Revolutionizing Wildlife Conservation: Animal Tracking with IoT

Introduction:

The growing population growth of humans in nearby national park areas has led to increased interactions with wildlife and an increase in conflict between animals and humans. Even though living with wildlife is advantageous, managing conflicts between humans and wildlife can be challenging because we need to look at numerous factors.

Animals are found to be roaming into human settlements destroying and eating crops. Animals may see humans or their pets as potential prey and attack them. Animals cause damage to human property by destroying them. Example: A big wild elephant destroying human houses. Some animals display aggressive behavior when they feel threatened. All these causes conflict between humans and animals. Although living with wildlife has its advantages, it can be challenging when there are conflicts between them.

Even if there are lots of challenges, preserving biodiversity is a top priority.The wide diversity of ecosystems found in national parks shows the special relationships between different species and all of these are essential to preserving ecological balance. As human activities coincide with ecosystems, it becomes essential to establish a harmonious balance that minizes negative impacts on biodiversity while also focusing on human concerns and safety.

This research highlights the importance of collaborative and long-term solutions for managing human-animal conflicts near national park areas. A harmonious living plan is required to protect biodiversity, local livelihoods and to achieve a peaceful balance between wild and human habitats.

Objective:

The main objective of this project is to promote peaceful and harmonious relationships between human settlements and wildlife. By using motion sensors, camera , microphone, we can have a deep understanding of wildlife behaviors by tracking animals and analyzing their behaviours carefully. We can analyze their movement patterns,their feeding behaviours and breeding habits.

WIth the help of the Internet of things we can track and monitor the animals. This system can detect when the animals are approaching human settlement or any when the animals are posing a threat to humans.This system can detect the areas where there are maximum animal conflicts as well.This proactive approach enables focused

and fruitful conservation efforts in areas where wildlife and human activity interactions are more prevalent.

This system generates an alert when the animals are approaching nearby for safety and awareness of human habitat. In areas where wildlife is frequently observed, this system is ready to send timely notifications to relevant stakeholders. Individuals can take necessary precautions by providing real-time information to local communities, fostering a safer coexistence between humans and wildlife.

In addition, our comprehensive strategy includes extensive data analysis, in which we employ cutting-edge techniques to generate insightful graphs depicting the frequency of animal sightings each month. This data is not only required for planning, but it is also a valuable resource for informed conservation efforts. Understanding seasonal variations in wildlife behavior allows us to tailor conservation strategies to address specific challenges at different times of the year.

This system also generates insightful graphs that depict sightings of wild habitat each month. The data obtained from this analysis not only helps for planning but also provides valuable information for conservation and preservation of animals. By looking at the graph obtained we can know and address all the challenges for effective planning to save the animals from extinction.

The only motive of this project is to bring people and animals closer in a smart and thoughtful way.

Data acquisition:
To track animal movements and appearances we use three different kinds of data: audio, video and motions. To capture audio data we use microphones, to capture video we use outdoor HD night vision cameras and to capture motions we use PIR sensors.

All the data captured by these data sources are processed on edge by embedded hardware with GPU. For this we will use Orange Pi.

Camera will be used to capture video and this video will be used to detect animals. For this we will extract each frame from the video and send this frame to an AI model to detect and recognize the animal and this information along with other data attributes like location, time stamp, will be sent to the server for further processing.

A microphone is used to capture audio for detecting animal sound. For this we will use pre trained AI models. First microphone will capture audio in sound form and this sound

will be further processed before feeding to the AI model to remove noise. Once any animal noise is detected from that sound will be sent to the server with other data attributes like location and time stamp for further processing.

As we are using motion sensors to capture motion data using PIR sensors. This data needs to be further processed within the same edge device to filter out any kind of noise. Once motion data is processed it is sent to the server with other data attributes like location, timestamp and motion intensity.

The reason we are using different kinds of data is to enhance accuracy of the animal tracking system.

All the data capturing devices and edge processing devices are powered by solar batteries with solar panels for eco-friendly environment and sustainability.

Data transmission:
As data capture is done far from the central server and remote places, choosing the right data transmission technique is crucial. As data capture will be installed where there is no power and electricity, it is very much important to choose a data transmission technique that is efficient, reliable, low- powered, low bandwidth and secure.

All the processed data is transmitted for server side processing through the 4G (Fourth generation) network using MQTT(Message Queuing Telemetry Transport) protocol.

