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SMART FARM PROTECTION AND INTRUDER ALERTING SYSTEM USING ARTIFICIAL INTELLIGENCE

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ABSTRACT: *India is mostly an agricultural nation. Security on agricultural farms is crucial to safeguarding the harvest. Animals or people with malicious intent to rob or damage the property have the power to wreck valuable assets. Introduction of modern technologies into agriculture has made it possible to consider developing security systems for farmlands. IoT technology facilitates the development of a number of applications for smart agriculture. The possibilities are unlimited when vision is integrated with IoT. This report makes a novel suggestion for agricultural farmland surveillance. The suggested solution uses a Raspberry Pi board to look for suspicious activity or movement in the farmland and activates the PiCam to snap pictures of the situation. The image processing module on the Raspberry Pi board uses Mobilenets Deep Learning and Single Shot detectors to identify the item in the image. The farmer will get notifications of this communication by email and telegram. The studies are conducted on farmland, and the system's precision and consistency are measured and tabulated. The findings demonstrate that the system is 100% reliable and 92% accurate in spotting fraudulent activities.*

Keywords: Raspberry Pi, Camera, Artificial Intelligence

1. INTRODUCTION

The foundation of our nation is agriculture. Food, raw materials, and employment are all provided by agriculture to a large subset of the Indian populace. It is essential to the expansion of the nation's economy. By 2050, almost 50% of Indians are expected to live in urban areas, according to the World Bank. Agriculture workers and laborers are expected to make up around 26% of the workforce in 2050, down from almost 60% in 2001. Consequently, agricultural mechanization is necessary throughout the nation. Crop productivity is highly desired in agriculture. Agriculture has been associated with the development of advances in farming technology for many years.Utilizing cutting-edge technologies like Vision Based IoT, which integrates image processing methods into IoT, will significantly contribute to making agriculture smarter in this area. The Internet of Things (IoT) is the most effective and cutting-edge method for creating answers to issues in a variety of human endeavors. Sensors, network components, software, and several other electronic devices are some of the diverse building parts that make up the Internet of Things. In order to increase agricultural output and address the labor crisis in the sector, Internet of Things (IoT) technology is anticipated to be crucial. By collecting field data in real-time, analyzing it, and deploying the results, smart agriculture uses IoT-based approaches and solutions to increase the productivity of agricultural operations, maximize output, and reduce agricultural waste. The improvement of agricultural operations will be made possible by a variety of IoT-based applications, including precision farming, variable rate technologies, smart irrigation, and smart security systems. IoT may improve the amount and quality of agricultural production, which will make agricultural areas more productive and address issues specific to agriculture. The improvement of agricultural operations will be aided by several IoT-based applications, including variable rate technology, smart irrigation, and smart security systems. IoT has the potential to improve agricultural productivity in terms of quantity and quality, hence making agricultural lands more intelligent and linked. Vision IoT is one such large area within IoT. IoT technology and image processing techniques are combined in vision-based IoT, which can make smart security systems for agriculture a reality. Vision IoT aids farmers in keeping an eye on and managing farm activity.

IoT devices that are new and improved, more responsive and smarter than ever before, and thus more valuable to the user, have been made possible by the introduction of vision technology. Vision is one of the most advanced sensor modalities. There are countless opportunities for monitoring, regulating the environment for agriculture, and other things when vision technology is combined with agriculture and IoT. Security and surveillance in agriculture is one of the key application areas for vision IoT technology . Even though there is only a small risk of violence on farms today, criminal acts including theft of farm machinery or crops, animal infiltration, criminal disturbance involving left-out machinery, damage of bioengineered plants, etc., pose substantial issues for farmers. Finding a novel, less expensive approach to spot harmful behavior on a farm, identify the thing that's doing it, and alert the farmers to it is urgently needed.

