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IMPLEMENTATION OF IOT-BASED WILD ANIMAL INTRUSION DETECTION SYSTEM

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Abstract: **The advancement of sensor technology has now reached an entirely new frontier, all thanks to the integration of image processing and the Internet of Things (IoT) sensor monitoring network technology. In regions characterized by the persistent conflict between humans and wildlife, the threat to human lives and the substantial depletion of resources, particularly in forested and agricultural areas, has become a grave concern. Individuals in these areas face the distressing prospect of losing their property, livestock, crops, and sometimes even their lives. Consequently, it is imperative to maintain continuous vigilance over these regions to deter wildlife incursions. To address this pressing issue, we have devised a comprehensive system designed for continuous field monitoring. In essence, this system employs a sensor to initially detect any intrusions within the vicinity of the field. Subsequently, a camera integrated into the system captures an image of the intruder, and this image is subjected to categorization through cutting-edge image processing techniques. Finally, the system takes appropriate action based on the identified type of intruder, ensuring a timely and effective response.**

IndexTerms - **IoT (Internet of Thing), Image processing, Animal detection, PIR sensors, camera, image processing, light emitter, sound generator, GSM module.**

I. INTRODUCTION

India is primarily an agrarian nation, with agriculture serving as the cornerstone of its economy. While a significant portion of India's population relies on agriculture for their livelihoods, farmers encounter a multitude of challenges. One prominent issue is the escalating human-animal conflict, which leads to substantial resource losses and poses a threat to human lives. In recent times, instances of such conflicts have been on the rise, necessitating continuous monitoring of affected areas to prevent the entry of these creatures or other disruptive intrusions. Human-animal conflicts often arise due to encroachments into wildlife habitats, poaching activities, human migration into forests for sustenance, land acquisition for agricultural expansion, and the rapid urbanization process encroaching upon animal territories. During periods of water scarcity in the summer, animals, such as wild hogs and elephants, venture into farmlands in search of food, damaging crops and endangering lives in the process. Regions like South Asia and Africa witness a high frequency of human-elephant conflicts, especially when farms are equipped with electric fences, altering animal behavior.

To combat this issue effectively, the implementation of an intelligent monitoring system is imperative. Such a system would continuously monitor the area, capture images of animal intrusions, and promptly alert humans to take necessary action. This survey paper explores various wired and wireless applications designed to alert individuals about animal intrusions, with a particular focus on animal image processing research. The emergence of the Internet of Things (IoT) has brought forth new possibilities, offering a multitude of applications, including enhanced emergency responses, intelligent control, and military purposes. Numerous methodologies have been developed to detect and respond to animal intrusions, utilizing IoT technology, sensors, communication devices, and diversion tactics. Various techniques and algorithms have been devised to enhance security against animal intrusions, particularly through digital image processing. Sensor-based systems find application across various real-life scenarios, promising cost-effectiveness, robustness, reliability, accessibility to farmers, and remote monitoring with minimal power consumption. Below given techniques are used to locate animal from intrusion.

Table 1: Methods of animal intrusion detection

Methods	Detection techniques
Electric Fences	Detection using Wheatstone bridge principle (Circuit setup).
Acoustic System	Scare animals by use of sound predators.
Microcontroller based system	Once intrusion found the buzzer will activate and send message alert to the farmers.
Intrusion detection system using Raspberry PI	Automatic highly efficient detection method.

Hardware requirements deal with the physical components of computers and other similar devices. Motherboards, hard drives, and RAM are examples of internal hardware.

1. Sensors-PIR HC-SR501 Motion Sensor.
2. Webcam
3. Microcontroller-Arduino Uno
4. Light-Bright Light Emitter.

The area of software engineering known as software requirements work with establishing the stakeholder needs that are to be solved by the software. The software requirement of our project is given below.

1. Microcontroller-Arduino IDE.
2. Image processing-MATLAB 2017a.

II. LITERATURE REVIEW

This section provides an in-depth examination of prior research conducted on the Animal Intrusion Detection System.

