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Smart Irrigation with Machine Learning Based Decision Support System

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***Abstract*—**Citizens in metropolitan centers, like developed areas, possess access to all basic amenities, such as electricity with few power outages, food, comparatively good roads and building infrastructure, and so on. Nevertheless, this may not be the case in rural areas, where power outages, agricultural issues, and inadequate water processing and marketing for various purposes, among other things, affect the majority of villages. As an outcome of our study, there are currently a number of variables that could affect the progress of a smart village. The define objectives of this study is largely automated hydrated agriculture, that is accompanied by an appropriate rainfall forecast system that can assist us in determining which farms are best for development in a certain location.A new method is also introduced, wherein the plants must be rinsed properly and the amount of time it takes for the motor to turn on. We can also save water and electricity that would otherwise be wasted on watering crops and put it to better use for village residents by re-using it for other purposes.

Keywords-*Rainfall Prediction; Smart Irrigation; Applications of Machine learning; Irrigation using Machine Learning*

I. Introduction

Crops are irrigated with a mix of groundwater resources, irrigated agriculture via hydraulic dams, and rainwater. Farmers select the crop for the season based on their geographic position on the planet, the atmosphere, and weather patterns in order to optimize earnings through maximum yield strategies. Meanwhile, as a result of these procedures, a considerable volume of water is lost to the ground, and there is no way to utilize it. The bulk of irrigation water originates from rivers, and because different forms of irrigation such as step irrigation, sprinkler, concentrated irrigation, and sprinkler irrigation may be used with the same quantity of water, different forms of irrigation such as sprinkler, intensified drainage, and drip irrigation may be utilized. Crops can receive water mostly during springs along with other times when freshwater is limited, resulting in an excess of electrical power generation and less fresh water for the sea.

The demand for food is increasing every day; as a result, gardening research teams, landowners, political figures, and geologists are doubling down on their efforts and implementing various agricultural systems to aid the country's development. As a result, the data generated in the field has been taken into consideration. As the quantity of data grows, a normal trajectory for mining and dissecting it when necessary is required. Only a few farm owners are successfully implementing sustainable irrigation techniques, equipment's, and continuous improvement production at this time.

Data mining can be used to forecast how future rural procedures will change. The procedures are effective in inspiring notable and useful learning that can be observed by a large number of people. Data mining programs are based on a variety of philosophies developed and used primarily by businesses and clinical research professionals. All of these strategies are aimed at achieving a specific learning goal. Standard measurable investigation methods are both time-consuming and costly to use. Constructive practices can be created and customized for illuminating complex soil statistical models leveraging data mining [1] to improve the feasibility and accuracy of the Classifier of large soil data sets.

These approaches can also be used in future irrigation applications, including interior and outdoor irrigation. A deep learning based model has been established that automatically modifies the crop's linear coefficients due to changes in soil humidity, temperature, root time beneath soil, as well as other contributing elements.

A. Complications Encountered while irrigating to crops

Now let us start with a discussion of the issues or difficulties that the villagers and farmers are experiencing. The majority of these issues ariseas a consequence of technological water usage, including a lack of comprehension of growing crops and the ground water needed for farming. The problem is categorized by 3 sections:

1) Water

There is a paucity of water in rural regions, as well as an unequal distribution of it. Many communities in our nation are expected to confront significant water shortage throughout the summer since more than necessary water is utilized to water crops. As a result, the villages' water supply for other reasons becomes insufficient. Many of the government sectors in these communities are unable to execute different water management strategies.

2) Power consumption

When another motorized pump is switched on, it consumes around 6 horsepower per acre. The motor does not need to operate for such an extended amount of time. In actuality, just 1-2 Horse Power is necessary to irrigate crops per acre. The motor is left on needlessly for the balance of the period. If we design and effectively install an automated watering system, we may use 70% of the electricity for other reasons.

3) Inadequate understanding of rainfall forecasting

Rainfall forecasting is an important factor in predicting the climate and the quality of the atmosphere g generating an adequate assessment is essential.Rain is a critical hydrologic requirement for asian countries, whose economics depend on it. In India, monsoon forecasting is extremely important. Farmers, on the other hand, are unable to predict the amount of rain that will fall and when it will fall because of less or no knowledge about it.

