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IoT and Machine Learning based Smart Agri -Farming System

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Abstract— In the topical age of competition and risks in markets, advancements in technology are a must for better feasibility and growth. In the same way, it applies to the agriculture industry. Based upon their yield and quantity every farmer experience high spikes on the crop. At present, maintenance of farm is a very hot issue that needs to be apparatus at utmost propriety by rising water issues and proper methodologies. Automation of farms is proposed in this research. The suggested solution is based on the Internet Of Things(IoT), which would be an inexpensive and more accurate solution to farm needs. The main purpose of the monitoring system is to solve over-irrigation, crop-specific irrigation and soil erosion problems will be evolved to ease and efficiently manage all the irrigation problem. The main well-known fact in agriculture is water scarcity and over wastage of essential resources should be reduced. The proposed solution will be developed by the setup of Wireless Sensor Network(WSN) so that every farmer will be getting some sensor modules that will be transmitting data on the common server. These scenarios will be supported by Machine Learning(ML) algorithms based on the prediction for irrigation patterns. So such a comfortable approach to irrigation is provided in this paper.

Keywords-Agriculture; IoT; Machine learning; Farming; Soil;

I. Introduction

Not only for developing countries but also developed nations, farming and agriculture report for the major portion of GDP (Gross Domestic Product). The major need of the country is to improve and optimize the current farming techniques and technologies. The only help for all the farming and agriculture sector is to development of mankind, fauna, and flora that will also help in dealing global crisis like epidemics and climate change. Good technology yields better yield. As a result, problems like malnutrition and starvation will be resolved. The main thing for every common man is to get technology at an affordable price so that many could impact on that and use those techniques regularly in the world. Smart home systems are developed in research, but the major area is to cover is agriculture, and that too smart agriculture tends to lag behind all other domains that require R&D to achieve those sustainable goals in both industry and root level of the agricultural industry. To increase crop yields automation techniques can be used. This paper provides a solution to the agriculture industry by using IoT and Machine Learning algorithms by using some wireless sensor network fields that need to be established in both farms and also in the household garden to monitor all the parts of the field. Proposed research showcases the best solution to all the farm needs and irrigation needs based on the open-source database that is available online [1]–[5]. Irrigation will be varied based upon the region and season. During various stages of crop production, Water needs to vary accordingly. The field will be the effect if there is over-irrigation or less irrigation and that also affects nature. So automation process is required for the system. Efficient irrigation certifies a sustainable use of water and also helps in recharging the groundwater. By using various sensor and various microcontrollers[1] like Arduino mega, Arduino UNO and raspberry modules soil topology and weather pattern is shown in the study that is conducted by irrigation. This paper represents an economical and easy approach to automate irrigation systems. Soil temperature, moisture, and soil fertility is controlled by chips along with sensors, transducers, and actuators[6]–[9]. The proposed solution in this research study is mainly based upon literature review and experimentation of all the high-quality research articles and machine learning algorithms. Dealing with various problems of farming and irrigation are described in this research. In this research following sections are organized as follows: A Detailed literature review is described in Section 2, Solution of smart farming requirement is described in section 3, Results of the research are described in section 4, List of all the challenges to the proposed system and research are described in section 5, the conclusion along with a future scope of the study is described in section 6. For the development of a smart farm monitoring system, an extensive literature review has been done with some of the efficient technologies and algorithms based on the literature review. In this proposal, a microcontroller-based irrigation system will be more effective and economical compared to other conventional methods. By using raspberry and Arduino smart irrigation systems are been proposed, with the help of ultrasonic sensors farm pest detection is proposed in this paper[1], [10]–[14]. A smart farm irrigation system is proposed in this research by using IoT and ML technique algorithms. In this research, deep learning and altitude based irrigation approach has been discussed for precious farming by using WSN approach. The smart farming approach is based upon edge computing and cloud which can almost overcome all the challenges and emerge farmers to more opportunities. This research work deals with current problems which are faced by farmers for decades and provides some respective solutions. This paper mainly deals with the precise solution for all the farming needs by using a suitable sensor network field whose prototype was developed.

