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Soil Moisture Detection and Crop Recommendation with Crop Disease Detection

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ABSTRACT

Farming is traditional practice which returns effective output if technology is implemented upon. The system proposes an innovative solution that uses Arduino-based sensors to detect soil moisture, temperature, and humidity, revolutionizing modern agricultural methods. System aims at providing an optimal and effective way to overcome the traditional practices and increase the yield or crop from this technical approach. It also uses a recommendation model powered by machine learning to select the best crops based on history and current environmental data in that particular area. Additionally, it incorporates image analysis methods for the early diagnosis of agricultural diseases, recommending remedial action. This paper presents in-depth analyses of the hardware configuration, dataset, code implementation, disease detection methodology, and potential directions for future precision agricultural research.

KEYWORDS: Soil Moisture Detection, Crop Recommendation, Disease Detection, and Image Analysis.

1. INTRODUCTION

The world economy relies upon the agriculture, sustaining millions of humans. Agriculture practices are based upon traditional and ineffective practices sometimes leading to huge loss in the country's economy. By using modern and tech-driven approach early prediction of loss, smart farming and effective yield utilization can be achieved. This paper aims at providing advanced solution to this traditional farming practices.

Crop Recommendation system provides an insight about the best crop that can be cultivated under the suitable natural condition. The soil quality, temperature, humidity and moisture content in soil are the main factors deciding the suitable crop in that region.

The advancement in technology provides solution to the unknown and unpredicted growth of disease leading to ineffective yield from the cultivation. To avoid this Crop Disease Detection system can be used for early detection and diagnosis.

In this paper, modern agriculture is approached with a user-friendly, cost-effective method for increasing crop output, resource management, and disease prevention. A significant advancement in the area, by using the combination of hardware and software components, addresses current agricultural issues and helps to make more effective and sustainable farming operations.

2. LITERATURE SURVEY

Previously, the farming was solely relied upon traditional prediction parameters and experience in the field. Current technology for the effective yield uses technology such as IoT, Machine Learning, Cloud, Satellite Imagery, etc. The system discussed here uses some of these technologies which makes it less complex and easier for implementation.

2.1. SOIL MOISTURE DETECTION

Sensing of soil moisture is an essential part of precision farming. For measuring soil moisture, a variety of techniques and sensors have been used, such as time-domain reflectometry (TDR), capacitance sensors, and resistive sensors. Measurements are accurate and affordable with capacitance-based sensors, such the popular FC-28 soil moisture sensor.

2.2. CROP RECOMMENDATION

Systems for recommending crops for cultivation use environmental data analysis. For this, machine learning algorithms such as decision trees and neural networks are used. These systems take into account parameters like soil properties, the environment, and previous crop performance.

Crop Recommendation uses machine learning algorithms for crop recommendation. Decision tree models like C4.5 and Random Forest have been used to categorize environmental circumstances and suggest crops in line with those categories. These algorithms are clear and easy to understand.

Past crop yields, soil data, climatic data, and expert knowledge are among the data sources used to recommend crops. For Best prediction, availability and quality of data is important in creating reliable recommendation models.

2.3. CROP DISEASE DETECTION

For disease management and prevention, early crop disease diagnosis is essential. Convolutional neural networks (CNNs), one type of image processing approach, have been used for many years to analyze photographs of leaves or plants to identify indicators of crop diseases.

To detect diseases using photographs of crops or plant leaves, computer vision techniques are used to recognize disease symptoms. To train and test CNN models for disease detection, researchers have created datasets of healthy and diseased plants.

3. HARDWARE & CONFIGURATIONS

The hardware is the key component for processing and analyzing the data. There are four types of hardware used Sensors, Microcontroller, Connectivity & Indicators/ Displays.

3.1. SENSORS

Sensors are the input unit for the machine. Sensors sense their working environment and collects the data according to its use. In smart Agriculture technology there are three sensors in use. They are Soil Moisture Sensor, Temperature and Humidity Sensor.

The soil moisture sensor or tensiometers are the type of sensors that measure the level of moisture or water content in the soil. This is achieved by measuring the tension between the soil particles. Higher the tension larger is the moisture content in the soil. Soil moisture sensors are used to detect the water content and deliver the data to the microprocessor.

