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Smart Agriculture Land Crop Protection Intrusion Detection Using Artificial Intelligence

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Abstract. Human-wildlife conflict is the term used to describe when human activity results in a negative outcome for people, their resources, wild animals, or their habitat. Human population growth encroaches on wildlife habitat, resulting in a decrease in resources. In particular habitats, there are numerous forms of human and domesticated animal death or injury as a result of conflict. Farmers and the animals that invade farmland suffer greatly as a result. Our project's primary objective is to lessen human-animal conflict and loss. The embedded system and image processing technique are utilized in the project. Python is used to perform image processing techniques like segmentation, statistical and feature extraction using expectation maximization, and classification using CNN. The classification is used to determine whether the land is empty or if animals are present. A buzzer sound is produced, a light electric current is passed to the fence, and a message alerting the farmer to the animal's entry into the farmland is transmitted. This prevents the animal from entering the field and enables the landowner to take the necessary steps to get the animal back to the forest. The result is serially sent to the controller broad from the control board.

1 Introduction

An essential scientific technique for monitoring the ecosystem and identifying possible climatic problems that could have an immediate impact on human environments is keeping track of animal population and mobility. Up until now, approaches based on human observations have been employed to count animals that are crowded. Although pricey, these techniques have poor precision. Information technology (IT) is used in precision agriculture (PA), a farm management technique, to guarantee that the soil and crops receive the precise nutrients they require for maximum health and productivity. PA's objectives include environmental protection, long-term sustainability, and profitability. PA is also known as satellite agriculture, as-needed farming, and site-specific crop management. The Internet of Things (IoT) and Wireless Sensor Networks are PA's main driving forces (WSN). IT Many services, equipment, and pieces of software are needed for precision farming. The program offers access to real-time information on crops, soil, and ambient air as well as forecasts for the localised weather, labour rates, and equipment availability [1]. The information is used by predictive analytics software to give farmers recommendations on crop rotation, the best times to plant and harvest, and soil management. The soil's temperature, moisture content, and air temperature are measured using field sensors. Farmers are able to monitor certain plants in real time using robotic drones and satellites [2]. To give a device for the now and the future, these images may be analyzed and linked with sensor data and other data. For example, these may be used to assess which regions require irrigation as well as when and where to sow a certain crop. Precision agriculture was previously only available to bigger businesses with the IT infrastructure and other technical resources needed to deploy it effectively and reap its benefits [3]. Nevertheless, because to modern with the use of smartphone apps, clever sensors, drones, and cloud computing, farming cooperatives and even small family farms may now practice precision agriculture. Farmers have complete remote-control over-all operations thanks to a precision agriculture technology. Even small farms can handle a number of little sections or large fields. It boosts production while saving money and dramatically increasing crops' efficiency. The latter point is very important because precision agriculture technology initially appear to be expensive. Long-term savings, however, are much higher than with traditional agricultural methods [4]. As a result, gardeners are able to calculate the precise amount of fertilizer

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needed and determine which kind of fertilizer are most effective in a particular area. In addition, the fact that precision farming technologies enhance the planning of agricultural operations over an extended period of time and adjust the real-time strategy in the event of force majeure underscores their significance. A stable supply of food is made possible by optimizing the use of the soil to maintain its quality. Precision farming in agriculture is essential to addressing the problem of world hunger as a result [5].