II. METHODS

A. *Situation Awareness And Model –Data Fusion*

Sensor network technologies have an impact on how we notice and sway our environment. They have had a noteworthy presence within the military context, where data and information fusion systems have been used in conflict situations, due to the entanglement and vigorous nature of the situation.

In this paper, we implement the “situation awareness” (SA) in a slippage irrigation control system. SA has been extremely regarded as the solution for handling vigorous situations. Researchers brought out ideas from how we as humans, distinguish, apprehend and anticipate our environment and aim to build computing models to recreate these behaviors. A situation-aware system should realize the following three behaviors:

1. Perception is the conduct in which the system spot multiple situational elements, such as attributes, status, and dynamics of the environment;

2. Comprehension connects the information obtained from a perception based upon the system’s goals. This behavior circumscribes expound and evaluation. The focus of this paper is an instance of conception behavior when soil hydrologic features are used to infer the textural class of the soil;

3. Projection is the elevated level behavior for SA. In projection, the system foresees the potential environmental changes based upon the information learned from perception and comprehension.

The key concept is to achieve “situation awareness” is using the process of model-data fusion. The process of learning models from the data obtained in the environment refers to Model-Data fusion. This evolves the model during the system interaction. These models cipher how experts will make decisions based upon their elucidation of the current situation can be used to form decisions.

B. *Proposed Work*

The proposed work in this research mainly relies on a microcontroller which is of 2 types namely Arduino mega and Raspberry. In this research, the microcontroller is chosen based upon the cost, ease of availability, and computational power. Based upon the various parameters that will be monitored constantly sensors are designed so that different types of the crop will be done in various regions. Figure 1. Represents the major enablers of the proposed work [1], [10]–[18].