For the 4G network we will be using the gsm module within edge computing devices. 4G networks are based on an ITU standard called International Mobile Telecommunications-Advanced (IMT-Advanced).The benefits of 4G fall firmly into three categories, which are improved speeds, reduced latency, and crystal-clear voice calls. 4G exhibits lower latency. It means the time it takes for data to travel between your device and the network is reduced.

MQTT(Message Queuing Telemetry Transport) is a lightweight and efficient protocol that can be used with low bandwidth networks and low powered devices. Also MQTT (Message Queuing Telemetry Transport) is based on publisher subscription architecture which can help for better data transmission throughput by utilizing multiple publishers and subscriptions. As MQTT is built on top of TCP/IP protocol, it ensures data transmission reliability. As we have multiple data capture points using MQTT(Message Queuing Telemetry Transport) will help to scale data processing horizontally and parallely.

Data delivery is guaranteed by Quality of service(QoS) of MQTT(Message Queuing Telemetry Transport) protocol so that there will be no data loss.

For troubleshooting and debugging all the edge devices that are used for data capture and data processing will send heart beat every 30 seconds to server and server will use this data to track availability of edge devices. If server does not receive heart beat from any edge device for more than 40 seconds server will mark that edge device offline and generate system alert to administrator so that administrator can fix the problem. This ensures high availability of all edge devices to ensure reliability of the system.

Data processing and management:
For the processing of all these captured data we are using edge computing and server side processing.This will help us to handle the captured data effectively.

The data captured from the cameras are processed at the same time using edge computing. Edge computing enables data to be analysed, processed, and transferred at the edge of a network. Edge computing offers high speed and reduces latency.

Once a frame is captured from camera it is processed to check if any animal is present in that frame and if any animal is present, it is further processed to categorize animals. Once the animals are categorized this information will be sent to the server for server sode processing.This will help us to save bandwidth and the data processing cost on the server side as we dont have to send video frames over the network.

Data capture with a microphone is also processed within edge devices to detect animal sounds and if any animal sound is detected it is further processed to categorize that sound to recognize animals. And this information is also sent to the server for further processing.

Data capture with motion sensors is also processed with edge devices and sent this information to the server side for further processing.

On server side processing once data is received from edge devices are processed, validated and stored in a relational database for reporting, alerting and visualization. As the received data is already processed on respective edge devices it will help us to reduce server side processing.

Data analytics and visualization

As all the data captured from all the data points are stored centrally on a relational database, they help us to generate reports, alerts and insights.
We generate two types of reports: tabular and graphical.
In tabular we will show mostly a list of animal appearance over the time with information like appearance data and time, appearance location, frequency, animal category and animal count. Also, we will provide export options in various formats to download and share data. There will be options to slice and dice data in different dimensions such as date and time, location, and animal category.
One of the objectives is to alert people nearby whenever there is any animal appearance. For this we are going to use real time alerting functionality based on incoming information from edge devices. Alerts will be sent via SMS to pre-configure phone numbers in the system. Based on types of animal and risk factors we will notify the people with sirens so that they can take necessary precautions.

For better planning to avoid human wildlife conflict these data can provide valueable insights like most appeared locations, frequently appeared animal categories and most appeared time we will use different kinds of visualizations to represent these insights. For most appeared locations we are going to use heat maps so that with a single glance we can know where the locations are affected mostly and we can take necessary steps to minimize the effects.

For frequently appearing animals we will use pie charts. As Pie charts can help us to understand trends better and can help national park authorities to take necessary steps to reduce animal appearance near human settlement.

For most appeared time we are going to use bar graphs. Bar graphs can help us to represent this information in a more insightful way so that we can know what are the times when animals appear. And with this information we can do pre-planning to avoid human wildlife conflict effects.

These insights will be presented with different dimensions like date time and locations. Also for future predictions we will use predictive analysis on historic data to predict any wildlife occurrence in different areas. This prediction can help for pre planning like we can alert humans before any wildlife appearance so that humans can prepare better to avoid any kind of conflicts with animals.

Conclusion

The growing conflicts between people and wildlife near national parks show the need for a comprehensive plan. We must understand why these conflicts occur and collaborate

with the various groups involved. Only by doing so can we create long-term solutions that manage and reduce conflicts, allowing humans and animals to coexist peacefully while protecting our diverse ecosystems.

So with this IOT based animal tracking system we will have complete wildlife movement data for better planning to avoid any kind of human animal conflicts. Also,this can help us to better understand the problem and deep dive to the root cause and find effective solutions to avoid human animal conflict for preserving wildlife and our national parks.

As in this fast paced technology era using technology to preserve wildlife is a remarkable milestone in wildlife conservation.

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