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Real-Time Monitoring of Agricultural Land with Crop Prediction and Animal Intrusion Prevention using Internet of Things and Machine Learning at Edge

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***Abstract*--Agriculture is considered as a foundation of life, since the primary source of food and other raw materials is from the agriculture. It plays a crucial part in the country's economic development. Agricultural growth is very critical for the improvement of our country's economic situation. Sadly, many farmers cultivate their land using the conventional methods. As water availability in today's world is becoming scarce and there is an urgent need to follow smart forms of irrigation. Most irrigation system in India is run manually. we should replace these obsolete techniques with advanced techniques. The paper describes how the use of the Internet of Things [IOT] and machine learning techniques can be combined to make irrigation smart. The proposed system saves time, avoiding problems like constant vigilance, crop prediction and does the animal intrusion prevention when wild animals enter the field to destroy the crops. It also helps in water conservation by supplying the plants / field with water automatically, depending on the water requirements. and finally, both SMS and Email notification will be sent to the farmer mobile phone during the abnormal conditions of his farm. The proposed system can be used for the for-edge decisions in real time using edge computing.**

Keywords--Internet of Things; Machine Learning; Image Processing; Sensors; Edge Analytics; Automation;

I. INTRODUCTION

The proposed system is configured to irrigate over predefined periods of time at regular time intervals. In this technique, soil moisture sensors are mounted in the plant's root region, and the gateway device manages the sensor information and transmits data to the controller, which in tum controls the water flow through the valves. The automated control systems are used to provide proper attention to the land which is located far away from the farmer, as in many processes, such as soil moisture, temperature, humidity, Ultrasonic, buzzer, rain sensors etc. needs repeated tasks and have to function under abnormal soil condition and overcome the weaknesses in the current system Here we irrigate the soil based on soil moisture, humidity, temperature and, at the same time, the irrigation status is wirelessly updated to the farmer by means of a notification to his mobile phone. The proposed system will allow farmers to continuously track the level of moisture, temperature, humidity, tank water, crop prediction and prevention of intrusion of animals in the field, and to control the supply remotely over the internet. As humidity drops below a certain amount, sprinklers will automatically be switched on, thereby achieving optimum irrigation using the Internet of Things. And when there is an odd condition on the field, the farmer is alerted with a warning alert. One of the main activities needed for smart farming is skills and time. Farmers should be mindful of when which plant should grow stronger. Cultivation takes a tremendous amount of time from the farmer. Reducing farmers' commitment, though, is a hard task. Large-scale, it requires multiple resources. So, our goal is to help the farmer predict the correct crops based on the soil parameters for his cultivation. Use modern agricultural techniques eliminates human effort as well as the time it takes to water a field. If we compare traditional system with modem system, for example water is the essential resource for agriculture, wasting specific resources is very high.

Developing automation system demand has increased in recent years, particularly in offices and households. This is usually because automation helps minimize electricity usage, eliminates waste, requires less manpower, and helps to conserve money. Automation uses power and water effectively and reduces much of the pollution. Intelligent irrigation system effectively utilizes water. The paper describes a smart farm irrigation scheme, using devices such as raspberry pi. Python programming language is used for purposes of automation.

Growing animal species has a particular habitat consisting of one form or a variety of vegetation that provides all the resources necessary for the species ' survival. Animals such as Tiger and Elephants need larger habitats to meet their needs and proper accommodation. Nevertheless, the increasing unplanned developmental events such as road building, railways, hydroelectric projects are causing disruption in the natural environment and contributing to the breakup of large forest cover areas into small fragments called habitat

fragmentation. Other practices such as the creation of human settlements, the clearing of forest land for agriculture and monoculture plantations often result in forest areas being divided into smaller patches. As a result, the wild animals in these scattered environments are left with very little resources and these ecosystems have frequently come into contact with the human settlements leading to interactions between humans and animals. Any of the major causes of human-animal interactions may be human population growth, land use changes, construction activities, and habitat degradation and shrinking. Thus, a method of protection is suggested that senses the entry of wild animals into the field and produces an acceptable level of annoyance for wild animals. Usage of ultrasonic sound is of great benefit because it is inaudible to human ears and does not affect certain forms of life. Proposed system also has the following benefits that the energy used is less, the sensors have a high reliability and less interference since only a warning signal is transmitted to farmers mobile.