B. The Importance of Climate forecast Crop-related information

Climate change will affect the agricultural sector now and in the future, posing a challenge to the agricultural reserves of the farm's performance. The data generated by climatic prediction models is capable of lessening the intensity of extreme weather occurrences. This data is useful to farmers, who may make suitable plans to minimize the adverse effects of inclement weather and maximize output when the weather is favorable. climate forecast for various crop types, such as monthly, yearly, or seasonal planting schedules, enables farmers to take better judgments where the crops to plant and, as a result, boosts an individual farmer's production.

C. The requirement for a crop irrigation system that is automatic

The use of the proper irrigation method is critical in the field of agriculture. It's difficult to accomplish with little human involvement while also still ensuring proper hydration. [1]. The primary cause is a shortage of rainfall and water for agriculture cultivation. Crop growth now necessitates the availability of water. The issue is that enough water is being wasted in the name of crop production, resulting in a decrease in groundwater levels. Farmers are, however, embracing new modern techniques such as drip irrigation, which evenly distributes water to plants with minimal waste. However, someone must still keep an eye on the pump motor to ensure that no water is wasted unnecessarily. As a consequence, an autonomous irrigation system may be programmed to turn on the engine whenever the crop need more water and turn it off when the crop's water or humidity requirements have been fulfilled. It may take any soil characteristic, such as moisture content, and operate the engine for the period required to achieve that moisture level. In the event of an invasion interference, the farmer's telephone will be notified. The main water supply in rural areas is rainwater. Consequently, crop planning depends heavily on the ability to predict average precipitation. Rainfall is typically forecast by extracting enormous numbers of data from a certain condition of the environment to explain how the level of the atmosphere depends on the atmosphere's current features. Although the Rainfall synthesis method has been used in this system, which is used to irrigate [2] although it is possible to use such devices in energy-efficient models.

II. LITRETURE REVIEW

The automated irrigation system integrates technology, equipment and software with multiple methodologies to computing such as Artificial intelligence, machine learning and IoT. It is important and necessary to civilization because of the effective production of crops and resource efficiency. Efficient ways are necessary to optimize the water, monitor humidity and enhance yields. This article [3] examines numerous current techniques for the use of IoT and artificial intelligence in agriculture using intelligent irrigation systems. The many parts, modern irrigation systems, numerous comparison measurements and their demands are discussed on this paper. Finally, many issues, barriers and future research objectives were emphasized in the intelligent irrigation system.

This paper[4] discusses an advanced smart system for prediction of the irrigation requirements of a field using a machine learning algorithm to monitor soil characteristics, such as soil moisture (ML). There are already excesses of existing algorithms such as K-mean and SVM. In order to resolve this issue, we have employed the K-Nearest Neighbor technique in conjunction with this recommended system, which has the capacity and depth of the information processing results utilising three weeks of pre-defined data based upon the provided methodology to implement a comprehensive automated irrigation system. The technology is capable and the forecasts accurate.

As time is scarce, individuals cannot provide time to conventional agriculture; hydroponic agriculture, an intelligent irrigation system approach, is thus applied in the present study to help individuals residing in urban and metropolitan areas[5]. In normal frame approaches, water and space are required abundantly and this irrigation system avoids water utilization and saves room. This proposed project aims towards the development of an automated irrigation agriculture system, which integrates data from all Rasperry Pi sensors and sends them over the network to an IoT server. In the meanwhile, the user can see the information stored on the system using a web-based application to see the condition of the system. The user may turn on/off the motor to water the system as necessary, knowing the status of the system. Plant growth may be forecasted using an approach of machine learning that accumulates sensor data.

The aim of this study [6] is to find the ideal period for administering water to an agricultural region by applying machine learning algorithms. The use of large amounts of data previously generated by the Wireless Sensors Network (WSN, for its initials in Spanish) disseminated in a field enables the exploration of technologies allowing users to determine if the optimal time to use water to reduce scheduled irrigation, which frequently leads to water waste.

The model proposed in this study [7] is a clever irrigation system with a machine learning algorithm that estimates crop water requirements. The most significant elements to consider when evaluating the amount of water required in each agricultural region are humidity, temperature and humidity. This system comprised of temperature, humidity and moisture sensors in an agricultural field, and transmits data by means of a microprocessor which leads to the establishment of a cloud connectivity IoT device. The Decision Tree Method, an efficient machine learning methodology, is used in order to effectively anticipate results for field observations. Farmers may make educated judgments regarding the water supply by sending an email alert to the conclusions of the decision-tree algorithm.

