Analysis of Precision Agriculture based on Random Forest Algorithm by using Sensor Networks

K.Pavithra, *PG Scholar*[1]
Computer Science and Engineering
National Engineering College,
Kovilpatti, Tamilnadu
kpavithrakrishna1996@gmail.com

M. Jayalakshmi, *Assistant Professor*[2]
Computer Science and Engineering
National Engineering College,
Kovilpatti, Tamilnadu
jayalacsmi@gmail.com

Abstract— **India is the largest country where most of the human lives depends upon agriculture. Due to the shortage of water facilities, the yield of irrigation is affected. To reduce this shortage of water, different types of methods are invented to supply the correct level of water to the agricultural lands. Here precision irrigation system is used to maintain the perfect water supply from this method wastage of water can be reduced. By using this technique, we can achieve better harvesting results. The total amount of water for lands and plants can be calculated by using the PH value. To detect the PH level, a random forest algorithm is used. There is a direct relationship between the number of plants in the land and the results it can get. It improves the prediction accuracy.**

Keywords— ***Irrigation, Precision Agriculture, Random Forest Algorithm, Water Prediction***.

I. INTRODUCTION

Agriculture is one of the most important aspects of the economic growth of India. It has been in the country for 1000 years. As agriculture has grown over the years, traditional techniques have changed with the use of new technologies and equipment. However, some small farmers in India still use old traditional farming methods. This is because there is not enough money to use modern methods. At present, the growth of agriculture is slowing due to water shortage. Traditionally, 50% of water is wasted, and production is reduced. To avoid this, an automated irrigation system can be used; 70 % of water can be saved in this manner. Various irrigation methods have come up in the last few years, such as drip, sprinkler, pivot, etc., an irrigation system is used to measure the soil moisture and temperature by using monitoring networks. This data hits the central computer for farmers to know

Wireless sensor network (WSN) is designed by using spatially distributed self-governing devices that use sensors for monitoring the physical or environmental condition.WSN measures temperature, wind speed, pressure, soil condition, humidity, and solar radiation, etc. There are different types of sensors used, such as temperature sensor, light sensor, proximity sensor, moisture sensor, etc. Moisture sensors used to collect the physical data and passed through cluster head. Cluster head analysis the data and sent the data to the data center.

A. Merits of precision irrigation

Accurate irrigation makes it possible to expand water use and financial capabilities. It has been reported that by using this irrigation (Center pivot & drip), the software effectiveness of water can enhance up to the tune of 70-80% as in opposition to 50-65% in the surface irrigation method. The potential financial merits of precision irrigation are reducing the cost of inputs or growing the harvest for the same information.

B. Water storage

The main purpose of precision irrigation is to maintain the most suitable irrigation during the fieldwork. This has been pronounced by many researchers as the most feasible ability to achieve enormous water savings. The online precise or variable-rate irrigation is considered as a critical or vital aspect of precision irrigation. Most investigators consider reducing water use in low-lying areas; the accumulated value of the whole fields is not reduced. The variable rate irrigation may want 20 to 25% of the water used in conventional irrigation practice. By using spatially different irrigation applications, the water's financial savings of around 35% are possible.

II. RELATED WORK

Soil fertility and moisture level are the two main aspects to be considered while designing an irrigation system. The authors in [1] discussed a module to control a motor and valves (pipes) based on the fact abstracted from various sensors. A Message Queue Telemetry Transport (MQTT) server analysis the whole system through data connectivity.

Proper irrigation is mandatory in water scarcity areas. Hence the author in [2] accentuates a framework to minimize the need for water level for agricultural purposes. In this paper, the threshold values from different sensors are programmed to design an efficient algorithm. The sensing and pumping unit plays a vital role in this automatic irrigation system.

Automatic irrigation plays a vital role in high crop yield. In [3], a microcontroller (ATMEGA) is used as an intermediate device between the sensors and the motor. The fluctuations in the sensors are monitored as are chance needed measures are taken for irrigation automatically. The main advantage is that it is cost-effective and user-friendly.

Agronomy practice is a key factory leading to chroman civilization. Hence author in [4] discussed the various parameters which play a significant role in crop yield and harvest. These sensors (humidity sensors) are at low applicable cost with high beneficial outcomes. The advanced methods are far improved from other traditional methods like overhead sprinklers etc.

Agriculture faces tremendous advancements and modernizations in today's era. In spite of these various measures, high crop yield and availability are still in demand. The proposed system in [5] deals with a sensor for soli monitoring. The complete network is automated in the control of dripper valves and motor pumps. Significant feedback of the soli detects it is provided to the final user, and hence the land is irrigated.

In [6] this irrigation system, water requirement per hectare is calculated. By considering certain factors such as Crop type, Crop state, soil condition, ETo, temperature level, Humidity, Pressure, etc. Based on the collected data, we find the Evaporation Rate (ETo) –The amount of water gets evaporated on climate. The higher the values of ETo are located in the area, which is hot, dry, windy, sunny, whereas low costs are observed in the locality where it is glacial, muggy, clouded with lacking air. The notification of water requirement will be sent to a farmer's mobile if the moisture level is below the threshold for a particular crop by using the mobile application (APP). This method is expensive because they require extensive hardware, and the accuracy level will reduce if there is any problem that occurs in the system. For water requirement calculation, some of the factors are considered, so effective mechanisms required in a mobile application that provides the result, even when hardware fails. For this issue, it is proposed to use the Random Forest Algorithm to improve accuracy.