II. LITERATURE SURVEY

In reference [1] This paper offers a novel method for reducing water use and improving irrigation system. Raspberry pi is the main component of the system and operating method. We used several sensors in this proposed system such as soil moisture to measure moisture level of soil, infrared sensor to wild animals, and ultra-sonic sensor to find the water level in well.

In reference [2] This system managed to reduce costs, eliminate wastewater and decrease the physical interaction between humans. Relays is used to power solenoid valve switching.

In reference [3] This proposed system controls energy and resource conservation, so it can be used in a suitable way. Through automating field or nursery irrigation, farmers will be able to distribute the right amount of water at the correct time

In reference [4] The goal of this paper is to develop a clever system for monitoring irrigation using raspberry pi. Parameters such as temperature and soil moisture will be at the focus field. This system will be a replacement for the conventional method of farming. We must create such a system that will help a farmer know his / her field status in his / her home or he / she will reside in any part of the world.

In reference [5] There are many strategies that exist for distinguishing disputes between human animals. The most common conflict is that of giant elephants, but our paper focuses on the threat of all wild animals , which is the next big challenge. Of this scenario, a wired fence-based intrusion prevention and warning system to distinguish wildlife environments and human settlements is common solution implemented. This cannot be used anywhere, and this is not possible in the case of all wild animals. The following systems were considered as threat prevention system was developed. In addition, they too are very costly. The non-imaging sensors can be used to distinguish between humans and animals.

In reference [6]. Wi-Alert wireless network-based intrusion prevention sensor is proposed to provide a mechanism for intrusion detection in real time, to produce immediate intrusion warnings and also to locate the intrusion.

In reference [7]. Ultrasonic sensors have been suggested by Kozo Otani and Mitsuru Baba to detect animal and human forms. As an alternative to ultrasonic sensors, the detector circuit is used on both sides of the street, which is normally man-made, these circuits detect the entry or presence of a wildlife animal that is about to cross the lane.

In reference [8]. This system is for a restricted range including road width only. Another successful approach is the technology of data collection, which offers spatio-temporal data to analyse the proposed movement.

In reference [9]. This system assists in animal activity modeling. G.Sasikumar, H. Vignesh Ramamoorthy, S. Natheem Mohamed studied the use of various wireless sensor networks to avoid animals.

In reference [10]. What one is considered. To avoid a potential human animal conflict, positioning and prevention using the spectral energy magnitude and the highest pitch frequency generated by elephants during contact is used.

III. SYSTEM ARCHITECTURE

Within this section we'll clarify the proposed system methodologies. In Fig-1, displays the system's overall architecture.

An IoT based irrigation system aims to utilize the features of embedded system to make agriculture simple and smart. Having sensors connected with controller, the proposed system reads the soil moisture level by soil moisture sensor placed at the root of the crops so whenever there is less moisture it turns on the sprinkler automatically with notification, temperature and humidity is measured through DHT11 sensor and farmer is notified when it reaches the threshold values, water level of the tank is measured through the Ultrasonic sensor placed in tank and turns on the motor automatically when the tank level is low with notification, rain sensor is used to turn off the sprinkler when it is raining and the sprinkler will be off when there is a moisture content in the soil, infrared sensor is used to detect the wild animals intrusion at the entry of the farm and USB camera will capture the image of the wild animal and comparing the image with the datasets by using CNN (convolutional neural network) algorithm and finds the animal and tries to prevent the animal with the huge buzzer noise and reports to the farmer through SMS and email warning notifications. and based on the soil parameters collected from the farm are sent to cloud and based on the soil parameters the proposed system can predict the crops like which crop is suitable for this climatic conditions using the SVC (Support Vector Clustering) algorithm which will help the farmers to reduce the loss of money for growing unwanted crops on his farm. In this way our automated techniques help the farmers to take proper decisions at right time.

