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# A Novel IOT Based Solution for Agriculture Field Monitoring and Crop Prediction Using Machine Learning

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**ABSTRACT:** Agriculture is the most prominent sector in the developing countries like India. A central challenge for the system is predicting crop. To get maximum profits from the crop proper irrigation system, weather and soil properties are required. The changes in the soil properties will effect the production of the crop.

In the existing system it mainly describes the automatic irrigation system which switches ON/OFF the motor on sensing the soil moisture, they still follow the traditional farming techniques for selecting the crops for cultivation. Due to the changes in water, weather and soil those traditional techniques cannot work out. There is no proper guidance for the farmers for cultivating appropriate crop using modern technologies. To improve the yield in the crop we have to use modern methods.

In this project we are using two modern technologies IOT and Machine Learning. The major thing is to predict the crop which gives maximum profits after the crop has been harvested. The prediction of the crop is dependent on numerous factors such as soil nutrients, location, weather and past crop production. The soil pH value will be known by using the pH Sensor, Optimal pH range for all the crops is in between 5.5 to 7.0. Based on the soil the pH values has to be maintained, if there is change in the pH value it will effect the crop in terms of quality and quantity of the production .So, by using the soil moisture sensor required amount of water has to be given to the farm to maintain the correct pH value and it will be kept informed to the farmer through the SMS. The advantage of this method is to reduce the human intervention and still ensure the proper irrigation. The usage of chemicals and fertilizers will be decreased and by this less usage of fertilizers the soil quality will not be lost, and the farmer can attain best quality of production.

**KEYWORDS:** Soil pH, Soil Moisture Sensor, Temperature and humidity, Crop Monitoring, Crop Prediction, Arduino UNO

### I. INTRODUCTION

Internet of Things (IOT) refers to the use of intelligently connected devices and systems to leverage data gathered by embedded sensor actuators in machines and other physical objects. Internet of Things is a concept which enables interaction among the objects that are present in environment. Now-a-days Internet of Things (IOT) was being used in the different areas in different forms. All applications pervade in all areas of our lives. In this new trend precision agriculture is one such application which is gaining more attention. In India the country income is mainly depends on the agriculture. India being an agricultural country it needs some innovations in the field of agriculture. To be successful, a farmer must know the usage of fertilizers, water according to the soil and the crop. The intended farmer should know the management of the input resources to the crop like water, fertilizers and chemicals. The excessive use of these fertilizers and water will effect the crop growth. It impacts badly on the output of quality and quantity of the crop grown. The key to achieve success is to maintain the quality of the crop product and in high quantity of the crop. Usually the rural area farmers and the smallholder farmers used to follow the conventional farming practices. Sometimes this conventional farming will leads to heavy losses in terms of low yields of the crop, lower quality of the farm produce and soon. Normal methods like crop investigation and soil analysis are taking lot of time. By using IOT



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and data based decisions and by predicting the implications of each and every decision, for example in regular intervals of time selecting the crop for harvesting. By this a farmer can use his field more effectively and can get high profits. By this it can help the farmers in lowering their input costs, optimizing the yield and reducing the bad impact on the crop growth.

In the present trend Machine Learning is the emerging technology. Machine Learning is one of the fields in artificial intelligence. It uses the statistical technique to give the computer systems the ability to learn from the given data without being explicitly programmed. For solving the non-linear problems multiple sources using the datasets Machine Learning techniques are appropriate.

