An automatic procedure for crop mapping using agricultural monitoring

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Abstract. IoT and Machine Learning are emerging techniques used in existing days. Agriculture plays a vital role in human survival. Mapping crop according to the current environment is important to improve agriculture. pH sensors, dielectric soil moisture Sensors, mechanical sensors, optical sensors, electro-chemical sensors and air flow sensors are used in this proposed system to gather data about the soil and supervised Learning associated with Association algorithm are used to analyze and predict which crop maps to the soil in the present circumstances. Ensemble Technique is integrated to make accurate classification to select the type of crop. Technology combining both IoT and Machine learning are used to improve the production of the crop which proportionally helps to improve the agricultural yield.

Keywords: Optical Sensors, Soil, Electro-Chemical Sensors, Mechanical Sensors, Association rule mining.

1. Introduction

IoT: Internet of Things is the internet-based technology which uses sensors to collect data and it is sent to IoT Analysis platform which accumulates the data and makes the decision. The workflow of IoT is shown in the Figure 1.

Figure 1. Workflow of IoT.
In this system pH Sensors with various types of sensors are applied. All the sensor nodes are inserted in the agricultural land and they gather data by sensing the soil. The sensor provides smart farming, it assists farmers in making a decision. Some of the sensors are,

- pH Sensors in crop growing: Sensor which inform about nutrient in the inserted soil and also it lists out unnecessary chemical molecules in the soil, by this we can get an idea about soil quality, which helps to make a decision about what crop can be cultivated according to its nutrient values. Figure 2 and Figure 3 Shows the pH Sensor and Dielectric Soil Moisture Sensors.

- Optical Sensors: These sensors are used to verify types of soil using light and also additional to that it informs about various organic matters and moisture inside the soil.
- Electrochemical Sensors: These sensors are used as assistance in gathering soil chemical information by sensing various ions in the soil.
- Mechanical Sensors: In crop production soil compaction can measure by these sensors and also the able to mechanical resistance.
- Dielectric Soil Moisture Sensors: It helps in measuring humidity and moisture levels in the soil by the help of calculating dielectric steady of the soil. It also gives information about the water level, the surface temperature in the soil
- Types of Soil used for agriculture: Identifying the type of soil is an essential one which helps to predict the suitable crop for that soil. Soil is classified into many types,
  - Clay earth: The property content is very high and it is sticky. The dimension of soil s takes away as 0.2mm. It is wealthy in natural substance. It was appropriate for crop cultivation like paddy and rice.
  - Loamy Soil: It contains sand, clay, and sediment. It has sufficient hummus. From this soil sugarcane, wheat, jute, cotton, oilseed vegetables and pulses can be produced.
  - Red soil: It has more iron oxide. It has a lot of water content and has a fusion of clay and sand,
antis not fertile. Moisture and humidity % is more in this soil. Groundnuts, pulses, cotton, and tobacco can be cultivated in this soil the texture of soils shown in Fig 4.

Machine Learning: In Machine Learning the Machine Analyses, learns past data to make Decision and Predicts the output. There are four types of Machine learning which provide a useful way to classify, they are Supervised Learning, Unsupervised Learning, and Reinforcement Learning. In our proposal we use a Supervised learning algorithm to classify the soil type to associate the suitable crop to grow. Supervised learning which generalizes and classifies targets based on this training set.

Association Algorithm: In large dimensional dataset, finding interesting useful hidden patents are more interesting. Researchers can association rule identify relations among variables. It produces strong rules using support and confident measures to claim the system. Here it maps soil and crop according to the molecules present in the soil. It helps more in forming smart farming. The accuracy makes more than 90% of the result in crop cultivation by using sensors and machine-learning technology.

2. Related work
Vishal Meshram et l. [1] focused on the analysis review about how the machine learning technique improves crop yield. Nguyen-Thanh Son[2] explained how the random forest and SVM technique approach helps to decide to predict the yield of the crop, he mainly focused on rice crop in Taiwan. Laura Dingle Robertson [3] determines how to make a preference of crop type by collecting data about soil stipulation and he categorizes the outcomes of his result. Papa Sai Venkat [4] states the enhanced stacking regression techniques and their vital role in improved prediction of accurate crop yield.

Hassan Afzaal et al.[5] focused on the improvement of potato yield in Atlantic Canada employing various supervised learning algorithms. Anu Bala [6] enumerates less expensive and most comprehensive, a sophisticated procedure that enables improved harvest and surroundings situation evaluation and choice making. Manjula Josephine [7] Explained how ML helps in the production of crops. Ayazf et al. [8] highlights the prospective of IoT in farming and various challenges issue faced while appending the new knowledge through conventional cultivation practices.