Xiaoyuan Yu et al 2013 [1] have proposed a computerized species acknowledgment strategy utilizing neighborhood cell-organized LBP (Local Binary Pattern) characteristic and worldwide dense SIFT (Scaleinvariant Feature Transform) descriptor for trademark extraction and make do (ScSPM) sparse coding spatial pyramid matching to remove dense SIFT descriptor and cell-established LBP as a close by characteristic. Worldwide capacities create max pooling and weighted sparse coding the utilization of multi-scale pyramid kernel. Support vector gadget set of rules characterizes and checks the dataset conveys 18 species from the area of various sites. This approach accomplishes round 82% curacy on real time animal identity even in muddled situations.

Radhakrishnan et al. 2018[2] proposed a creature interruption identification framework in view of image processing and AI (MachineLlearning). A creature picture is portioned utilizing a watershed calculation to separate different items from the picture and look at whether any compromising creatures are tracked down in the division. This calculation is intended to create a boundary that is the framework just when the noticeable region meets various imprints. Gabor filter is generally utilized inExtract a scope of text to identify looks at changed frequencies. Linear SVM is a regulated learning algorithm for preparing the dataset and characterizing text and hypertext. This strategy for creature interruption discovery accomplishes a general normal of around 54.32%.

Divya, Usha Kiran et al. 2018[3] proposed IOT-based creature interference identification framework. PIR (Passive Infrared Sensor) perceives movement and activates the camera to snap the photograph of the creature. At the point when the sensor recognizes the creature, the sign is moved to the camera through an ArduinoUno microcontroller. The image is saved with the photos of shows that they are in the data set. In case the wild creature is perceived aselephants, the stunning light transmitted is used and when a panther is recognized a noisy commotion is used to divert it. Consequently, a ready SMS is sent to forest authorities and landowners through the GSM module.

Santhoshi K. Jai et al. 2018[4] interruption recognition in farmland through WSN (wireless sensor network) technology. The motion sensor is set in different areas to recognize movement and speak with the coordinator through a radio frequency transceiver. The detection increments, and afterward the coordinator sends a caution call to the proprietor of the mobile farm through the Global System for Mobile (GSM) module. An Arduino board is mounted close to the central sensor and the GSM module shapes the interface along with the buzzers and the RFID transmitter. Radio Frequency Identification (RFID) tags are utilized to recognize authorized and unauthorized entry into agricultural land.

Sheela S, Shivaram. K. R et al 2016[5] proposed low expense system to uncover creatures by the use of IOT gadgets. The PIR sensor tower incorporates Raspberry Pi module that is connected with a USB digital digicam to hold onto photos on the time of movement is detected and sends photos through a web server by the use of web. For picture handling Open CV is laid out on raspberry pi moreover in this paper, to reduce the charge of electrical strains, sun electricity is fixed in each sensor tower the sun

board will prices the battery from the light and presents power to the sensor tower. This presents low power consumption and shops battery power even at night.

Andavarapu Nagaraju et al 2017[6] proposed Weighted Cooccurrence Histograms of Oriented Gradients (W-CoHOG) capability vector to capture creature. Histogram leveling is accomplished to diminish commotion, twists and to enhance the featured area of interest. The gradients are determined in worth and course is addresses to change into eight orientations. Sliding window systems select creatures in exceptional sizes with zoom phase of the camera. The proposed set of rules become advanced in Python - OpenCV with two Benchmark Dataset and LIBLINEAR classifier become utilized for arrangement.

Tibor Trnovszky et al 2017[7] proposed animal prevalence procedure basically founded absolutely on CNN. To decrease the impact of things, the enter photograph might be taken care of with a chain of preprocessing strategies. A renowned photograph prominence approach is utilized to capture processed fragment like Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), and Local Binary Pattern Histograms (LBPH). Proposed CNN and SVM class approach have been productively find animal faces from the made animal information database, Convolutional Neural Network (CNNs) are a class of Neural Networks which have been really capture animal than SVM classifiers. CNNs accomplishes standard astounding accuracy precision of 97%, various tried strategies had been applied in MATLAB and C++/Python.

Nirit Datta and Souvik Sarkar [8] clarifies the procedure for conquer the issue of human and creature injury and mortality because of the wandering of wild creatures out of the national parks and wildlife sanctuaries by the utilization of programmed tracking and ready alert system. Programmed tracking and ready alert system has been carried out by consolidating GSM and GPS innovation as a gadget that would be connected to the body of a creature and would be continuously observing the place of the creature as for the GPS characterized limits set up inside a wildlife sanctuary or national park. On the off chance that a creature strays out of the GPS characterized zone, a alarm system that will be introduced in a human populated zone will go off, illuminating individuals about the coming risk. This system is adaptable, cost effective and simple to execute and can be gainful for monitoring natural life related complexities like poaching, rail route and street accidents, train delays, destruction of vegetation and danger to human existence on the event of wandering of wild creatures out of their home zone.

