SEA TURTLE HABITANT MONITORING AND TRACKING SYSTEM

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Project Proposal Report

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Declaration page of the candidates & supervisor

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

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The above candidates are carrying out research for the undergraduate Dissertation under my supervision

…………………………………….
21/08/2024

Signature of the Supervisor: Date:
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Abstract

Sea turtles play a crucial role in maintaining healthy marine ecosystems, but their populations are declining due to various threats such as habitat degradation, climate change, and human activities. With the growing concerns over marine biodiversity, there is an urgent need for effective monitoring and conservation strategies to protect these endangered species. Technology can significantly aid in the early detection of habitat changes and threats, thereby enhancing conservation efforts and supporting population recovery.

This research aims to develop a mobile-based application for monitoring sea turtle habitats by predicting sea turtle presence, identifying critical nesting sites, and detecting environmental factors that impact their survival. The proposed system utilizes deep convolutional neural networks to analyze satellite imagery and environmental data for accurate prediction and identification tasks. Additionally, the application integrates Google Maps and OpenStreetMap APIs along with K-Means clustering and OpenCV techniques to detect and visualize important geographical features affecting sea turtle habitats. Data on sea turtle sightings and environmental conditions will be collected and processed to train and validate the predictive models effectively.

Keywords: Sea turtles, Habitat monitoring, Convolutional Neural Networks, K-Means clustering, OpenCV, Satellite imagery, Environmental analysis, Conservation technology.

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1.1 Background & Literature survey

With the growing impact of climate change, pollution, and human activities on marine ecosystems, protecting vulnerable species like sea turtles has become more important than ever. Sea turtles play a crucial role in maintaining the health of ocean environments, but their populations are under serious threat due to habitat loss, illegal poaching, accidental capture in fishing gear, and the effects of climate change. Monitoring and tracking sea turtle habitats is essential to help ensure their survival and to guide conservation efforts effectively.

Sea turtles rely on specific areas for nesting, feeding, and migration. By predicting where and when sea turtles are likely to be found based on environmental factors, conservationists can better protect these animals. Developing predictive models for sea turtle sightings involves analyzing data such as satellite images, ocean conditions, and records of past sightings. Identifying patterns in this data can help predict the presence of sea turtles in certain areas, allowing conservation efforts to be more focused and effective.

Research has shown that modern technologies like satellite tracking, remote sensing, and machine learning can be very useful in monitoring and protecting marine life. For example, GPS tracking has been used to follow the migration routes of sea turtles, providing valuable information about the long distances they travel and the dangers they face. Additionally, machine learning, a type of artificial intelligence, has been used to predict where different species might be found based on environmental data.

For instance, one study by Patel and colleagues used deep learning, a form of machine learning, to analyze satellite data and environmental factors to predict the occurrence of marine species, including sea turtles. This study showed that certain computer models could accurately predict where sea turtles are likely to be found.

Another study by Smith and colleagues developed a model to identify the best habitats for sea turtles using remote sensing data and machine learning. This model helped pinpoint key areas for nesting and migration, which are important for conservation efforts.

The "SEA TURTLE HABITAT MONITORING AND TRACKING SYSTEM" aims to build on these methods by developing predictive models specifically for sea turtle sightings. This system will combine satellite tracking data, environmental information, and past sightings to create a model that can forecast where sea turtles are likely to be. This will help direct conservation efforts to the areas where they are most needed, helping to protect sea turtles in their natural habitats.

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In summary, combining modern technologies like machine learning and satellite tracking with traditional conservation methods can greatly improve efforts to protect endangered species like sea turtles. The predictive models created in this project will be an important tool in the ongoing work to monitor, track, and conserve sea turtle populations, helping ensure their survival for future generations.

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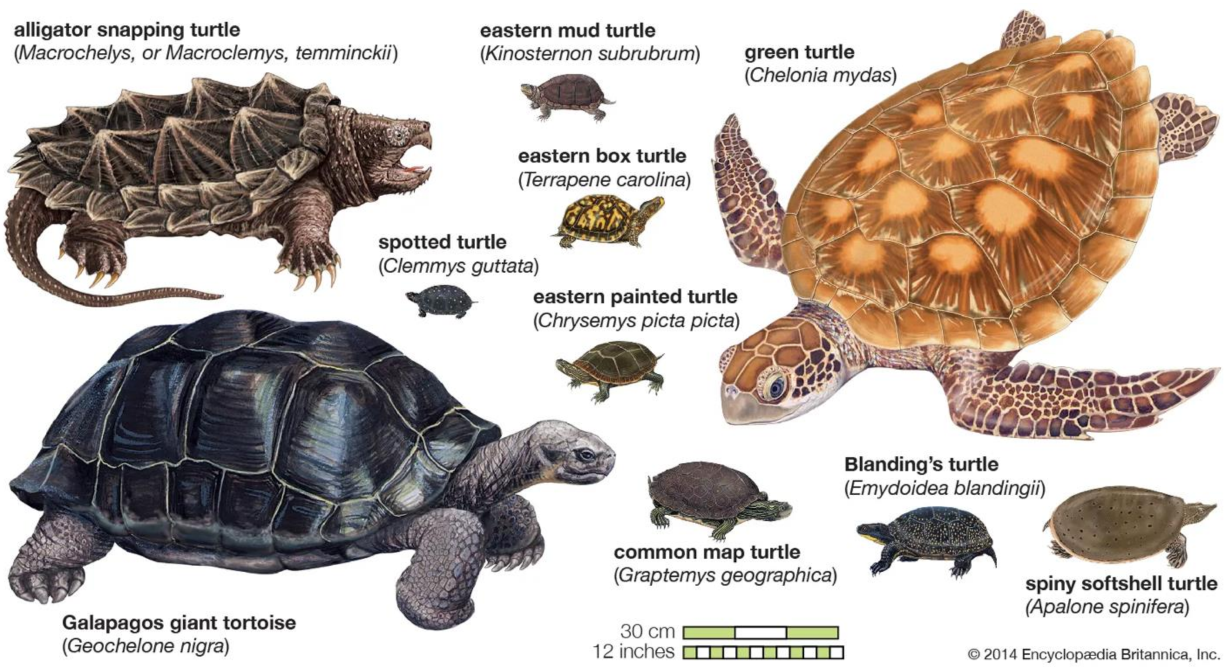


