Project Proposal:

Safeguarding Wildlife and Enhancing Sustainable Tourism in Semenggoh Nature Reserve

Background

The Semenggoh Nature Reserve is a key habitat for the critically endangered Bornean orang utan, a species that has seen a sharp decline in population due to deforestation, poaching, and human encroachment. Over the last two decades, more than half of their natural habitat has been lost, resulting in a 50% drop in their numbers over the past 60 years. While conservation efforts have been put in place, including the establishment of protected areas, many orangutans still reside outside these zones, making them vulnerable to threats.

To address these challenges, there is a growing need for innovative conservation efforts that blend technology, tourism, and community involvement. This project, in collaboration with the Sarawak Forestry Corporation, aims to protect orangutan populations while promoting sustainable tourism. By leveraging modern technologies like AI, IoT, and real-time data analytics, the project seeks to provide a comprehensive framework for wildlife conservation and enhanced tourist experiences

Problem Description

The main problem to be addressed in this project is the **lack of comprehensive monitoring and wildlife management systems** in the Semenggoh Nature Reserve. This has resulted in two major issues:

1. **Ineffective Wildlife Monitoring and Enforcement**: Current systems are inadequate in monitoring orangutan habitats and preventing illegal activities such as poaching. There is a lack of real-time data to track orangutan movements and identify potential threats, leading to delays in response and enforcement.
2. **Limited Tourist Access to Wildlife Information**: Tourists visiting the reserve often have difficulty accessing up-to-date information on wildlife sightings, such as orangutans and other native species. This limits the overall visitor experience and the potential for engagement in conservation efforts.

The purpose of the project is to implement **technological solutions** that address these issues. Specifically, the project will develop an AI-powered wildlife monitoring system, create a mobile/web application for tourists, and implement IoT-based poacher tracking mechanisms. These initiatives will ensure the safety of wildlife, improve tourist experiences, and promote responsible eco-tourism.

Scope

To ensure that the project can be done smoothly ensuring high quality deliverables at the end of the project, the project scope will have to be defined to clarify certain limitations on what must be done and what can be ignored now. Several things will need to be defined in this project scope starting with the aim and goal of this project, what solutions can be used to resolve the problems faced and what features will be developed during this project.

The main point of this project is to create comprehensive technology-driven platform to safeguard wildlife species such as orangutans while also enhancing the tourism experience within the Semenggoh Nature Reserve. This project will involve creating a solution to tackle key challenges such as monitoring the wildlife and providing better opportunities and wildlife education for visitors elevating their overall experience when touring the nature reserve. This will be achieved through a digital solution that consists of a website and mobile application, donation platforms and publicity tools along with advanced data science methods to integrate and visualise wildlife data from various sources. Furthermore, the power of AI will be leveraged to perform data analysis such as species identification and data processing. Moreover, an IoT solution will be utilised to monitor for any signs of illegal activities to enhance wildlife protection efforts. Advanced cybersecurity measures such as secure access control will be implemented to safeguard all the data.

Objectives:

1. Enhanced Orangutan monitoring system:

- Develop a comprehensive monitoring system through the implementation of an automated wildlife threat alert system that uses AI to detect and respond to potential threats that may endanger the orangutans.
- Automated threat alert system leveraging AI and IoT to detect and deter illegal activities that may threaten the safety of the animals. The system will trigger an alert to the staff allowing them to take immediate action to prevent any harm from befalling the animals.
- Creation of a website that gives the staff working at the nature reserve the power to perform data visualization and analysis allowing them to effectively monitor the wellbeing of the orangutans in real-time

2. Elevate the tourism experience:

- Develop a user-friendly mobile and web application that provides tourists with real-time information on wildlife sightings and common orangutan locations to increase the chances of observing an orangutan.
- Offer interactive and immersive experiences to the tourists through educational content in regards to the environment within the reserve such as the flora and fauna while also promoting responsible tourism practices that should be practiced within the reserve.
- Create a secure donation platform allowing tourists to seamlessly donate for wildlife conservation initiatives and other fundraising campaigns.

Stakeholders

Stakeholder	Interest
Product Owner	Communicate with the client to understand the features needed for the completion of the project
Developers	Develop the various requirements of the project
Sarawak Forestry Corporation	Monitoring system to know whenever something is happening in the forest for management and safeguarding purposes
Visitors	Learn more about wildlife and their general locations for sightseeing
Project Sponsor	Provide the needed equipment for the completion of the project
Scientists	Obtaining data about the various wildlife to help with research or conservation efforts

Deliverables and schedule

In this project, we will utilize HTML and JavaScript for the front-end development, while PHP will handle the back-end development. We will also use Python to perform model training for our AI components. The Pi Camera will enable image capturing, while the various sensor units (IR, Light, and ENV.II) will gather environmental data to enhance our application's functionality. The LED will serve as a signal indicator: it will light up when motion is detected and remain illuminated during recording, providing users with clear visual feedback. The XBee module will facilitate wireless communication between devices, and the FIRE Development Kit will provide a robust platform for integration. Additionally, we will prepare comprehensive user manual documentation to assist users in navigating and utilizing the features of our software. This documentation will include step-by-step guides, troubleshooting tips, and examples to ensure a smooth user experience. Overall, this project aims to seamlessly integrate hardware and software components, providing users with a powerful and intuitive tool.