III.PROPOSED METHODOLOGY

In this system, three main modules for the water irrigation systems are dataset collection, preprocessing, random forest classification. For the first module, data are gathered from three different sources; they are water transportation statements, weather data brought from the wireless sensor network, spatial data. After that, to perform preprocessing for water delivery statements, Reference Evapotranspiration based Pre-processing (REP) is applied. The weather-based method uses atmospheric temperature, humidity, solar radiation, wind velocity, soil texture, root zone depth, crop coefficient (Kc), and rainfall data as inputs. The water requirement of the plant is calculated based on current weather data like-sun radiation, atmospheric temperature, wind velocity, and air humidity. Evapotranspiration (ET) represents the combined effect of evaporation and transpiration process. It is used to measure the water consumption of the plant. Finally, make the overall training dataset and then apply the Random Forest classification algorithm to predict the water requirement and time.

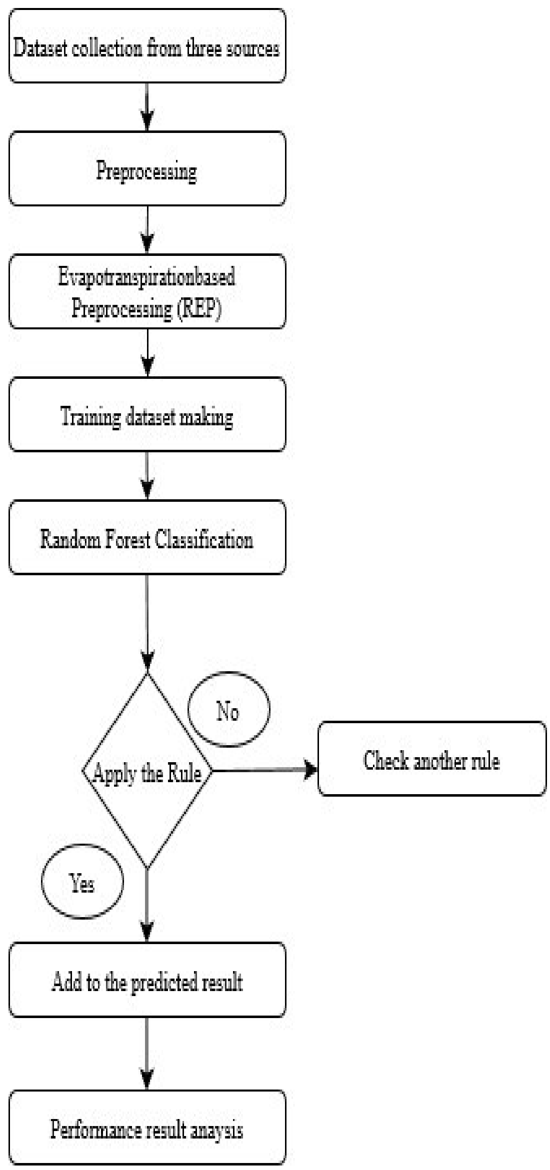

Fig.1. Proposed Flow diagram

A. Data Set collection

In this module, to collect the dataset wireless sensor network used. Data are collected from three different sources to build the training dataset. The first source is the water supply reports received from CICL, and it provides information on total water use for the crop growing season on each farm. The second source is weather data obtained from weather stations installed in the study area. The third source is two types of spatial data. A) Land use land covers pictures that provide us with information on the crops and the area under which they are cultivated. B) Soil type pictures that provide information on different soil types associated with farms in the study area.

	airtemp-average	airtemp-max	airtemp-min	humidity-average	humidity-max	humidity-min	pressure-average	pressure-max	pressure-min	rain_fall	soil_temperature
0	35	31	30	94	93	88	545	469	614	0.1	20.5
1	39	38	37	90	99	81	659	484	407	0.1	26.2
2	32	36	33	91	97	84	587	642	498	0.6	22.4
3	34	33	37	91	93	85	651	615	695	1.9	24.3
4	37	36	32	93	93	81	677	421	633	0.7	20.2
5	38	39	30	92	97	80	442	577	627	0.8	25.9
6	30	31	37	90	93	89	559	494	484	1.8	24.3
7	38	38	32	91	91	81	487	614	557	1.1	20.5
8	34	36	37	93	96	84	608	583	557	1.0	20.1
9	37	36	35	94	91	80	439	696	625	0.4	23.5
10	36	33	35	91	93	86	582	673	606	0.3	25.6
11	36	35	31	92	98	89	529	642	465	1.3	24.8
12	37	35	32	90	97	86	472	479	449	1.3	23.0

Fig.2. Shows the meteorological dataset obtained by various weather stations.

