText(maxConfidenceString);
        } else {
            result.setText(classes[maxPos]);
            confidenceRate.setText(maxConfidenceString);
        }
        // Releases model resources if no longer used.
        model.close();
    } catch (IOException e) {
        // TODO Handle the exception
    }
}
```

Figure 6.19: The code of "is Classified by image"

See more details

Initially, a hidden 'see more' button is set here, and if a trained fish is detected by the model, this hidden button becomes visible. Then, by pressing that button, the user is able to view the specifics of the fish.

```
    result.addTextChangedListener(new TextWatcher() {
        @Override
        public void beforeTextChanged(CharSequence charSequence, int i, int i1, int i2) {
        }
        @Override
        public void onTextChanged(CharSequence charSequence, int i, int i1, int i2) {
            String fishName = charSequence.toString();
            if(fishName.isEmpty() || "Invalid object".equals(fishName) ){
                seeMore.setVisibility(View.GONE);
            }
            else {
                seeMore.setVisibility(View.VISIBLE);
            }
        }
        @Override
        public void afterTextChanged(Editable editable) {
        }
    });
    seeMore.setOnClickListener(new View.OnClickListener() {
       @Override

       public void onClick(View view) {
           String fishNamForPass = result.getText().toString();
           Intent intent=new Intent( packageContext: MainActivity.this,details.class);
           intent.putExtra( name: "fishNamForPass",fishNamForPass);
           startActivity(intent);
}
```

Figure 6.20: The code of see more

Chapter 7

Testing

7.1 Chapter introduction

Testing a mobile application or software is a unique aspect that involves comprehensive validation of all activities. The process includes addressing issues related to performance enhancement and error prevention. Many forms of testing are employed, including unit testing, functional testing, performance testing, regression testing, stress testing, and usability testing.

Validating the base requirements is a vital examination that must be conducted in all cases. The testing process may differ based on the time and resources available, but the overall system should function flawlessly as designed *What Is Ichthyology?* 2023.

7.3 chapter conclusion

Finally, the performance of the application was viewed through various aspects of the application. At the end of 10 test cases, it was confirmed that the application functions as expected

7.2 Unit testing

Test case ID	Test Case	Expected out-outcome	Test Input	Actual out-come	Test sta-tus
TC01	Using the Emai and password, the user should be Registered to the application	User should register to the application with given Email and password	Provide the email and password to the application	User is registered as expected	ok
TC02	Using the Emai and password the user should be logged in to the application	User should logs in to the application with the Email and password that were provided	Provide the email and password to the application	User login in successfu	ok
TC03	Upon pressing “capture image” button, the camera should open	Logged in user should be able to open the camera	Logged in user touches the capture image button and opens the camera	Upon touching the capture image button, the camera is opened	ok
TC04	With the opened camera user should be able to capture the image	Capture the image	Using the opened camera capture the image	Using opened camera image is captured	ok
TC05	If the image is A freshwater fish native to Sri Lanka show details	The details should be shown In the display	A Sri lanka native freshwater fish is detected	Details are shown as per the expected	ok
TC06	If it is not a fish, show “This is not a fish”	This is not a fish	Fish is not detected	Message is shown as per the expected	ok

Test case ID	**Test Case**	**Expected out-outcome**	**Test Input**	**Actual out-come**	**Test sta-tus**
TC07	Using "Gallery" button, logged in user should opens the Gallery	Logged in user should be able to open the Gallery	Logged in user upon touching the Gallery button, opens the Gallery	the Gallery is opened upon touching the Gallery button	ok
TC08 ok	User can select the image	From the opened gallery	select the image	Using opened gallery, selects the image	the image is selected from the opened gallery
TC09	If the image is A freshwater fish native to Sri Lanka, show details	The details should be shown in the display	A Sri Lanka native freshwater fish is detected	Details are shown as expected	ok
TC010	If it is not a fish display "This is not a fish"	This is not a fish	Fish is not detected	Message is shown as expected	ok
TC11	User can log out using log out button in the action bar	User log outs	touch the logout button in the action bar to log out	User log outs	ok

Table 7.1: Unit testing

Chapter 8

conclusion and future works

8.1 Conclusion

Fish Guide Pro is an easy-to-use application that replaces traditional fish identification methods such as books and notebooks. The application was thoroughly planned and researched to ensure its success. The primary goal was to provide a user-friendly and efficient tool for students, researchers, and observers who are interested in fish. The first step in the development of Fish Guide Pro was identifying the problem domain. Once the problem domain was identified, the corresponding problem context was explored. This involved identifying various aspects such as difficulties in identification, current fish identification methods, the role of technology, and the importance of data collection. Fish Guide Pro was then introduced as a solution to the identified problem domain and the problem context.