2 Related works

The wireless network concept of precision agriculture completes all of the tasks given to it, including determining the leaf's moisture content, PH value, wetness, and humidity. To perform all of these tasks, we have connected Arduino and XBee to the agriculture field for monitoring and control. A High Performance, Low Power AVR and an Arduino Uno are utilised to regulate the field, which is controlled by the microprocessor ATmega328. We can use Arduino, a testing and development framework, in our application because it has many helpful functions [6]. A framework with a low cost, low power, and constrained data rate is required for agricultural wireless sensor network. Many sensors, including DHT 11, BMP 180, SEN 0114, and MQ 135, and others, were used by Yash Bhojwani [7]. to gauge variables such as air purity, soil moisture, pressure, temperature, humidity, and other variables. In order to collect data, these sensors will be installed throughout the field and connected to a microprocessor. Things speak, an Internet of Things hub, will then assist in the transmission of acquired data to the cloud. The data will be evaluated using MATLAB code running in the thing talk backend. MATLAB will subsequently be used to display the data in real time. so that the user can quickly understand it and take appropriate action. The MATLAB code running on the website's backend enables the user to view the visualized data on their own device as well as the predicted future values [8].

Leslie Dutra Coelho, the historical register of the data is made possible by the Lora WAN protocol, which features an IoT platform, an app that can be used on mobile devices, and is stored in real time in a database. The number of animals in crowded animal photos of various sizes could not be counted using the previously taught density map regression methodology-based counting processes [9]. The reason for this is that the target density maps were made by hand and are too rough. Our initial proposed density activation map is a consequence of DAM counting (DAM). To precisely count the number of animals, the network uses the DAM, a CNN viewpoint density map with high activation values. In order to estimate the number of animals based on the total of all the DAM variables [10]. The network is configured to recognise the appropriate locations and levels of DAM activity. The greenhouse monitoring system described is based on wireless communication and consists of a database that stores all of the parameters, several sensors that will provide information about temperature, humidity, and light intensity, and a mobile app [11]. This are all interconnected to a focal server, addressed by a Raspberry Pi load up, which will send and get data from client end through web network without limitation of general setting. Actuators will be used to start the activities inside the greenhouse. The development of a control strategy is a crucial step in effectively controlling the microclimatic parameters.

El at [12], Jianbo Xin, Fan Li, and an animal nest on a transmission line tower damages the transmission machinery and potentially puts the security and stability of the power grid at risk. The annual growth in the number of animal pests in transmission lines has resulted in substantial economic losses in recent years. The conventional transmission line method of locating an animal's nest is labour-intensive, time-consuming, and unsafe. This leads to the proposal in this research of a Faster RCNN convolution neural network-based method for automatically detecting an animal's nest on a transmission line tower [13]. Shuman Tian, Xianbin Caol el.at detection has recently received a lot of attention in computer vision. With the opening of low-altitude airspace, this becomes an urgent task. However, trapping flying animals in aerial videos is much more difficult than traditional object detection tasks due to the small target sizes, intricate backgrounds with a lot of variation, and animal-like object disturbances [14]. To catch flying animals in aerial videos, we propose a unified framework we call glance-and-stare detection (GSD) in this paper. The fact that people first look at the entire image before looking at the parts where they think the object might be until they get confirmation is the inspiration for the GSD.

According to Peter Jancovic , the acoustic scene is initially separated into distinct pieces that correspond to the observed sinusoids. Each segment is represented by a series of sinusoid frequency and magnitude data. The temporal evolution of these properties is modelled using hidden Markov models (HMMs). We propose a novel approach to the unsupervised modelling of individual animal vocalization components. After initialising the element models with HMM-based clustering, the maximum likelihood label re-assignment repeatedly approach is utilised to further train them [15].

According to Kamal Kumar Ghanshala and Rahul Chauhan, The suggested system consists of solar panels, sensor nodes, metos NPK, an Arduino processing module, a wireless Zigbee module, a motor, and sprinklers. The ESP8266 Wi-Fi module is used to wirelessly connect to the network. Each sensor node is made up of a combination of temperature, humidity, wetness, soil pH, and moisture NPK sensors, and the processing unit is an Arduino. The sensor nodes collect data from the ground as well as being powered by solar panels [16]. It offer a computationally efficient approach for reliably and robustly recognising moving objects in a typical three-dimensional picture.

