An IOT based Smart Irrigation System using Soil Moisture and Weather Prediction

Dr. S. Velmurugan[1], V. Balaji[2], T. Manoj Bharathi[3], K. Saravanan[4]
[1]Professor & Head, Department of Electronics and Communication Engineering,
[2, 3, 4]Student, Department of Electronics and Communication Engineering,
T.J.S. Engineering College, T.J.S. Nagar, Kavaraipettai, Chennai-601206, Tamil Nadu, India

***Abstract*:- The scarcity of clean water resources around the globe has generated a need for their optimum utilization. Internet of Things (IoT) solutions, based on the application specific sensors' data acquisition and intelligent processing, are bridging the gaps between the cyber and physical worlds. IoT based smart irrigation systems can help in achieving optimum water-resource utilization in the precision farming landscape. This paper presents an open-source technology based smart system to predict the irrigation requirements of a field using the sensing of ground parameter like soil moisture, soil temperature, and environmental conditions along with the weather forecast data from the Internet. The intelligence of the proposed system is based on a smart algorithm, which considers sensed data along with the weather forecast parameters like precipitation, air temperature, humidity, and UV for the near future. The complete system has been developed and deployed on a pilot scale, where the sensor node data is wirelessly collected over the cloud using web-services and a web-based information visualization and decision support system provides the real-time information insights based on the analysis of sensors data and weather forecast data. The paper describes the system and discusses in detail the information processing results of three weeks data based on the proposed algorithm. The system is fully functional and the prediction results are very encouraging.**

Keywords: Internet of Things (IoT), sensors, prediction algorithm, Irrigation Management, Precision agriculture.

1. INTRODUCTION

In India, where 60-70% economy depends on agriculture, there is a great need to modernize the conventional agricultural practices for the better productivity. Due to unplanned use of water the ground water level is decreasing day by day, lack of rains and scarcity of land water also results in decrement in volume of water on earth [5]. Nowadays, water shortage is becoming one of the biggest problems in the world. We need water in each and every field. In our day to day life also water is essential. Agriculture is one of fields where water is required in tremendous quantity. Wastage of water is the major problem in agriculture [7]. Every time excess of water is give to the fields. There are many techniques to save or to control wastage of water in agriculture.

The objective of the system includes conserve energy and water resources, handles the system manually and automatically, detects the level of water. Due to the climatic changes and lack of precision; agriculture has resulted in poor yield as compared to population growth. Irrigation is mostly done using canal systems in which water is pumped into fields after regular interval of time without any feedback of water level in field. This type of irrigation affects crop health and produces a poor yield because some crops are too sensitive to water content in soil.

For effective and optimum utilization of fresh water in irrigation, it becomes essential to develop the smart irrigation systems based on dynamic prediction of soil moisture pattern of the field and precipitation information of upcoming days. This paper presents an intelligent system that predicts soil moisture based on the information collected from the sensors deployed at the field and the weather forecast in- formation available on the Internet [13]. The field data has been collected through a self-designed sensor node.

The server-side software has been developed with node side connectivity along with information visualization and decision support features. A novel algorithm has been developed for soil-moisture prediction, which is based on Machine Learning techniques applied on the sensor node data and the weather forecast data. The algorithm shows improved accuracy and less error. The proposed approach could help in making effective irrigation decisions with optimum water usage.

2. LITERATURE REVIEW

In the system uses arduino technology to control watering and roofing of the green house [1]. It uses statistical data acquired from sensors (like temperature, humidity, moisture and light intensity sensors) compared with the weather forecast for decision making. Kalman filter is used to eliminate noise from the sensors. Agriculture System (AgriSys) [2] uses temperature, pH, humidity sensors and the hybrid inference to input the data from sensors.

The system monitors the sensors information on LCD and PC. Muhammad (2010), [3] Proposed a simple approach to "Automatic Irrigation control problem using Artificial Neural Network Controller". The proposed system is compared with ON/OFF controller and it is shown that ON/OFF Controller based System fails miserably because of its limitations. On the other hand ANN based approach has resulted in possible implementation of better and more efficient control. These controllers do not require a prior knowledge of system and have inherent ability to ANN based systems can save lot of resources (energy and water) and can provide optimized results to all type of agriculture areas.

Sanjukumar (2013), [4] Proposed "Advance Technique for Soil Moisture Content Based Automatic Motor Pumping

for Agriculture Land Purpose" was developed and successfully implemented along with flow sensor. Salient features of the system are: Closed loop automatic irrigation system, temperature and water usage monitoring. User can easily preset the levels of the Moisture and is regularly updated about current value of all Parameters on LCD display. In future, other important soil parameters namely soil pH, soil electrical conductivity will also be incorporated in the system.