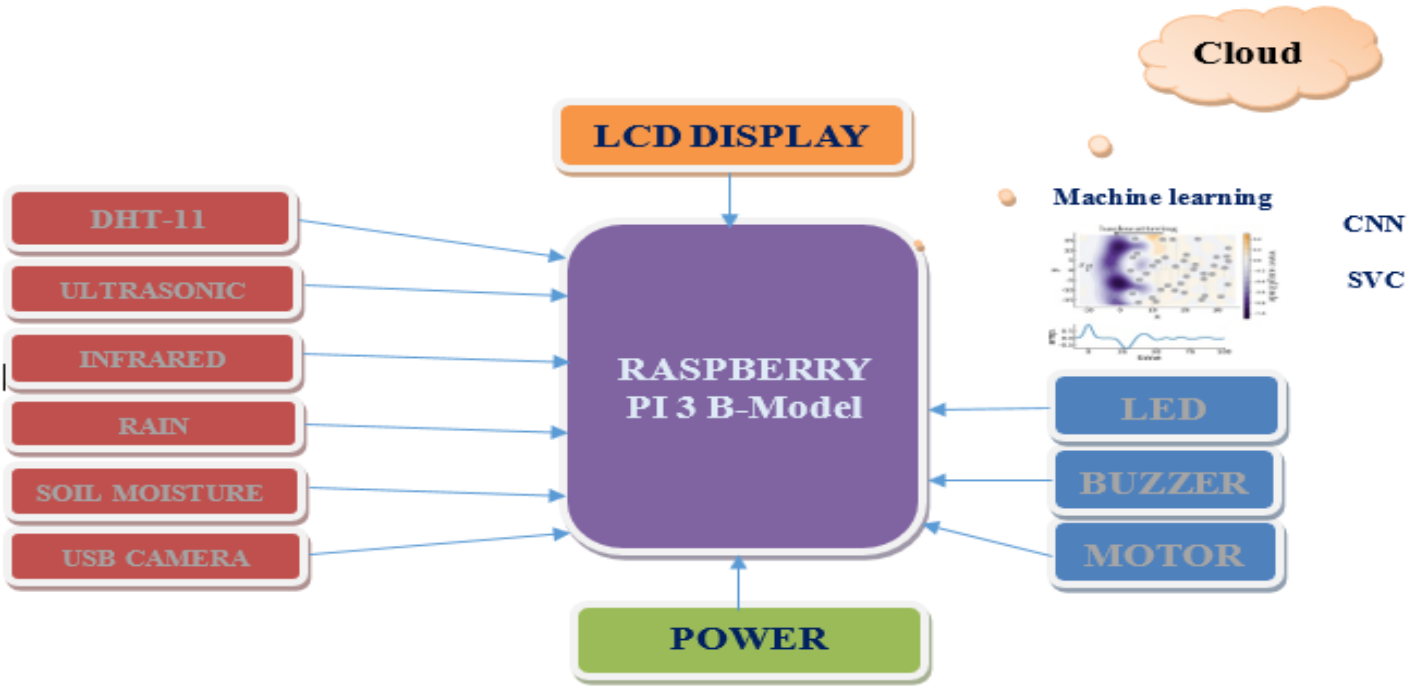


Fig 1: Architecture of Smart Agriculture

IV. HARDWARE REQUIREMENTS

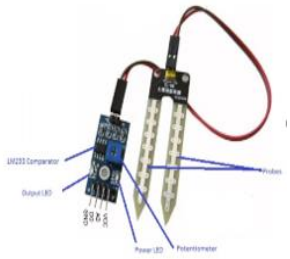
A. Raspberry Pi 3 [B-Model]

The Raspberry Pi is a low-cost, credit-card-sized device that attaches to a computer monitor using a regular mouse and keyboard. This is considered as the heart of the system. Raspbian OS (Operating System) should be loaded to this board through micro SD (Secure Digital) card and all the sensors must be connected to this board including power supply. All the sensor data collected through the sensors are processed in this microprocessor and those values are send to cloud via Thing speak. This raspberry pi 3 consists of 1 HDMI (High-Definition Multimedia Interface) port, 4 USB ports, 1 audio jack port, 1 Ethernet port, SD card slot, micro USB slot, PI camera slot, 40 GPIO (General Purpose Input Output) pins, Processor and Graphics chip, quad-core 1.4GHz CPU with 1GB RAM.