This study intends to develop an IoT security system that detects motion in the farm environment, activates PiCam to take an image of the scene, and uses deep learning to identify the entity, such as an animal, person, or thing, that is producing the motion using MobileNets and Single shot detectors. On devices with limited resources, like smartphones and Raspberry Pi, these techniques may be combined and applied to identify objects in real time and very quickly. A pre-trained object identification network is loaded using OpenCV's Deep Neural Network (DNN) module. When the input pictures are forced to travel through this network, the output bounding box (x, y)-coordinates of each item in the image are acquired. The findings of the object detection are notified to the farmer by email and SMS when there is motion information in the scene image. This system's importance is in notifying the user via email and SMS of real-time information on the recognised object. The system's accuracy, measured as the ratio of correctly detected objects to all objects that entered the farm within a given time frame, has produced satisfactory results in the experiments that have been conducted on it. The accuracy of the system is 92% with regard to object detection and identification. The system's consistency, which is determined by comparing the number of user notifications issued to the number of incursions in the farm, is discovered to be 100%. This document provides a thorough explanation of the proposed system. The work is divided into five sections, with Section 2 providing a literature overview on the contributions made to security systems in smart agriculture employing the Internet of Things and image processing. Section 3 discusses computer vision-aided security systems for smart agriculture, particularly to detect motion and malicious activities in farms and identify the object causing motion. It also presents the hardware and software components used in the framework and the image processing mechanism to identify the object in an image.

2. EXISTING TECHNIQUE

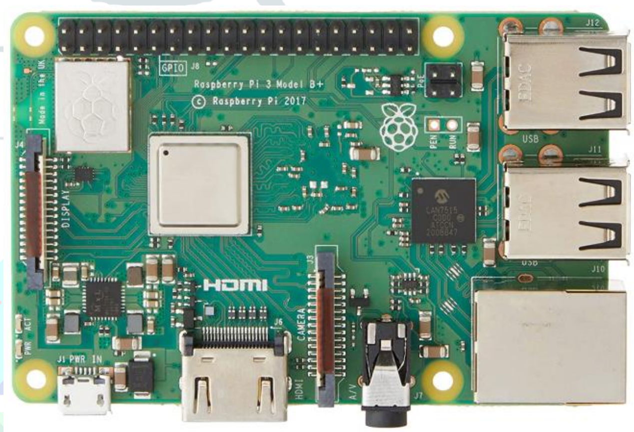
There have been a number of approaches put out in the past to cope with elephant invasions.

There has been a proposal for a surveillance system that tracks elephant movement using seismic sensors.When comparing patterns, the fastICA algorithm is used. An IOT-based embedded system was created. The Arduino receives the detected data from this system. Elephant vibrations are detected by the system using geophones, and utilizing a microprocessor, these impulses are transformed into electrical signals. The forest officials are then sent a warning notice.

3. SYSTEM HARDWARE

3.1. RASPBERRY PI 3

The Raspberry Pi is important because it offers an affordable, easy to use platform for experimentation and learning. It is also incredibly versatile, and can be used for a variety of different projects as well as educational activities. For example, it can be used to create robots, computers, or even a basic home automation system. It also provides a great starting point for those looking to get into programming and electronics.



Raspberry Pi 3 can be used for a variety of projects, from creating a home media center to a personal cloud storage system. It can also be used for educational purposes, such as robotics and programming. With a Raspberry Pi 3, you can also make a retro game console, a smart mirror, or even a smart home device. Furthermore, you can use the Pi as a low-cost computer to create a home server or a web development platform.

3.2. CAMERA MODULE

A specially created add-on module for Raspberry Pi hardware is the Raspberry Pi Camera Board. It uses a unique CSI interface to connect to the Raspberry Pi hardware. In still capture mode, the sensor has a native resolution of 5 megapixels. It supports up to 1080p at 30 frames per second for video mode capturing. The camera module is the perfect option for mobile projects because it is compact and light..

3.3. BUZZER

A piezo buzzer is another name for a buzzer. It simply functions as a little speaker that you can connect to a Raspberry Pi directly. You can set a frequency and make it emit a tone. Based on the reverse of the piezoelectric action, the buzzer emits sound.

