SMART WATER RESOURCE MANAGEMENT IN AGRICULTURE FARM FIELD BY ANALYSING THE SOIL STRUCTURE OR MOISTURE WITH IMAGE PROCESSING

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Abstract:

The system primarily keeps an eye on agricultural field factors like temperature, moisture content, humidity, and water level. IoT-connected Raspberry Pi primarily keeps an eye on the sensors for data, and further research can be done using the photos that are taken by the Raspberry Pi. Based on the soil structure and wetness, users may keep an eye on and manage the field motors. The system can react based on both the most recent data and previously taught data. This technology has several uses in places where physical presence is impractical. When sensor modules, cameras, and other communication contexts are implemented, the system will be used with the Raspberry Pi processor. The system provides a full, affordable, potent, and user-friendly method of remote monitoring and control in real-time. The system offers a complete, low cost, powerful, and user-friendly way of real-time monitoring and remote control of the agriculture field. With this system, we can develop and test a prototype model with high accuracy results.

I. INTRODUCTION

With the development of Internet technologies and Wireless Sensor Networks (WSN), a new trend in the era of ubiquity is being realised. One of the main measures must be closely monitored in real-time to reduce the manpower and automation in working. Sensors for detecting soil moisture are used to manage irrigation systems effectively. Planned irrigation systems are necessary to improve crop output and profitability and to help us understand what is occurring at the root of the plant. Recognizing the type of soil we have allows us to choose the best crop, type of fertilizer, etc.

Agriculture water irrigation is a crucial tool for creating systems with sensible designs. SWC (Soil Water Content) is a word used by the author [1] to obtain enhanced accuracy for various depths. SWC data and meteorological data are jointly tracked and provided to the BiLSTM and ResNet for the extraction of both special and time series features. Seven different maize plant sites in China (from 2016 to 2018) underwent this investigation. Data is trained and tested at various depth sets, including 20, 30, 40, and 50 cm. To ensure that the suggested analysis performs better than existing state-of-the-art moisture detection and recognition techniques, results are analysed using MAE (Mean Absolute Error) and MSE (Mean Square Error).

II. Literature Survey

According to data from the past two decades, crop production in agriculture has changed as a result of climate change, as seen in [1]. The development of a Cuckoo Search Algorithm makes it possible to allocate water for farming under all circumstances. The various characteristics, including temperature, turbidity, pH, and moisture, were gathered utilising an Internet of Things (IoT) platform, which was furnished with the necessary sensors and wireless communication systems with a Thingspeak server. In India, agriculture is crucial to the growth of the food industry. IoT is utilised in agriculture for remote crop production employing a variety of sensors, including soil moisture, temperature, and air moisture. The farmer controls the decision-making process by using a microcontroller. Wireless transmission is used to transfer the sensor data to a server database.

The irrigation will be automated when the moisture and temperature of the field is reduced. The farmer is notified with the information regarding field condition through mobile periodically. This system will be more useful in areas where there is scarcity of water and will be worth efficient with satisfying its requirements [2]. Agriculture falls under the primary sector category which indicates that the majority of the country's economy is depending on that. China is the top in the list of agricultural countries and India is recorded as the second top agricultural country in the world.

Numerous variables, including water, ambient temperature, soil quality, etc., affect crop output. Among these, irrigation is one of those things that needs more human involvement. The traditional method of watering plants has two key considerations: when to water the plants and how much water would be enough for the plant. Different crops have different water requirements. Rice and other crops require more water than weeds do. In order to boost crop productivity, a smart irrigation system based on IoT technologies is suggested in this study. Multi-cropping is a smart strategy to increase crop yields or earnings if there is limited available land.

This essay puts forth the concept of a smart irrigation system with smart decision-making that relies on real-time data collected from the land. Based on the soil's moisture content, the pumping motor in this automatic irrigation system turns ON and OFF. An operating amplifier will control the pump by receiving information from a soil moisture sensor.