B. Temperature & Humidity Sensor (DHT11)

The temperature and humidity sensors are both combined with a single device that is DHT11 sensor which measures the temperature and humidity of the soil. Whenever there is an abnormal behavior in the soil temperature and humidity the farmer is notified with the email and SMS notifications and these values which are sensed by the DHT11 sensor are also used as the primary parameters for the crop prediction. and the values of this sensor will be displayed in the LCD 32-bit character display. This sensor comes with the 3 pins they are VCC, GND and output pin. And it comes with the light to confirm its working whenever this sensor is plugged in to the power supply.

C. Soil Moisture Sensor



The sensor for soil moisture consists of two probes used to test the volumetric water content. Usually the values of this sensor will be in 0's and 1's (0 is no water content and 1 is water is present) whenever there is no water content in the soil it sends a notification saying that moisture level is low and automatically turns on the sprinkler.

D. Motor & Motor Driver

In the proposed system motor is used to supply the water whenever the tank water level is low and when the moisture content is less the motor is used to turn on the sprinkler.

E. Character LCD Display [16*2]

The character LCD (Liquid-crystal-display) can display 16 characters in 2-line format totally 32 characters can be displayed. This LCD is used to display all the sensor readings.

F. USB Camera

The USB (Universal Serial Bus) camera is used in the proposed system to capture the images of all the wild animals when they are detected by the infrared sensor while entering the farm after the wild animal detection this image is processed by the CNN algorithm to find the animal name with the available datasets and a huge noise is generated to get rid of the animal.

G. Infrared Sensor

This sensor is used to detect the animal intrusion to the farm. After detection of the wild animal immediately the image of the animal is captured, and the notification is sent to the farmer.

H. Ultra-Sonic Sensor [HC-SR04]

This sensor is used to detect the water level in the tank so there are 3 level of measurements in this water level distance they are low, medium and full whenever the water tank level reaches to low immediately the motor will be turned on with the notification message to the farmer and when the water level reaches to full then it automatically turns off the motor.

I. Rain Sensor

This sensor helps in saving the water. whenever the soil moisture is dry and if this sensor does not detect any rain droplets then only the sprinklers will be turned on because it is waste to sprinkle water when it is raining.

J. GSM Module

This GSM module plays a major role in the proposed system as it requires SIM (Subscriber Identity Module) to send the warning messages/notifications during the abnormal conditions of the farm so that the farmer is able to monitor his farm when he is far away from his land and can take a necessary action to prevent it.

K. Buzzer

This device is used to make the beep sound whenever there is an abnormal behaviour in the farm for example if there is any wild animal intrusion is detected in the farm this device makes a huge noise to get rid of the animal in the same way we have used this buzzer to make noise whenever the tank is full and low and motor off and on just to notify the farmer.

V. ALGORITHMS

A. Support Vector Clustering

The purpose of clustering is to partition a data set into groups in an attempt to organize data into a more meaningful form according to some criterion.

```
from sklearn.model_selection import train_test_split
from matplotlib import pyplot as plt
import pandas as pd
from sklearn.svm import SVC
import urllib2,json
response = conn.read()
print conn.getcode()
print(field1,field2,field3,field4)
print(y_pred)
```

B. Convolutional Neural Network

Through its use of image data, the Convolutional Neural Network has gained popularity, and is currently the state of the art for detecting what an image is or what is embedded in it.

```
from keras.preprocessing.image import img_to_array
from keras.models import load_model
import numpy as np
import cv2
import argparse
import imutils
import pickle
import socket
import os
path="C:/Users/Dell/Desktop/cnnkeras/examples/00000002.jpg"
return_value, frame = camera.read()
gray = cv2.cvtColor(frame,cv2.COLOR_BGR2RGB)
cv2.imshow('frame',gray)
cv2.imwrite(str(i)+'.png', frame)
```