During the planning stage, a comprehensive examination into image detection and mobile application development was undertaken. This included an in-depth review of various literature related to past constructions to gain a well-rounded understanding of the problem domain. With a new plan in place, the objective for developing Fish Guide Pro became clear. Further research into machine learning models led to the final decision to use MobileNetV2, one of the most widely used models for mobile and mobile devices. However, the creation of this application was met with the challenge of finding an appropriate dataset. As no datasets of exotic fishes for Sri Lanka were available online, a new dataset had to be created from scratch. The necessary permissions were obtained under the legal framework, and the National Aquaculture Development Authority Dabulla branch was enlisted to provide pictures and information about five fishes. Fish Guide Pro has a profoundly positive impact on society, as it promotes the exchange of personal knowledge, environmental awareness and conservation, scientific research, interest in fish, and education.

8.2 Challenges

During the development of the Fish Guide Pro app, several challenges arose. One of the major challenges was distinguishing between similar fish species through the application. To overcome this, more attention was paid to the unique features of each fish and their subtle differences were added to the app's database. Maintaining an updated dataset and information with current and available information was another challenge. However, it is crucial to keep the dataset up-to-date to provide users with accurate information. Creating user-friendly interfaces was also a challenge. To overcome this, a wireframe was created after conducting thorough research. The wireframe was then transformed into a creative design using Figma. Training the dataset created by the selected MobileNetV2 model was another challenge. The integration of the trained dataset into Android Studio was also difficult. However, after thorough study and repeated training, the challenge was overcome.

8.3 Limitations

Understanding the limitations of the current deployment is important before making plans. By understanding these limitations properly, plans can be made.

- Limitation of species coverage - Limiting the input dataset to only 5 Sri Lankan freshwater fish endemics.
- Impact on Device Compatibility and Operating System- Limiting the built-in app only to the Android operating system.

- User Learning Curve - People who are not tech-savvy may need the help of another person in the beginning to get used to the application.
- Resource - The application may run slowly on older mobile phones due to high power consumption.

8.4 Future Works

Future plans to increase the value of Fish Guide Pro and increase its benefits are as follows.

- It is intended to comply with all operational procedures in the future. It will be available for download on any mobile phone running any operating system.
- It is planned to boost fish stock in multiple phases. It is envisaged that by the end of the process, a rich app will be available for the users that will include information on all of the fish native to Sri Lanka.
- The age of the fish in the photo is not yet visible, but plans are being made to include it in the future.
- In the future, the program will have a feature that will allow users to connect and share information with one another.
- Currently, information is only available in English, but plans are being made to provide material in Sinhala and Tamil in the future.

Appendix A

Appendix Title

A.1 Google form survey questions

1. Are you interested in freshwater fish in Sri Lanka?

    1 Yes

    2 No

2. Current knowledge about your Sri Lankan freshwater fish?

    1 Excellent

    2 Above average

    3 Average

    4 Below average

    5 Poor

3. Do you know what ichthyology?

    1 Yes

    2 No

4. What is your occupation?

1 Fish Genetic Specialist

2 Fish Nutritionist

3 Fish Pathologist

4 Aquaculture Farm Manager

5 Fish watcher

6 Fish Farm Worker/Technician

7 Student

8 Other

5. How you are currently studying fish?

1 By books

2 By letters and articles

3 Google search

4 By asking from someone who knows about fish

6. Currently, do you use an application to identify the fish?

1 Yes

2 No

7. Do you think a mobile application is needed to study freshwater fish in Sri Lanka?

1 Needed

2 Not Needed

A.2 Requesting permission letter from APIIT

A·P·I·I·T
Inspire love for learning

Our Ref: CB011632

12th May 2023

Director General,
National Aquaculture Development Authority of Sri Lanka,
No. 41/1,
New Parliament Road, Pelawatta,
Baththaramulla.