A sensor that measures the precise moisture content of the soil is called a soil moisture sensor. It is now the responsibility of IOT to inform farmers about the state of the water moisture. Farmers can access a mobile application or a web page to view the moisture content status. They could

The amount of moisture needed for a particular type of crop will be demonstrated to the farmer using saved data. With this, the number of people in the area may be reduced and the field can receive a precise flow of water [3]. The development of the nation depends heavily on the agricultural sector. In our nation, one-third of the population—or more than 72% of the population—works in agriculture. In order to prevent the development of the nation, attention must be given to the difficulties and problems in agriculture. The only advised course of action is to use cutting-edge technology to modernise agriculture. By automating human intervention, IoT can make agriculture and farming processes more efficient.

Irrigation is one of the agricultural practises that helps crops grow by giving the earth the water it needs. Farming irrigation systems need a lot of time and work. An effective way to control agricultural activity is using a sensor-based automated watering system. The irrigation system in smart agriculture is thoroughly studied in this research work [4]. A farming practise known as "precision agriculture" makes use of information technology to give crops and soil the exact nutrients they require for optimum health and yield. Today's smart farming technology is expanding along with the idea of precision agriculture (PA).

We can connect all of these components thanks to the idea of the Internet of Things (IOT). Real-time environmental monitoring is crucial to smart farming. The hardware system will be controlled by software with a graphical user interface, and it will be completely separated and furnished with sensors such as temperature and humidity sensors. In order to solve the monitoring issues, we use IoT-based smart agriculture solutions. We address the issue of connecting the Internet of Things with Raspberry Pi and sensors to increase the effectiveness of agriculture in the framework of Smart Security and Monitoring System for Agriculture. the use of a sensor network that uses a Raspberry Pi to transfer data to a primary server after collecting it from various types of sensors.

All of the information is saved in the cloud and is accessible through IoT. A cloud service that is intelligent processes data. Mobile phones can be used to remotely operate the built multimedia platform. It makes use of the very energy-efficient LoRa WAN network technology, which enables long-distance communication. This suggestion is made in response to a farmer's growing requirement for availability and amenities [5].

III. PROPOSED SYSTEM

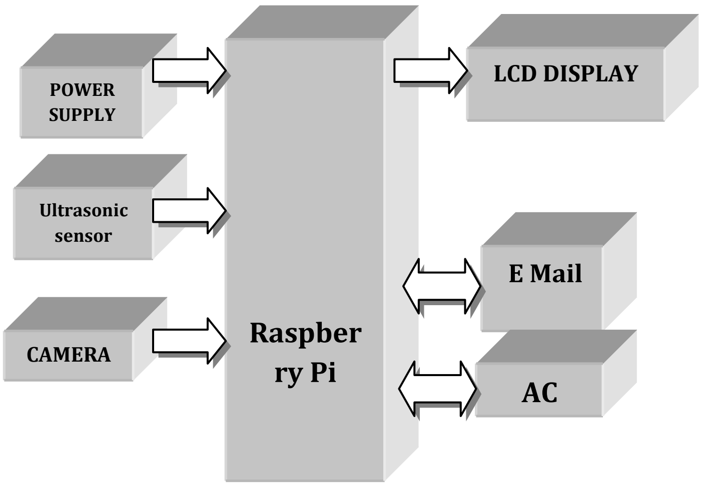


Fig 1: Block Diagram of Project

In proposed work we clearly explained the methodology we used for soil structure and soil moisture. Image Dataset Used We used soil type data from Kaggle.com which includes 4 different types of images as

a) Alluvial Soil
b) Black Soil
c) Red Soil
d) Clay Soil

Surface water soil deposited is called as Alluvial soil. Mostly it can be found in larger flood regions which spreads more compare to other soil types. This soil is nothing but transformation of rock which takes almost million years.