Kushagra Agrawal [9] narrated how IoT technology helps in less consumption of resources with more productivity of crop that solve cultivation issues by identifying the suitable occasion of seeding of crops. Gandhimathi [10] enumerates how the Feed Forward Neural Network helps to detect the Plant Disease. G Kavitha [11] tells about smart farm improvement in yield by priory identifying plant syndrome and Soil Quality. Muthaiah and Balamurugan [12] provided a solution for determining the yield of the crop by means of the Random Forest algorithm. Andrew Crane-Droesch [13] suggests a deep neural network for improving cultivation. Robert Jana,

Malikarjun B.C [14] Implemented IoT Technology to supervise the significance of soil quality and type. Ashok Tatapudi, P Suresh Varma[15] analyze humidity, moisture, and temperature status of the soil using a sensor device by using ML Algorithms. Erik et al. [16] found out famine monitoring system for moisture in the soil. Mazaheriet al.[17] Show how soil humidity affects crop yield.

P. E. Francis et al.[18] implemented the assessment of moisture deficits of soil. Ranjini Guruprasad et al.[19], study tells about complete investigation of new machine learning technique with relevant features to improve the performance of the crop yield. Mhuchuay et al. [20] focused by means of deep Q-learning to discover the best dealings for rice cultivation, at this juncture they represent the past climatic statistics to predict the yield, and employ the deep Q-learner to choose at what time to begin cultivation and what time to harvest to maximize the income. Marion Olubunmi Adebiyi et al. [21], tells about machine learning (ML)–aided transportable scheme for farmland optimization, make use of a variety of inputs such as place, crop category, mud variety, soil pH, and spacing.

3. Proposed Architecture
It represents how the proposed system works,

- Sensors are installed in the soil and it used to gather data from the soil.
- Data is analyzed by the IoT processing module
- The analyzed data are given to the ML techniques.
- SVM classifier is exploited to classify the type of soil based on moisture, organic, and humidity value of the soil collected from sensors.
- The parameter of the soil is analyzed and a suitable crop is selected by using the association Apriori algorithm.
- Ensemble Learning is used for the accurate selection of a suitable crop. The workflow is represented by Figure 5.

**Figure 5.** Work flow of proposed work.

**Figure 6.** Task of the proposed work.
3.1 Task performed in the systems:
The above Figure 6 shows how the framework is done in the proposed work were, then used by the
help of IoT technology choose the suitable crop, Here first sensors are inserted in the land and the data
collected by the sensors are analyzed and the parameter is monitored based on moisture, humidity,
temperature, PH, and Rainfall at that present situation. Machine learning algorithms are used to
classify the soil type and an ensemble learner is used to select a suitable crop for cultivation. here
combining IoT and Machine learning algorithms used to form smart farming which leads to 90% of
the success rate in cultivation, the Fig 7 shows how ensemble choose appropriate crop based on sensed
data using voting results of different classifiers.

![Figure 7. Working principle Ensemble learner.](image)

4. Implementation Results
The graph shown in Fig 8 is the visualization of the result collected by the Sensors that are installed in
agricultural land Kaligoundanpalam, Namakkal district and the analyzed value of Rainfall in (mm) and
Temperature in (C) for all the months of the year had taken and moisture % and humidity of the soil is
also measured and taken for implementation and the analyzed data given to ensemble Learner and
suitable crop type example Rice crop is selected in the month of November through this result and
which provide the higher success rate of production of the rice crop.

5. Conclusion and Future Enhancement
Machine Learning technique with IoT plays a vital part in recent days, it is also employed in the
agriculture field to improve the throughput. Agriculture plays a vital role so mapping crop according
to climate is important therefore various sensors added with IoT technology are used in this proposed
system to gather data and the results shown in the above graph and they are analyzed and according to
the data analyzed crop is mapped to the soil. Ensemble Technique is integrated in this study makes
accurate classification to select the type of crop. Technology combining both IoT and Machine
learning is used to improve the production of the crop which proportionally helps to improve the
agricultural yield and for hit rate and performance improvement in the future deep learning model can
be used.
Figure 8. Graph Shows (a) Rainfall (b) Temperature (c) Humidity (d) Moisture level analyzed by Machine learning Algorithm.

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