A Study of IoT Based Smart Agriculture Management System Using Machine Learning

[1]Ashok Tatapudi, [2]Suresh Varma P

[1]Assistant Professor, [2]Professor

[1,2]Department of Computer Science and Engineering, University College of Engineering

[1,2]Adikavi Nannaya University, Rajamahendravaram, India.

Abstract : Agriculture plays a significant role in economic growth and food security of agro-based country. Selection of crops based on suitable conditions is an important issue for agriculture system. It depends on various parameters such as soil conditions, weather conditions, production rate, market price and government policies. The combination of more data from the Internet of agricultural things and new machine learning capabilities can contribute a crucial part on this. Many researchers studied prediction of yield rate of crop, prediction of weather, soil classification and crop classification for agriculture planning using IoT sensors, statistical methods and machine learning methods. We intend to bring an enhancement in the field of precision agriculture by achieving better results in predicting crop yields as compared to the work already done in the field.

IndexTerms **– Agriculture, IoT, Machine learning, Classification, Ensemble, Prediction.**

I. INTRODUCTION

Agriculture is a step by step process like ploughing of soil, preparing for planting, applying proper fertilizer, pest and disease control, to get maximum yield. For decades agricultural science has been working to evolve technologies in farming. The major factors affecting farming are climate change, nature of soil, population growth, pest & diseases. Farmers should be able to produce maximum yield from the land available to them. Studies to maximum exploit the minimum available land to bring the best yield has been carried out. Majority of the population are directly or indirectly dependent on agriculture. In this modern world, agriculture has to be supported with technology to bring the best output. There is a big revolution in agriculture from traditional methods. Recent development in technology has a great impact on agriculture. Evolution of machine learning (ml) and internet of things (IoT) has helped researchers to apply these techniques in agriculture to help farmers. These in turn helped farmers to increase the productivity, make use of maximum land available, control pest, and so on. This paper is an attempt to study the various ml as well as IoT techniques applied to the agriculture sector to predict soil moisture, weather, and other factors affecting agriculture.

The paper is organized as: Sect. 2, describes research activities carried out using ML techniques in agriculture and Sect. 3 about the use of IoT in agriculture and the paper concludes in Sect. 4.

II. MACHINE LEARNING APPLIED IN AGRICULTURE SECTOR

The Capability of acquire their own knowledge, by extracting patterns from raw data is known as machine learning **[Goodfellow-et-al-2016]**. A machine learning system is trained rather than explicitly programmed. It's presented with many examples relevant to a task, and it finds statistical structure in these examples that eventually allows the system to come up with rules for automating the task. A machine learning model transforms its input data into meaningful outputs, a process that is learned from exposure to known examples of inputs and outputs **[Francois Chollet et al]**. Machine Learning is mainly derived two classifications of algorithms that are supervised Learning and unsupervised Learning. In supervised learning the system is trained on a pre-defined set of training data which then facilitates the ability to do predictions given a new data. Where as in unsupervised learning the system is given a bunch of data to learn on its own by identifying patterns and relationships **[R. Juhi Reshma et al]**.

Numbers of models were used to predict the type crops based on physical parameters of soil, Moisture, Weather conditions and Water Properties. Planning a crop based on these properties are very important for production, a wrong estimation leads to heavy damage. Lot of researches carried out to predict the crop based on different properties with the help of Machine learning models. Different learning algorithms are used to train the system in order to predict the type crop based on characteristics of crop **[R. Juhi Reshma et al]**. In this section the analysis made it on different crop prediction systems using machine learning.

In this **[A. L. Diedrichs et al]** proposed a model to predict frost events in peach orchards based on surrounding thermos-dynamical conditions which are illuminating for prediction. This paper provides improved frost prediction performance by using IoT based Machine Learning models which combine data from nearby weather stations. This system is composed of three integrated stages.

They are:

- From a number of designated internet enabled weather stations historical meteorological data is collected. This historical data is supplied to the prediction engine firstly and then produce new data to uninterruptedly revamp the prediction model.