S Nalini Durga (2018) proposed "Smart Irrigation System Based on Soil Moisture Using Iot" Agriculture remains the sector which contributes the highest to India's GDP. But, when considering technology that is deployed in this field, we find that the development is not tremendous. Now a day's there is huge enhancement in technologies which have a significant impact on various fields like agriculture, healthcare etc. Agriculture is the primary occupation in our country. India's major income source is depending on agriculture therefore the development of agriculture is important. In today also most of the irrigation systems are operated manually. The available traditional techniques are like drip irrigation, sprinkler irrigation etc. These techniques are need to be combined with IoT so that we can make use of water vary efficiently. IoT helps to access information and make major decision making process by getting different values from sensors like soil moisture, water level sensors, water quality etc.

In paper [6], wireless sensor network is integrated with ZigBee to transmit soil moisture level and temperature values. The data is transmitted to a web server using GPRS through cellular network. The data monitoring can be achieved via internet using graphical application.

3. PROPOSED SYSTEM

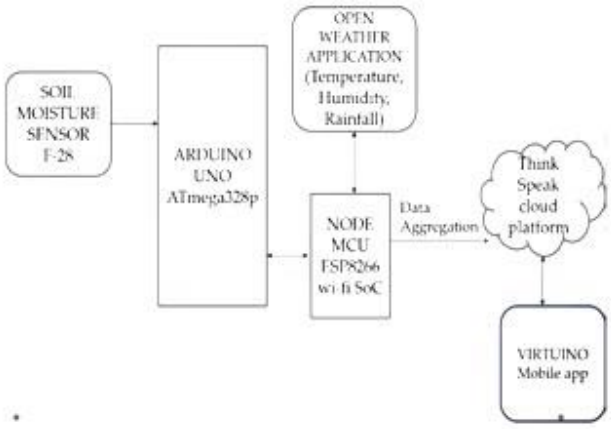

Fig.1 Block diagram of proposed system

Irrigation can be automated by using sensors, microcontroller, Wifi module, android application as shown in Fig.1. The low cost soil moisture sensor continuously monitors the field. The sensors are connected to arduino board [14]. The sensor data obtained are transmitted through wireless transmission and are reached to the user so that he can control irrigation [8].

The mobile application can be designed in such a way to analyze the data received and to check with the threshold values of moisture, humidity and temperature [9]. The decision can be made either by the application automatically without user interruption or manually through application with user interruption. If soil moisture is less than the threshold value the motor is switched ON and if the soil moisture exceeds the threshold value the motor is switched OFF. The sensors are connected to the Arduino. This hardware communicates through wifi module so that user can access the data through his mobile that has an android application which can get the sensor data from the arduino via wifi Module.

Further, it also provides a facility for irrigation scheduling. The user can schedule the irrigation at a specified threshold value of soil moisture. The system guides to maintain the threshold value based on the predicted pattern of soil moisture and precipitation information. The system can automatically start the irrigation, which stops after achieving the specified threshold value of soil moisture. In this module, a water pump is connected to a relay switch that is controlled by a Wi-Fi enabled node [17]. The node is controlled by the web service through a trigger from the responsive web based interface for real-time monitoring. Using this web based interface the water pump can be managed remotely in manual and auto modes. In the proposed architecture, the WiFi module/Mobile data communication module can be used as communication media between the field device and the server. In this experiment a WiFi module has been used to send the data to the server [20]. WiFi module or Mobile data communication module can be used to send the data from the gateway node to the server.

4. SMART IRRIGATION SYSTEM

Automated Irrigation system using WSN and GPRS Module having main goal is that optimize use of water for agriculture crops [10]. This system is composed of distributed wireless sensor network with soil moisture and temperature sensor in WSN. Gateway units are used to transfer data from sensor unit to base station, send command to actuator for irrigation control and manage data of sensor unit [11].

Algorithm used in system for controlling water quantity as per requirement and condition of filed. It is programmed in microcontroller and it sends command through actuator to control water quantity through valve unit [12]. Whole system is powered by photovoltaic panels. Communication is duplex take place through cellular network. Web application manages the irrigation through continuous monitoring and irrigation scheduling programming. It can be done through web pages. The subsequent section introduces the Bluetooth technology [15]. Wireless Sensor network crop monitoring application is useful to farmer for precision agriculture.

The main working principle behind this system is in connecting the soil moisture sensor, which was previously embedded into the plant, to the Arduino microcontroller, which is also connected to other electronic components listed above as shown in Fig.1. Measurement of soil moisture is done by the sensor which forwards the information and parameters regarding the soil moisture to the microcontroller, which controls the pump. If the level

of soil moisture drops below a certain value, the microcontroller sends the signal to the relay module which then runs a pump and certain amount of water is delivered to the plant [16]. Once the enough water is delivered, the pump stops doing its work. Power supply has a task to power the complete system and the recommended voltage should respect the input supply range for the microcontroller, that is, from 7V to 12V.