VI. RESULTS

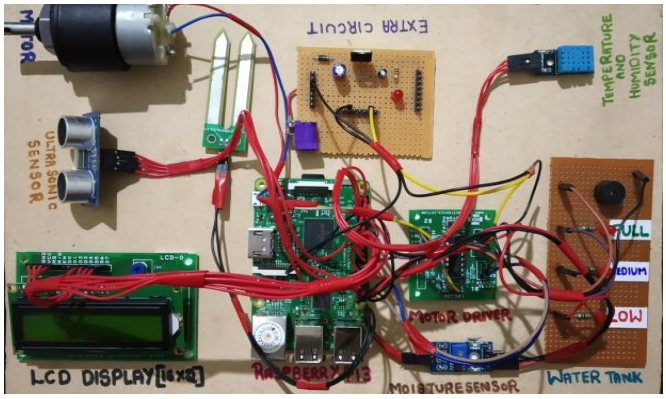


Fig 2. Smart Agriculture System

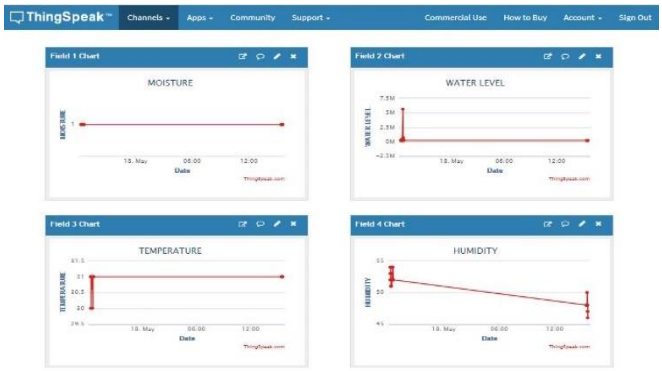


Fig 3. Thing Speak Graph

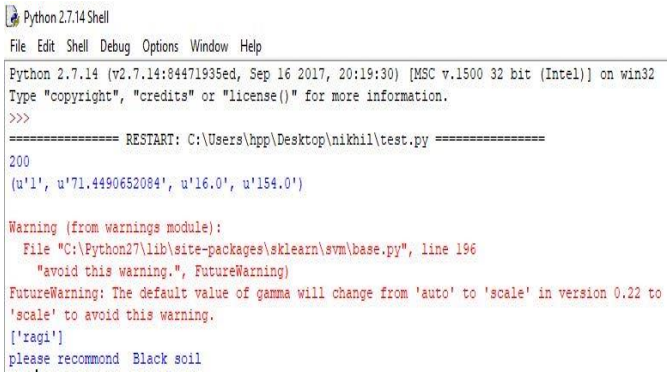


Fig 4. Crop Prediction

Fig 5. Animal Detection

VII. CONCLUSION

The implemented smart agriculture program is cost-effective for maximizing agricultural farm water supplies, crop prediction, and wild animal protection. Depending on the level of soil moisture, the proposed device can be used to tum the water sprinkler on / off, thereby making the process easier to use. The system proposed can be used to predict the crop based on the soil condition which helps the farmer grow the correct crops. Through this project it can be inferred that with those of IOT and Automation there can be significant progress in irrigation. The proposed system is thus a solution to the problems facing the current irrigation cycle.

The program proposed also helps in the prevention of trespassing wild animals in the agricultural sector. Using ultrasonic sound, the machine irritates wild animals and makes them leave the area. Using the alarm tone flooding technique without any data has increased the wireless sensor network's efficiency because there is no transmitting load. This therefore requires less energy In addition, the device is eco-friendly, because there is no harm to the ecosystem and no disruption to humans. The requirement may be expanded and applied by adjusting the frequency range of the ultrasonic sound wave to avoid the trespassing of different animals.

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