1.2 Research Gap

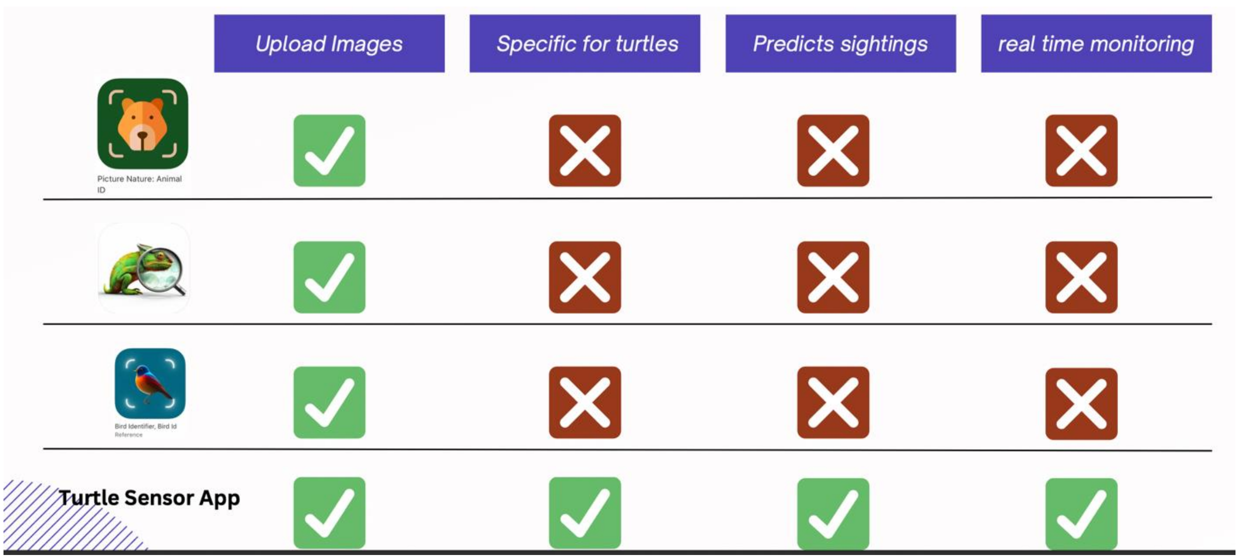
A thorough review of the literature has highlighted that while various systems have been developed using machine learning and image processing techniques to address issues like magnesium deficiency and plant diseases in various plants, there remains a significant gap in the context of sea turtle habitat monitoring and tracking. Specifically, there has been no system designed to predict sea turtle sightings and monitor their habitats using advanced technologies such as machine learning, satellite tracking, and remote sensing data. This gap is critical because accurate predictions and monitoring can significantly enhance conservation efforts, yet existing research has not fully explored these avenues.

Research A focuses on marine species monitoring using traditional tracking methods. While effective in some contexts, these methods often rely on historical data and manual observations, lacking the integration of real-time data and machine learning techniques. As a result, they may not provide timely or accurate predictions of sea turtle presence in specific habitats. The system proposed in Research A is also limited by its reliance on predefined observation points, which may not capture the full range of sea turtle movements and habitat use. This limitation restricts the effectiveness of conservation efforts based on this data.

Research B explores the use of satellite tracking and remote sensing to monitor sea turtle migrations. Although this research introduces the use of modern technology, it primarily focuses on tracking long-distance migrations rather than predicting local habitat use. Additionally, while satellite data can provide valuable insights, it may not be sufficient on its own to predict sea turtle sightings with high accuracy. Research B also does not incorporate machine learning algorithms that could analyze complex patterns in environmental data to improve prediction accuracy.

Research C proposes a model to monitor marine habitats using a combination of environmental data and traditional observation techniques. The research highlights the potential of using oceanographic data to understand sea turtle behavior, but it stops short of integrating machine learning to predict sea turtle sightings based on these environmental factors. Moreover, Research C does not fully utilize the potential of historical sighting records to enhance the accuracy of predictions. The research also lacks a robust framework for real-time monitoring and data integration, which is essential for effective conservation management.

The proposed "SEA TURTLE HABITAT MONITORING AND TRACKING SYSTEM" seeks to address these research gaps by developing a comprehensive model that integrates satellite tracking, environmental variables, and historical sighting records. By employing machine learning algorithms, this system aims to predict sea turtle sightings with greater accuracy, thereby supporting more effective conservation strategies. The system will not only provide real-time monitoring capabilities but also enhance the understanding of sea turtle habitat use, contributing to the broader goal of preserving these endangered species.