This research[8] provides a strategy for machine learning that detects water from aerial irrigation systems imaging. This automatic identification can help to examine irrigation systems, saving system maintenance time and money. Preliminary results show that water on images obtained by a non-manned aerial vehicle is recognizable using the Mask R-CNN Network (UAV). The aim is to detect defective watering systems that might lead to under watering or overwatering that might risk the proper implementation of the irrigation plan.

In order to capture soil moisture, pH and temperature data, the study's author[9] built a smart low cost device. The author concentrates on building a device with Arduino and a variety of sensors and modules for collecting data at various points across the farm. After the gadget collects this data, it may transfer them to a service via the Wi-Fi module. The author simultaneously analyses this data with a high accuracy Artificial Network model. Based on the results the system controls a valve to automatically start and stop the flow of water in the farm.

This work[10] enhances intelligent irrigation systems with the monitoring of soil humidity and the use of deep classifications to characterize soil conditions for water-sensitive crop plants. This shows that plants, such as chalk, carrots and spinach, are not able to prosper with little or much water as a topic of this study. The results of this simulation of the water system show that water volumes and good soil humidity conditions are classified using a droplet water system which enables plants to develop properly.

The authors in this paper [11] compared NaiveBayes, J_{Rip}, and J48 soil categorization methods. The most successful approach was identified to be J48. They also use regression techniques such as linear regression and the least square Median. In terms of prediction outcomes, they discovered that least mean average squares regression outperformed classical linear regression.

Here [12] the authoruses a decision tree to help them choose the optimal irrigation pump. This study [13] forecast rice yield using Multiple Linear Regression. Using the decision tree induction methodology, whereas the author in [14] study the effect of maximum and lowest temperature on soybean productivity. The author in [15] uses agricultural data to examine four regression approaches. In terms of yield prediction, he observed that support vector regression beats the MLP, RBF, and RegTree models.The study presented in [16] uses MLP and K- Mean to forecast yield in the Andhra Pradesh district of East Godavari.

III. Methodology

The methodology consist of three sections as follows:

- Analysis based on Time-series
- Artificial Neural Network Model.
- Multi Linear Regression Model.

While regression is, in fact, a knowledge methodology, it leverages the connection between two or more elements in an empirical dataset to determine the dependent variables from some of the other variables. These are some of the objectives of a regression model is to determine if the independent variables are able to determine the frequency (dependent variable) [17][18].

Adjusted R2, also known as variables are measured or strength of determination, is a measure of the accuracy of the prediction.

A multiple linear regression analysis [19] is used to predict the regression models where Y provided a series of measurements (X_1, X_2 ...X_N).

A. Moving Average

A moving average (sometimes called as a composite index or shifting average) is a statistical technique that evaluates data points by computing the mean values of several subgroups of the full data set [20]. It is also known as a moveable mean (MM)[21]. That a first element of the resistance line is estimated by using the training dataset estimate little proportion of the number series[22][23] given a sequence of blocks and an adjusted subset size. The subset is then amended by "shifting forward"[24], which includes eliminating the first number in the sequence while including the for another number in the series following the initial subset.This results in the establishment of a new subcategory of statistics, which is then averaged. This procedure is repeated throughout the entire data set[25].

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots\dots\dots + \beta_n X_n$$

Where,

Y= Prediction of Rainfall

X1 denotes the Average value of Temperature (C)

X2 denotes the Maximumvalue of Temperature (C)

X3 denotes the Minimumvalue of Temperature(C)

X4 denotes the value of Average Humidity(C)

X5 denotes the Pressure of the Sea Level value (hPa)

X6 denotes the value of Speed of the Wind(km/h)