Recognizing moving objects in a video taken by a freely moving camera is the hardest task in computer vision. By applying a coarse-to-fine thresholding strategy to the particle routes in the video sequence, this problem is resolved [17]. Many matrices made from bundles of particle trajectories are used in reduced singular value decomposition to first estimate the coarse foreground region (RSVD). There are a number of ways that artificial intelligence and machine learning are used in agriculture. A smart farm environment can be created by combining IoT and machine learning to control farm equipment. Farmers will greatly benefit from the adaptability of manual control based on processed data for remote access to farm equipment [18].

3 Problem identification

In India, agriculture is extremely important. Farmers frequently lose crops to animals including buffalo, cows, goats, birds, and wild elephants. Animal encroachment in fields causes substantial losses in agricultural revenues that a farmer cannot afford, especially if they have restricted farming grounds, like the majority of farmers in India. Farmers cannot protect their fields by being on them all day. In order to identify the presence of animals, provide a warning, and safely move the animal away from the danger area, an animal detection system has been designed. The system is set up to continuously scan the field for any animal activity. In order to increase production in the agriculture sector by automating chores, computer vision is being used more and more. We suggest an AI-based system that uses cameras to monitor the field for animal infiltration and alerts the farmer or can even take some steps on its own.

4 Proposed system

Our newly developed counting approach, DAM counting, produces the first density activation map (DAM) that we have ever proposed. To properly count the number of animals, the network employs the DAM, CNN viewpoint density map with high activation levels. In order for the aggregate of all DAM data to produce an estimate of the number of animals, The network has been programmed to figure out where and how much the DAM should be active on its own. The present density map regression method can be efficiently replaced by DAM counting, which considerably increases counting accuracy. Selective search produces a huge number of candidate regions of various sizes for each sample video input. The hardware components of the proposed efficient repellent system for image processing are PC-based. A buzzer that makes predator sounds to scare away animals, a microcontroller that is connected to the PC, and a Python and Open CV library software component for identifying animal features. The whole system flow may be broken down into three basic components.

1. Creating an animal detection model that works with real-time video streaming.
2. Repelling the dangerous invader (if identified, only wild animals) without killing it.
3. Sensing Water Level, if it is overload its transmit through nearby water storage systems.

The process in detail is depicted in the preceding fig. 1, which follows the web camera's video. Images or frames will be separated from the video. After that, the frames are sorted according to the input data that the program already fetched to identify the image. The relevant frequency of the animal or bird will be generated by the buzzer with the assistance of NodeMCU-ESP8266 after it has been identified in Fig.1.