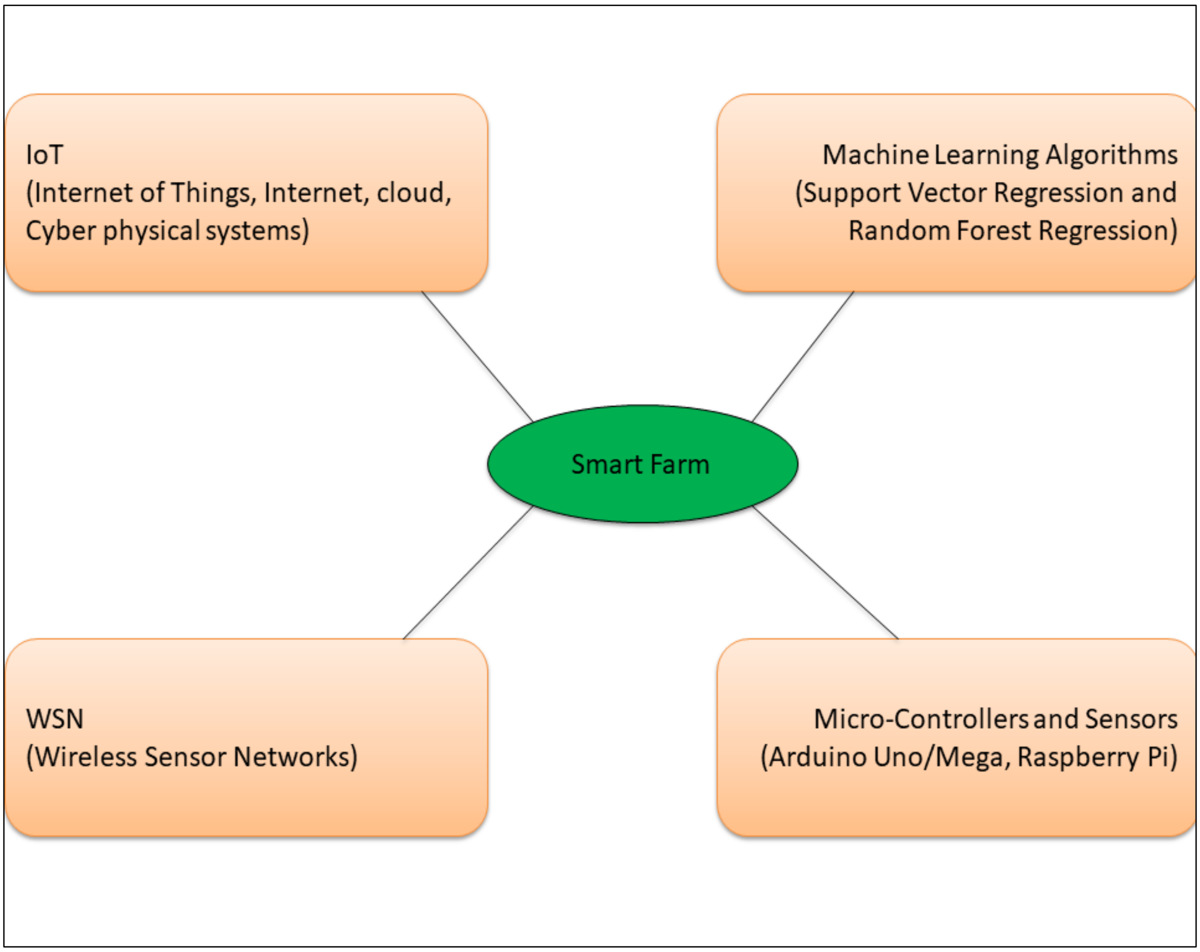

Fig 1. The technology proposed in this Research Work

C. *Functional Architecture*

In the implementation of a smart irrigation system for farm automation, first, we need to place all the wireless sensor network field and cross-check every node is interconnected by Wi-Fi module, and make sure that all the data is balanced over a common server where a script can keep polling the data and send an alert to the respective person for the required operation. In Figure 2, the overall topology of various sensors are been represented. Actual network topology depends upon the demographics of the region. The first step, concerning an automatic irrigation system is to collect data from various sensors that got attached to the field or garden. Here Raspberry pi will be acting as a gateway node that is responsible for communicating with all the other connected sensor nodes. Other microcontrollers namely Arduino mega unit contain advanced soil moisture sensor, GSM module, Wi-Fi module, Temp and Humidity, Bluetooth module, water level indicator, MQ2 gas sensor, battery, relay module, alarm clock module. Ultrasonic sensors are used for the detection of major intruders as well as rodents. Data can be presented to the end-user through an application layer as follows: Every node will carry some information to the gateway node or base station which is raspberry pi, here some script will be passed inbuild to the sensors that are responsible to store the data in the cloud [16]–[20]. Data transmission from raspberry to the server internet is not an important requirement, intranet can also be used for the proposed work so that it can be used at places where there is no internet connectivity or less internet connectivity. The connection of various sensors to the microcontroller is based on the fundamental concept of receiver, ground, positive, and transmitter connections need to done accordingly in the same way and Arduino mega impart ample number of TXD, RXD, analog, and digital pins along with several Vcc and Gnd pins. The first phase of a proposed application is completed after that network topology establishment and collection of data is required. Collection of data through various sensors is most prior and the first this will be the first step for the data processing.