	Upload Images	Specific for turtles	Predicts sightings	real time monitoring
Picture Nature: Animal ID	✓	✗	✗	✗
	✓	✗	✗	✗
Bird Identifier, Bird Id Reference	✓	✗	✗	✗
Turtle Sensor App	✓	✓	✓	✓

1.3 Research Problem

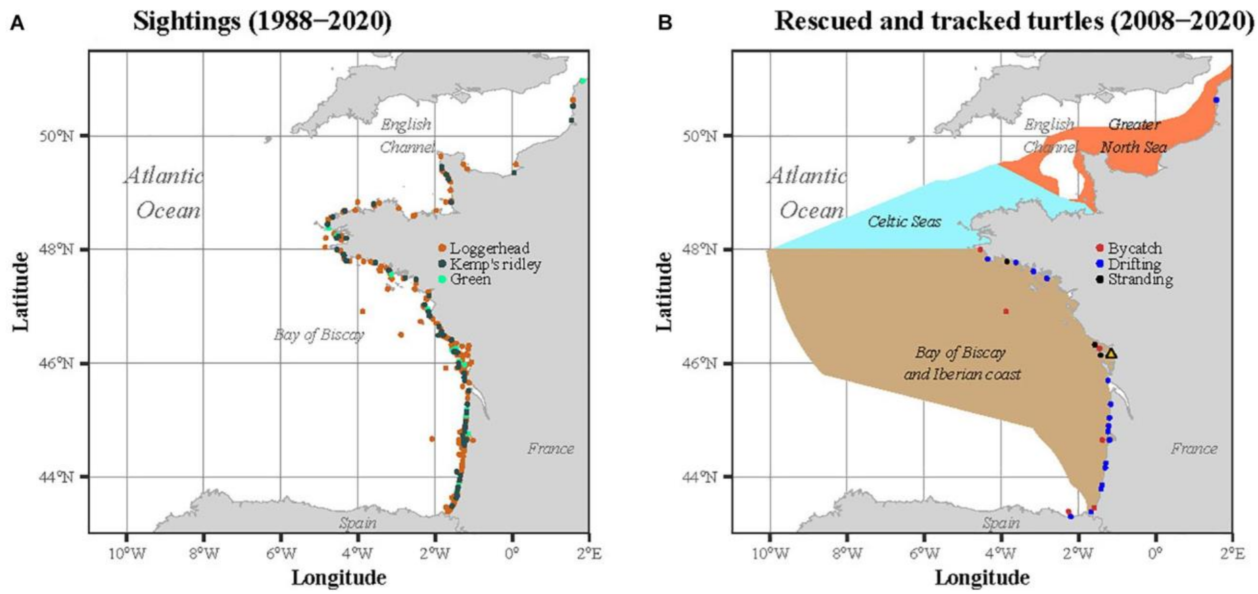
Sea turtles are vital to marine ecosystems and contribute significantly to the health of ocean environments. However, sea turtle populations are facing severe threats due to various factors, including habitat loss, illegal poaching, bycatch in fishing gear, and the impacts of climate change. These threats have led to a decline in sea turtle numbers, posing a risk to the biodiversity of marine habitats.

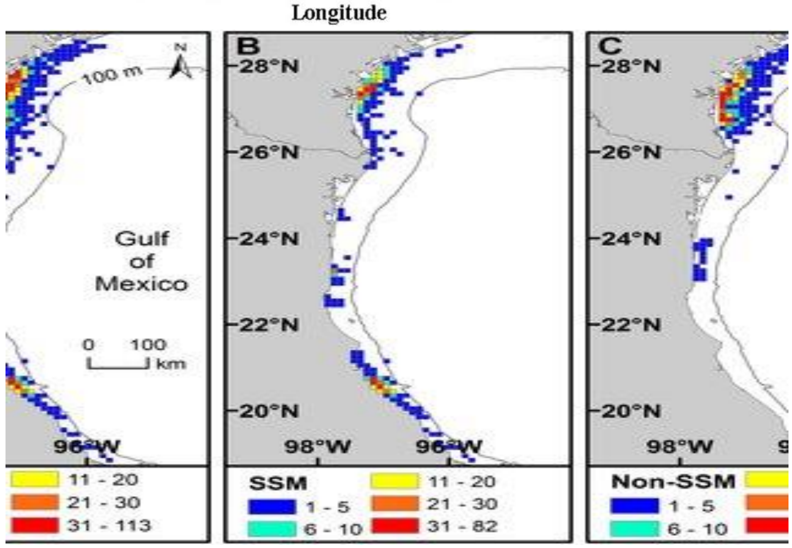
One of the major challenges in sea turtle conservation is the lack of accurate tools and systems to monitor and predict sea turtle movements and habitat use. Current conservation efforts often rely on traditional methods, such as manual tracking and observation, which are time-consuming and may not provide real-time or accurate data. As a result, conservationists may miss critical opportunities to protect sea turtles in their natural habitats, particularly during key periods such as nesting or migration.

Additionally, the ability to differentiate between various environmental factors affecting sea turtles is crucial. For instance, environmental changes such as temperature shifts, ocean currents, and pollution levels can significantly influence sea turtle behavior and habitat use. However, without advanced monitoring systems that can integrate and analyze these factors, it is challenging to predict where sea turtles are likely to be found and what specific threats they might face in different areas.

Furthermore, while some research has been conducted on sea turtle migration and habitat use, there is a lack of comprehensive systems that integrate satellite tracking, environmental data, and machine learning to predict sea turtle sightings accurately. Such a system would be invaluable for conservation efforts, allowing for targeted protection measures in areas where sea turtles are most at risk.