Now-a-days there has been demanding immediate attention to provide the real time farm information like soil moisture, temperature and pH of the soil to the farmer. These are the important soil parameters that effect in the complete growth. Different crop requires different irrigation strategies for the effective growth. Soil Moisture is one of the key feature which help in overall irrigation management. Based on the crop and the soil the required soil Moisture has to be maintained. If the moisture in the soil was not at required level it will effect the crop growth. To avoid the problems faced by the farmers is by maintaining the real time soil moisture and the temperature. Soil temperature is another important factor for the crop growth. If the soil temperature is below 20° C it will affect the soil fertility by impeding the nitrogen fixation. Soils are classified in three categories they are acidic soils, alkaline soils and neutral soils. The change in these soils will effect in providing the necessary nutrients to the crop. Soil pH is one of the important features. It is a measure of the acidity and the basicity of the soil. pH is defined as the negative logarithm of the activity of hydronium ions in a solution. The optimal pH range is in between 5.5 to 7.0. If the pH of the soil is too high, the plants ability to absorb certain nutrients is disrupted. The pH has to be maintained in the correct range according to the soil and the crop for the effective yield.

In this work the crop will be predicted based on the location, past crop production, soil moisture, temperature and humidity and the soil pH. Soil pH is determined by the concentration of hydrogen ions (H+). It is a measure of the soil solution's (soil water together with its dissolved substances) acidity and alkalinity, on a scale from 0 to 14. If the pH of the soil was changed it will be maintained by supplying required amount of water to the farm. The pH of pure water is related to the relative number of hydrogen and hydroxyl ions. The soil's ability is influenced by the water is related to its texture. Soils have a high number of very small particles, the group of this small particles is called as colloids. The positive particles will retain in the soil. This process is known cation exchange capacity. As the positive ions fixed in soil the negative ions will come out. This gives an impact on the soil Ph. As we provide water to the farm the influence of the H+ ions will be more, so by this it alters the pH value. Both the soil and the water contain negatively and positively charged ions that influences the chemical composition there by the change happens in soil pH . By maintaining the correct pH the soil will be fertile and the crop growth will be desirable.

#### **II. LITERATURE SURVEY**

**D.S.Zingade et al.** have described an approach for predicting the crop using multiple linear regression. For the prediction of the crop D.S.Zingade et al. uses the machine learning techniques. Crop prediction is based on the weather data which is collecting from the IMD (INDIAN METEROLOGIACL DEPARTMENT) gives insight into which crops are suitable to be cultivated in a particular area. D.S.Zindage et al, proposed a system that will integrate the data obtained from the repository, weather data by applying multiple linear regression model. Regression analysis is a form of predictive modelling technique which investigates the association between a dependent (targets) and autonomous variable (s) (independent variables).

A Multiple Linear Regression model with two predictor variables,  $x_1$  and  $x_2$ .

 $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots + \in$ 

In multiple linear regression it uses the predictive techniques

- 1. R Square method
- 2. Adjusted R Square
- 3. Standard Error
- 4. Anova



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Here it uses the weather data from the IMD it can be enhanced by using IOT sensors for real time data **Monali Paul et al.** describes about the prediction of crop yielding. In this prediction firstly the crops are analysed later on they will be classified. Data Mining algorithm is used for the classification process, It uses the Data mining techniques like Naïve Bayes, K-Nearest Neighbour.

Awanit Kumar et al. gives the detail about the prediction of crop production. The algorithm used in this model is K-Means. K-Means is a data mining algorithm which is used to determine the crop production. It is used to analyse the datasets. Fuzzy logic is another mechanism used for the prediction. It is rule based prediction logic. Certain set of rules are applied for the production of crops. Here it provides set of rules to apply on the crop which will lead to maximum profit based on the previous years.

**N.Sakthi Priya** describes about the wireless sensor network (WSN). Here it uses several sensors for soil moisture, leaf wetness, soil pH, and atmospheric pressure. If the soil has inadequate water the moisture activates and it provides required amount of water to the farm and here the sprinkler automatically ON/OFF when it was required. The pH value of the soil will be sent to the farmer through message by this he can able to select the required fertilizers for the crop. WSN provides the real time information to the farmer and thus reducing the human intervention.