3.4.POWER SUPPLY

Depending on the Raspberry Pi model, different power supplies are needed. All models need a 5.1V supply, although the amount of electricity supplied varies depending on the type.A micro USB power connection is required for all devices up to the Raspberry Pi 3.

4.WORKING OF PROPOSED METHOD

This section describes a Smart Security System for Agriculture using Raspberry Pi, integrated with OpenCv, which detects movements inside the farm, takes a snapshot of the environment upon detecting the motion, processes the captured image using OpenCv inside the Raspberry Pi, determines the object such as an animal, person, or any other causing the intrusion in the scene and trigger the notification to the farmer. As shown in the proposed system." **S**mart farm protection and intruder alerting system using artificial intelligence" is made up of a sensor module, a deep learning module that uses OpenCV to process the acquired image, a PiCam module, an email notification module, and an SMS notification module. There is a PIR sensor in the sensor module. PIR sensors are used to monitor the farm for suspicious activity and track down trespassers. There are two slots in the PIR sensor. These holes were created using a unique substance that can recognise infrared photons. When the sensor is not in use, the slots detect the same number of infrared photons. One half of the PIR sensor is intercepted by the IR rays that a warm body, such as an animal or a person, emits as heat energy when it passes by. The positive difference between the two halves changes as a result of this. When the warm body departs the detecting region, the situation flips, resulting in a negative differential change (Raj G Anvekar, 2017). These variations in pulse rate validate the motion detection. The processing module is made up of a Raspberry Pi board and an image processing component that leverages OpenCV to provide quick image processing. When a PIR sensor detects motion, Raspberry Pi will instruct the PiCam to capture a photo of the surrounding area. The Raspberry Pi creates a local copy of the picture once the PiCam collects it. The system is implemented using two PIR sensors and a camera. At this level, deep learning is used to identify objects in the collected scene picture utilizing Single Shot Detectors (SSD) and MobileNets. There are two components to the SSD object detections. Convolution filters are used in combination with feature maps to detect objects. In contrast to RPN-based techniques like R-CNN, which require two shots—one to create regional proposals and the other to identify items that are present in each proposal—SSD recognizes several objects inside the picture in a single shot. Compared to two shot RPN-based methods, SSD is quicker. In contrast, Mobilenets' simplified architecture-based approach builds lightweight deep neural networks using depth-wise independent convolutions. The two approaches discussed above are combined to provide a super-quick, real-time object detection technique that operates on devices with limited resources, such as smartphones and Raspberry Pi. An object identification network that has already been trained is loaded using OpenCV's deep neural network (DNN) module. The network allows for the transmission of input photos, and the output allows for the retrieval of the bounding box (x, y) coordinates for each item in the image. The Raspberry Pi's OpenCv module, which is installed, performs object identification, provides information about the object that has moved or engaged in any harmful action, and then passes that information to the Email notification module.The email notification module uses the SMTP protocol and will have the user's email address, where an email with an alerting picture will be sent. The SMS notifier module sends the registered user a security alert message using the Telegram messenger's capabilities. The ensuing sections explain the system's architectural architecture in detail, as well as the hardware and software used.

4.1 ARCHITECTURE

Three layers are used in the developed architecture for data transmission, processing, and gathering. The IoT architecture described here may be thought of as a three-layer design.

1.The perception layer: The perception layer is first. Perceiving the characteristics of the surroundings and the objects around the agricultural area is the primary goal of the perception layer. Many of the well-known sensing technologies enable the perception process (e.g RFID, GPS, WSN, NFC etc). Information is converted here into digital signals, which are needed for network transmission.In the system as it is intended, the PIR sensor and camera operate at the perception layer. These sensors collect real-time data from the farm environment and transmit it to the Raspberry Pi computing unit. The Raspberry Pi is used to monitor the values and programmatically operate the sensors. The Raspberry Pi's built-in gateway offers an interface to link the network layer and perception layer.

2 .The network layer: It handles the data that was sent from the perception layer. Through a variety of networking techniques, including local area networks and wireless/wired networks, the data is sent to the application layer. Data is sent via transmission methods such as FTTx, wifi, 3G/4G, Zigbee, Bluetooth, and infrared technologies. Between sensors and processes on the Raspberry Pi, the network layer interacts.