The proposed "SEA TURTLE HABITAT MONITORING AND TRACKING SYSTEM" aims to address these challenges by developing a predictive model that can accurately forecast sea turtle sightings based on a wide range of environmental factors. This system will help conservationists identify critical habitats and implement timely protection measures, ultimately contributing to the survival of sea turtles and the preservation of marine biodiversity.





2 Objective

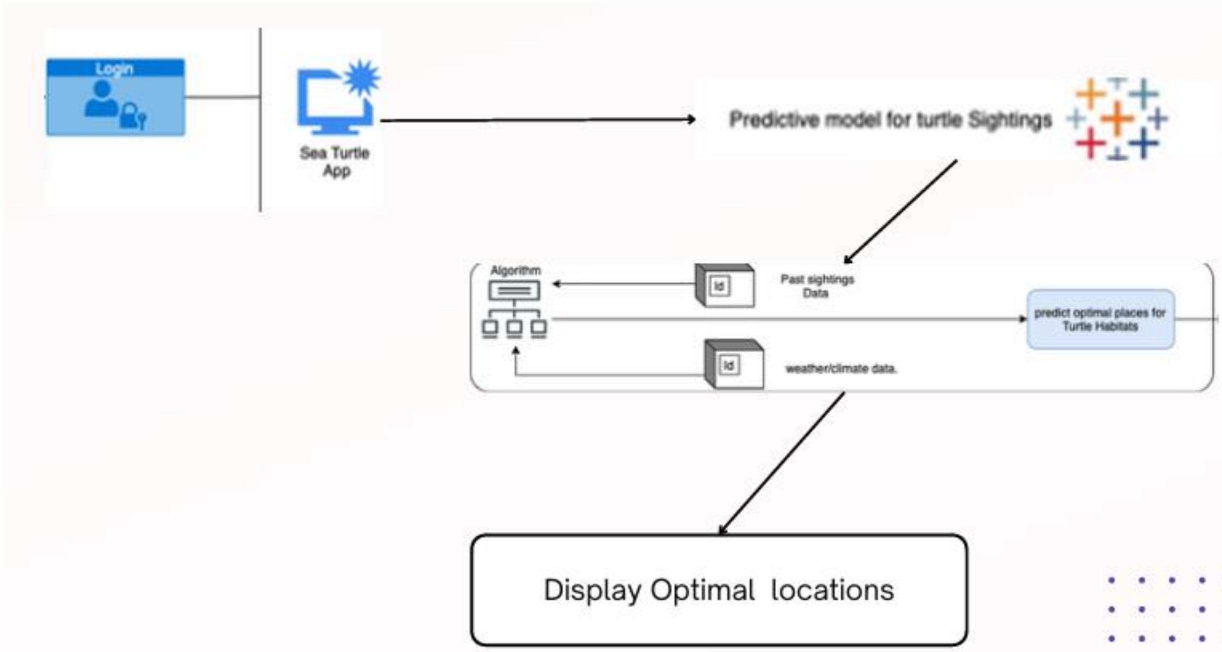
2.1 Main Objectives

The main objective is to develop a predictive model for sea turtle sightings by integrating satellite tracking data, environmental variables, and historical sighting records. This model will be part of a smart system aimed at enhancing conservation efforts by identifying critical sea turtle habitats and predicting their presence in various regions.

2.2 Specific Objectives

- **To study and understand** the various environmental factors, such as ocean currents, temperature, and pollution levels, that influence sea turtle movements and habitat use.
- **To study and understand** how to collect and process satellite tracking data and historical sighting records for use in training predictive models.
- **To study and understand** how to integrate environmental data with satellite tracking information to predict sea turtle presence in specific areas.
- **To study and understand** the application of machine learning techniques, such as deep learning, to analyze and model sea turtle movements.
- **To study and understand** how to develop and implement a mobile application that utilizes the predictive model to provide real-time alerts and information on sea turtle sightings for conservationists and researchers.

3 Methodology



The primary goal of this project is to develop a smart mobile and web-based solution to assist conservationists, marine biologists, and environmental researchers in monitoring and protecting sea turtle populations. As illustrated in Figure 3.1, the proposed system will allow users to predict sea turtle sightings, identify critical habitats, and track the movement of sea turtles across different regions. By analyzing environmental factors and historical sighting data, the system will provide valuable insights into sea turtle behavior and help prioritize conservation efforts.

This system has the following capabilities:

- **Predicting Sea Turtle Sightings:** Utilizing machine learning techniques, particularly Convolutional Neural Networks (CNNs), to analyze environmental data and predict the likelihood of sea turtle sightings in specific areas.
- **Identifying Critical Habitats:** Using the K-Means algorithm and satellite tracking data, in combination with Google Maps API and remote sensing tools, to identify and map key nesting sites, feeding grounds, and migration corridors for sea turtles.

- **Visualizing Habitat Use and Movement Patterns:** The system will provide a visual representation of sea turtle movements and habitat use, highlighting areas with high conservation priority. This will enable researchers and conservationists to monitor the dispersion of sea turtles and take timely actions to protect them.

In addition, the mobile application will allow users to input or capture real-time data, such as environmental conditions or sightings, which will be processed to update the predictive models and improve the accuracy of the system's forecasts.