R.Shanmugasundaram and S.Pavithra [9] proposed a framework to follow the area of Creature in the zoo or public parks. This framework would incorporate a temperature sensor and PIR sensor. The temperature sensor detects the temperature of every creature and PIR sensor detects the human presence inside the creature limits or confined regions. By and large every creature having specific scope of internal heat level. In the event that the creature having any injuries or fever the internal heat level will be naturally expanded. To screen this, we are utilizing temperature sensor. It persistently screens the creature's temperature assuming any variety in the temperature, it will be shown on the LCD. The PIR sensor is utilized to screen the human presence in confined regions or close by the creature limits. At the point when the human presence is distinguished, the voice processor will give caution to individuals through the pre-recorded voice. The GPS receiver send the area, creature temperature to the controller and it is connected with the IOT, It will give the total data to the site on PC or laptop.

III. IMPLEMENTATION

In the ongoing project, PIR (Passive Infrared) sensors and cameras play a crucial role as the initial layer of security. These sensors are responsible for detecting animal movements, and upon detection, they activate the camera to capture an image of the animal. This image is then transmitted for processing through a microcontroller, specifically via a Wireless Sensor Network (WSN). The microcontroller facilitates the transfer of the captured image from the camera to a central computer located in the command center, where image processing and animal classification take place. When an animal is identified as a potential threat, the computer system will relay a message to the repellent system through the microcontroller, triggering an appropriate response to mitigate the threat effectively.

PIR sensors and cameras are strategically positioned on poles along the perimeter of the farm. The sensor-to-camera ratio is approximately two to one. These sensors possess a detection range of roughly 30 meters, while the cameras have an extended range of 50 meters. The cameras are powered by a combination of batteries and solar panels, ensuring continuous operation. When a PIR sensor detects the presence of an animal, it initiates a signal transmission to the camera via a microcontroller. The microcontroller, in response to the signal, captures an image of the specific area from which the signal originated. Subsequently, the camera forwards the captured image of the animal for further processing and classification, with the aim of determining whether it poses a threat or not. When an animal is identified as a potential threat, a series of predefined actions are activated. Firstly, an SMS notification is dispatched to both the farmer and the local forest officials, providing them with precise information regarding the animal's location and its specific type attempting to access the protected zone, which is typically a farm. Concurrently, a repellent system is employed, consisting of bright lights and ear-piercing, irritating loud noises. This repellent system operates in tandem, emitting these deterrents at four-second intervals. The continuous activation of the repellent system is designed to effectively discourage and drive away the intruding animal for enhanced effectiveness and safety.

Figure 3.1 shows the processing flowchart of implemented system.