- In this stage the frost prediction engine is trained by the data gathered from weather stations. Here in this stage instead of using traditional formula-based predictions this model considered machine learning algorithms for regression based on Bayesian networks and Random Forest (RF).

- The local field data is assembled from a network of IoT sensors pushed on to the model triggered by the prediction engine to bestow a frost forecast output.

This model was assessed by training regression and classification models using several machine learning algorithms. The data is augmented using Synthetic Minority Oversampling Technique (SMOTE), which increases the rate of frost detection (sensitivity). For comparison against competitors this method logistic regression and binary trees are used. To ensure better performance and no-over-fitting in classification problems RF was chosen. And Bayesian Networks are also chosen in contrast to provide complete framework for inference and model uncertainty which is not provided by the Random Forest.

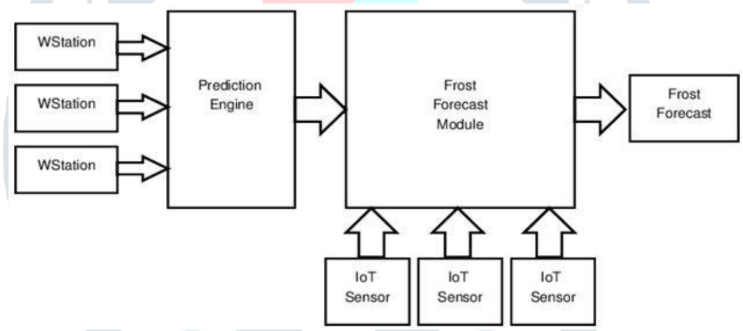

Fig. 1: The IoT-based frost prediction system

However the results reveal that choosing most imperative neighbors and training models using SMOTE lessens the prediction errors of regression predictors and increases the Random Forest classification predictors. This method discloses that it is better enough to suggest present approach is convenient and viable for producers and decision makers.

[T.Trunog et al] Introduced a machine learning model using Super Vector Machine regression (SVMr) algorithm to predict environmental conditions for fungal detection and prevention. By the help of day-to-day temperature, relative air humidity and wind speed predictions the existence and escalation of fungal diseases are easily managed by the crop field managers. Various sensors are used to collect the data like humidity, rainfall, sunlight intensity, wind direction. However, the results show that this model on an average can be able to predict daily average air temperature, relative air humidity and wind speed values with in 20C, 7% and 2km/hr. respectively. In **[D.Rajesh et al]** authors have explained the use of spatial data mining in agricultural domain. They have used K-means algorithm along with optimization method progressive refinement for spatial association analysis. Temperature and rainfall is given as initial spatial data and analyzing it for the improving the crop yield and to reduce the crop losses.

This paper **[R Kumar et al]** presents a technique named CSM to select sequence of crops to be planted over season. CSM method may improve net yield rate of crops to be planted over season. The proposed method resolves selection of crop (s) based on prediction yield rate influenced by parameters (e.g. weather, soil type, water density, crop type). It takes crop, their sowing time, plantation days and predicted yield rate for the season as input and finds a sequence of crops whose production per day are maximum over season. Performance and accuracy of CSM method depends on predicted value of influenced parameters, so there is a need to adopt a prediction method with more accuracy and high performance. This paper **[Abdullah Na et al.]** discusses various data mining techniques like Market based Analysis, Association Rule Mining, Decision Trees, Classification and Clustering. It entirely covers Data Mining concept. Various data mining algorithms such as Naive Bayes classifier, J48, K-Mean are explained in this paper. It also provides classification of soil based on Naive Bayes, Genetic algorithm, Association Rule Mining. Eventually, it covers Clustering in soil database. This paper helped us in understanding and analysis of different data mining algorithms and classification mechanisms. This will prove to be extremely beneficiary while developing our project and will help in mining the dataset obtained from sensors employed remotely.**[Monali Paul et al.]**