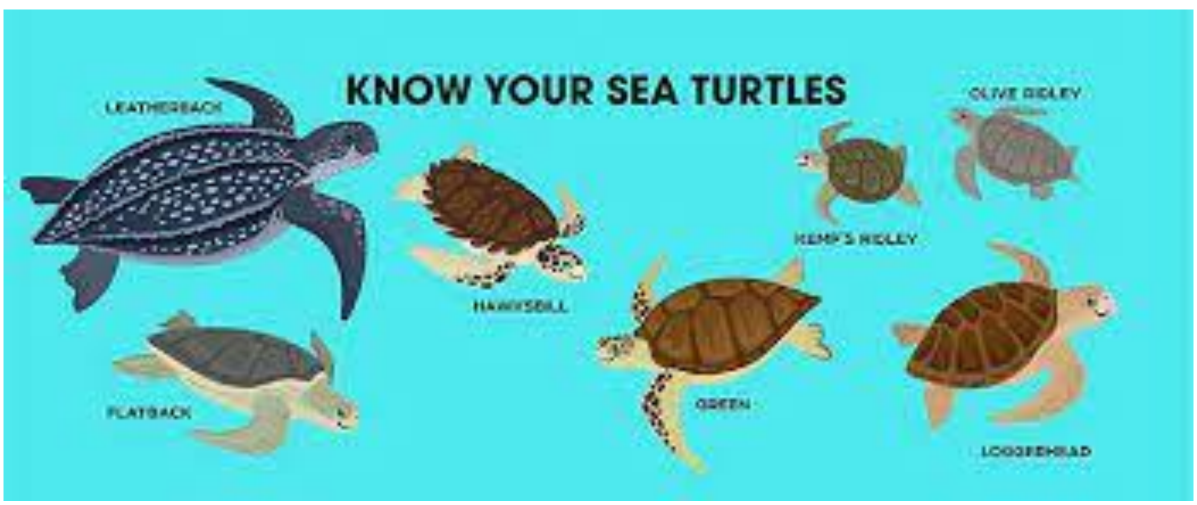
3.1 Software Solution

3.1.1 Development Process

In traditional development methods like Waterfall, changes in requirements can be difficult to manage because each step must be completed in sequence. This approach doesn't allow going back to previous steps once they're finished.

Agile development, on the other hand, is more flexible and responsive to change. It breaks the project into small, iterative cycles called sprints, where planning, development, testing, and review happen continuously. This allows the project to adapt quickly as new requirements emerge.

Among Agile frameworks, **Scrum** is particularly suitable for this project. Scrum is a lightweight framework that helps manage complex projects through collaboration and iterative progress. Its flexibility makes it an ideal choice for developing a system that integrates various technologies like machine learning and satellite tracking to monitor and protect sea turtle habitats.



3.1.2 Feasibility Study

1. **Technical Feasibility**

   Based on the literature review, various tools and technologies have been successfully applied in similar projects, such as using machine learning and data analysis techniques to predict sea turtle sightings. Additionally, the project team has the necessary skills in developing mobile and web applications, as well as working with satellite data and machine learning models. Therefore, the project is technically feasible to execute.

2. **Scheduling Feasibility**

   Each phase of the proposed system needs to be carefully planned and executed to ensure timely completion. The project timeline will be structured to produce credible outputs at each stage, leading up to the final submission on the scheduled due date. This approach ensures that the project remains on track and is completed within the allocated timeframe.

3.1.3 Requirement Gathering and Analysis

1. **Gathering Requirements from Sea Turtle Research Institutes**

   The initial step involved meeting with experts from a sea turtle research institute to understand the specific needs and challenges related to sea turtle monitoring and tracking. During this meeting, it was decided to develop a mobile and web application to predict sea turtle sightings based on environmental factors and historical data. The experts highlighted the difficulty in differentiating between various environmental conditions affecting sea turtle sightings and the need for a system that can integrate satellite data, oceanographic conditions, and historical records. They also emphasized the importance of accurate predictive models for effective conservation efforts.

2. **Conducting a Survey**

   A survey was conducted with marine biologists and conservationists to gather additional insights into sea turtle habitats and movement patterns. The questionnaire aimed to collect information on current methods used for monitoring sea turtles, challenges faced in tracking their movements, and the types of data that would be most useful for improving predictive models. This feedback was crucial for tailoring the system to address real-world needs and ensure it provides valuable insights for conservation efforts.