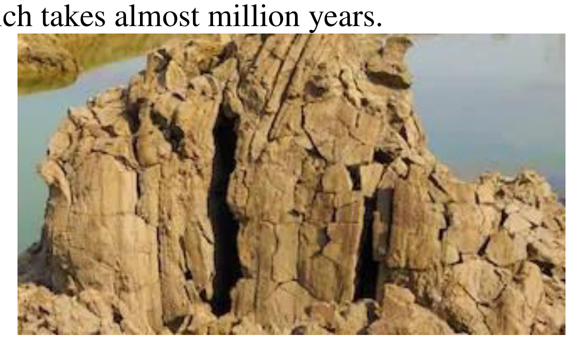


Fig2 . Sample images for Alluvial Soil from Kaggle dataset

Black soil has black surface with mineral soil which contains carbon. Some of the sample images used for black soil recognition from Kaggle dataset are shown in below figure,

Fig3. Sample images for Black Soil from Kaggle dataset

The soil in areas such as moist climate, high temperature and warm places like mixed forest is the red soil. The color of soil is yellowish brown and some of the sample images of red soil type images collected from Kaggle dataset are as shown below,

Fig4. Sample images for Red Soil from Kaggle dataset

Clay soil is the combination of moisture, organic materials, chemical components and living organism. The ability of soil for more yield of crops is its texture and for clay soil we will get good texture which helps to get more yield. Some of the sample images for clay soil are as shown below,

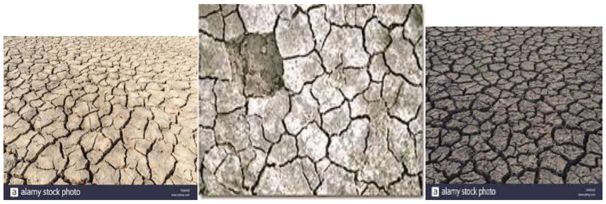


Fig5. Sample images for Clay Soil from Kaggle dataset

Above we had shown all 4 types of soils from Kaggle dataset. These all images are having different features which helps neural network in classification.

Proposed algorithm used neural network for soil type and moisture recognition. The structure used for soil type and moisture identification is as mentioned below.

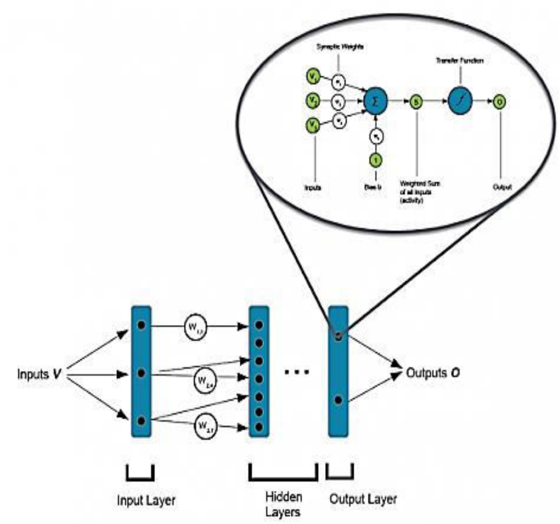


Fig.6 Basic Neural network structure used for soil type and moisture recognition

The neural network used consist of 3 main layers as

1. Input Layer
2. Hidden Layer
3. Output Layer

Input layer is helpful for providing input data to the network. Input layer is used for taking input sample for proposed work analysis.As shown in the figure it is attached to many hidden layers. Hidden layer may consist of convolutional layer, max pooling layer, SoftMax layer,etc. All the computation is done using these hidden layers. Output layer helps us in getting predicted output by the network structure.