3. The application layer: Data that has been processed from the preceding layer is used in the application layer. This layer serves as the IoT architecture's front end, allowing its full potential to be realized. The PiCamera is used in our system to capture the scene picture at the perception layer, identify the item in the scene image at the application layer, and send email and Telegram message notifications to the user. layer of applications. These three layers are all included in the Raspberry Pi and utilized appropriately.

The four phases of the proposed system's operation are motion detection, event capture, object identification, and event notification

1. Motion Detection Phase: Using the PIR sensor installed in the farm environment, the motion detection phase entails the detection of any hostile activity in the farm field. The Raspberry Pi receives the signal information from this PIR sensor and processes it further.

2. Event Capture Phase: When motion is detected, the PIR sensor's data is analyzed and the camera is set to take a picture of the scene. The image that was collected will be saved on the Raspberry Pi, and the following step will include object detection.

3. Object Identification Phase: The Raspberry Pi's image processing module receives the collected image. The object(s) in the image are identified by this module. MobileNets and Single ShotDetectors, which are the preferred object detectors as mentioned in Snowber Mushtaq et al, may be used for object detection using deep learning (2018). For real-time, quick object identification on devices with limited resources (such as the Raspberry Pi, cellphones, etc.), several techniques are integrated. A pre-trained object detection network may be imported via OpenCv's DNN module.This will make it possible to send photos over the network as input and get the (x, y)-coordinates of each detected item in the image as output.

4. Event Notice Phase: The user is informed about any detected motion in this phase by email and SMS with a notification that includes a taken image. Both the email and the SMS are sent to the user's registered email address and registered mobile number respectively. The four stages are briefly covered. The proposed methodology's algorithm is described below.

Algorithm: Working of the system.

Step 1: Get going while anticipating motion detection

Step 2: Moving on to Step 3 if motion detection is detected in Step 2 else go to Step1

Step 3: Turn on the camera and take a picture of the scene.Step 4

Step 4: Gather images in Raspberry Pi Media in step four.

Step 5: Process the image to determine the things it contains.

Step 6: Email and text the user with item details.

Step 7: Stop

The main component of the system that is used in this instance is object identification. In the next part, an extensive description of object detection and the system's implementation algorithm is presented.

4.2 OBJECT IDENTIFICATION USING OPENCV IN RASPBERRY PI

In order to identify objects without transferring them to a remote server and processing them there, OpenCv may be installed on Raspberry Pi. The latter method is both inefficient and time-consuming.

According to Wilson Feipeng Abaya, single Shot detectors and mobile nets are effective tools for deep learning-based object detection (2018). Two elements make up the SSD object detections. Convolution filters are used to recognise objects by 1) extracting feature maps and 2) applying them. In contrast to techniques based on regional proposal networks (RPNs), such as RCNN, which require two shots—one to create regional proposals and the other to identify items that are present in each proposal—SSD recognizes several objects inside the picture in a single shot.

In contrast, Mobilenets' simplified architecture-based approach builds low weight deep neural networks using depth-wise independent convolutions. The algorithm below outlines the stages the suggested system takes.

It builds a pre-trained class with training data for

In the process, animals including a cat, a horse, a dog, a human, a bird, a sheep, a pig, an elephant, a monkey, a bear, a motorbike, a bicycle, a goat, a bus, a train, and a

A blob is produced after a query image has been sent across the network. To keep track of the identified items, a list is produced.

When the confidence value exceeds the threshold value, which is set at 40%, an item is considered to have been discovered. After assessing the training network for a few known item detection outcomes, this threshold value is chosen.

Object identification algorithm utilizing MobileNets and SSD.