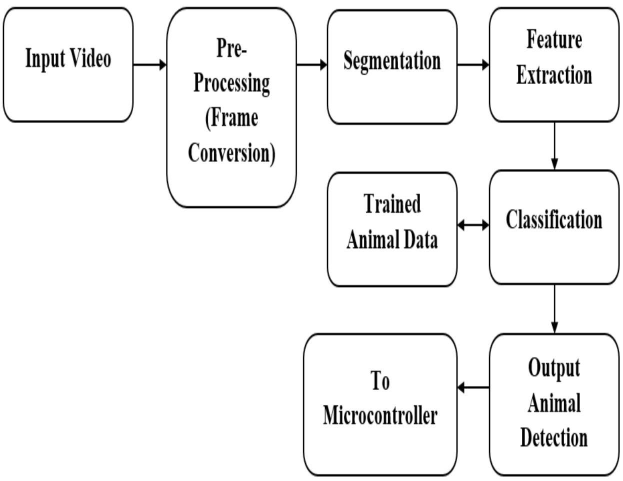

Fig. 1. Animal Detection Block Diagram

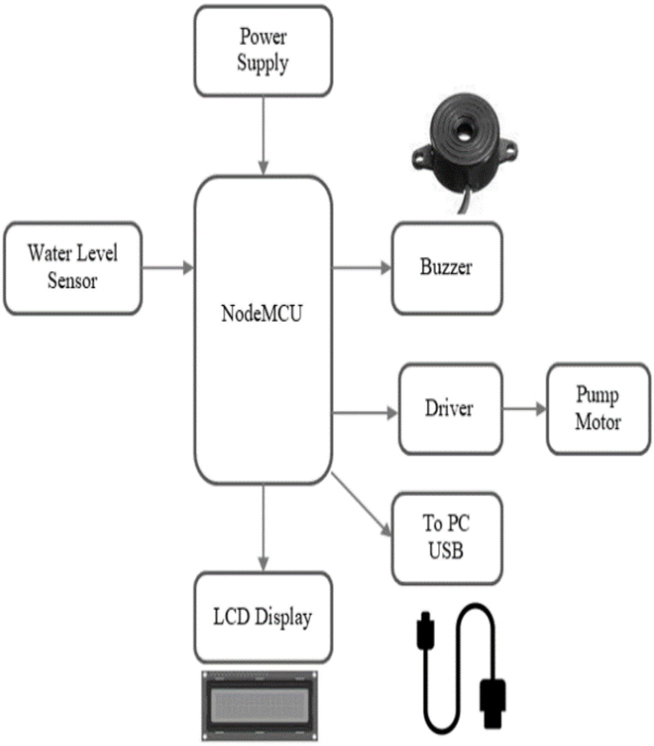

Fig. 2. Water Level Detection

Fig.2 is made up of hardware modules. Most of the time, all of the parts are connected to the NodeMCU-ESP8266, which is a microcontroller that controls the buzzer, pump motor, and water level sensor. The percentage reading of the water level and the frequency value of the animal that was detected will be displayed on the LCD display. While there is a possibility of human error, it is less expensive to monitor the field with the assistance of any workers. This system, in which the camera automatically detects movement in the field, has been developed to avoid this. On the off chance that there is any movement, it finds for an interloper, on the off chance that found, vital move will be initiated.

5 Hardware components

Camera

Using the PC and the Arduino Board, the system as a whole is constructed using two distinct hardware components. As a processing unit for animal detection and image capture, the components of the temperature sensing and scare-away mechanisms are connected to the Arduino and PC. The B. Image Capturing Process is used to wirelessly connect the two boards to each other. It is used to capture rice field scenes. The camera has a resolution of 640 x 480. Use a higher-resolution camera for more accurate and complete detection. Birds may be recognised by the camera at a linear distance of around 2 metres from the prototype. The two processes in the video acquisition process are video streaming and frame capturing. Obtaining the video file from the camera is a stage in the video streaming process.

Python (PC Development Language):

The PC and Raspberry Pi's initial programming development environment is Python. It is a literal translation-based, object-oriented programming language for computers. The code for detecting birds was written in the Python programming language.

OpenCV (Image Processing):

OpenCV, which stands for Open-Source Computer Vision, is a cross-platform library for computer vision based on an According to Xinyu and Chang, open source distribution (2017). It works with Windows, Mac OS, and Linux operating systems. Programming languages like Python enable OpenCV to implement many common image processing methods.

Alarm and Alert Notification

The Buzzer is linked to the computing module. Upon confirmation of the wild animal intrusion, a buzzer alarm will be sounded to return the animal back to its environment without physically hurting or threatening any animals or people. Moreover, pop-up text messages with alert notifications are sent to the mobile devices of the relevant authorities. Even if they are far away, this makes them aware of intrusion detection.

NODEMCU-ESP8266

The widely used ESP8266 -12E Wi-Fi module serves as the foundation for the open-source Node MCU development board and firmware. You can use either the Arduino IDE or the straightforward and efficient LUA programming language to programme the ESP8266 Wi-Fi module.

With only a few lines of code, you can turn your ESP8266 into a web server, generate input/output pins precisely like Arduino, make a Wi-Fi connection, and much more. It serves as the ethernet module's Wi-Fi counterpart. You already have an internet of things (IoT) tool.