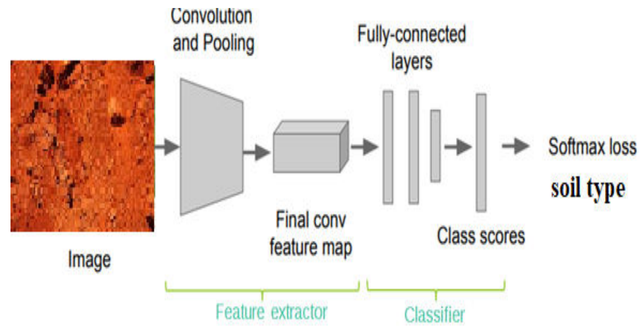


Fig. 7 Proposed Model for soil type and Moisture calculation

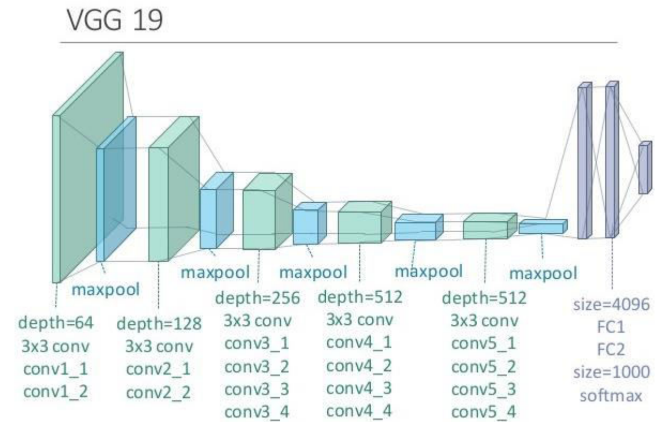


Fig. 8 VGG 19 model used for training and testing

This VGG19 model is the pretrained model available at library of TensorFlow, which has representation as shown in above figure. This network structure comes under deep learning which has very fast response for analysis of results for higher dataset or multiple input types.

IV. METHODOLOGY

The design and development of a smart water resource monitoring and controlling system for agriculture environment in real time has been reported. The system principally monitors parameters such as temperature, moisture level, humidity and water level of the agriculture field. The system can also be used to monitor the soil structure and crop using camera. Train the data path according to the crop and soil with water level. The system can respond to the monitored data with soil type automatically based on the trained data and the same can be uploaded to webserver or mail. Users can monitor and control status Web pages. This system finds a wide application in areas where physical presence is not possible all the time. The system offers a complete, low cost, powerful and user friendly way of real-time monitoring and remote control of field. Open cv with image processing was used in raspberry pi to train and test data according to need.

V. ALGORITHM USED FOR PROPOSED WORK

1. Prepare the database with different soil type and moisture level
2. Use all the database images for training using VGG19 neural network model
3. Select image for testing
4. Pre-process image and load neural network trained model
5. Give image to the neural network and all hidden layers will help to get features and details
6. At output layer we will compare the trained model and testing features to get classified results (Soil Type / Soil Moisture level)
7. Postprocessing (Motor will be ON/OFF depending on soil moisture level)
   And email has been sent to user for more details.

The dataset is prepared

VI. RESULT ANALYSIS

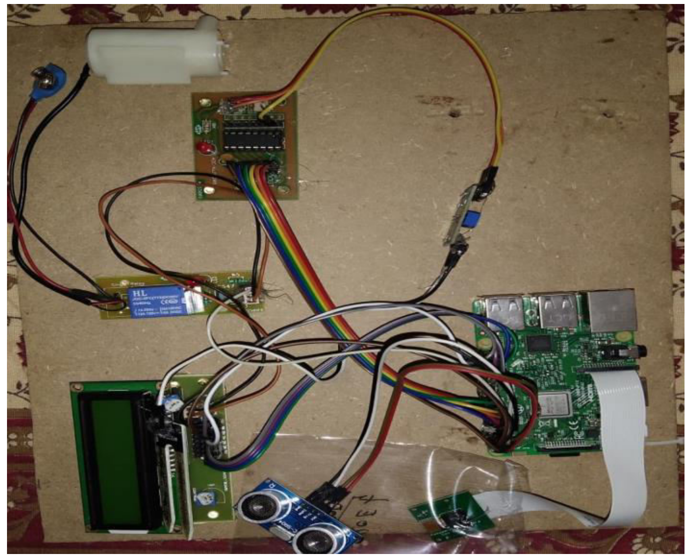
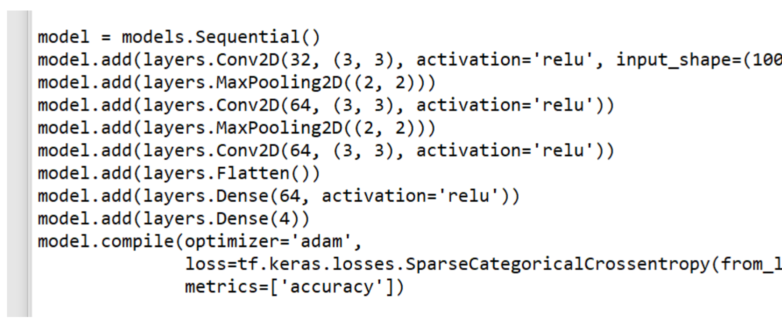