The Temperature Sensor is used to measure the temperature in the surrounding. Temperature is the key factor for efficient farming. Ideal temperature for the crops can yield qualitative output. The temperature sensor works on the principle of voltage generation at the terminals across the diodes. Increase in voltage signals increase in temperature.

The humidity sensor measures the humidity in the air or the moisture content in the air. Humidity is prime factor, because each crop holds its requirement of humidity for qualitative growth. Humidity in the air is measured by detecting minor changes that alter electric currents or temperature of the air.

In this system DHT11 sensor has been used. This sensor measures both temperature as well as humidity of the surrounding. The use of DHT11 decreases the complexity and working of microcontroller, preventing load on processor.

3.2. MICROCONTROLLER

The microcontroller is the brain of the system. All the inputs are handled by the microcontroller and the actuators are controlled accordingly. Microcontroller is programmed accordingly to take decision on the basis of data collected by the sensor.

Arduino UNO microcontroller is programmed by using Arduino IDE and specific code to operate upon. The controller powers the sensor and capture the data. This data is further processed to figure out whether the soil is dry or moist, similarly the air quality is determined on the basis of data processed by the micro controller.

3.3. CONNECTIVITY

Connections are an important part of all the hardware systems. These connections are based upon the use and working of each component. Here to connect all the sensor jumper wire is used. They may be male to male, male to female or female to female according to purpose. To avoid the complexity and load on microcontroller majority of the connections are done on breadboard.

3.4 INDICATORS/ DISPLAYS

Indicators refers to the outcome or the output processed by this system. The user is indicated the moisture level in soil by using LED bulbs. According to the moisture level each bulb glows. This indicators are useful for manual watering of fields.

Displays are the electronic display of the information processed by the system. In this research the laptop/system display is used.

4. METHDOLOGY

The system uses the microcontroller to fetch the data and process it to display the indicators. The data is also fetched and stored on the local machine/system/laptop. This data is further used by the model to classify which crop will give excellent yield, on the basis of parameters such as temperature, humidity and soil moisture. Also, the system or the local machine is provided with image of crop to recognize the disease it is infected with.

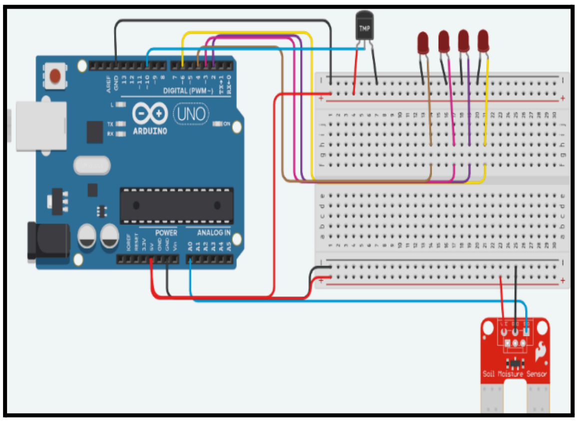

Fig. 1. Circuit Connection

Table 1. Connection of components with microcontroller.

Component name	Component Pin	Micro-controller Pin	Comment
Soil Moisture Sensor	1.Power 2.Ground 3.Signal	1. 5v 2.GND 3. A0	INPUT
DHT11 Sensor	1. Power 2. Ground 3. Signal	1. 5v 2. GND 3. D10	INPUT
LEDs	1. Anode 2. Cathode	1. D2 2. D4 3. D6 4. D8	OUTPUT

As reference from Table 1. The connections are made to Arduino microcontroller and the display indicators are controlled as per data from sensors. The soil moisture sensor measures the moisture content and accordingly it is calculated on the scale of 1000. If the value is between 0 to 200 1st LED is set to ON similarly if the value is between 201 to 400 2nd LED is set ON and so on.

The data sent from the soil moisture sensor and DHT11 is stored in dataset, and accordingly the recommendation of crop works. The machine learning model is pre-trained to classify crops on the basis of these [moisture, humidity, temperature] parameters.