The training dataset includes historical data on soil type, crop name, and crop water usage, including characteristics of various climate parameters such as air temperatures (T-Max & T-min), wind speed, humidity, pressure, and solar radiation.

B. Evaporation rate calculation

Crop water usage can be calculated by Evapotranspiration (ET), which is the product of crop coefficient Kc and reference evapotranspiration (ETo). Each crop has a fixed crop coefficient value for a given growth stage. The crop water usage of a particular day can be calculated as follows. Let 'n' be the number of days between two consecutive water supplies per farm, 'WT' be the amount of water supplied during the delivery at the beginning of the 'n' days and 'Wi' is the water utilization in the i^{th} day. For all n days, ETo values are collected from our automatic weather stations (AWS) located in different parts of the irrigation area. Next, coefficient 'xi' determined for the i^{th} day. Finally, 'Wi' is calculated by multiplying xi and WT,

$$Wi = xi \times WT.$$

	crop	water	Area	per sqar	barch size	consumewater	0
0	Rice	4000	1	100	435.600000	9.182736	0.11644
1	wheat	3000	1	200	217.800000	13.774105	0.14274
2	Sugarcane	5000	1	200	217.800000	22.956841	0.51618
3	Jute oilseeds	3000	1	200	217.800000	13.774105	0.29816
4	pulses	3000	1	200	217.800000	13.774105	0.12906
5	wheat	3000	1	200	217.800000	13.774105	0.12906
6	Rice	4000	1	200	217.800000	18.365473	0.00282
7	millets	3000	1	200	217.800000	13.774105	0.21310
8	gram	3000	1	400	108.900000	27.548209	0.02504
9	pulses	3000	1	400	108.900000	27.548209	0.08322
10	oilseeds	3000	1	400	108.900000	27.548209	0.14392
11	cotton	3000	1	400	108.900000	27.548209	0.27562
12	sugarcane	5000	1	400	108.900000	45.913682	0.31722
13	wheat	3000	1	400	108.900000	27.548209	0.44318
14	groundnut	3000	1	9	4840.000000	0.619835	0.22438
15	wheat	3000	1	400	108.900000	27.548209	0.06856
16	maize	3000	1	200	217.800000	13.774105	0.21994
17	barley	3000	1	200	217.800000	13.774105	0.25084

Fig.3. Shows that crop water usage

C. water prediction

Random Forest Algorithm will be used to get better results. The output from this RF Algorithm will be compared with the ETo method results. Due to this comparison, efficiency and databases are improved.

	0	1	2	3	4	Soil Type	Crop Type	predicted
0	24.8	23.1	91.0	3.0	21.5	Alluvial soil	Rice	1.069238
1	22.9	22.8	94.0	3.0	22.7	Alluvial soil	wheat	1.966116
2	20.1	21.2	93.0	4.0	25.2	Alluvial soil	Sugarcane	11.849862
3	23.1	23.4	96.0	3.0	22.8	Alluvial soil	Jute oilseeds	4.106887
4	23.3	20.2	95.0	2.0	24.0	Alluvial soil	pulses	1.777686
5	20.2	21.4	94.0	3.0	23.4	Red soil	wheat	1.777686
6	22.8	20.2	92.0	3.0	21.4	Red soil	Rice	0.051791
7	24.8	21.2	91.0	3.0	23.8	Red soil	millets	2.935262
8	24.2	20.7	95.0	2.0	24.4	Red soil	gram	0.689807
9	23.9	23.2	99.0	3.0	22.5	Red soil	pulses	2.292562
10	21.2	20.5	93.0	4.0	21.6	Red soil	oilseeds	3.964738
11	21.6	21.6	98.0	3.0	21.0	Red soil	cotton	7.592837
12	22.8	22.2	94.0	3.0	20.2	Black Soil	sugarcane	14.564738
13	21.9	21.4	96.0	4.0	22.0	Black Soil	wheat	12.208815
14	21.1	22.5	98.0	4.0	23.2	Black Soil	groundnut	0.139079
15	21.1	20.5	93.0	2.0	24.9	Mountain soil	wheat	1.888705
16	21.3	21.4	93.0	4.0	22.6	Mountain soil	maize	3.029477
17	20.4	22.2	97.0	3.0	24.7	Mountain soil	barley	3.455096

Fig.4. Water Prediction

It Shows (figure 4) the water prediction on different soil condition using random forest algorithm to save the water level.

IV. CONCLUSION

The intention of this project is to regulate the water supply for the agriculture area; for this process, three datasets are collected from three different sources, such as water transportation report, meteorological data & spatial data. These obtained datasets are preprocessed by using a novel approach. By using this method, proper utilization of water can be occurred according to the soil moisture level. From this analysis, it is identified that the ETo & Random Forest Algorithm well suits to predict soil moisture levels. Based on the soil moisture level, it is highly possible to improve accuracy and increase agriculture production.

V. FUTURE WORK

In the future, the deep learning method is used to analyze the soil moisture level to improve efficiency. Recurrent Neural Network is used to predict the water level to enhance agriculture production.

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