Fig.9 Hardware kit implemented for proposed method

Proposed system hardware part is shown in above picture.

It consists of

- LCD Display
- Ultrasonic sensor
- Raspberry Pi
- Soil moisture sensor
- Motor



```
model = models.Sequential()
model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(100
model.add(layers.MaxPooling2D((2, 2)))
model.add(layers.Conv2D(64, (3, 3), activation='relu'))
model.add(layers.MaxPooling2D((2, 2)))
model.add(layers.Conv2D(64, (3, 3), activation='relu'))
model.add(layers.Flatten())
model.add(layers.Dense(64, activation='relu'))
model.add(layers.Dense(4))
model.compile(optimizer='adam',
              loss=tf.keras.losses.SparseCategoricalCrossentropy(from_l
              metrics=['accuracy'])
```

Fig.10 Hidden layers used for processing on image

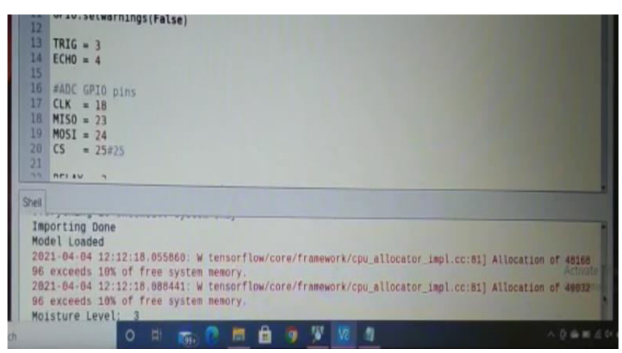


Fig. 11 Coding and moisture level detected is Level-3

Code consists of both soil type and soil moisture content. Image processing is used for detection of soil type and sensors are used to find the moisture level in the soil. The information is then showed on LCD display.

On LCD Message displayed area as below,

1.'InitializingSystem!', 2.'Importing Done' , 3. 'Model Loaded' ,4.'READY!PRESS ENTER', 5. ‘Press Enter to Capture Image’ 6. ‘Display moisture level and water level’ 7. ‘Motor ON/OFF’ condition based on moisture level and water level 8. ‘Detected soil type’ 9. ‘Detected Moisture Level’.

CONCLUSION:

In this we detected the color and type of moisture in soil given as input with the help of proposed algorithm. Proposed algorithm has 2 methods for detection of soil type and moisture content from the soil type using digital image processing and python software. We successfully detected the soil type and soil moisture content from image with higher accuracy of classification. Complete hardware part of the project is shown in fig.1 where we can see all the components used for application design.

FUTURE SCOPE

In future we can implement an android app which can be useful for every to detect the soil type and the moisture using an android app so that farmers can further take crops which are suitable for given environment.

Even the type of crop and fertilizers used for particular soil detected by proposed work can be informed to farmers automatically using IoT (Internet of Things) concept.

In future not only soil type, we can even detect soil porosity, mineral particles contained in soil, Chemical components in the soil, partiole density, etc.

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