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AUTOMATED ANIMAL INTRUSION DETECTION USING OPENCV SOFTWARE

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ABSTRACT
The integration of OpenCV in Python with embedded systems has facilitated innovative solutions across various domains. This project introduces a real-time animal detection system utilizing an embedded platform. With components including a camera module, LCD, Bluetooth module, and audible alarm, the system detects animals using OpenCV and triggers alarms for immediate notification. Integration with LoRa enables long-range communication, expanding its applicability to remote monitoring. An LCD provides user feedback, while a manual off button allows users to deactivate alarms. Controlled by a Python script, the system exemplifies the fusion of computer vision, embedded systems, and human-machine interaction, offering a solution for wildlife monitoring and security applications.

Keywords: LCD, OpenCV, LoRa, Image processing, Python.

INTRODUCTION
Concerns are mounting over wild animals encroaching into villages and towns, particularly near forests, posing safety risks and causing economic losses through crop damage and livestock attacks. Human population growth and forest depletion exacerbate conflicts between humans and animals. Traditional methods like electric fences and manual surveillance are harmful, costly, and ineffective. Recent advances in computer science, notably computer vision, offer promising solutions. Deep learning techniques, such as Deep Convolutional Neural Networks (DCNN), excel in image classification tasks. This project aims to design a computer vision system for detecting and tracking wild animals' movements using DCNNs. Object detection is crucial for monitoring and tracking as it not only identifies animal presence but also localizes them within images. The proposed solution entails ongoing monitoring of vulnerable areas through a network of cameras, providing cost-effective and precise surveillance customized for specific regions, effectively tackling a critical issue.