5. CODE

In this section, the code for sensing the data from the environment using the sensor is provided. This code is written in variant of c++ language. which is used by Arduino uno board and is compiled and built in Arduino Ide.

There are three types of codes written for this system:
Code A: Read Data from Sensor
Code B: Store data to file
Code C: Analyse and predict crops

Code A:

```
#include <DHT.h>

#define DHTPIN 10
#define DHTTYPE DHT11
const int soilMoisturePin = A0;

unsigned const int A = 6;
unsigned const int B = 2;
unsigned const int C = 3;
unsigned const int D = 4;

DHT dht(DHTPIN, DHTTYPE);

void setup() {
  Serial.begin(9600);
  dht.begin();


  pinMode(A, OUTPUT);
  pinMode(B, OUTPUT);
  pinMode(C, OUTPUT);
  pinMode(D, OUTPUT);

}

void loop() {

    int soilMoistureValue1 =
analogRead(soilMoisturePin);

  int soilMoistureValue = soilMoistureValue1/10;

  if (soilMoistureValue > 0 &&
        soilMoistureValue <=40){
    digitalWrite(D, HIGH);
  }
    else if (soilMoistureValue > 40 &&
soilMoistureValue <=60){
    digitalWrite(C, HIGH);
  }
    else if (soilMoistureValue > 60 &&
soilMoistureValue <=80){
    digitalWrite(B, HIGH);
  }
    else if (soilMoistureValue > 80 &&
soilMoistureValue <=100){
    digitalWrite(A, HIGH);
  }

float humidity = dht.readHumidity();
float temperature = dht.readTemperature();

  Serial.print("\n");
```

```
  Serial.print("Soil moisture: ");
  Serial.print(soilMoistureValue);

  Serial.print("humidity: ");
  Serial.print(humidity);

  Serial.print("temperature: ");
  Serial.print(temperature);

  delay(2000);


}
```

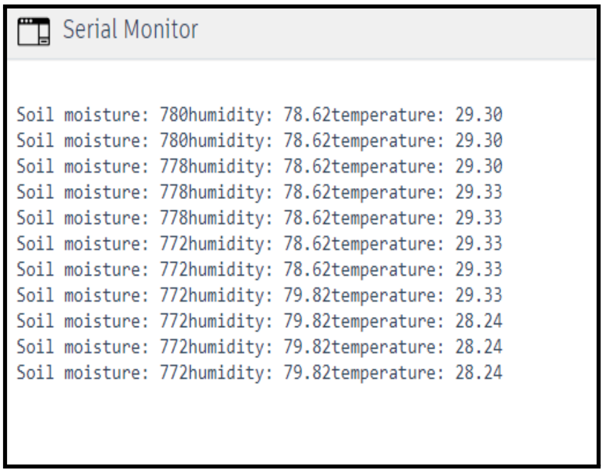

Fig. 2. Sensor Data Output

Code B is used to fetch the data from serial monitor in Arduino or serial stream and store it for database creation.

Code B:

```
import serial

ser = serial.Serial('COM4', 9600)
arr = []

while True:
  try:
    line = ser.readline().decode('utf-8').strip

    if line:
      print(line)
      arr.append(line)
     else:
        continue
  except KeyboardInterrupt:
    break

ser.close()
```

Here the arr[] array stores all the sensor readings. Next step is to filter and clear the data. This data is now stored in excel or tabular format for use of crop recommendation. The labelling of data is done manually i.e., which crop will be optimal to grow at what condition must be mentioned in the dataset.

Code C:

```
import pandas as pd
dataset_path=
"/content/gdrive/MyDrive/crop_data.csv"
crop_data = pd.read_csv(dataset_path)

soil moisture = float (input("Enter soil moisture level (in %): "))

#ssuitable_crops = crop_data[
crop_data['humidity'] <= soil moisture] ['label'].tolist()

suitable_crops_list(set(crop_data[crop_data['humidity'] <=  soil_moisture]['label'].tolist()))

# Printing recommended crops
if len(suitable_crops) = = 0:
print ("Sorry, no suitable crops found for this soil moisture level.")
else:
print("Recommended crops for this soil moisture level:", suitable_crops)
```

This code gives the list of all crops that are optimal to be grown in that environment.