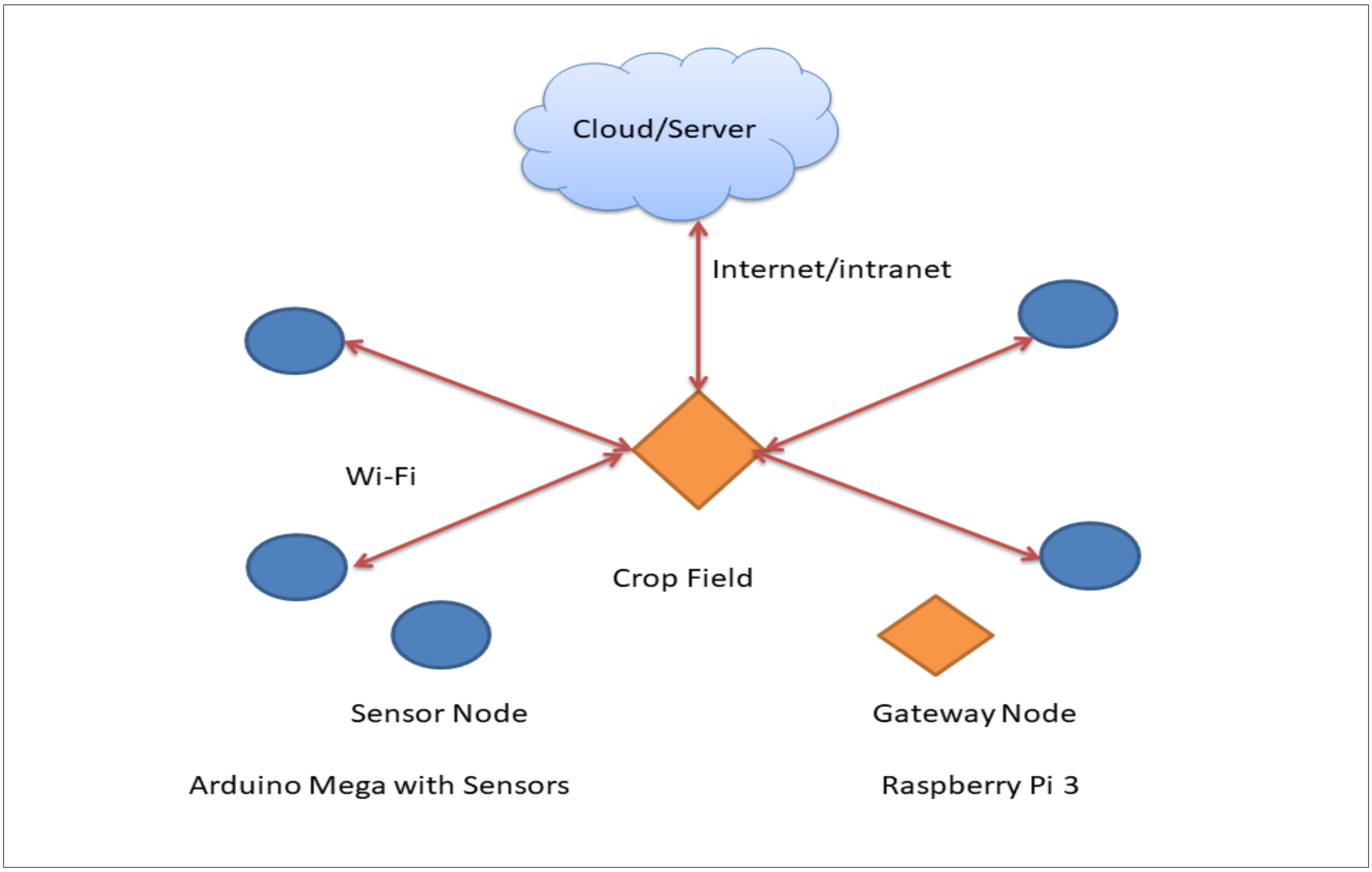

Fig 2. Distributed Wireless Sensor Network Representation

D. Node Structure Mode

Use The best scope of the solution will be produced when each node in the automation system consists of a microcontroller which is recommended to be Arduino mega, but this depends upon the scale of implementation the other can also be chosen such as Arduino Uno R3 and Node MCU. Every node in the automation system is connected to the DTH11 sensor, MQ2 sensor, Wi-Fi module, and battery module. Figure 3, represents a block diagram of each node.

