AI and IoT Based Monitoring System for Increasing the Yield in Crop Production & Security: A Survey

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Abstract - Artificial Intelligence (AI) and Internet of things (IoT) based monitoring systems are in great demand and gives a precise extraction and analysis of data. In this system, the system is performed on a sugarcane plant to detect the most suitable conditions for plant growth. The philosophy behinds this work is to reduce the risks in agriculture and to promote smart farming practices. The effect of physical conditions like humidity, temperature, soil temperature and moisture and light intensity on the plant growth, is monitored using IoT based monitoring system. The data responsible for the plant growth is obtained using different sensors units like DHT11, LDR, and DS18B20, Soil Moisture sensors, single-board microcontrollers and Application Programming Interfaces (APIs). The further analysis of the extracted parameters is done using different Machine Learning (ML) algorithms. This system will also help to protect the crop from the cattle. In India, land owned by the farmer is minimal in size. Therefore, the safety of the crop field is essential. This system will be uses passive infrared sensors to detect the motion of cattle in the fields. This system will provides smart irrigation system which predicts the water requirement for a crop, using machine learning algorithm.

Keywords- Agriculture, Smart farming, KNN Prediction, Node MCU, IOT, Sensors, Machine Learning, Analytics.

I.INTRODUCTION

Agriculture is the main source of our food and most people in India are dependent on agriculture as their prime source of income. According to the United Nations Food and Agricultural Organization, almost 800 million people are chronically hungry and 2 billion suffer micronutrient deficiencies. Further, another report from the State of Food Security and Nutrition in the World 2019 showed, 194.4 million people are undernourished in India. It is high time where the agriculture sector needs to be digitized and smart. Robert J. Mc Queen et al. (1995) [1], predicted the abilities of automatic process which could the combination of various systems. These systems could be applied in the farming sector for the welfare of humankind.

This era of 21st century focusses on automatic technologies like Internet of Things (IoT), Machine Learning (ML), and Data Science (DS). However, the application of these technologies in the agriculture domain is challenging. Because of regular variations in physical and chemical conditions of the surrounding, increasing the yield in the production of the crop is a real-time challenge and a problem needed to be solved. Hence, continuous monitoring and strict management is needed for agriculture parameters like humidity, temperature of the environment as well as of soil and light intensity, etc.

The major issues for the failure of crop production and low yield is lack of nutrients and suitable environmental conditions. Thus, the foremost motivation of this work is to provide an agricultural research solution. For this the ML algorithms is applied on the data generated by the technique of the Internet of Things. Here, we first create a dataset with the help of the Internet of things and the data collected is stored on the cloud. The data has features that consist of physical properties of surrounding like soil humidity, soil temperature and intensity of light. The target variable for our dataset is the rate of increase in height and width respectively which is the growth rate of the plant. After this the supervised machine learning algorithm are applied on the data which will give the best conditions for the plant for maximum growth.

II. LITERATURE SURVEY

IoT solutions are focused on helping farmers close the supply demand gap, by ensuring high yields, profitability, and protection of the environment. The approach of using IoT technology to ensure optimum application of resources to achieve high crop yields and reduce operational costs is called precision agriculture. IoT in agriculture technologies comprise specialized equipment, wireless connectivity, software and IT services.BI Intelligence survey expects that the adoption of IoT devices in the agriculture industry will reach 75 million in 2020, growing 20% annually. At the same time, the global smart agriculture market size is expected to triple by 2025, reaching $15.3 billion (compared to being slightly over $5 billion back in 2016).

Smart farming based on IoT technologies enables growers and farmers to reduce waste and enhance productivity ranging from the quantity of fertilizer utilized to the number of journeys the farm vehicles have made, and enabling efficient utilization of resources such as water, electricity, etc. IoT smart farming solutions is a system that is built for monitoring the crop field with the help of sensors (light, humidity, temperature, soil moisture, crop health, etc.) and automating the irrigation system. The farmers can monitor the field conditions from anywhere. They can also select between manual and automated options for taking necessary actions based on this data. For example, if the soil moisture level decreases, the farmer can deploy sensors to start the irrigation. Smart farming is highly efficient when compared with the conventional approach.

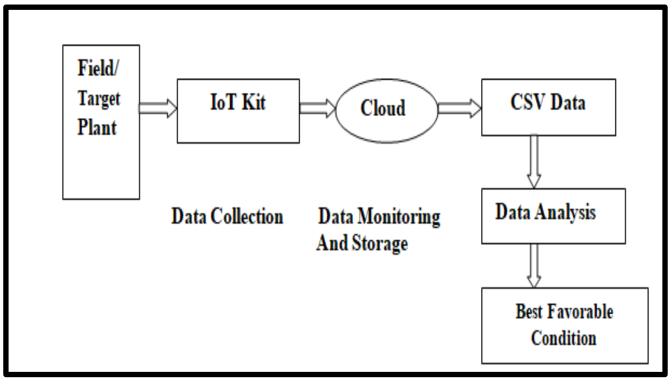
IoT have the potential to transform agriculture in many aspects and these are the main ones. Data collected by smart agriculture sensors, in this approach of farm management, a key component are sensors, control systems, robotics, autonomous vehicles, automated hardware, variable rate technology, motion detectors, button camera, and wearable devices. This data can be used to track the state of the business in general as well as staff performance, equipment efficiency. The ability to foresee the output of production allows to plan for better product distribution.

