# Drone System to Monitor Animals Final Report Summary

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The Drone System to Monitor Animals is a wildlife tracking and monitoring system that uses drones with onboard artificial intelligence capabilities, event reporting, and real-time data analysis to support conservationists, researchers, and environmental authorities.

The project's primary goal was to develop a fully autonomous drone system that could help clients with wildlife research, anti-poaching surveillance, and support real-time analysis of animal behavior. The current typical wildlife monitoring methods, like stationary cameras and GPS collars, are limited in scope, costly, and unsuitable for real-time data collection. The new system provides a scalable, efficient alternative. Drones are equipped with AI-powered image recognition to identify species and individuals, take video of the wildlife, and collect data from observations. Another feature also includes recognizing poaching activity for better anti-poaching efforts. The project measures success through improved image recognition accuracy, fewer poaching incidents, reduced costs, and positive feedback from end users.

Each drone uses onboard AI to recognize species and individuals with over 97% accuracy. Poaching detection is a standout feature, using pattern recognition to trigger real-time alerts. The system supports live video feeds, long-term storage, data visualization, and autonomous deployment based on user-defined regions and targets.

The system will be built using the Model-View-Controller system architecture. There are multiple use cases of the project that involve the system's users accessing a UI to interact with it, so MVC fits in perfectly. The model part includes classes like Drone, Wildlife, and GeoLocation, which represent real-world entities and data. The view part consists of user interfaces that allow users to interact with the system's data, such as live drone footage or visual dashboards. Finally, the controller layer manages logic and data flow between the other sections of the architecture, which will include classes like DroneDeployer, AiEnvScanner, and DBManager.

We have also determined multiple subsystems with minimal coupling and high cohesion between the system's classes to leave room for updates. The Drone subsystem handles drone deployment, on-board AI environmental scanning, and any included maintenance or updates. The Data and Storage subsystem manages persistent data through a central database. The Visualization subsystem converts raw data into graphical visualizations for users to examine. The User Access subsystem ensures appropriate access based on user roles.

The functional requirements of the project outline the capabilities that the system must implement, including image recognition, real-time tracking and viewing of drone footage, data transmission, and antipoaching alerts. Data requirements are also worth mentioning as they detail how the system will store and manage data, making sure the information generated by the drones is readily available. The data requirements include how the data each drone stores about itself, wildlife data, alert logs, and the storage format for the system data types.

Security and reliability were also important to consider when designing the system. The idea is to set it up so that access is based on user roles;  researchers, conservationists, or law enforcement officers can see or interact with parts of the system related to the context of their role. For reliability, the system needs to stay up and running as frequently as possible because the drones will be constantly active and sending data during missions. To bolster the reliability, we also aimed for strong performance in important areas like live video streaming, fast response times, and reliable drone communication over 95% of the time.

To test the requirements of the system, a test suite is used to validate the many different feature implementations. There are many tests of the system, but some of the key ones include Image Recognition Accuracy (T-1), Real-time Tracking (T-2), and Data Transmissions (T-3). These requirements are related to the drone missions and ensure that the artificial intelligence each drone uses can identify its environment with high accuracy, follow wildlife in real-time, and without losing any data in the process.

We used several software design patterns to help keep the system organized. The singleton pattern will be used to ensure that a single instance of DBManager handles all database operations. The observer pattern is used to allow the SystemHealthManager to track drone status and trigger alerts without affecting the drone's features at all. The factory pattern is used in the DroneMissionFactory to configure mission parameters dynamically. Data flow, system interactions, and fallback mechanisms are handled by a centralized GlobalControlModule. It arranges drone missions, manages system recovery, and ensures consistency across subsystems.

The primary users of the system include wildlife conservationists, researchers, and government agencies in related fields. Each user will only need to have access to select parts of the system that are related to their job. For example, conservationists focus on tracking and alerts, while researchers prioritize data analysis and generating data visualizations. The supporting roles for the system will include drone technicians, AI engineers, and usability testers.

The stakeholders for the project, which include legal advisors, usability specialists, and project sponsors, also played a key role in documenting the system's requirements. Their input directly influenced the development of specific features, such as user access permissions, interactive data dashboards, and customizable interface options.

While the project succeeded in meeting many of its technical goals, it faced challenges with potential data privacy concerns and unsurety of environmental restrictions on drone use. The system could benefit from stronger AI recognition. In the future, we can explore ways to streamline development by using existing technologies. Previous projects in areas like wildfire detection and agricultural monitoring also served as valuable inspiration for the system's alert and navigation features.

This project demonstrated how combining drone technology, artificial intelligence, and real-time data systems can make a real impact in wildlife conservation. The platform we developed is both smart and practical, capable of detecting threats and adapting to different environments. It's built to scale and evolve, providing a strong foundation for future improvements and broader environmental monitoring efforts.