BLOCK DIAGRAM

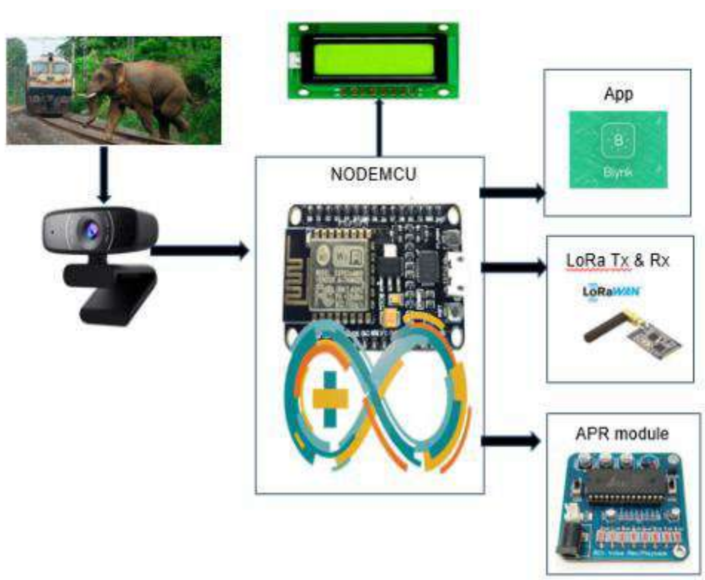

Figure 1. Block diagram of the proposed system

CIRCUIT DIAGRAM

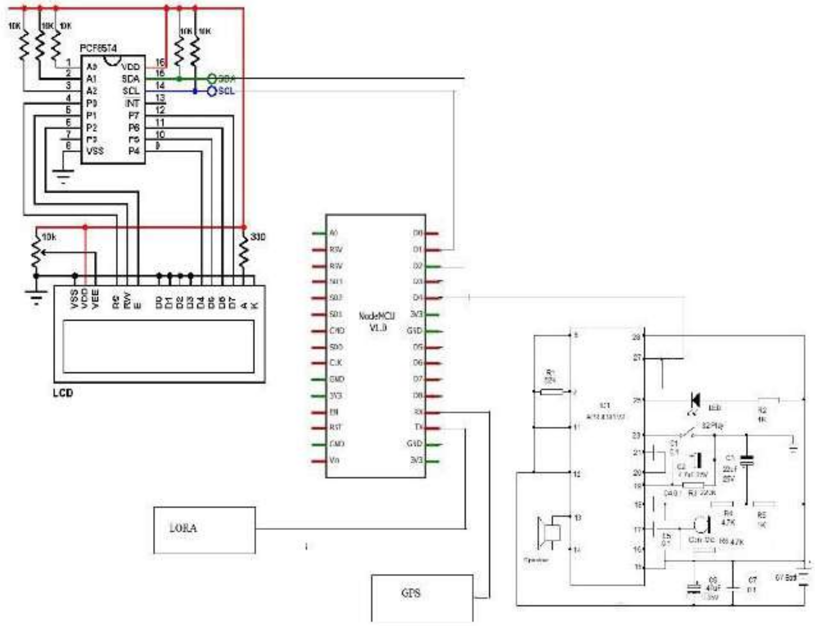

Figure 2. Circuit Diagram

LITERATURE SURVEY

This document outlines an innovative, comprehensive design for a cross-camera tracking system focused on animal intrusion detection, leveraging Computer Vision and Deep Learning techniques. [1]. The system comprises a camera, train status monitor, and alert application, with the camera capturing track images at regular intervals, processed for recognition. [2]. The GPS module and GSM modem aid in identifying and transmitting railway geometric parameters for crack detection to the nearby railway station. [3]. Contemporary technologies such as sensors, machine learning, and data analytics are employed to facilitate the development of a comprehensive and proactive approach to issue detection. [4]. The inspection methods include visual inspection and ultrasonic inspection.[5].

HARDWARE USED

a. Node MCU

The Node MCU ESP8266 Wi-Fi Module functions as an independent System-on-Chip (SoC), granting any microcontroller access to Wi-Fi networks. With the capacity to handle Wi-Fi networking duties independently, it can either support or host applications, simplifying integration with microcontrollers through its pre-programmed AT command set firmware. Its onboard processing power and storage eliminate the need for extensive external hardware, making it an efficient solution for various applications. Additionally, it requires no additional RF components. It supports features like Automatic Power Save Delivery (APSD) and interfaces for Bluetooth coexistence, catering to a wide range of applications including Voice over IP (VoIP) applications.

Table No 1: Specifications

Components	Range
Wi-Fi Capabilities	802.11b/g/n
Low power consumption	<1.0mW, DTIM3
On-board memory	1MB Flash
Multiple communication interfaces	SDIO, SPI, UART
Fast wake-up and transmission time	<2ms

b. LORA SX1278

Using Wireless Antenna Packets that follow the LoRaWAN format, which is utilized to interact over two LoRa extensions. We convey the information from a particular board onto another by using two NodeMCU boards and LoRa modules. The SX1278 Ra-02 LoRa module, which uses the 433MHz frequency band, is the one used here.

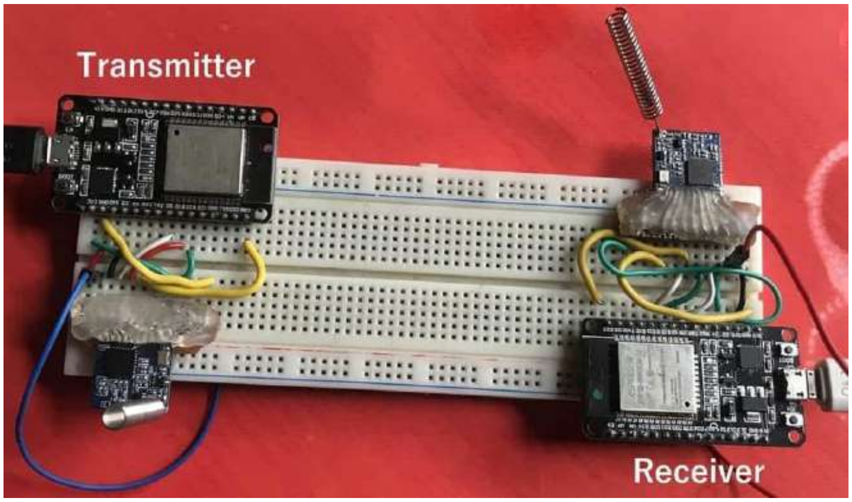

Figure 3. LoRa Transmitter and Receiver

c. LCD

To produce a viewable image, LCD screens need external light because they do not produce any light on their own. This light, which is provided at the back of the glass "stack" in a "transmissive" type LCD, is referred to as the backlight. Active-matrix displays almost always have backlighting, unlike passive-matrix displays (such as those used in calculators and wristwatches). Some LCDs can put on various illustrations(like those on personal computer displays) or static pictures with little data that can be shown or concealed, such as text, numbers, and 7-segment displays like those on electronic timers. They both adopt similar fundamental automation however different displays have larger elements whereas random images are made up of a lot of tiny pixels.