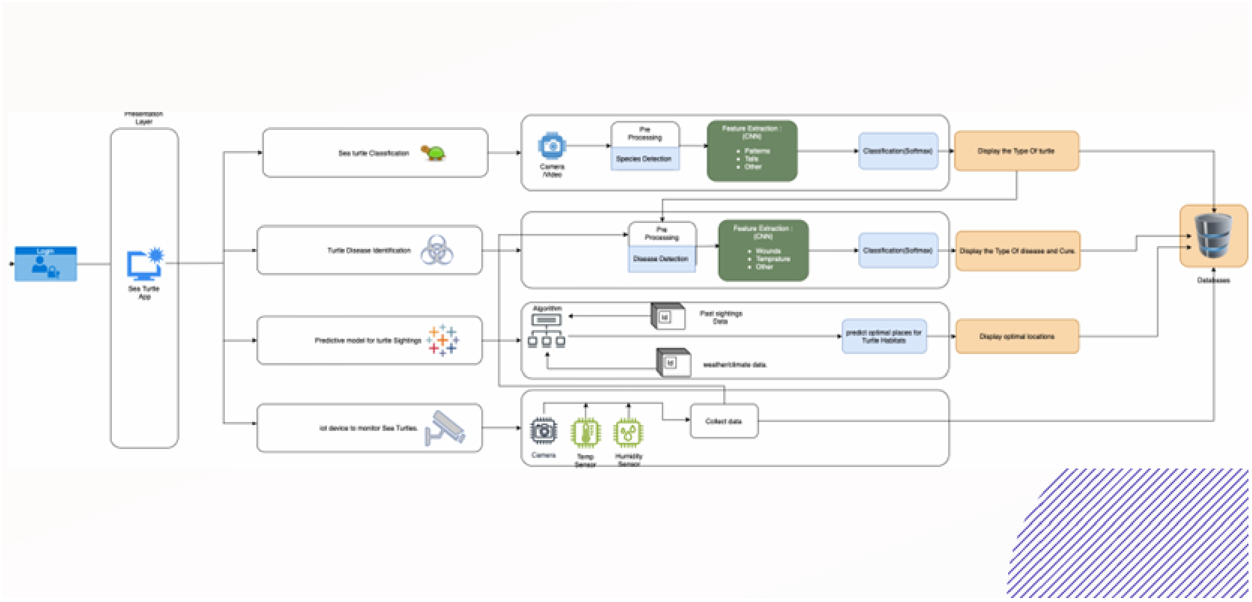
3.1.4 Data Set

For developing the predictive models, clear images of sea turtle habitats and related environmental conditions will be collected. Images and data will be gathered from various locations known for sea turtle sightings. Specifically:

- **Sea Turtle Sightings Data:** Images of sea turtles in different habitats, such as nesting sites and feeding grounds, will be collected from regions like the Great Barrier Reef, Galápagos Islands, and the Caribbean.
- **Environmental Data:** Satellite images and oceanographic data will be sourced to analyze conditions like water temperature, salinity, and current patterns. This data will be collected from marine research institutes and satellite databases.

For training the model accurately, it is crucial to obtain clear and comprehensive images and data from these diverse locations to cover various environmental scenarios and sea turtle behaviors.

3.1.5 Implementation



3.1.5 System Workflow

According to the system diagram, the workflow for the proposed solution involves several steps:

1. **Image Capture and Upload:** Users can capture images using a mobile phone or use previously captured images. After capturing, the image is uploaded to the Node server as form-data. The Node server then converts the image to a base64 string and sends it to the Flask server.
2. **Coconut Caterpillar Identification:**
    - **Initial Processing:** If the symptoms in the image do not match those of Coconut Caterpillar Infestation (CCI), the image is processed to identify Leaf Scorch Decline.
    - **Leaf Scorch Decline Detection:** Convolutional Neural Networks (CNNs) will be used to analyze the image for two visual symptoms:
        1. **Necrosis or Scorching:** This involves detecting the browning of the leaf tips.
        2. **Leaf Curling and Withering:** CNNs will perform color segmentation to identify brown patterns and extract features to detect leaf curling and withering. The

architecture with the highest accuracy for these symptoms will be selected.

3. **Water Resources Identification:**
    - **GPS Location and Map Snapshot:** If CCI is detected, the system will obtain the farmer’s current GPS location from the Node server. It will then retrieve a snapshot from Google API or Open Map Tiles within a 100m radius. This snapshot is sent to the Flask server.
    - **Water Resource Detection:** OpenCV and the K-means algorithm will be used to identify any blue color watermarks in the map snapshot. The K-means algorithm clusters blue color regions to detect water bodies. The final result, including CCI details and water resource information, is sent to the crowdsourcing component.
4. **Magnesium Deficiency Identification:**
    - **Secondary Processing:** If Weligama Coconut Leaf Wilt Disease is not detected, the image is processed for Magnesium Deficiency identification.
    - **Deficiency Detection:** CNNs will analyze the image for color changes between green and yellow, which indicate Magnesium Deficiency. CNNs will be employed to perform color segmentation and feature extraction to identify these patterns accurately. The system will use architectures such as MobileNetV2, ResNet, VGG19, and custom models to determine the most effective approach for detecting Magnesium Deficiency.

This component is designed to ensure accurate and efficient identification of coconut plant diseases and related factors, enhancing the effectiveness of the proposed system.