The next part is the crop disease detection this is achieved using computer vision and machine learning technique. A model is built, trained and tested for classification of disease of a crop on the basis of its features. The image is collected from the user. It is pre-processed to the required format. Feature extraction is performed to help model identify and classify the image.

6. RESULTS AND DISCUSSION

The result from code A is the sensor data that is collected from the environment. This data is fetched into python code to create a dataset with real-time data. This dataset can be expanded as and according to its use. Large the dataset provided greater is the result, but complexity and chance of error increases hence only limited dataset is provided.

The data is labelled so as to get classified for which crops are suitable for the environment. Accordingly, the sensor data is again calculated to get the required result. And here the data is provided manually and a list of crops suitable for that region is displayed.

For the disease detection the user is required to give an image as input to the model and from the dataset of images and diseases, the disease whose features are matching with the input image feature, that image is selected. And hence the disease of the crop is classified.

7. FUTURE WORKS

This system can be extended further and to get more precision in result sensors such as mineral sensor, carbon sensor, gas sensor, light sensor etc. can be used. Mineral sensors can be used to sense the minerals required for specific crops from the soil, whereas gas sensor can be used to detect the CO_2 gas or polyhouse gas to regulate the airflow in the polyhouse. Light sensor can be used to control artificial light in cloudy seasons.

Through this technology the limitation of seasons and barrier of knowledge is overcome. Using the advanced technology such as computer vision to detect the disease the remedy and prevention measures can also be provided through the expansion of dataset.

8. CONCLUSION

Precision and sustainability are now crucial in the dynamic world of modern agriculture. Adoption of data-driven technologies has the potential to transform farming methods and ensure that world can meet the rising global demand for food while consuming the fewest resources possible and having the least negative environmental impact. In order to address important difficulties in agriculture, the paper discusses the integrated system that uses Arduino-based sensors, machine learning algorithms, and image analysis approaches.

REFERENCES

[1] NIGAM, S., & JAIN, R. (2020). "Plant disease identification using Deep Learning: A review." *The Indian Journal of Agricultural Sciences*, *90*(2), 249–257. https://doi.org/10.56093/ijas.v90i2.98996

[2] Zhaoyu Zhai, José Fernán Martínez, Victoria Beltran, Néstor Lucas Martínez, Decision support systems for agriculture 4.0: Survey and challenges, Computers and Electronics in Agriculture,Volume 170,2020,https://doi.org/10.1016/j.compag.2020.10526 .

[3] Bala, J.A., Olaniyi, O.M., Folorunso, T.A., Daniya, E. (2021). "An IoT-Based Autonomous Robot System for Maize Precision Agriculture Operations in Sub-Saharan Africa." In: Singh, K.K., Nayyar, A., Tanwar, S., Abouhawwash, M. (eds) Emergence of Cyber Physical System and IoT in Smart Automation and Robotics. Advances in Science, Technology & Innovation. Springer, Cham. https://doi.org/10.1007/978-3-030-66222-6_5

[4] S. D. Khirade and A. B. Patil, "Plant Disease Detection Using Image Processing," 2015 International Conference on Computing Communication Control and Automation, Pune, India, 2015, pp. 768-771, doi: 10.1109/ICCUBEA.2015.153.

[5] A. Anand, N. K. Trivedi, V. Gautam, R. G. Tiwari, D. Witarsyah and A. Misra, "Applications of Internet of Things(IoT) in Agriculture: The Need and Implementation," 2022 International Conference Advancement in Data Science, E-learning and Information Systems (ICADEIS), Bandung, Indonesia,2022,pp.01-05,doi:10.1109/ICADEIS56544.2022.10037505.

[6] Ji-chun Zhao, Jun-feng Zhang, Yu Feng and Jian-xin Guo, "The study and application of the IOT technology in agriculture," 2010 3rd International Conference on Computer Science and Information Technology, Chengdu, 2010, pp. 462-465, doi: 10.1109/ICCSIT.2010.5565120.