1. Hardware
    a. Pi Camera
    b. LEDs
    c. FIRE Development Kit/ ESP32
    d. XBee
    e. IR Unit Sensor/ Ultrasound sensor
    f. Light Unit Sensor
    g. ENV.II Unit Sensor
2. Software
    a. Node.js
    b. Python
    c. PHP
    d. HTML
    e. JavaScript

Initial Release Schedule

No.	Item	Dependencies	Business Value (1 least – 10 most)	Release Schedule (Sprint #1 | 2 | 3 | …
1	Wireframing		9	Sprint 1
2	User Authentication (Login and Logout)		9	
3	Page Development: Index (Home Page, Wildlife Sighting Map, Tourist Information Page, Donation Platform)		9	Sprint 1
4	Orang Utan Data Visualisation		9	Sprint 2
5	Real-time Wildlife Monitoring Page	3	9	Sprint 2
6	Poaching Alert System		7	Sprint 2
7	Visitor Wildlife Information	11	8	Sprint 2
8	Donation Platform	3	9	Sprint 2
9	Publicity Tools (social media integration)	3	9	Sprint 2
10	Model Training		8	Sprint 1
11	AI classification – Orangutan	10	8	Sprint 2
12	Data Cleaning	AI Classification	8	Sprint 2
13	IOT Building		10	Sprint 1
14	Detect movement and activate machine to collect data	13	9	Sprint 1
15	IOT Data Collect	14	10	Sprint 1 & Sprint 2
16	Integrate with AI model to auto capture the object.	13, 14	7	Sprint 2
17	Self-preprocess the data locally before upload to database.	16	7	Sprint 2

Solution Direction

Known Factors:

The chosen solution for the Semenggoh Nature Reserve project integrates Pi Cameras, AI, and IoT to build a comprehensive wildlife monitoring system. Pi Cameras will capture high-resolution images, while AI models will process the data to identify orangutans and detect threats in real time. IoT devices will monitor environmental conditions and poaching activities. Additionally, a user-friendly mobile and web platform will provide tourists with access to real-time information and enable them to contribute to conservation projects via donations.

Opportunities:

This solution offers significant scalability, allowing it to be expanded across different regions of the reserve or to monitor various species. The real-time data gathered from cameras and sensors will improve conservation efforts by allowing immediate responses to threats like poaching. Furthermore, the mobile and web platform presents opportunities to engage tourists more deeply, offering them educational content about wildlife and promoting responsible eco-tourism. The donation feature also provides a direct link to raise funds for ongoing conservation efforts.

Strengths:

One of the major strengths of this solution is its ability to provide real-time monitoring without requiring continuous internet connectivity, as data processing can occur locally. Additionally, it is a cost-effective approach, using Pi Cameras and IoT devices instead of more expensive technologies like drones or satellite tracking. The seamless integration of hardware and software—combining wildlife monitoring with AI-driven analysis and a tourist-focused platform—creates a robust system that enhances both conservation efforts and visitor experiences.

Threats:

There are potential challenges to consider, such as the need for ongoing maintenance of the Pi Cameras, sensors, and other hardware, which could be difficult in remote or harsh environments. Environmental conditions, like humidity or extreme weather, could also affect the performance of the cameras and sensors. Finally, data security is a critical concern, as real-time wildlife data and user information collected on the platform must be safeguarded from cyber threats through strong encryption and access control measures.

Albeit, other options were considered, each with their own advantages as well as disadvantages as shown in the table below. The chosen solution provides a balance between technological capabilities, cost, scalability, and simplicity of implementation.

Alternative	Description	Known Factors	Opportunities	Strengths	Threats
Wearable IoT Trackers on Wildlife	Attaching IoT devices to orangutans (e.g., GPS trackers, health sensors) for real-time monitoring of their movements and health status.	Provides detailed data on movements and health. Requires attachment to animals.	Allows for in-depth monitoring of individual animals and their health conditions.	Offers high-resolution data on specific animals.	Can cause stress to the animals; requires frequent maintenance that could disturb wildlife.

Drone Surveillance	Using drones to track wildlife movements and detect illegal activities.	Provides aerial views and can cover large areas. Requires drones and pilot expertise.	Capable of capturing large-scale data and detecting illegal activities from above.	Effective for large area coverage and detecting poaching from the air.	Expensive, weather-dependent, and lacks consistent ground-level monitoring.
Satellite Tracking	GPS-based satellite tracking for monitoring orangutan movements.	Provides broad geographical coverage. Limited to large-scale movement tracking.	Useful for tracking long-range movements of animals.	Effective for monitoring large areas and long-distance tracking.	High costs, less effective for dense forest environments, and limited to tracking larger movements.