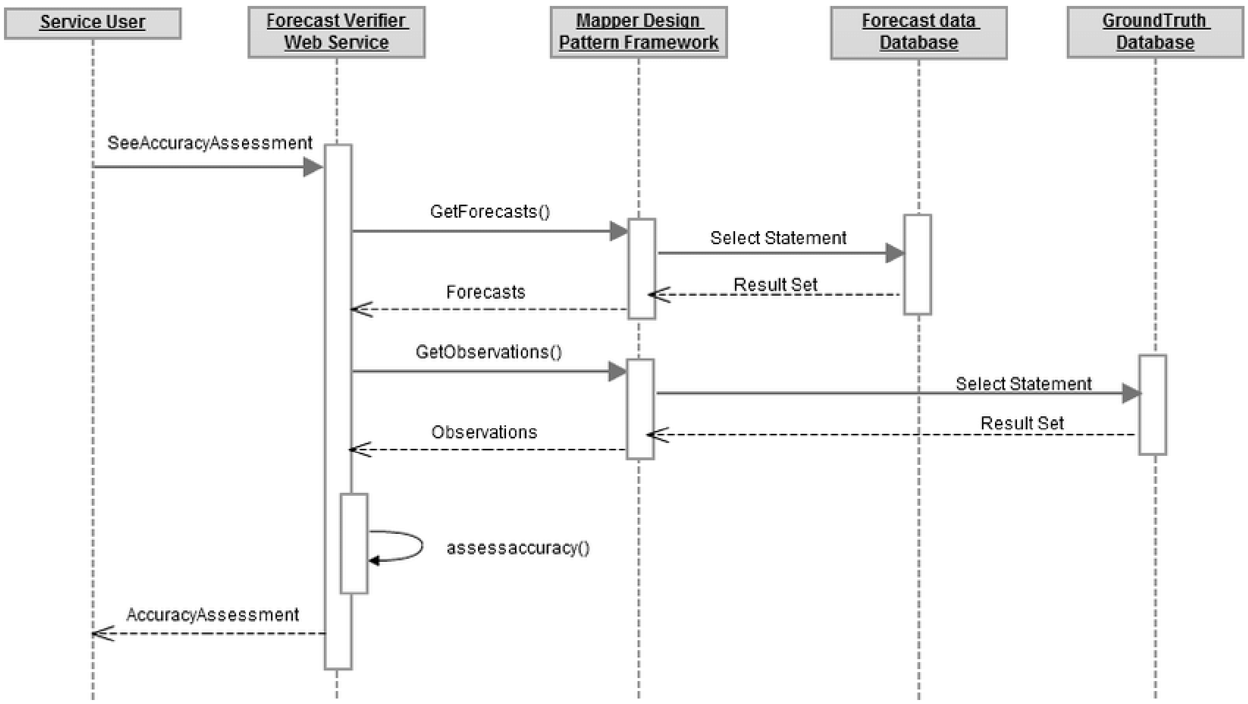
5.0 BUDGET

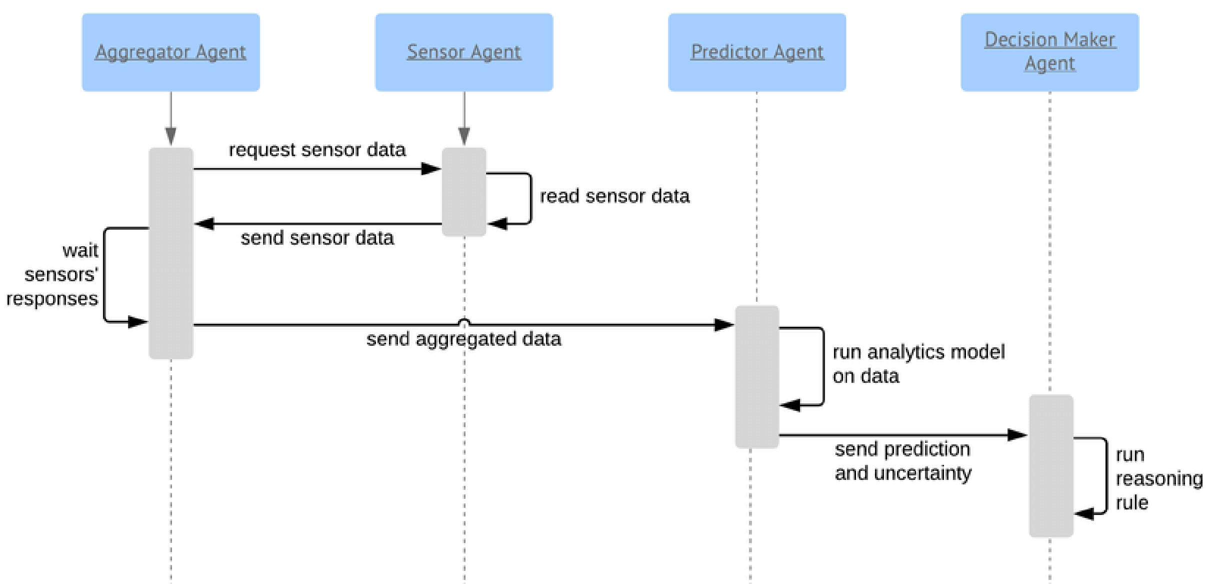
Since the outcome of the proposed model is a software-based solution, there are no hardware components connected to the implementation. The primary source of the cost will be the subscription fees to the cloud provider for the computing power of the virtual machines. However, there will be some other costs expected to as be given in the table below.

Type	Cost
Internet use and web hosting	5000 LKR
Publication costs	12110 LKR
Stationary	5500 LKR
TOTAL	***22610 LKR***

Table 4: Cost Management Plan

3.1.7 Sequence Diagram





3.1.8 Testing

The testing phase is crucial to ensure the application functions correctly and meets all quality standards. It involves unit testing, integration testing, system testing, and user acceptance testing.

1. **Unit Testing:**
   - **Objective:** Check each function of the application individually to ensure it operates without errors.
   - **Process:** Test each function separately, focusing on the accuracy of the source code. This is a form of white box testing that helps identify and fix issues within individual functions.
   -
2. **Integration Testing:**
   - **Objective:** Verify that the integrated sub-modules work together as expected.
   - **Process:** After combining the individual components, this phase tests their interactions to detect and address any integration problems or failures.
   -
3. **System Testing:**
   - **Objective:** Test the complete, integrated application to ensure it functions as a whole.
   - **Process:** This phase involves testing the fully assembled system to ensure all components work together seamlessly and meet the specified requirements.

4. **User Acceptance Testing:**

- **Objective:** Ensure the application meets the initial requirements and is ready for use.
- **Process:** Conducted by coconut growers and researchers from the Coconut Research Institute, this testing verifies that the application meets their needs and expectations. Feedback from this phase will be used to make final improvements before deployment.