III. INTERNET OF THINGS APPLIED IN AGRICULTURE SECTOR

IoT is based on Internet, mobile communication, and other communication networks, through intelligent sensors, radio frequency identification, infrared sensors, global positioning systems, laser scanners, remote sensing, etc. Information sensing equipment and systems, in accordance with the agreed protocol for the needs of different applications, and all the physical objects can be individually addressable and interconnected to achieve a comprehensive perception, reliable transmission and intelligent processing, building a things and things Internet intelligent information Service System.**[N.Hemageetha et al]**

Agricultural IoT is the specific application of IoT technology in agricultural production, operation, management and services, using various types of sensors, RFID, visual perception collection terminals, and other equipment, extensively collecting field planting, horticulture, livestock and poultry, aquatic products' site information breeding, agricultural logistics, and other areas **[Li et al]**.

Currently, IOT applications are mainly in the following mature technologies:

- Agricultural sensor technology. Agricultural products have been covered by many categories of sensors such as soil sensors, water sensors, meteorological sensors, heavy metal detection sensors, biosensors, gas sensors, and so on.

- Intelligent irrigation technology. Relying on satellite positioning network and "shallow wells underground cables, field automatic irrigation system pipe" technology, it can collect irrigation water, electricity, irrigation, and time data to achieve automation of farmland irrigation and through a comprehensive analysis of information technology software to guide irrigation.

- Precision seeding and spraying techniques. Relying on technology combined with GPS navigation technology, variable rate fertilization, and seeding technology, it can achieve uniform implementation of the planting, spraying, and improving the utilization of seeds, pesticides, and so on.

This study **[Kang et al]** suggested a system that helps recognize the information of things such as environmental changes or crop growth changes through the monitoring of environmental information based on the sensors connected through the Internet. Such information is expected to provide the methods to identify the surrounding environments of things through the sensing, delivery and exchanges between differentiated devices. In addition, this information is likely to enable the search and grouping of physically separated growth environments according to various conditions and their management under various conditions corresponding to environmental or other pertinent changes. This agriculture monitoring system **[S. R. Prathibha et al]** serves as a reliable and efficient system and corrective action can be taken. Wireless monitoring of field reduces the human power and it also allows user to see accurate changes in crop yield. It is cheaper in cost and consumes less power. The smart agriculture system has been designed and synthesized. The developed system is more efficient and beneficial for farmers. It gives the information about the temperature, humidity of the air in agricultural field through MMS to the farmer, if it fallout from optimal range. The system can be used in green house and temperature dependent plants. This system **[G. Sushanth et al]** generates irrigation schedule based on the sensed real time data from field and data from the weather repository. This system can recommend farmer whether or not, is there a need for irrigation. Continuous internet connectivity is required. This can be overcome by extending the system to send suggestion via SMS to the farmer directly on his mobile using GSM module instead of mobile app. This agriculture irrigation system **[R. N. Rao et al]** is developed with low complex circuitry. A two sensors are used efficiently those are temperature and moisture of soil in the circuit to get the calibrated information to the system. Two sensors and Raspberry pi microcontrollers of all three Nodes are successfully interfaced various Nodes. All observations and experimental tests proves that proposed is a complete solution to field activities, irrigation problems, Implementation of such a system in the field can definitely help to improve the field of the crops and overall production. . With the help of this approach the irrigation system completely automated also provides real-time information about the lands and crops that will help farmers make right decisions.

IV. CONCLUSION

In this paper different machine learning techniques to predict the crop based on different factors and the real time use of IoT in agriculture is discussed. There are many researches that has been carried in the field of agriculture using machine learning algorithms. There is a need to further enhance IoT with machine learning techniques to improve real time use of sensors in agriculture. IoT applications must be easy to use so that the farmers can take the advantage of it. We need to develop applications to analyze data captured by sensors in real time using Machine learning algorithms. In the future, we can plan to extend and improve this by implementing a novel method for predicting the crop using both IoT and Machine Learning with less complexity and with the usage of very important features.

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