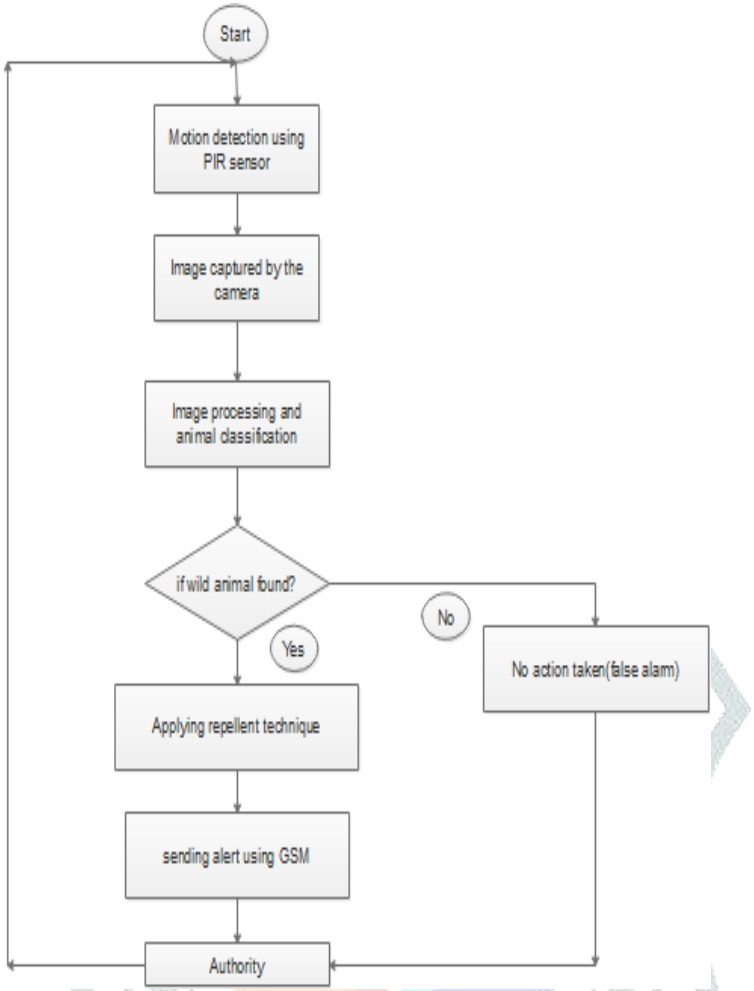

Figure 3.1: Processing architecture.

IV. BLOCK DIAGRAM

The computer receives images transmitted by the camera and employs them for animal classification. These images are then used to build a database, which stores a collection of sample images. The program encompasses various functions, including image indexing, image configuration, and image retrieval. A group of images is maintained within the image set, and an image search index is generated using the indexed image. When searching for images, the index image is utilized in conjunction with the retrieve image function.

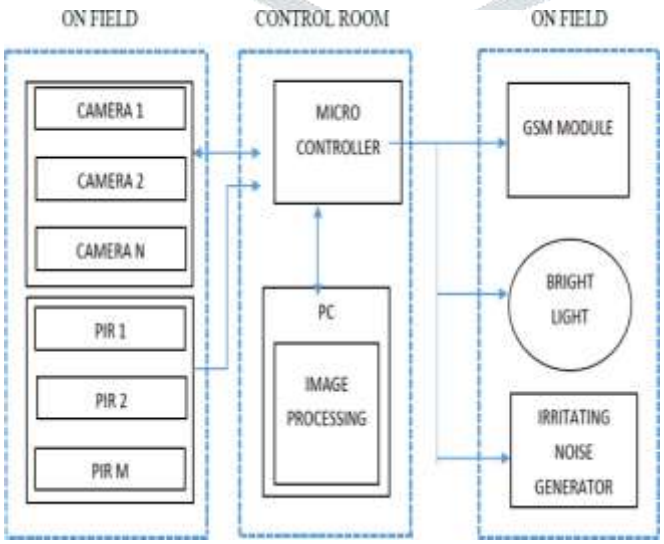

Figure 4.1: Block diagram

The processing system accepts a captured image as a query image, which, along with an image from the database, serves as inputs for the image retrieval function. The output yields indices corresponding to images within the image index that closely resemble the query image. These indices are presented in ranked order, ranging from 0 to 1, representing the degree of similarity. A value of 1 indicates a perfect match between the query and stored images, while a value of 0 signifies no match. Values falling

between 0 and 1 indicate varying degrees of similarity, signifying that the content in the query image shares similarities with the stored image. To determine the animal's identity, a regular expression is used to match the image's name. If there is a match, it's identified as an elephant; otherwise, it's classified as a leopard. For values falling within the range of 0.1 to 0.9, indicating a match, a repellent system is activated. When an elephant is detected, a bright light is emitted, while an irritating loud noise is employed for leopard detection. To alert forest officials and field owners, an SMS notification is dispatched. However, if the detected object poses no threat, no SMS alert is sent, thereby preventing false alarms.

V. RESULT AND DISCUSSION

To gain a comprehensive understanding of the system, it is essential to analyse all varieties of results obtained from it. This section demonstrates how the outcomes of the proposed system compare to existing methodologies in the context of specificity, sensitivity, and accuracy.

The system was executed utilizing a Raspberry Pi 4 Computer equipped with 4GB of RAM. For animal movement detection, a PIR HC-SR501 Motion Sensor was integrated alongside a webcam. The camera and sensor assume pivotal roles in the project, serving as the primary layer of security. Upon identifying an animal as a potential threat, a deterrent system was deployed to emit loud noises and intense lights. This deterrent system was constructed using a Bright Light Emitter and a portable Bluetooth speaker. Figure 5.1 illustrates the experimental configuration of the proposed system.