B. Block Diagram

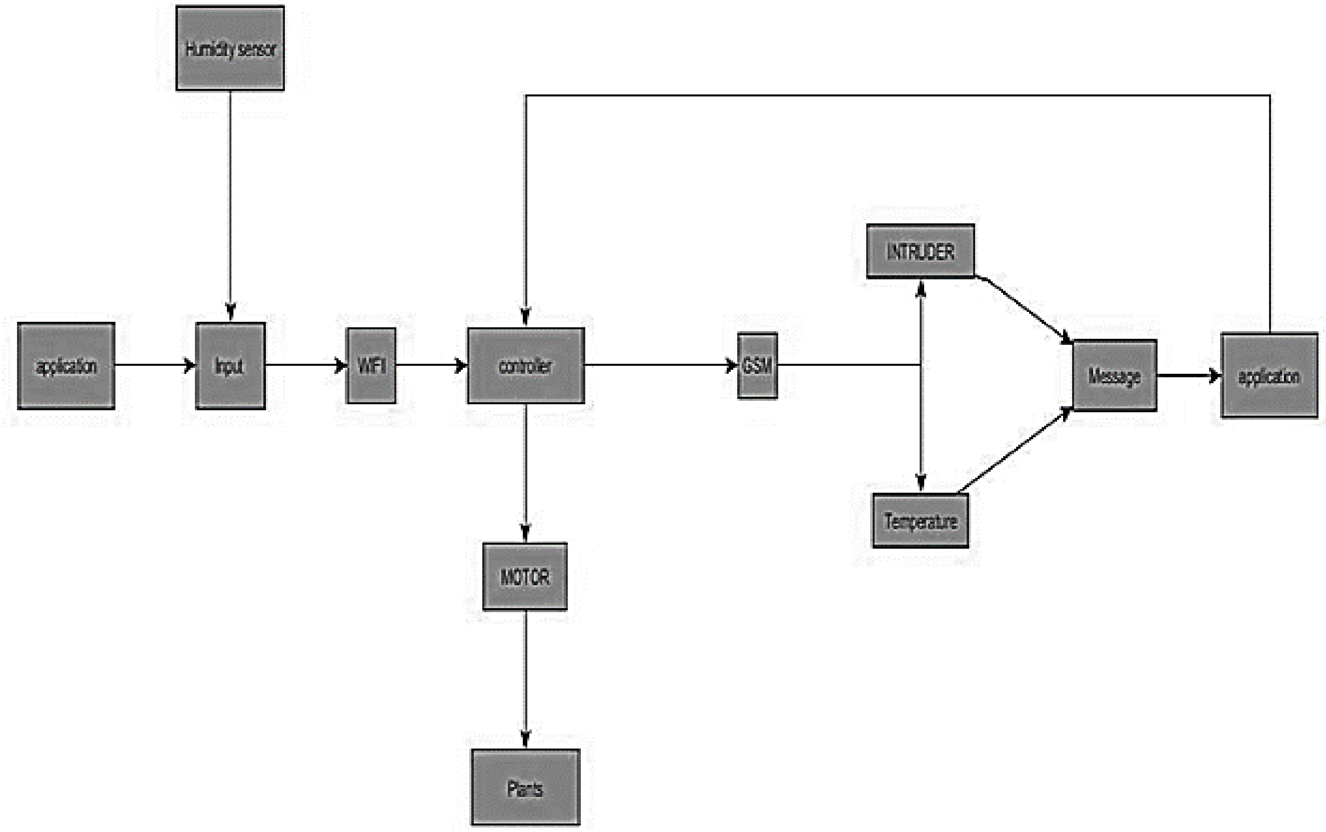

Figure 1. Block diagram of the system

C. Execution Steps:

- An android Application is been used for controlling the system
- Based on the stage of the crop and its type, the input will be given
- WIFI will act as a receiver.
- If the system suspected anyintrusion or detected any rise in temperature,the system will send a message to the farmer. The farmer can than make a decision to turn ON or OFF the controller.
- The quantity of the water to be given to each crop will be calculated using method called as Romyan.

D. Romyan's Algorithm:

Evaluation of the amount of time required to water crops for each type of soil.

One cubic meter of soil is equalized with x cubic meters of water, resulting in a humidity level of 100 percent.

M X N crops are considered to be present per sq. meter

Area be Y sq meters.

For each stage, set the depth of the root immersed in the soil to Z meters.

Let P denote the motor's power consumption in Horse Power.

Let W represent the quantities of water rate that Pump can discharge.

1 Gallon of water which is equivalent to 0.3 mm is required

F represents the soil factor

- Ideal case:

$$Wreq = N \times M \times Y \times Z \times X$$

When different types of soils are present, as well as humidity values, Depending on the soil, the optimum level of soil humidity for crops is 60 to 80 percent.

$$Wreq = N \times M \times Y \times Z \times X \times F$$

• Time= $T = \frac{Wreq}{W}$

Where W is the water delivered in liters by pump of P Hp.