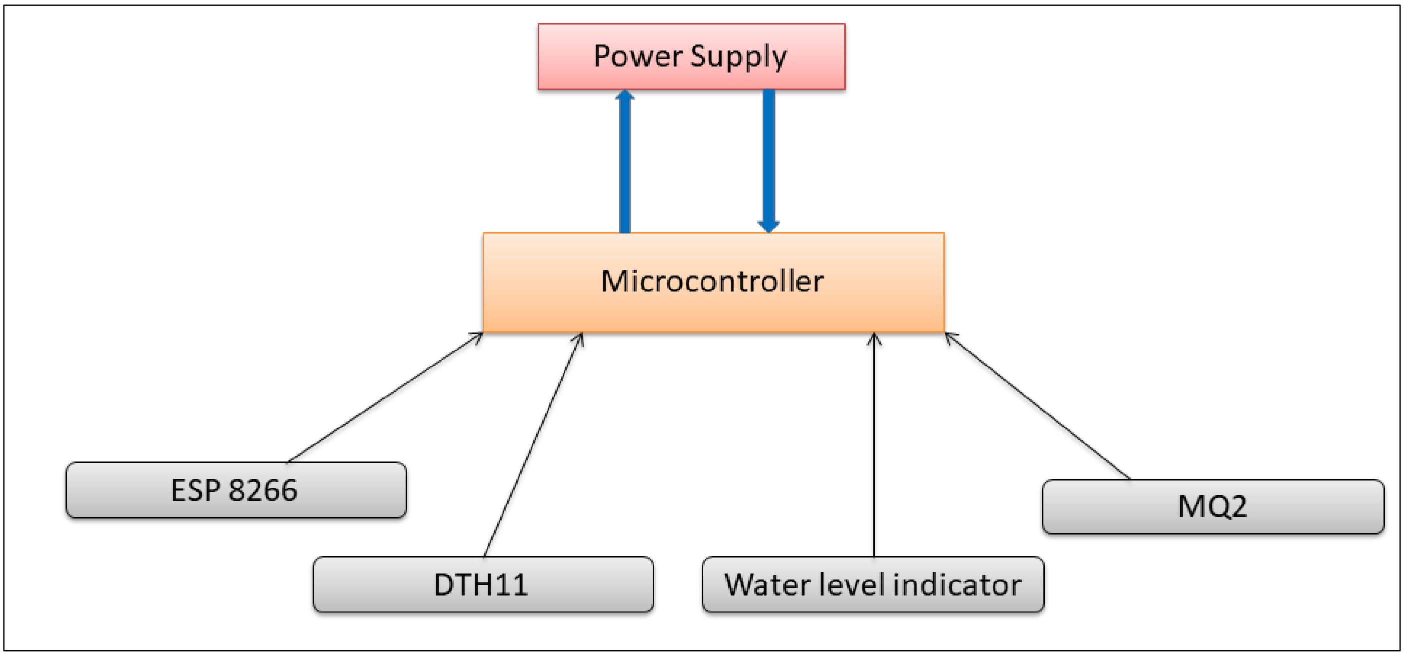

Fig 3. Sensor Nodes Configuration at Field

III. DATA MODELING AND ANALYSIS

An exploratory data analysis is done on "Agriculture Production in India ", for understanding the numerous crops which are grown in India, and based upon their production quantity and cost aspects many datasets available on Kaggle. Using Tableau, analysis is done in python and visualizations. An analysis is needed to be done for the foundation of substance This analysis lays the foundation of substance and need for automation in the sector where we need to reduce cost and surge productivity. Fig.5. represents the graphical results of data analysis [15], [21]–[23].

A. *Data Pre-Processing*

The data which has been collected by the sensors need to be processed and analyzed for the future as the signals need to be sent to actuators so that automatic alerts can be sent to the end-users to perform the necessary actions. Fig. 4. represents the flow diagram of the overall system. The script which is written in python will run in the raspberry pi that checks for all the different conditions from the data received from both nodes and the web. By using online open-source APIs, data of the weather will be fetched continuously. Based upon the weather condition if there is any probability of rain then an alert will be sent to the end-user so that the farm will not be irrigated. If there is any change in the weather condition like a probability of humidity drops beneath a certain threshold for a specific crop, then an automatic alert will be sent to the end-user so that they will be irrigating their farm. Using machine learning techniques, based upon the farm soil type will be determined automatically. Support vector classification is the best algorithm for soil type classification as per the literature review. Thus, after processing all the available parameters a control signal will be passed from the gateway node (Raspberry Pi 3 B+) to the actuators (Solenoidal Valve, etc.) which will start the water pump in the farm. Based upon the certain level of humidity of the farm, the fixed time interval of the continuous polling of the soil humidity will be operated and irrigation will be stopped.