This thorough testing process aims to enhance the software's reliability and ensure it performs effectively in practical scenarios.

4.Project Requirements

4.1 User Requirements

1. Users should be able to input location data and environmental parameters.
2. Users should be able to view predicted sea turtle sighting probabilities for specific areas.
3. Users should be able to access historical sighting data and prediction accuracy.

4.2 Software Requirements

1. Python (for data analysis and machine learning)
2. R (for statistical modeling)
3. PostgreSQL (for database management)
4. Jupyter Notebook (for data exploration and model prototyping)
5. Docker (for containerization and deployment)

4.3 Functional Requirements

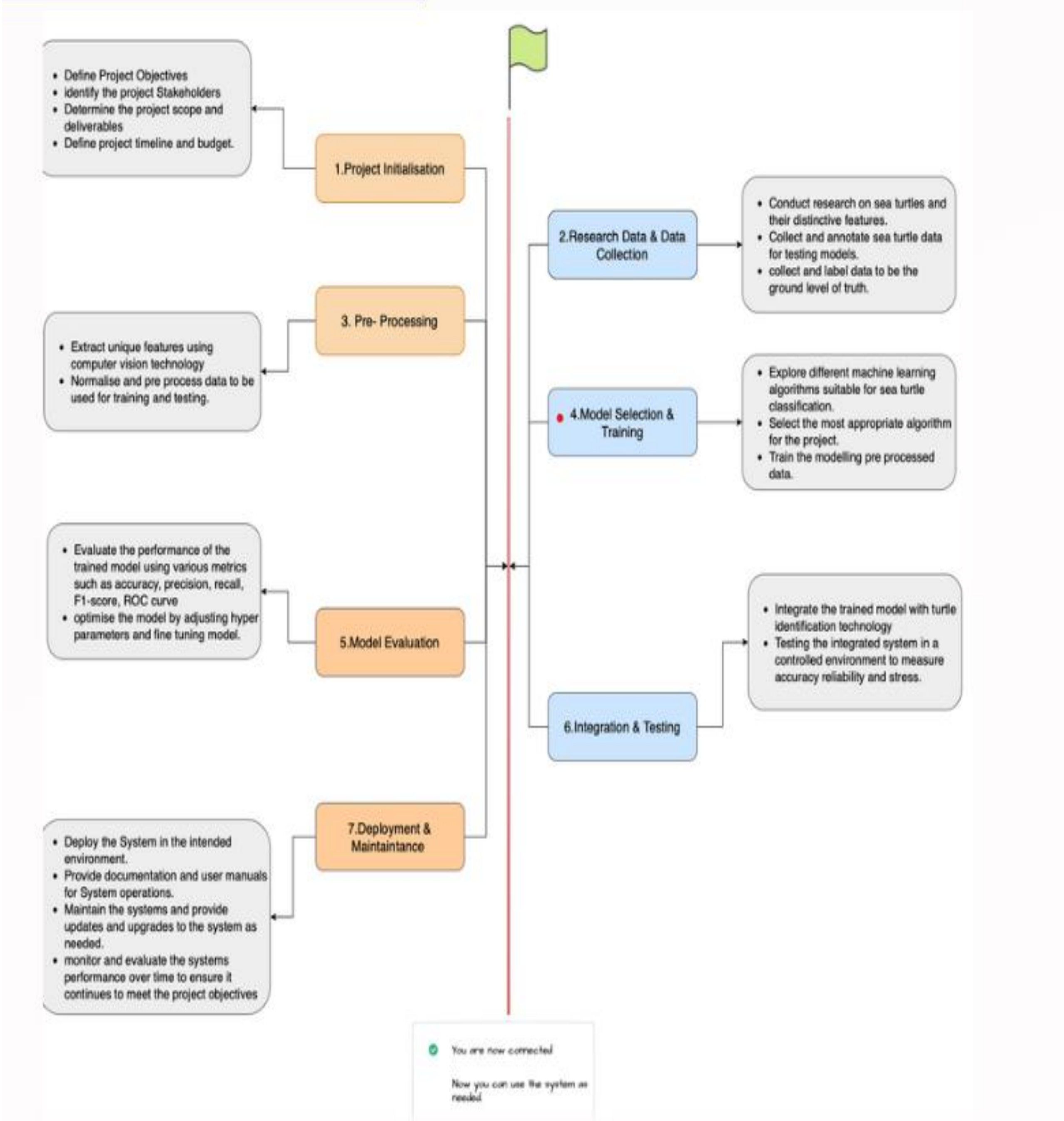
1. The system should be able to collect and process various environmental data (e.g., water temperature, tide patterns, beach conditions).
2. The system should develop and maintain machine learning models to predict sea turtle sightings based on historical data and current conditions.
3. The system should provide visualization tools for displaying prediction results on maps.
4. The system should be able to update its models with new data to improve prediction accuracy over time.

4.4 Non-Functional Requirements

1. The predictive models should achieve a minimum accuracy of 80% in predicting sea turtle sightings.
2. The system should be able to process and generate predictions within 5 minutes of receiving new data.
3. The user interface should be intuitive and accessible to both researchers and conservation volunteers.
4. The system should be scalable to handle increasing amounts of data as more locations are monitored.
5. Data security measures should be implemented to protect sensitive information about sea turtle habitats.

5 Gantt Chart

6 Work breakdown Chart



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