6 Artificial intelligence implementation

The deep learning technology subfield of artificial neural networks is categorised under artificial intelligence. A subset of machine learning called "deep learning" uses different varieties of neural networks. Since that these algorithms are created to imitate how our brains work, many experts think they represent our best hope of creating actual artificial intelligence (Artificial Intelligence).

Input Surface:

This is the layer into which we feed model data. The amount of characteristics in our input is the same as the number of neurons in the input layer.

Hidden Surface:

The input characteristics are received by the hidden layer(s) that contain the multiple processes and activities. There can be several hidden layers. In combination with an activation function, the layers are subjected to mathematical operations such as matrix multiplication, convolutions, pooling, and so on.

Output Surface:

Our model's output is then translated into the layer that calculates probability scores using sigmoid or SoftMax functions. Create an image input layer by utilising one already in existence. Images are sent into a network via an image input layer, which standardises data. To select the picture size, use the input Size option. The size of an image is influenced by the quantity of colour channels, as well as their width and height.

Input Sequence Surface:

A sequence input layer sends sequence data to a network. When the input and output sequences are different lengths (as in machine translation, for instance), the target cannot be anticipated until the entire input sequence is delivered. When someone refers to "sequence to sequence models" without more clarification, they usually mean a more sophisticated configuration.

Convolution Surface:

Convolutional layers are the fundamental components of convolutional neural networks. Convolution is a straight forward method that involves the process of applying a filter to an input to produce an activation. A feature map is created by repeatedly using the same filter on an input, such as an image, to represent the positions and degrees of a recognised feature. the use of convolutional neural networks are distinct from other types of neural networks in that they may adapt to the demands of a specific predictive modelling problem, such image classification, while learning several simultaneous filters that are fitted to a training dataset. As a result, input photographs could exhibit characteristics that are both quite unique and common.

Pooling Surface:

In a CNN design, it is typical to sporadically insert a Pooling layer between parallel Convolution layers. It gradually reducing the spatial dimension of the representation helps to control overfitting by reducing the amount of parameters and calculations that must be made in the network. Prior to performing the MAX operation to increase each slice's spatial size, the Pooling Layer processes each depth slice of the input separately.

SoftMax and Classification Surface:

SoftMax takes the exponents from each output and norms each of these values by the sum of these exponents to convert logits into probabilities. This makes sure that every probability should equal one and that the output

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vector as a whole adds up to one. In many classes, the loss of such a problem is frequently cross-entropy loss. In the final layer of an image classification network like CNN.

7 RESULTS AND DISCUSSION

Hardware and software parts make up the proposed system; Consequently, those two aspects receive distinct attention. As a result, the software component serves two primary purposes: animal detection and user notification There are two main purposes for the hardware section: put in place processes for capturing images and scare-away mechanisms. The procedure depicted in Fig.3, Fig.4, Fig.5, Fig.6 will be used to implement the system's overall concept. The repellent continuously monitors the environment's temperature within its range, and it send notification through related person on message and mail. When the system can be detect water level also, because during rainy season, many amount of water can be move to the field to affect the crop, so we detect the water level by using sensors, when the sensors can be connected to the NODEMCU-ESP8266, it will detect the water level, if its high when the water can be transmit through the nearby storage system like pounds etc in Table.1. When the water level is high, it will send notification to the related person through message in Fig.7.