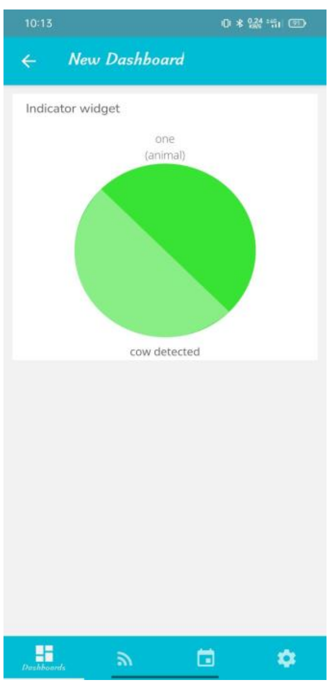
When motion is detected, the PiCamera Module captures a picture of the scene.

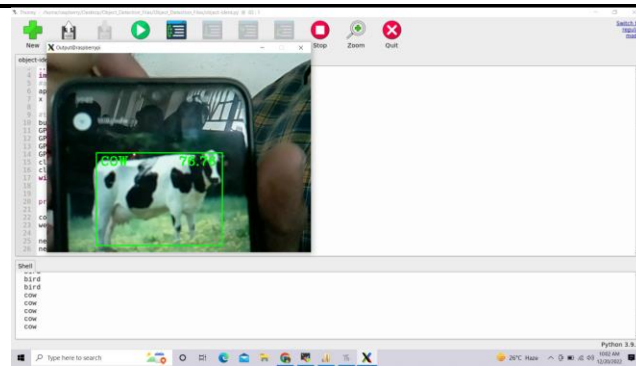
Output: Each object in the input image is annotated with the objects that have been recognised and are present in the bounding box.

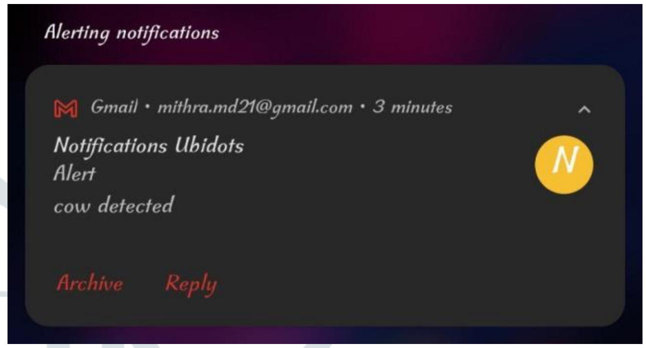
5. RESULT

The four phases of this system—Motion Detection Phase, Event Capture Phase, Object Identification Phase, and Event Notification Phase—are set up on an agricultural field and discussed in this section as well as how they interact to create a Computer Vision Assisted Security System for Smart Agriculture. These four phases are implemented and tested on an agricultural field.

This system notices any motion or malicious activity that occurs in the farm environment, takes a picture, uses the Raspberry Pi's image processing module to identify the object(s) producing the motion, and alerts the farmer or user through email and telegram message.







6. CONCLUSION

Modern agriculture requires a lot of technology for farm security. A vision-based Internet of Things (IoT) system is suggested and put into place utilizing a Raspberry Pi and OpenCv to do this. The Raspberry Pi serves as a processing module in the design, gathering data from the sensors placed in the farmland in the Perception Layer. The system may be built in a methodical fashion because of the layered architecture, which consists of the perception layer, network layer, and application layer. The sensor data is analyzed, and the picture that was collected is transferred to the image processing module, where the item that caused the motion in the image is recognised using OpenCV's deep learning DNN module.The object is highlighted by a blob that is produced around it. Users receive the same information as notifications via SMS and mail. The framework created may be utilized in Smart Agricultural applications, including those that identify criminal activity on fields, stop wild animals from getting in, and safeguard crops from fire mishaps. According to the findings, the system is 100% reliable and 92% accurate in spotting malicious behavior. Thermal imaging may be employed for night vision to operate the system in dimly lit agricultural areas.The system employs the JPEG format to communicate photos to users via email and telegram messages, which needs a significant quantity of data to be transferred over the network in order to get notifications—hundreds of KBs. To speed up the notification process for users as detailed above, more picture reduction techniques can be developed for the suggested architecture.

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