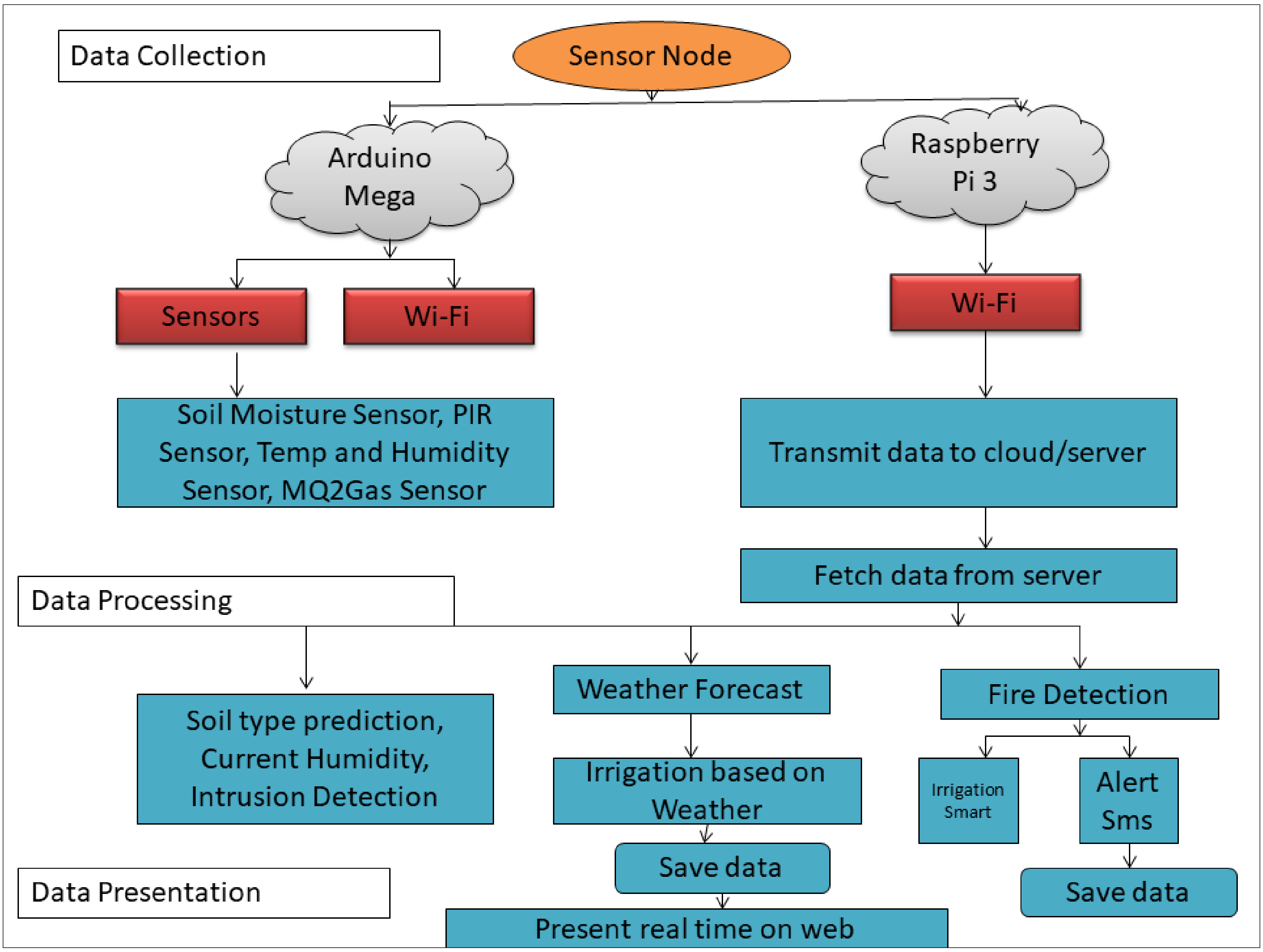

Fig 4. Smart Farm – Functional Block Diagram

B. *Indian Agriculture Data Analysis*

An exploratory data analysis is done on "Agriculture Production in India ", for understanding the numerous crops which are grown in India, and based upon their production quantity and cost aspects many datasets available on Kaggle. Using Tableau, analysis is done in python and visualizations. An analysis is needed to be done for the foundation of substance This analysis lays the foundation of substance and need for automation in the sector where we need to reduce cost and surge productivity.

C. *Soil Moisture and Weather Data Processing*

Digital Humidity and Temperature sensor (DHT1) is been used to measure soil, which will be measuring both humidity and temperature. The current state of irrigation in addition to the exact need for more water resources determined by DHT11 which gives RH %.The general range of DHT11 RH % varies from 20% to 90%. Machine learning algorithms that were appealed on the previously collected data so that they can be used to optimize the crop irrigation. A qualified study of multiple linear regression and Support vector regression and random forest regression was carried out For predicting the soil moisture, which accords the following results as shown in fig. 6. For predicting the relative humidity which is based upon the past data and condensation probability fetched from open source weather API providers using R programming and ***rvest*** package of R. The predictions are mostly made because of past day relative humidity and condensation probability, The

Table depicts data of certain observations from DHT11 sensor which are carried out during investigation phase and the condensation data fetched from online open sources. For More specific crop irrigation, the formula:

$$EVo \times Cf = Wneed \quad (1)$$

EVo , Cf, and Wneed are explained in detail as follows, Where EVo is the evapotranspiration reference, Cf is crop factor and Wneed is the per day water need of the crops. As this paper comes up with automated farm monitoring and irrigation is one of the most noteworthy activities in agriculture so it needs to be taken care of with utmost high accuracy. The amount of water required to the crop is based upon the crop type, weather conditions, and the growth stage of the crop play a vital role and thus the generic salute towards water needs of crops tends to provide wrong details. The complete detail about irrigation direction and their approaches provides some of the best viable ways for irrigation. Thus with exact water need data, irrigation is to be carried out efficiently and sustainably.