d. APR module

The APR (Audio Playback and Recording) voice module is a versatile tool for audio applications, featuring a compact size and user-friendly interface for easy integration into electronic projects. It enables high-quality audio recording with adjustable durations and built-in memory storage for extensive sessions. With playback controls like volume adjustment and speed, it offers enhanced user control. Its compatibility with external amplifiers ensures clear audio output, is suitable for voice prompts, alarm systems, and message playback devices. The module's simplicity and robust performance make it a popular choice among hobbyists, enthusiasts, and professionals for audio recording and playback projects.

e. GPS Transmitter

We've deployed a third-gen POT (Patch Antenna on Top) GPS module known for its precise accuracy and sensitivity, especially in urban environments. This module outputs standard NMEA0183 strings in "raw" mode, ensuring easy integration with any microcontroller. It provides crucial data like time, date, latitude, longitude, speed, altitude, and direction, making it perfect for navigation, tracking, fleet management, mapping, and robotics. Operating independently, it only requires power supply decoupling capacitors and includes an internal RTC backup battery. Supporting up to 51 channels, it allows for the connection of an external active antenna if needed, enabling direct connection to a Microcontroller's USART. Powered by MediaTek Inc. GPS chipsets demonstrate advancements in performance, accuracy, integration, computing power, and flexibility, streamlining the process of integrating them into embedded systems.

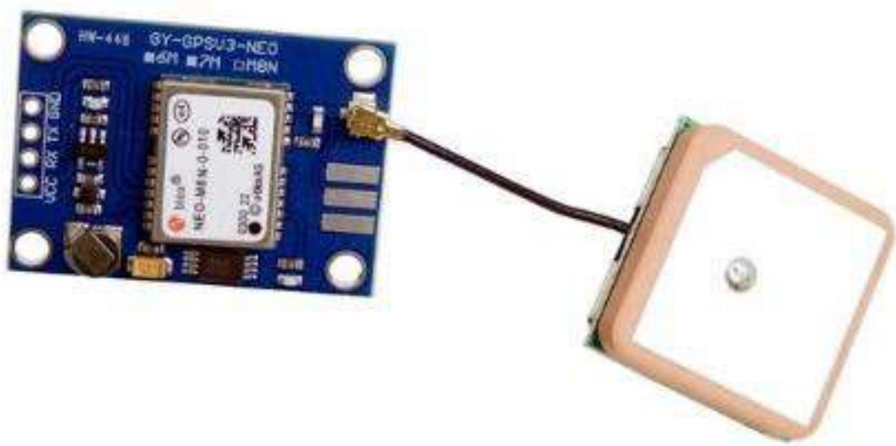

Figure 4. GPS Transmitter

SOFTWARE USED

Python's image processing ecosystem, including libraries like PIL (Python Imaging Library) and OpenCV, empowers developers to efficiently manipulate, analyze, and enhance digital images. Python offers a range of operations from basic tasks like resizing and cropping to more intricate transformations and analysis. With numerous algorithms and techniques available, Python facilitates tasks such as filtering, segmentation, edge detection, and feature extraction. Its support for numerical and scientific computing libraries like NumPy and SciPy amplifies its capabilities, enabling advanced mathematical operations and algorithms in image processing. OpenCV, a renowned open-source library for computer vision and image processing, is widely used due to its C++ core and Python bindings, seamlessly integrating into Python projects. With a broad spectrum of functions and algorithms, OpenCV simplifies tasks like image manipulation, object detection, feature extraction, and transformations. Its extensive set of pre-built functions streamlines complex image processing for robust computer vision applications. Supporting diverse formats, camera interfaces, and hardware acceleration, OpenCV caters to various platforms. Its modular design and well-documented API make it accessible to developers of all levels, utilized in robotics, surveillance, augmented reality, autonomous vehicles, and medical imaging.