**Rakesh kumar** et al.'s have proposed an crop selection method(CSM) to solve the crop selection problems and to increase the crop yield. In this paper comparative analysis of all the Machine Learning algorithms such as Artificial neural networks, Random Forest, Decision Trees, Support Vector Machine, Gradient Boosted Decision Tree (GBDT), Regularized Greedy Forest (RGF).

**H.Navarro-hellin** et al.'s have proposed an smart irrigation model. This model is based on two different parameters. One is soil moisture and the other is climatic conditions. For the real time monitoring of the soil different sensors are equipped in the field to gather the data. Soil moisture sensor is used to know the moisture content of the soil. These soil moisture sensors are placed at different corners in the field. The data collected from these sensors will help in estimating the required for the farm in upcoming weeks. The agro-meteorological stations which are nearer to the farm are used to record the climatic variables data. Temperature (T), Relative humidity (RH), Global radiation (GR), Wind speed (WS), Rainfall (RF), Dew point (DP), Vapour Pressure Deficit (VPD) are some of the climatic data downloaded from agro-meteorological stations from SIAM websites.

#### **III. SYSTEM DESIGN**



In this project, based on the soil properties, the crop will be predicted. The prediction of the crop is dependent on numerous factors such as soil nutrients, location, weather and past crop production.



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The advantage of this method is to reduce the human intervention and still ensure the proper irrigation. The usage of chemicals and fertilizers will be decreased and by this less usage of fertilizers the soil quality will not be lost. In this project we are using two modern technologies IOT and Machine Learning. For the measure of soil properties like temperature & humidity, soil moisture and pH of the soil we are using the sensors.

### **IV. DATA SET DESCRIPTION**

The overall dataset is having 10 features. Here we are considering the state of Andhra Pradesh which is having 13 districts. Here we have taken the past crop year data from 1994-2014. The overall dataset consists of 9628 observations. The production of the crop, temperature and pH values are taken into consideration.

	Α	В	С	D	E	F	G	Н	I. I.	J
1	State_Name	District_Name	Crop_Year	Season	Сгор	Area	Production	temperatureMax	temperatureMin	Ph
2	Andhra Pradesh	ANANTAPUR	1997	Kharif	Arhar/Tur	21400	2600	18	30	7.5
3	Andhra Pradesh	ANANTAPUR	1997	Kharif	Bajra	1400	500	15	30	8
4	Andhra Pradesh	ANANTAPUR	1997	Kharif	Castor seed	1000	100	20	30	7
5	Andhra Pradesh	ANANTAPUR	1997	Kharif	Cotton(lint)	7300	9400	15	30	7.5
6	Andhra Pradesh	ANANTAPUR	1997	Kharif	Dry chillies	3700	7100	14	25	6.4
7	Andhra Pradesh	ANANTAPUR	1997	Kharif	Groundnut	650800	228400	10	30	7.5
8	Andhra Pradesh	ANANTAPUR	1997	Kharif	Horse-gram	3300	1000	20	30	7
9	Andhra Pradesh	ANANTAPUR	1997	Kharif	Jowar	10100	10200	16	30	9
10	Andhra Pradesh	ANANTAPUR	1997	Kharif	Korra	2200	700	15	35	8
11	Andhra Pradesh	ANANTAPUR	1997	Kharif	Maize	2800	4900	20	35	7
12	Andhra Pradesh	ANANTAPUR	1997	Kharif	Moong(Green Gram)	1300	500	20	35	8

### INTERNET OF THINGS

#### Sensors

A Sensor is a transducer device to detect events or changes in its environment, and then provide a corresponding electrical output. The most important characteristics of a sensor are precision, resolution, linearity and speed.

#### SOIL MOISTURE SENSOR

The Moisture sensor is used to measure the water content(moisture) of soil. When the soil is having water shortage, the module output is at high level, else the output is at low level. This sensor reminds the user to water their plants and also monitors the moisture content of soil. It has been widely used in agriculture, land irrigation and botanical gardening.