Table 1. represents the relative humidity predicted values.

Actual Relative Humidity %	Precipitation %	Predicted RH %
41	3	39
37	70	65
73	99	77
46	0	32
91	59	71
75	95	75

Table 1. Smart Farm based Irregative –relative Humidity prediction

D. *Data Presentation*

The data needs to be obtainable on a potent website, which will be representing the real-time data analytics and the time-stamped irrigation ornamentation so that in case of any peculiarity corrective measures can be taken easily. Visual line graphs tend to dispense temperature and humidity values with the timestamps thus authorize an easy-to-understand, agile and fast implementation of the system. Table 2. represents the sample temperature graph of raspberry pi 3.

Hours of Time (IST)	Temperature
9	27
10	30
11	33
12	35
13	36
14	40
15	38
16	35
17	33

Table 2. Variations in the Temperature based on Time Frame

E. *Results*

An automated farm monitoring system is prospered which is an imperishable solution to various existing and un-for seen plagues such as starvation due to food shortages and economic crisis. IoT and Machine learning algorithms such as SVR (Support Vector Regression) and SVM (Support Vector Machine) with Radial basis function kernel help in categorizing and vicenary predictions of crop type, soil type, and amount of irrigation required by the crops. In different regions of India, The analysis of the “Agriculture Production in India “dataset gives guidance about the agriculture industry. The comparative analysis of various algorithms recommends that Random forest regression gives a level-headed accuracy of 81.6% and the soaring F score for predicting RH(%), in contrast to other algorithms. The p-value appointed by the model for independent variables and the dependent variable is less than the significance level of 0.05. Smart farming salute that could help everyone from a large-scale farming industry to a small-scale farmer to even household garden owners. The inter-comparability of various devices certify a smooth flow of all activities at an ease. The soil moisture prediction results are shown in Fig5.