Agricultural Drones Ground-based and aerial-based drones are being used in agriculture in order to enhance various agricultural practices: crop health assessment, irrigation, crop monitoring, crop spraying, planting, and soil and field analysis. Livestock tracking and geofencing Farm owners can utilize wireless IoT applications to collect data regarding the location, well-being, and health of their cattle. This information helps to prevent the spread of disease and also lowers labour costs.

Smart Greenhouses a smart greenhouse designed with the help of IoT intelligently monitors as well as controls the climate, eliminating the need for manual intervention. Predictive analytics for smart farming Crop predication plays a key role, it helps the farmer to decide future plan regarding the production of the crop, its storage, marketing techniques and risk management. To predict production rate of the crop artificial network use information collected by sensors from the farm. This information includes parameters such as soil, temperature, pressure, rainfall, and humidity. The farmers can get an accurate soil data either by the dashboard or a customized mobile application. Farmers have started to realize that the IoT is a driving force for increasing agricultural production in a cost-effective way. Because the market is still developing, there is still ample opportunity for businesses willing to join in.

III. METHODOLOGY

The main aim of the suggested system is to take various sensor readings from the soil and predict the type of crop that is the most suitable to grow for that particular type of soil. First, let us understand the architecture of our system which will help us to understand our concept very much in-depth.



1. System Architecture

A. Capturing the plant's height and width:
To capture plants' height and width we used the concept of image processing and with the help of open CV library. The extracted height and width of the plant is stored in form of CSV file. Meanwhile, all the environmental parameters are collected and stored in the cloud by using IoT. These values also extracted from a cloud in CSV form.

B. Preparing the Dataset:
We have got the target variable data that was the plant's height and width and then we found the rate of plant growth by using the formula in equation 2,

Height/Width Growth Rate=$\partial x/\partial t$ (2)

Where, ∂x changes in height or width. And ∂t is the difference in time during which the properties are measured.

C. Data Analysis and Cleaning:
We analyzed and visualized the data and how valuable our features were and estimated a few predictions after features selection. Further, some of the extracted data was used for training the algorithm

D. Applying Algorithms:
After having the trained data, we applied supervised machine learning algorithms over it.

a) Artificial Neural Network:
An ANN is based on collection of connected unites or nodes called artificial neurons, which loosely model the neurons in a biological brain.

b) Linear Support Vector Classifier:
This model is essentially representing various classes in a multidimensional space hyperplane.

c) Decision Tree:
A decision tree is a classifier with feature marked internal nodes. Each node marked with possible output and leads to a lower-ranked decision node on various input features.

d) Random Forest:
This algorithm is used for classification as well as regression predictions. It creates different decision trees on data and gives predictions from them. Finally, provides the best solution to the problem for which it is employed.

e) Adaptive Boosting Classifier:
AdaBoost helps u combine multiple "week classifiers" into a single "strong classifier". The weak learners in AdaBoost are decision trees with a single split, called decision stumps. AdaBoost works by putting more weight on difficult to classify instances and less on those already handled well.

f) Feed Forward algorithm:
In this network, the information moves in only one direction **-Forward-** from the input nodes, through the hidden nodes. (If any) and to the output nodes.

g) Backpropagation algorithm:
The Backpropagation algorithm calculates how much the final output values, o1 and o2, are affected by each of the weights. To do this, it calculates partial derivatives, going back from the error function to the neuron that carried a specific weight.

E. Hardware Components:

a) Soil Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

b) LDR sensors

An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits. Light Dependent Resistors (LDR) are also called photoresistors. They are made of high resistance semiconductor material.

c) DHT11

The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers.

d) Node MCU

Node MCU is a low-cost open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espress if Systems, and hardware which was based on the ESP-12 module. Later, support for the ESP32 32-bit MCU was added.

IV. CONCLUSIONS

- We have to find the best favorable conditions for the marigold plant by data visualization and later on, this trained model can be used to detect the rate of growth of sugarcane plant just supplying it the environmental physical conditions.
- This technique has a great scope in the field of artificial farming.
- Not only we can detect the best favorable conditions for particular crops like millet, chilies, tea, coffee etc., but also we could prepare a dataset using IoT which could tell us the best suitable plant for a particular soil and climatic condition.

V. REFERENCES

1. Richa Singh, Sarthak Srivastava, Rajan Mishra, "AI and IoT Based Monitoring System for Increasing the Yield in Crop Production ". 2020 International Conference on Electrical and Electronics Engineering (ICE3-2020).
2. Anju Upadhyay. Sanjay Kumar Maurya, "Protecting the Agriculture field by IoT Application", 2020 International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARK).
3. Kasara Sai Pratyush Reddy, Y. Mohana Roopa, Kovvada Rajeev L.N., Narra Sai Nandan, "IoT based Smart Agriculture Using Machine Learning", 2020 Second International Conference on Inventive Research in Computing Application (ICIRCA).
4. https://ieeexplore.ieee.org/document/9087235
5. https://ieeexplore.ieee.org/document/9183373