The proposed system offers real-time monitoring with minimal disturbance to wildlife, unlike wearable IoT trackers that may stress orangutans. AI-driven analysis enables non-intrusive data collecting from a distance, preserving the animals' natural behaviour while allowing for fast threat identification.

Drones and satellite tracking are not ideal for 24/7 surveillance in such a localized zone due to their high investment and maintenance requirements and content internet access requirements. In contrast, IoT-based sensors and AI models are more cost efficient and can lowering operational costs, assuring long-term sustainability.

Quality Management

In the context of the **"Safeguarding Wildlife and Enhancing Sustainable Tourism in Semenggoh Nature Reserve"** project, *quality* refers to the effectiveness, accuracy, and reliability of the technological solutions implemented to address both wildlife conservation and tourist engagement.

Quality:

Effective Wildlife Monitoring: The AI-powered system must accurately track orang-utan movements and detect threats in real time.

Enhanced Tourist Experience: The mobile/web application must provide accurate, up-to-date information about wildlife to visitors, improving engagement and educational opportunities.

System Reliability and Integration: The IoT and AI components must function seamlessly, ensuring real-time data collection and integration without delays or errors.

Measuring Quality Using the S.M.A.R.T. Framework

3. **Specific:** Quality will be measured based on the functionality and user experience of the wildlife monitoring system, tourist application, and data integration system.

Wildlife monitoring should accurately detect and classify orang-utans with a detection accuracy of at least 95%.

Tourist applications should provide updated wildlife data within 5 minutes of observation.

The system should ensure 100% uptime during peak tourist hours (8 a.m. to 6 p.m.).

4. **Measurable:**

Wildlife monitoring accuracy will be measured using real-time data validation and AI model classification tests.

The response time of the tourist app to update wildlife sightings will be measured using response logs.

System uptime will be tracked through monitoring tools and uptime logs.

5. **Achievable:**

Implement machine learning models that have proven high accuracy in wildlife detection.

Utilize scalable cloud services to ensure real-time data updates for tourists and system reliability.

Regular system maintenance and stress testing to guarantee system uptime.

6. **Relevant:** These quality measurements are linked to the project's goals of improving wildlife conservation through real-time data monitoring and enhancing visitor experiences through timely information.

7. **Time-bound:**

Achieve a minimum 95% accuracy in wildlife detection by the second sprint.

Ensure system uptime meets the 100% goal by the third sprint.

Tourist application response times should meet the 5-minute update target by the final sprint.

Acceptable Measurements

Wildlife Monitoring Accuracy: ≥ 95%

Tourist App Response Time: ≤ 5 minutes

System Uptime: 100% during operational hours

Resources

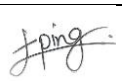
- Knowledge
  - Know how to build a simple IoT system.
  - Know how to train a classification model.
  - Know how to build a webpage.
- Abilities and Skills
  - Know how to use microcontroller to communicate with the sensor and actuator.
  - Know how to use Python language to code the AI classification model.

    - Know how to use PHP language to develop the webpage.
    - Can find and fix the bugs.
- Attitudes
    - Willing to help each other.
    - Always show positive attitude.
- Energy
    - Able to work at least 4 hours per week.
- Time
    - 12 Week
- Cost
    - No Cost (24/09/2024)
- IoT Technologies
    - Pi Camera
    - LEDs
    - FIRE Development Kit/ ESP32
    - XBee
    - IR Unit Sensor/ Ultrasound sensor
    - Light Unit Sensor
    - ENV.II Unit Sensor
- Service
    - AWS (Unconfirmed)

Approval Signatures:

Project Team

Provide a summary of the team members and their roles.

	Name of student	Student Id	Signature	Roles
1	Lim Teck Ping	102774145		***Computer Science – Software Development & Artificial Intelligence*** Roles: IoT Solutions for Wildlife Monitoring and Protection
2	Aaron Guo Yang CHONG	104382692		***Computer Science - Data Science*** Roles: Wildlife Data Integration and Visualisation
3	Teng Yong Goh	102774284	*Kenneth*	***Computer Science - Artificial Intelligence*** Roles: AI-Powered Wildlife Data Analysis Support: IoT Solutions for Wildlife Monitoring and Protection
4	Voong Zhe Hong	102785862	*Raymond*	***Computer Science - Artificial Intelligence*** Roles: AI-Powered Wildlife Data Analysis
5	Prince Chikukwa	102784429	Prince	***Computer Science - Cyber Security*** Roles: Advanced Cybersecurity for Wildlife Conservation Data
6	Gary Fung Jing Xian	102778613	*Gary*	***Computer Science – Software Development*** Roles: Digital Solutions for Wildlife Conservation and Engagement
7	Rohan Mehdi Kabir	104388386	Rohan	***Computer Science – Software Development*** Roles: Digital Solutions for Wildlife Conservation and Engagement

Project Sponsor [Your Tutor]

Tutor's name (on behalf of the client)	Signature: