Wildlife Poaching Detection System Using AI, Satellite Imagery, and Sound Data

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Arosh Jamal
Department of Computer Science
University of North Georgia
Dahlonega, GA, United States of America
ajama4305@ung.edu

Abstract—**Wildlife poaching remains a serious issue in many protected areas, especially in remote areas. In remote areas, there aren't enough rangers to monitor everything at once. Some tools like satellite imagery and motion sensors are used today. Although, most systems still require a lot of manual work and aren't fast enough to stop poachers on time. As a result, poaching often goes undetected until it is too late. The goal of this project is to build a simple app that can automatically spot unusual activity, such as abnormal animal movement patterns or suspicious environmental sounds. This is done by analyzing images and sound data. An OpenAI model will be trained to analyze these signs and send alerts so that rangers can react more quickly. This research will look at how well AI can understand patterns in images and audio data and how accurate it can be at spotting real threats. The goal is to build a tool that helps give rangers smarter, faster insights and protects endangered wildlife more effectively.**

Keywords—*wildlife poaching, artificial intelligence, satellite imagery, sound analysis, image analysis, OpenAI*

I. INTRODUCTION

Wildlife poaching is one of the most harmful environmental threats facing the planet today. It is the illegal hunting or taking of wild animals in violation of local, state, federal, or international law. Some of the main reasons they are poached are for their meat, horns, scales, or any other useful body parts. It also includes capturing live animals for illegal wildlife trade. Which is mainly done to own exotic pets. Illegal wildlife trade is one of the world's most profitable activities. Due to this, animals such as elephants, rhinos, lemurs, gorillas, the ploughshare tortoise, and many others are close to being extinct. Not only are the animals being tortured, ecosystems are being destabilized, tourism is decreasing, loss of biodiversity, and many other negative side effects are occurring because of this.

One of the biggest problems in stopping poaching is the lack of real time monitoring and immediate response. Most of the heavily poached areas in the world are immense, remote, and underfunded. These areas are heavily dependent on rangers who are having to cover hundreds of miles with limited and outdated tools. Although there are tools such as camera traps, GPS trackers, and motion sensors that have improved monitoring in recent years. However, these solutions typically rely on human review after an incident occurs. These reviews are often too late, and the animals are already harmed. This delay in decision making is a major weakness in the anti-poaching systems. Even with the addition of drones and satellites surveying areas, the footage still needs to be reviewed by human beings. This once again slows the process substantially. There are also places with limited workers and poor internet connectivity. Which makes it even more difficult to act upon. To overcome these issues, rangers need a smarter, faster, and more portable solution that helps them act quickly.

Artificial intelligence is the ability of computer systems to carry out tasks that usually require human intelligence. This includes human reasoning, problem-solving, perception, and decision-making. AI can even analyze complex data such as images and sound recordings due to deep learning and natural language processing. Image recognition systems can help identify animals and track their condition. Sound recognition systems can interpret animal calls and detect signs of stress or pain. According to this, AI is the best tool to help rangers prevent wildlife poaching. It can now be integrated into mobile apps and used directly in the field.

This project is all about making it easy for rangers, researchers, and conservationists to use AI-powered wildlife analysis right from their phones. The mobile application is built using React Native and Expo. It is designed to allow users to upload wildlife images and audio recordings directly from their phones. These uploads are then analyzed by OpenAI's GPT-4o for image reasoning and Whisper for audio transcription. The models have been prompted to evaluate whether the content shows signs of animal distress or abnormal behavior. They then provide instant feedback to the user in both text and spoken form.

This app is a very powerful, portable analysis platform. Instead of long periods of time for someone to review footage, users can get quick insights directly on their phones. Whether it's spotting signs of distress in a photo or picking up unusual sounds in a recording, the app presents real-time feedback. This can help rangers on the ground make faster, smarter decisions. The bigger goal here is to give rangers the chance to

step in while something's happening, not after the damage is already done.

What really makes this app stand out is its simplicity and ease of use. It was designed with the understanding that not everyone working in the field has a technical background or time to navigate a complicated interface especially in urgent situations. That's why the app keeps things minimal with just a few buttons and straightforward steps. Users can quickly upload an image or audio recording. The system processes the file and delivers AI-generated feedback right away so users don't have to wait long periods of time. All analysis results are saved automatically so anyone can go back and review past uploads when needed.

There are also important ethical and environmental factors to think about when using AI in conservation work. Although these technologies have incredible potential to protect wildlife, they also come with responsibilities. Powerful models like GPT-4o can be energy-intensive. This raises major concerns about their environmental impact, especially in a field that's all about preserving the natural world. At the same time, tools that involve surveillance like image or sound monitoring must be used with care too. This is to avoid violating the rights or privacy of local communities living near the conservation areas. However the app is designed, keeping these challenges in mind. A backend is used with limited data collection to only store what's necessary and makes sure users stay in full control. The goal isn't just to build something powerful, it's to build something responsible. This is done by balancing both innovation and sustainability, so that conservation efforts can be effective and ethical.

This paper walks through the key motivations that led to the development of this system. It explores the urgent need for more responsive tools in wildlife conservation. It reviews relevant research, technologies, and real-world case studies where AI has already shown proof in supporting conservation efforts. The design decisions and methodology are also explained, highlighting the technical considerations involved. Finally, the early evaluation results are presented. They show how the system performs in real-world conditions. This project combines the power of artificial intelligence with the convenience of mobile technology. The goal is to create a practical tool that helps fight wildlife crime and protect endangered species.

II. Literature Review / Related Work

A. Benefits of Using AI in Wildlife Conservation

Artificial intelligence is quickly becoming one of the most powerful tools available for wildlife conservation. Ecosystems are facing growing pressure from climate change, habitat loss, and illegal poaching. AI technologies can help provide predictive analytics, generate forecasts, and even detect suspicious activity such as signs of poaching before situations escalate [1]. These tools make it possible to respond more quickly and intelligently, which can make a real difference when endangered animals are at risk.

Machine learning, in combination with smart sensors, drones, and camera traps, are already helping conservationists respond to threats in real time [2]. AI keeps watch over remote areas that are hard for people to reach. This makes conservation work quicker and more efficient. It can also analyze massive amounts of environmental data far more quickly than humans could. This makes it ideal for scanning wide ecosystems and spotting trends that might otherwise go unnoticed [2].

Ultimately, AI doesn't replace the work of human conservationists, but it does enhance it. By automating routine tasks and detecting early warning signs, these technologies have the ability to free up rangers' time and resources. This helps them focus on what matters most, protecting vulnerable species and preserving biodiversity.

B. Drawbacks of Using AI in Wildlife Conservation

While artificial intelligence has opened up many new possibilities for wildlife conservation, it's important to acknowledge that it also comes with a range of concerns. Like any tool, AI can be misused, sometimes even unintentionally. In some cases, conservation efforts that rely on AI can end up causing harm instead of helping. For example, if the data used in the system is flawed, outdated, or biased, the AI's predictions and insights may be unreliable. This can lead to poor decision-making or even put animals at risk by misidentifying threats [3].

There are also real environmental costs to consider. Many AI systems, especially the more advanced models require a lot of computing power, which consumes energy and water. These resources contribute to carbon emissions and strain natural systems. Which raises serious questions about how sustainable this technology truly is in the long run for a field like conservation that protects the environment [4].

Another emerging concern is the risk that these technologies could be exploited by the very people conservationists are trying to stop. If poachers gain access to AI tools, they might be able to track and target animals more efficiently than before. They can easily use the same technology [3]. This shows why clear guidelines are essential when deploying AI in wildlife conservation.

There are also barriers around accessibility and practicality. Not all conservation organizations have the funding, infrastructure, or technical knowledge to adapt to AI tools. In

many cases, the systems can be too expensive to develop, difficult to maintain, and require specialized skills to operate [4]. This means that well-funded organizations are often the only ones able to access and fully benefit from AI tools. So, smaller groups may struggle to keep up, putting some regions at a disadvantage when it comes to protecting wildlife.

As AI continues to grow in popularity and influence within the field of conservation, it is important to approach its use thoughtfully. A significant part of this includes being mindful of potential consequences and ensuring that AI tools truly align with the goals of wildlife protection. Overall, the focus should remain on using technology in ways that are both effective and ethically responsible.

C. REAL WORLD USE CASES

There are many ways artificial intelligence is already making a real difference in protecting wildlife around the world. One example is the Elephant Protection Initiative, which uses advanced predictive analytics to fight elephant poaching in Africa. Thanks to this innovative tool, poaching rates have dropped by as much as 50% [5]. But it is not just about reducing poaching statistics. The technology also helps conservation teams allocate their resources more efficiently by guiding patrols to the areas where elephants are the most vulnerable. This makes sure help gets to the animals and areas that need it most [5].

Another inspiring example comes from Southeast Asia, where satellite imagery combined with AI is being used to identify deforestation hotspots and illegal logging activities. This approach has been very helpful in preventing habitat loss, especially for critically endangered species like orangutans. Their survival depends on the preservation of their natural environment [6].

These real-world success stories highlight how AI is already changing the way conservationists work. By providing faster, smarter insights, AI tools are helping protect wildlife and their habitats more effectively than ever before. As these technologies continue to develop and spread, their potential to support global conservation efforts grows even stronger.

III. DESIGN / METHODOLOGY

A. PROJECT OVERVIEW

The mobile application is developed using React Native in combination with Expo. The backend is built with Node.js and Express, providing a stable server environment to handle file uploads, user requests, AI integration, and data processing efficiently.

B. DATA FLOW

The system's data flow is intentionally designed to be straightforward, allowing for fast and efficient decision-making in the field. A user selects and uploads a wildlife image or audio recording through the mobile app. The file is then securely transmitted to the backend server using the fetch API in React Native. The backend, which uses the Multer middleware, receives the upload, processes the data, and temporarily stores the file for analysis.

C. BACKEND DESIGN

The backend plays an essential role in connecting the app's user uploads to the AI systems responsible for analyzing wildlife images and audio. It is built with performance, security, and scalability in mind to support real-time detection in unpredictable conditions.

At the core of the backend is a Node.js server. It is ideal for handling multiple uploads and API requests efficiently. To keep things organized and efficient, the backend also uses Express.js, a minimal framework that simplifies the process. Incoming image and audio files are handled using Multer. This middleware handles multipart data uploads and temporarily saves the files locally for later analysis.

When a user uploads a file, the backend receives it. Multer processes the request and attaches important metadata, such as the original file name, file type, and upload timestamp. Before moving forward, the file is validated to ensure it's in an acceptable format. The format is JPEG or PNG for images and WAV or MP3 for audio and it should also fall within size limits. If the file fails any of these validation checks, the server responds with an appropriate error message.

Once validated, the file is prepared for AI processing. Images are forwarded to OpenAI's GPT-4o model, which is prompted to assess animal behavior and detect signs of distress. For audio recordings, the process involves two steps. First, the sound is transcribed using OpenAI's Whisper model. Then, that transcript is analyzed by GPT-4o using a separate prompt designed to classify behavior as either normal or abnormal.

After receiving the AI's analysis, the backend formats the results into a structured JSON response. This includes the classification or transcription result and a timestamp. The response is then returned to the mobile app, where it is displayed and read aloud to the user. To maintain security and privacy, uploaded files are automatically deleted after processing. However, logs are kept that include metadata, AI results, and timestamps to support future analysis.

The backend uses async and await throughout the code to keep things running efficiently. This helps the server manage multiple tasks at once. For example, it can upload files and send requests to OpenAI without slowing down or freezing. It's especially useful when the system needs to wait for a response from an external service, like Whisper or GPT-4o. It is because it allows the server to keep handling other requests in the meantime.

The backend also includes built-in error-handling tools that catch issues as they happen. Whether it's a file upload that didn't go through properly or a timeout while waiting for AI results, these tools make sure the system doesn't crash. It also responds with helpful messages and logs the problem for future debugging. Altogether, these features make the backend more stable and reliable for users.

D. PROMPTS

A key part of making this system work effectively is creating clear prompts that guide the AI model to deliver accurate results. For image analysis, the prompt tells the AI to take on the role of a wildlife expert who specializes in animal behavior and health. The instruction is specific and directs the model to give one of two simple responses, either that the animal is in distress or that it is not. This was refined by multiple rounds of testing. Each time the wording had to be adjusted to eliminate vague or overly detailed replies. The result is a fast and easy-to-understand output that users in the field can rely on.

Figure 1: The JavaScript code that shows the image analysis prompt.

For audio recordings, the system first transcribes the sound using Whisper. Then it sends the text to GPT-4o with a similar type of prompt. This prompt asks the AI to analyze the behavior described in the transcript and respond with a clear response. The response will be either the behavior is normal or that the animal is in distress. Like the image prompt, this one was also tested and adjusted to avoid confusing results. Overall, these prompts help ensure that the AI responses are consistent, relevant, and useful for conservationists working in real-world situations.

Figure 2: The JavaScript code that shows the audio analysis prompt.

E. FRONTEND DESIGN

The app's user interface is intentionally designed to be accessible for users with a wide range of technical backgrounds. As soon as the user opens the app, the layout makes it easy to get started. It has a clear and minimal design that keeps things focused on the task at hand. Uploading data is straightforward. Users can easily choose whether they're submitting an image or an audio recording, and the app guides them through the process step by step.
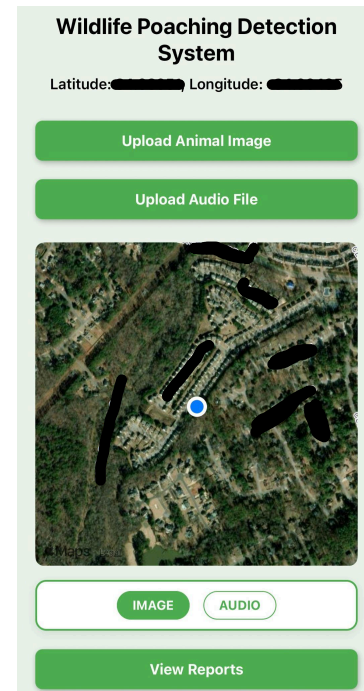

Figure 3: The main screen that the user sees when they first open the app. It represents the frontend design including the coordinates, button to upload the files, map, filter, and view reports button.

As files are being processed, a status bar keeps users informed. It shows progress updates like when a file is uploading, when the AI is analyzing it, and when the results are ready. Once the analysis is complete, the AI's response appears in a clean, readable textbox, ensuring that users can quickly understand the outcome. To make the experience hands-free, the app includes text-to-speech functionality that

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automatically reads results aloud. This is especially helpful for rangers or researchers who may be on the move or in a rush.

The app also includes a reports page where users can review a complete history of their submissions. Each time an image or audio file is uploaded and analyzed, the app automatically generates a report entry. It contains the original file, the AI's response, the time of submission, and other relevant metadata. These reports are organized in an easy-to-navigate layout and can be exported as a PDF for later reference. This feature allows conservationists and rangers to track observations over time without needing to manually record results.
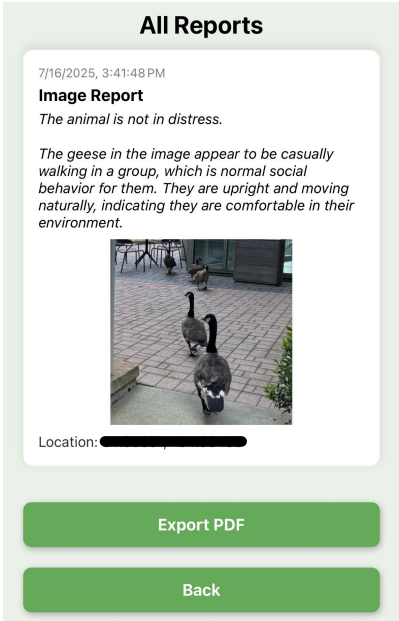

Figure 4: The reports page on the app that shows a complete history of all the previous submissions. It includes the timestamp, location, and analysis.
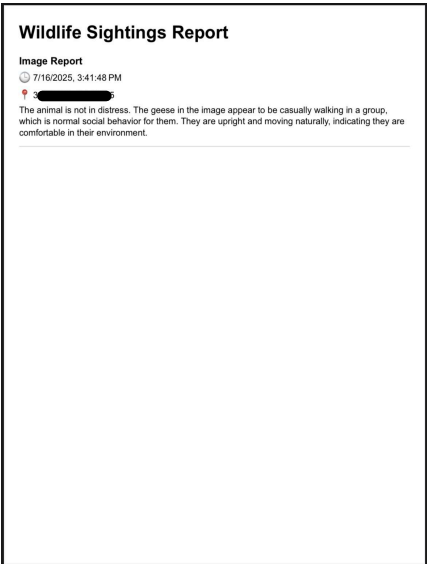

Figure 5: The wildlife sightings report PDF when the user exports and saves the reports page. It includes the timestamp, location, and analysis.

Alongside the reports list, the app also features an interactive map view that visually displays all past sightings and AI analyses. Each upload is shown as a marker on the map at the location it was submitted. Markers are color-coded. For example, red is for the images and blue is for the recordings. This helps users quickly identify areas of concern. This can also be incredibly useful in detecting patterns, such as recurring distress signals in the same region or large amounts of abnormal activity. Tapping on any map marker reveals a popup with the associated media, AI result, and timestamp, giving users instant information without leaving the map screen.
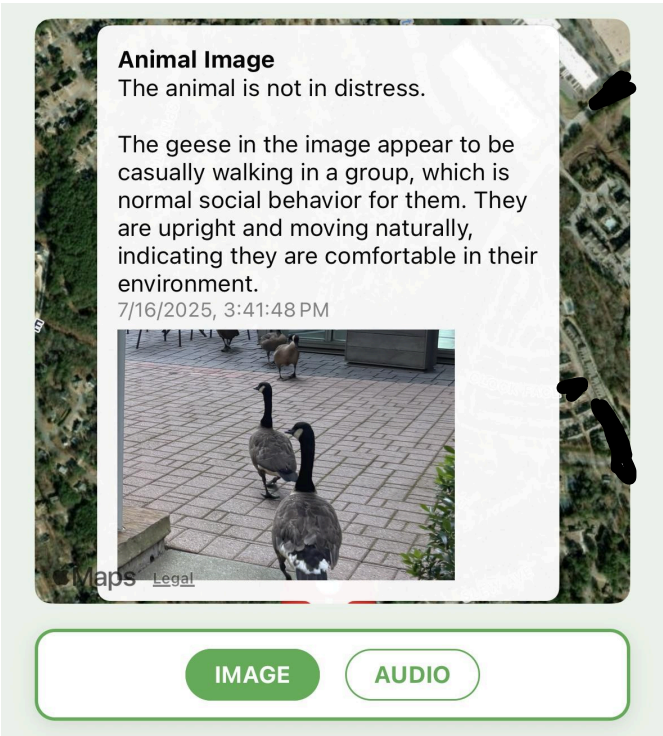

Figure 6: The interactive map, filter that contains the image and audio files, and the popup containing the associated media, AI result, and timestamp.

F. DIAGRAM

When a user uploads a file, it's sent to the backend server, which checks and processes it. The server then sends it to the appropriate AI model provided by OpenAI. For images, the server uses GPT-4o to analyze the content. For audio recordings Whisper is used to transcribe and interpret them. Once the AI model returns a result, the backend sends that information back to the app's frontend. It is then displayed to the user and spoken aloud. At the same time, the backend saves the uploaded files, records the analysis results, and a timestamp. It's set up to be fast and easy for anyone to use. The diagram below illustrates how all the key components such as the frontend, backend, AI services, and storage interact to create a smooth and functional system.
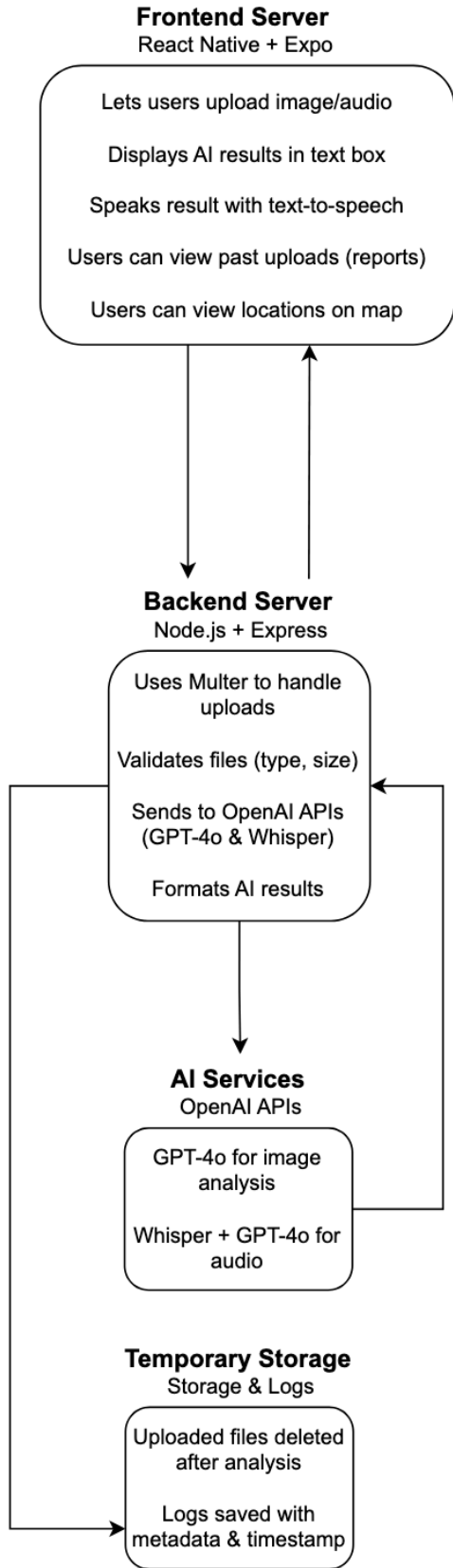
Frontend Server
React Native + Expo

Lets users upload image/audio

Displays AI results in text box

Speaks result with text-to-speech

Users can view past uploads (reports)

Users can view locations on map

Backend Server
Node.js + Express

Uses Multer to handle uploads

Validates files (type, size)

Sends to OpenAI APIs (GPT-4o & Whisper)

Formats AI results

AI Services
OpenAI APIs

GPT-4o for image analysis

Whisper + GPT-4o for audio

Temporary Storage
Storage & Logs

Uploaded files deleted after analysis

Logs saved with metadata & timestamp

Figure 7: The diagram featuring how the backend, frontend, AI services, and storage work together.

A. APP FUNCTIONALITY

The mobile app was successfully deployed and tested on iOS platforms using Expo Go. Users were able to upload both wildlife images and environmental audio recordings directly from their device. The file selection interface worked smoothly across platforms. AI analysis consistently returned within seconds. This demonstrated that the system could support real-time use cases. The text-to-speech feature was especially helpful in improving accessibility for rangers who may be multitasking.

B. AI PERFORMANCE

For image analysis, the GPT-4o model provided concise results when prompted with instructions. Outputs like "The animal is in distress!" or "The animal is not in distress." appeared. Similarly, audio recordings were transcribed effectively by Whisper, and GPT-4o's classification of behavior as "normal" or "abnormal" proved accurate for the test samples. In test cases using real animal calls and distress sounds sourced from online datasets, the system generally responded accurately. It was able to identify key indicators of distress or unusual behavior.

C. RELIABILITY AND LOGGING

Uploaded files were processed quickly and stored temporarily before deletion, as expected. The backend successfully logged analysis results, submission times, and other metadata into a local database. This logging enabled the reports page to show a reliable history of previous submissions. No major crashes occurred during file handling or AI response processing. This proves that the backend ran smoothly and was able to handle the testing process without issues.

D. MAP & REPORTS FEATURE TESTING

Both the reports page and interactive map view functioned correctly during testing. Test data with various distress and normal classifications was displayed with accurate timestamps and color-coded markers on the map. Clicking the markers led to detailed popups that matched expected results. This shows that the feature is genuinely helpful for spotting patterns in when and where animals are showing unusual behavior.

V. CONCLUSION

Creating this wildlife poaching detection system has been a valuable step in applying AI to real-world conservation

challenges. This mobile app connects directly to powerful AI models like GPT-4o and Whisper. It gives rangers, researchers, and conservationists working out in the field easy access to powerful technology that can help them make better decisions.

One of the key lessons from building this system is just how powerful and meaningful this technology can be in real-world situations. The goal wasn't to replace the tools conservationists already rely on. Instead, it was to provide improved tools and information out in the field. The success of this project goes beyond just getting the AI to work. It's about making sure the technology is practical in unpredictable conditions out in the field.

Important lessons also came out of this project such as the responsibilities that come with using AI in conservation efforts. Technologies that are meant to protect wildlife must be implemented with care. Not only to ensure their accuracy, but also to avoid unintended harm. Some of the challenges are the environmental cost of large-scale AI systems, the potential misuse of tools by poachers, and the unequal access to this technology. These factors need careful consideration as this technology becomes part of everyday life. This is why this system was built with important values in mind like being ethical, using data responsibly, and keeping things sustainable for the long run.

This project demonstrates that AI doesn't need to be complex or intimidating to make a difference. Combining a simple user-friendly interface and clear instructions, can make even the most advanced AI models easy to use and helpful. This is just the beginning of the app. There's a lot more that can be added and improved over time. This could be factors such as improving location tracking or expanding the app's ability to handle different species or ecosystems. However, the system is proof that with the right tools, conservationists can respond faster, smarter, and protect vulnerable wildlife more effectively.

In the future, hopefully this project will aim to inspire new ways of using technology to help protect wildlife and the planet as a whole. It's about finding practical tools that make a real impact where it truly counts. Innovation doesn't need to be high-tech, expensive, or complicated. What really matters most is that it works in the places where it's needed and truly supports the people doing the hard work.

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