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#### Arduino UNO

The Arduino Uno is a micro controller board based on the Atmega328.It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. Simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started



#### **Temperature and Humidity sensors**

Humidity sensors detect the relative humidity of the immediate environments in which they are placed. They measure both the moisture and temperature in the air. As air becomes hotter, it holds more moisture, so the relative humidity changes with the temperature.DHT11 is a Humidity and Temperature Sensor, which generates calibrated digital output. DHT11 can be interface with any microcontroller like Arduino, Raspberry Pi, etc. and get instantaneous results. DHT11 is a low cost humidity and temperature sensor which provides high reliability and long term stability.



#### pH sensor

The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution. It operates on 5V power supply and it is easy to interface with arduino. The normal range of pH is 6 to 8.5.





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#### **CIRCUIT SETUP**

The connections of all the IOT devices is shown in the below figure.



#### Machine Learning:

The machine learning algorithms used in our project are Random Forest, Linear Regression, K-Nearest Neighbour algorithms.

#### Algorithmic survey

Linear Regression: Regression analysis is a form of predictive modelling technique which investigates the association between a dependent (targets) and autonomous variable (s) (independent variables). Regression is a technique used to model and analyse the relationships between variables and often times how they contribute and are related to producing a particular outcome together. A linear regression refers to a regression model that is completely made up of linear variables. Beginning with the simple case, Single Variable Linear Regression is a technique used to model the relationship between a single input independent variable (feature variable) and an output dependent variable using a linear model i.e a line. The more general case is Multi Variable Linear Regression where a model is created for the relationship between multiple independent input variables (feature variables) and an output dependent variable. The model remains linear in that the output is a linear combination of the input variables. We can model a multi-variable linear regression as the following:

### $Y = a_1 * X_1 + a_2 * X_2 + a_3 * X_3 \dots A_n * X_n + b$

Where a,n are the coefficients, X,n are the variables and b is the bias. As we can see, this function does not include any non-linearities and so is only suited for modelling linearly separable data. It is quite easy to understand as we are simply weighting the importance of each feature variable  $X_n$  using the coefficient weights  $a_n$ .

#### **Random Forest:**

Random Forest is a supervised learning algorithm. Like you can already see from its name, it creates a forest and makes it somehow random. To say it in simple words: Random forest builds multiple decision trees and merges them together to get a more accurate and stable prediction. One big advantage of random forest is, that it can be used for both classification and regression problems, which form the majority of current machine learning systems. I will talk about random forest in



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classification, since classification is sometimes considered the building block of machine learning. Below you can see how a random forest would look like with two trees:



#### **K-Nearest Neighbour**

The **K-Nearest Neighbours**(**KNN**) method of classification is one of the simplest methods in machine learning, and is a great way to introduce yourself to machine learning and classification in general. At its most basic level, it is essentially classification by finding the most similar data points in the training data, and making an educated guess based on their classifications. Although very simple to understand and implement, this method has seen wide application in many domains, such as in **recommendation systems, semantic searching,** and **anomaly detection**.

1. Compute a distance value between the item to be classified and every item in the training data-set

2. Pick the k closest data points (the items with the k lowest distances)

3. Conduct a "majority vote" among those data points — the dominating classification in that pool is decided as the final classification





The Accuracies values of these algorithms are mentioned above. The Random Forest algorithm which develops the large number of random decision trees analysing the set of variables. This algorithm helps to enhance the ways that technologies analyse complex data. The random forest is having the highest accuracy of 89% than all the above algorithms we have used.

For these algorithms the resultant accuracies are shown in the graphs



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#### VI. CONCLUSION

Agriculture is the predominant sector where major enhancements have to be done. In this paper we have analysed some of the crop prediction methods based on their accuracy using Machine Learning algorithms and the real time monitoring of soil properties using the IOT. The algorithms are used for the better crop prediction based on the soil properties will ensure in good quality and quantity of the crop.

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 analyse data captured by sensors in real time using Machine learning algorithms

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