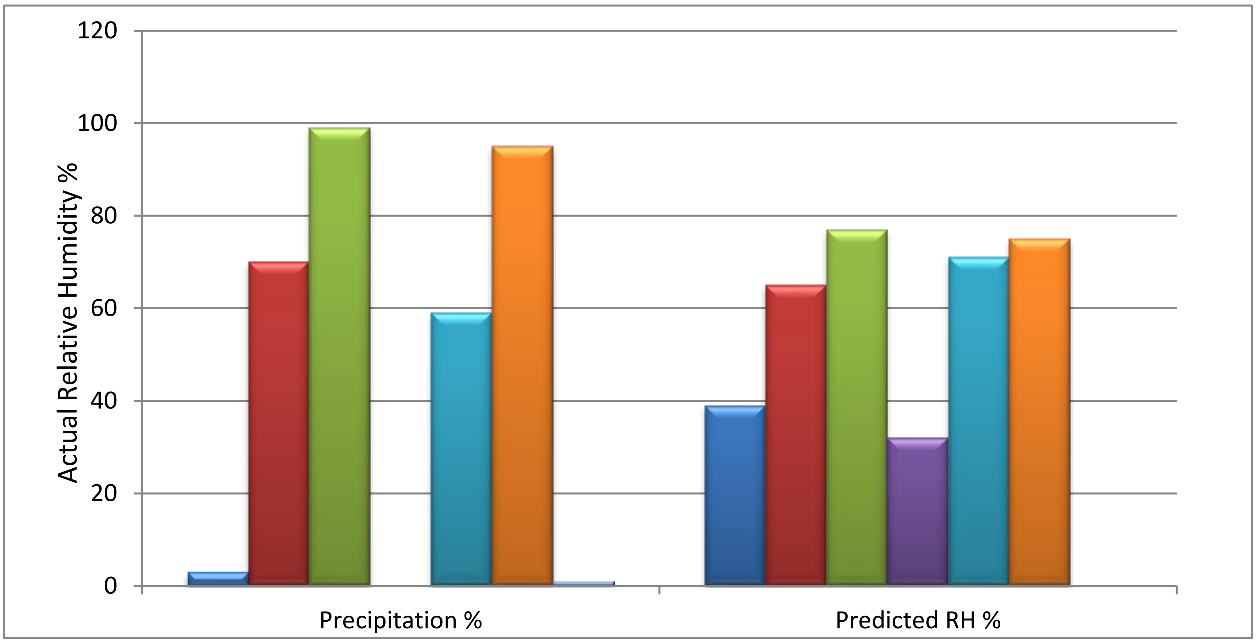

Fig 5. Predicted RH %

IV. CONCLUSIONS AND DISCUSSION

There are few challenges around the implementation of this research those are, 1.Utmost weather conditions constitute a serious threat to the solution proposed in this research. 2. The projection accuracy hangs upon the proper installation of the setup. 3. Machine learning algorithm needs to be upskilled on large as well as region-specific data. 4. Wild animals also pose a threat to the hardware although they would be recognized upon entering the field but requires manual intercession to prevent any kind of damage to the hardware. 5. A committed server/network storage needs to be there for the visualization purpose. 6. The reliability of the model prediction depends on data available. 7.The SVR fidelity depends on the hyper-parameters and type of kernel selected. The scope of this research presents an inexpensive approach towards automating the agriculture industry, it provides a feasible and computationally well-organized approach based on the Internet of Things. Exhibit a proper distributed network bestow to the accuracy of the predictions made by Random Forrest Regressor, SVR. Node inter-connectivity of the sensor will help monitor the complete field conscientiously. To implement a system that would be mobile and can help in every step of farming i.e. from the sowing of seeds to reaping of crops is proposed as future work. The use of tools for automating predictions with the help of hyperparameter regulate and septet learning is suggested as future work in this research study. A mobile, dynamic and vigorous approach towards the proposed automation represents the future scope.

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