•W_{req} of water

Pf is calculated power $Pf = Wreq \times \frac{P}{W}$

Power saved= $Psaved = (1 - \frac{Pf}{P}) \times 100$

Also, $Psaved = (1 - \frac{Wreq}{W}) \times 100$

D. Flowchart

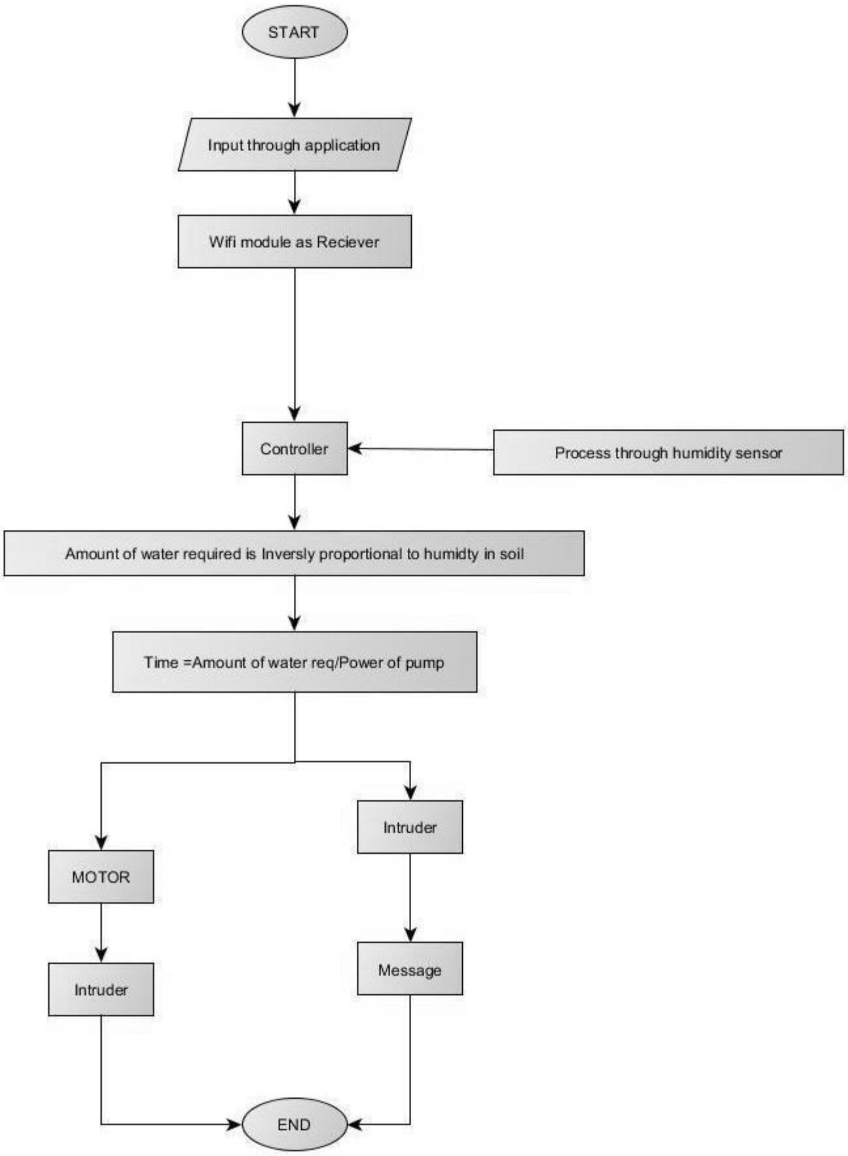

Figure 2. Flowchart of the System

IV. EXPERIMENTAL RESULTS

The dataset utilized in this system provides rainfall data from different places throughout the country. It includes rainfall data from 2000 to 2010. Along with the whole, rainfall data and precipitation between both the transition of two months have also been considered. The collection has a total of 1136 rows. This information was acquired through Kaggel.com.
Category :--- Rainfall in India
Released under – NDSAP
Group – Rainfall
Sectors – Atmosphere science, earth sciences, science & technology.

This technique utilizes a dataset containing rainfall measurements from several places around the nation. The precipitation from 2000 to 2010 is the same for the reservoir. Additionally, rain that occurs every year is also included in the total amount of rain consumed. Rain that changes from one month to the next is also counted. There are 1136 rows in the dataset, including null values. The dataset has been acquired from Kaggel.com.
Category – Rainfall in India
Released under – NDSAP
Group – Rainfall
Sectors – Atmosphere science, earth sciences, science & technology.
The following figure 3. Shows the year wise prediction of rainfall measures against the measured rainfall. Similarly, figure 4. Shows the comparison day wise.