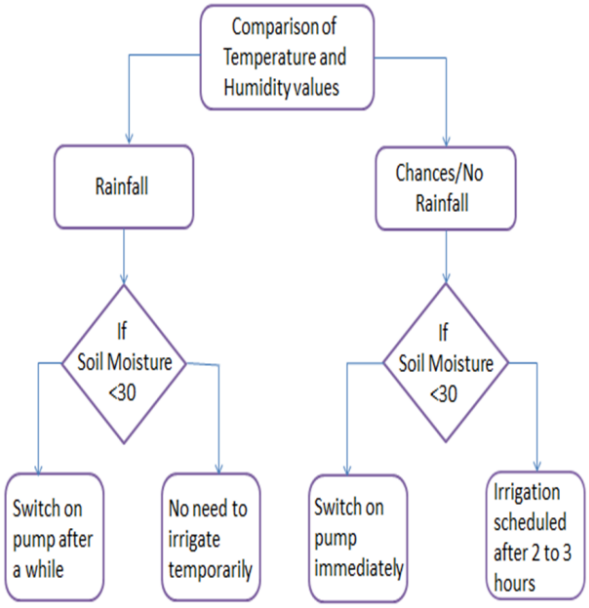

Fig.2 Algorithm of proposed system

Table: 1 Test Case Analysis

Soil Condition	Moisture Content	Relay Status	Water Pump Status	Test Case Status
Dry	<1000 >600	ON	ON	TRUE
Damp	<600 >400	OFF	ON	TRUE
Wet	<400	OFF	OFF	TRUE

The application monitors the whole farm from remote location using Internet of Things (IoT). Application works on sensor network and two types of nodes. Energy saving algorithm is used in node to save energy [19]. Tree based protocol is used for data collection from node to base station. System having two nodes one node that collect all environmental and soil parameter value and the other consist of camera to capture images and monitor crops [18]. In this System Environmental changes are not considered for sensor reading. System user is not able to program application. There is no controlling system for application.

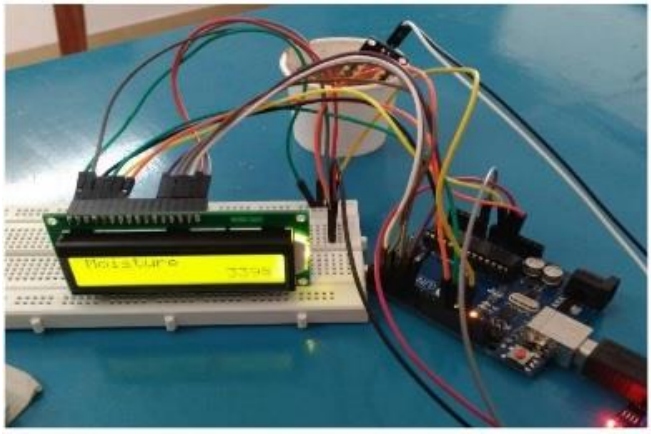

Fig.3 Moisture Level Measuring

5. CONCLUSION

The soil moisture is a critical parameter for developing a smart irrigation system. The soil moisture is affected by a number of environ- mental variables, e.g., air temperature, air humidity, UV, soil temperature, etc. With advancement in technologies, the weather forecasting accuracy has improved significantly and the weather fore- casted data can be used for prediction of changes in the soil moisture. This paper proposes an IoT based smart irrigation architecture along with a hybrid machine learning based approach to predict the soil moisture.

The proposed algorithm uses sensors' data of recent past and the weather forecasted data for prediction of soil moisture of upcoming days. The predicted value of the soil moisture is better in terms of their accuracy and error rate. Further, the prediction approach is integrated into a standalone system prototype. The system prototype is cost effective, as it is based on the open standard technologies. The auto mode makes it a smart system and it can be further customized for application specific scenarios. In future, we are planning to conduct a water saving analysis based on proposed algorithm with multiple nodes along with minimizing the system cost.

6. FUTURE SCOPE

The machine learning requires a mass data so our recorded metero-logical data helps a lot in improving the performance. The region or area wise prediction can be done for giving more accurate farming suggestions of which crop can be grown by analyzing the data based on the soil and weather conditions.

This paper can further be industrialized with camera feeds for checking the discoloration of leaves or plants and accordingly send the results to control the disease from anywhere. The field area can be protected from the trespassers by the deployment of AI and surveillance.

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