PROPOSED SYSTEM

The proposed system consists of a NodeMCU Microcontroller, LCD, APR module, LORA Module, Relay, GPS module. Integrating OpenCV in Python and embedded systems, the proposed animal detection system seeks to surpass the constraints of current solutions. By harnessing the power of LoRa technology, it enhances communication capabilities over long distances. This innovative approach merges real-time image processing, user-friendly interfaces, and integrated components, offering an efficient, cost-effective, and adaptable method for animal detection and monitoring. Furthermore, by incorporating LoRa, it ensures seamless connectivity and data transmission even in remote areas, enhancing its applicability across diverse landscapes. Additionally, the system prioritizes scalability and reliability to meet the evolving demands of wildlife conservation and human safety.

FLOW CHART

Initially, the camera captures images of animals, which are subsequently processed using Python image processing and OpenCV algorithms for detection. Following detection, the information is relayed to the NodeMCU microcontroller. The detected animal's details are then displayed on an LCD screen and transmitted to an IoT application for further monitoring. Simultaneously, the animal's location is shared with the application via a GPS transmitter. Additionally, the use of LoRa transmitters facilitates long-range transmission of detected animal data to LoRa receivers. Furthermore, an APR module emits sounds designed to deter animals when necessary, augmenting the system's functionality for wildlife management and safety.