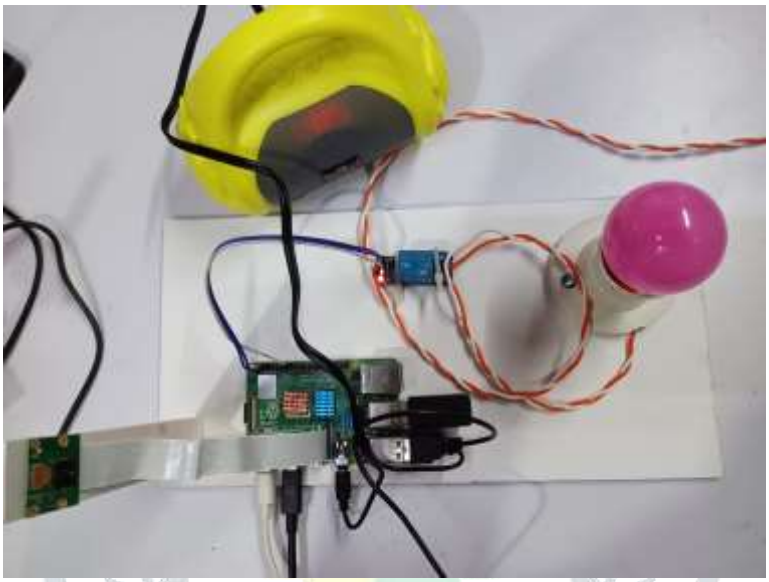

Figure 5.1: Experimental configuration

To show the results the animal's picture is shown to the camera. Figure 5.2 shows the captured image of elephant by camera. Once animal is identified as a threat, first the SMS notification will go to the both farmer and local forest officials. Simultaneously, the repellent system will be activated, consisting of bright lights and ear-piercing, irritating loud noises. It will help to drive away the intruding animal.

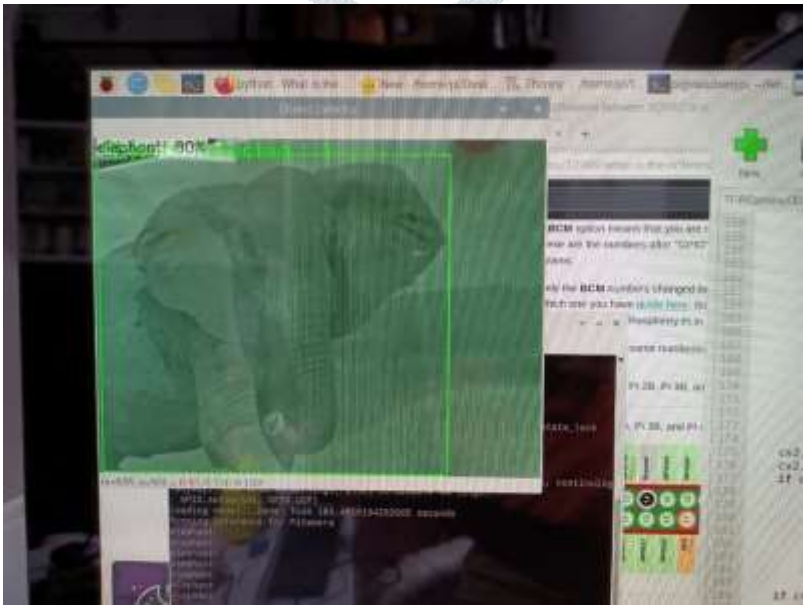

Figure 5.2: Captured image of elephant

VI. CONCLUSION

In an attempt to prevent conflicts and the unnecessary killing of endangered or threatened animals, it is essential to implement ongoing monitoring measures in vulnerable areas to deter the entry of wild animals. To address this critical issue, we have undertaken the development of a comprehensive system that utilizes sensors and cameras to monitor these regions. The system operates by capturing images of animals within the monitored area and subsequently classifying them through advanced image processing techniques. This classification enables timely and appropriate actions to be taken in response to the identified wildlife presence, promoting peaceful coexistence between humans and animals while safeguarding endangered species.

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