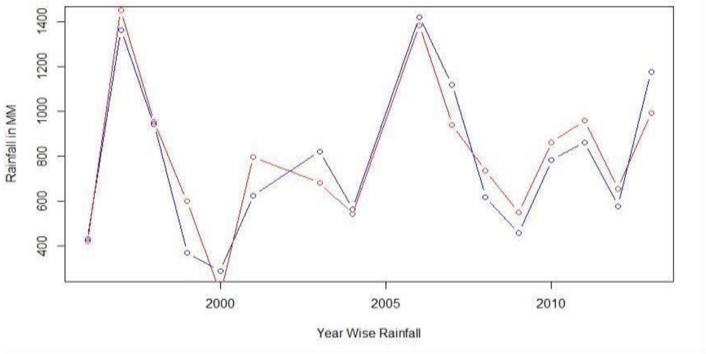

Figure 3. Year wise Prediction

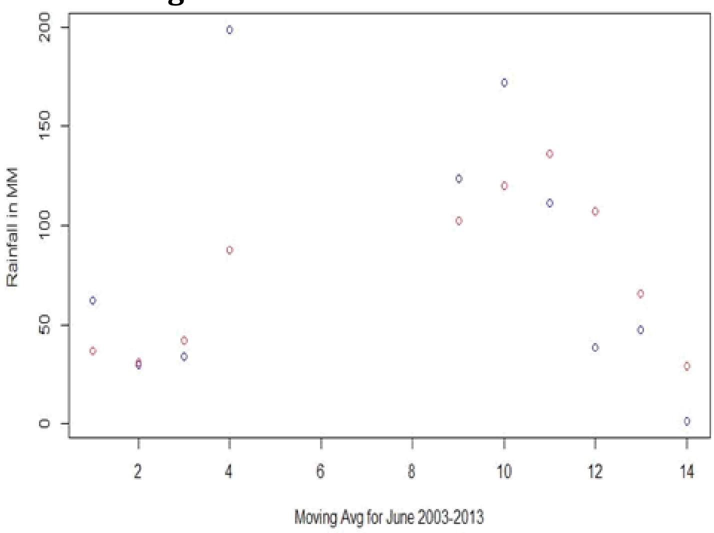

Figure 4. Day wise Prediction

Table 1. Water consumption For Each Plant during thecomplete Crop season

	Type of Crop						
stage	Beans	Citrus	Cotton	Groundnut	Maize	Millet	Rice
1	300	900	700	500	500	450	1000
2	350	1000	900	550	600	500	1100
3	450	1100	1100	600	700	600	1200
4	500	1200	1300	700	800	650	1200

Table 2. Water consumption For Each Plant per Day for Each Stage

	Type of Crop						
Stage	Beans	Citrus	Cotton	Groundnut	Maize	Millet	Rice
1	1.17	3.33	2.6	1.5	1.11	3.611	6.1
2	1.2	3.5	2.78	1.75	1.24	3.642	6.334
3	1.38	3.72	3.12	1.67	1.27	3.7	6.56
4	1.4	3.98	4.75	1.6	1.27	3.712	6.667

Table 3. Amount of water required

	Type of Crop						
Stage	Beans	Citrus	Cotton	Groundnut	Maize	Millet	Rice
1	4712	6628	8970	5175	3830	12459	21048
2	4140	12075	9591	6037	4280	12567	21855
3	4761	12834	10764	5982	6352	12766	22635
4	4830	13731	16387	5520	7660	12807	23005

V. CONCLUSION

This study proposed a strategy for developing an improvised system for irrigation as well as an effective forecasting algorithm for rainfall prediction. These two features, if carried out appropriately, may be one of the most significant components in ensuring that all of the resources available to it are utilized properly. In the future, we will be able to update the irrigation system we created and the rain classification techniques we created to sophisticated and more innovative levels. We can apply the rainfall prediction system we developed for analyzing and predict the rainfall for a broader area, such as with a state or a district. The experiment presented in the study, uses the structured data for the analysis. In the future, it will be feasible to operate with unstructured data. From a technology aspect, we may utilize a number of machine learning approaches to try to find the optimal forecasting methodology.

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