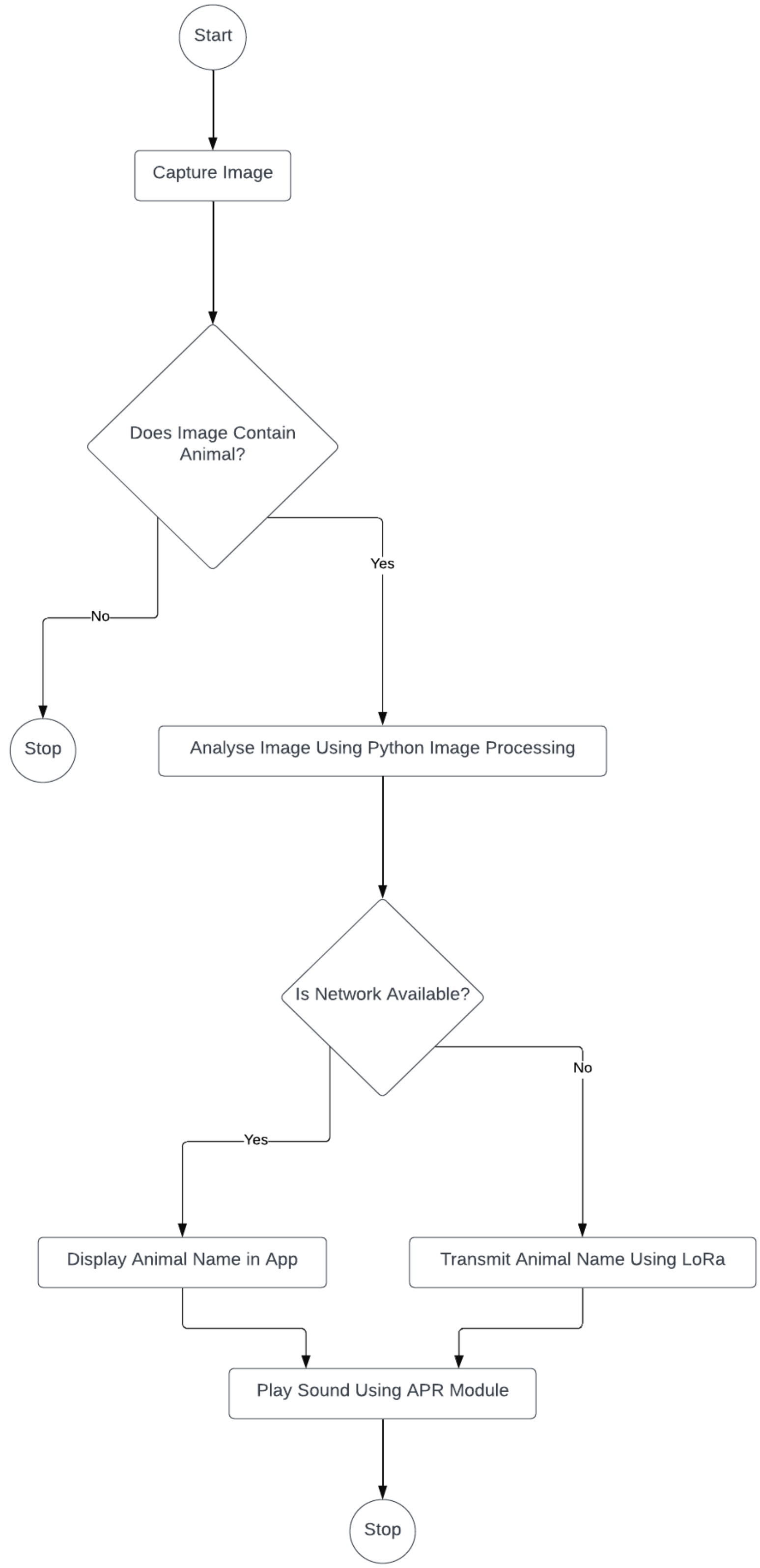

Figure 5. Flow chart

HARDWARE

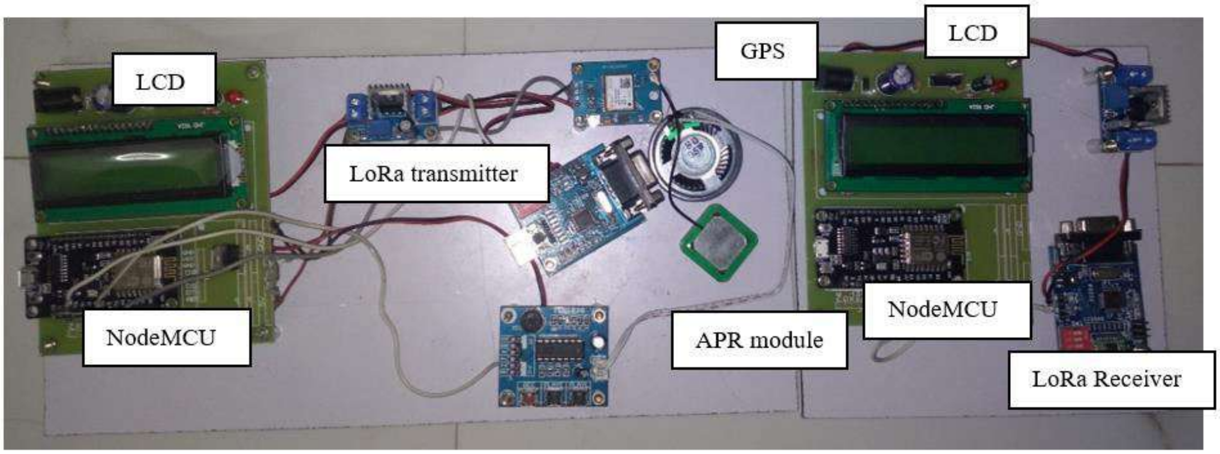

Figure 6. Hardware set up

9.1 Hardware Output

Figure 7. Outputs using LoRa and Blynk IoT

Figure 8. Location output on Blynk IoT

Figure 9. Sound output on APR module

CONCLUSIONS

The Railway Track Tracer System represents a significant leap in railway safety, particularly in preventing wildlife-related accidents. It leverages modern technologies like image processing, GPS tracking, and LoRa communication to offer real-time animal detection on railway tracks. Through the integration of NodeMCU and OpenCV, the system ensures efficient data transmission and precise image analysis, enabling prompt alerts to railway authorities and train operators. Additionally, the use of APR modules provides a humane approach to deter animals from tracks, fostering coexistence between trains and wildlife. With its intuitive interface and robust features, the system enhances overall railway safety and supports wildlife conservation efforts. Continued refinement and implementation of this system hold promise for significantly reducing accidents and safeguarding passengers and wildlife on railway networks worldwide.

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