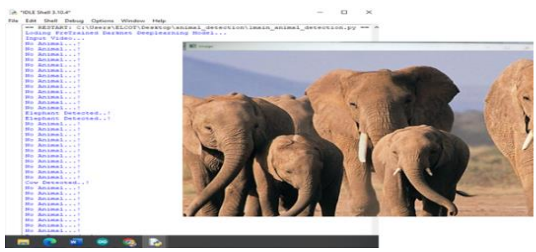

Fig. 3. Elephant detection software output

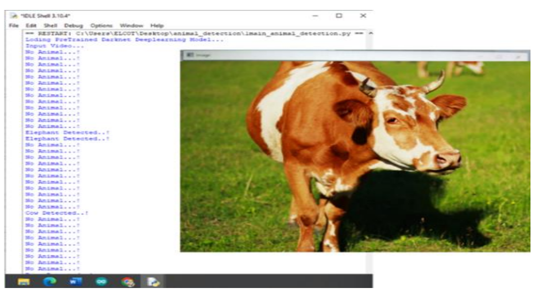

Fig. 4. Cow detection software output

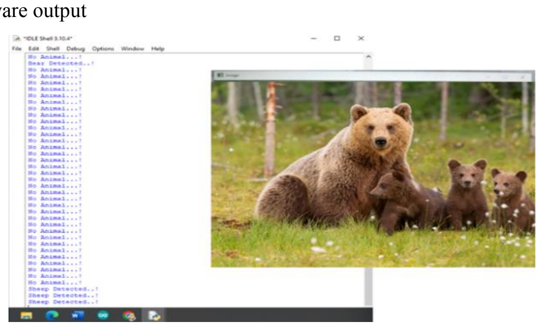

Fig. 5. Bear detection software output

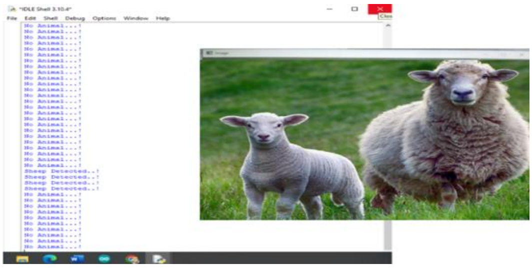

Fig. 6. Sheep detection software output

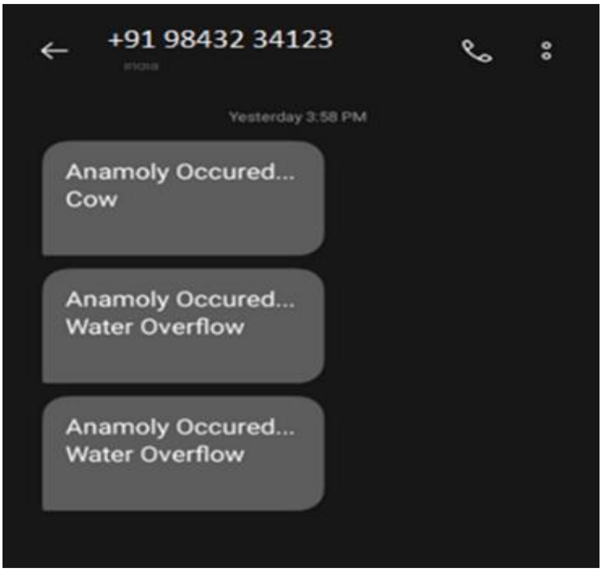

Fig. 7. SMS sent when anomaly occurred

Table 1. Database Table

Object	Action	Status
No Motion	Normal	Normal
Low Water Level	Motor OFF	Normal
Excess Water Level	Motor ON	Send Data

8 Conclusions

Because agriculture is the foundation of the Indian economy, protecting it is our primary responsibility. The proposed work has utilized a Camera sensor, which effectively detects intruder movement. In addition, a camera is used here, so the entry and exit times are recorded. This concept of protecting crops is simple to implement and can be done so without harming humans or animals. Additionally, the relatively low cost of the system's components makes it feasible. As a result, this product can be used to safeguard farm crops. Instead of the current methods, it might be very useful for agriculture. It focuses on agricultural-related issues and is a convenient way to keep records. because the product is practical, effective, and records movement in its immediate vicinity. Although the animal recognition algorithm has been trained to differentiate between flying items and animals, the motion detection algorithm detects motion in the imaging system (video) without making a distinction between animals, flying objects, or other moving objects.

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