TO WHOM IT MAY CONCERN

This is to certify that **Mr. MANORATHNA ACHARIYALAGE SAMEERA MADUSANKA (CB011632)** is following 3rd year of the BSc (Hons) Computer Science degree offered by the Staffordshire University, U.K. This is a 3-year full time study programme conducted in English Medium at Asia Pacific Institute of Information Technology Sri Lanka.

As a part of the course assessment for Final Year Project, the above student has been approved to conduct a research based on identifying ethnic fishes and APIIT will be giving him the necessary academic guidance to complete this project.

We wish to explore the possibility of you providing necessary assistance in gathering required information from your organization, for the successful completion of the project.

We assure you that the information gathered will be utilized only for the above assignment and would be treated confidential.

Yours Sincerely,

Nirosha Perera,
Manager Academic Administration – School of Computing.

ASIA PACIFIC INSTITUTE OF INFORMATION TECHNOLOGY LANKA (PVT) LTD (Reg.No. PV 3052)
Colombo - 388, Union Place, Colombo 2, Sri Lanka | Kandy - No. 63 King's Street, Kandy, Sri Lanka
T Colombo +94 11 7 675 100 | Kandy +94 81 7 81 81 81 F +94 11 26 87 249 E info@apiit.lk W www.apiit.lk

Figure A.1: Permission grantting letter from APIIT

A.3 Permission approved letter form Ministry of fisheries

ධීවර අමාත්‍යාංශය - கடற்றொழில் அமைச்சு - Ministry of Fisheries

විසිතුරු මසුන්, මිරිදිය මත්ස්‍ය හා ඉස්සන් ඇති කිරීම, ධීවර වරාය සංවර්ධන,
බහුදින ධීවර කටයුතු හා මත්ස්‍ය අපනයන රාජ්‍ය අමාත්‍යාංශය

அலங்கார மீன்கள், நன்னீர் மீன்கள், இறால்களை வளர்த்தல், கடற்றொழில் துறைமுகங்கள்
அபிவிருத்தி, பலநாள் கடற்றொழில் அலுவல்கள் மற்றும் மீன் ஏற்றுமதி இராஜாங்க அமைச்சு.

NAQDA

State Ministry of Ornamental Fish, Inland Fish & Prawn Farming, Fishery Harbor Development,
Multi day Fishing Activities and Fish Exports.

ශ්‍රී ලංකා ජාතික ජලජීවී වගා සංවර්ධන අධිකාරිය
இலங்கை தேசிய நீர் உயிரின வளர்ப்பு அபிவிருத்தி அதிகாரசபை
National Aquaculture Development Authority of Sri Lanka

මගේ අංකය எனது இல. My No.	ඔබේ අංකය உமது இல. Your No.	දිනය திகதி Date
NQ/DG/69		25/05/2023

Manager Academic Administration – School of Computing
Asia Pacific Institute of Information Technology Lanka (Pvt) Ltd.
No.63, King's Street
Kandy

Request permission for the Research Project

This refers to your letter number CB011632 dated 12th May 2023 requesting permission for your student Mr. Manorathna Achariyalage Sameera Madusanka (CB011632) to collect information for the research project on identifying ethnic fishes in the country.

As requested by the letter permission is hereby granted Mr. Sameera Madusanka to collect necessary information for his proposed research project from the Aquaculture Development Center, Dambulla under the supervision of Mr. A. R. Mudalige, Fish Genetic Specialist of National Aquaculture Development Authority of Sri Lanka.

Dr. (Mrs.) J. M. Asoka
Director General

CC – Mr. A. R. Mudalige, Fish Genetic Specialist – for information pls.

41/1, නව පාර්ලිමේන්තු පාර, පැලවත්ත, බත්තරමුල්ල. இல 41/1 புதிய பாராளுமன்ற வீதி, பெலவத்த, பத்தரமுள்ள. 41/1,New Parliment Road, Pelawatte, Battaramulla.

පොදු දුරකථන / காரியாலயம் 011-2786495, 2786577 — සභාපති / தலைவர் 011 -2786497 — අධ්‍යක්ෂ ජනරාල් / பணிப்பாளர் நாயகம் 011 -2786498

Figure A.2: The code of see more

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