Efficient water management system for mulberry garden using IOT

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Abstract- ***Irrigation is one of the key operations in agriculture. With water resources that can be used for irrigation slowly depleting across the world, it is important to minimize the amount of water used for irrigation while also not negatively impacting the yield of crops. Many irrigation techniques have been implemented over the past few decades to save water as much as possible with drip irrigation coming out as the most popular technique. Drip irrigation is a continuous supply of water to plants in small quantities or droplets for a certain interval of time. This process has proved to be very efficient in minimizing the water consumed for irrigation while not compromising the yield of crop. But it comes with its flaws. Drip irrigation controls water flow but it cannot decide whether or not the water is sufficient or deficient for the plant without manual intervention of the farmer. The water flow is not dictated by the soil moisture in which the plant thrives but on the decision of the farmer. There is a lot of scope for improving on this technique by automating the process. By analyzing the minimum soil moisture content that the crop grows in without compromising yield, a threshold value is generated for the crop and embedded in a device. The device uses this soil moisture threshold as a function that dictates whether or not the crop should be watered. This in theory will prove to be the most optimal way to minimize water used for irrigation since it will not only let out water in minimal quantities but also check regularly if the soil holds enough water required for the plant.***

Keywords – ***IOT, Drip Irrigation, Minimum soil moisture threshold value***

I. INTRODUCTION

In India, agriculture plays an important role for development in food production. In our country, agriculture depends on the monsoon rains which in most parts of the sub-continent, is not a sufficient source of water. So irrigation is used in agriculture fields. Also, it has been proven time and again that the amount of water for the particular crop affects the gross yield in a crop cycle. Keeping this in mind, we have developed an automatic irrigation system based on control units capable of learning the physical conditions of the land to make appropriate decisions as to when the irrigation should take place and the amount of water the crop requires, at the given time. Until now, the agriculturists and farmers have been irrigating the fields themselves since mass cultivation began. With minor improvements such as drip irrigation or usage of sprinklers, the whole process of irrigation remains completely manual as such, requiring a person to take decisions to control respective decisions. Observing this is a labor intensive process and is completely dependent on the availability of electricity, which is not the case always, everywhere. This module solves the aforementioned problems. As the module is completely independent of any human interaction and being a standalone system, it is active round the clock to activate the irrigation system when the electricity is available.

The Minimum soil moisture threshold value depends on the type of soil, the type of crop, optimal sunlight received, water holding capacity of a soil sample and the density. The threshold value is calculated by classic testing and determined to be correlated and compared to make the decision to either irrigate the fields or not to irrigate the fields. The binary decision is taken by a decision making unit that contains in house soil moisture sensors to read and record the moisture value to make a decision as to either irrigate the field or not. The decision taken is recorded and stored remotely to further analyze the usage of water and reduce consumption based on the yield of the crop. This method ensures the plants do not get over watered nor let the soil dehydrate, regardless of the environmental conditions.

If the soil moisture level is observed to be less than the threshold level:

- Analyze soil moisture content for a given crop and decide on a threshold moisture value.
- Implement this threshold in controlling the water flow to the crop by regularly monitoring the soil moisture without manual intervention by farmers.
- Compare results of water consumption by this technique with the manual drip irrigation used by the farmer in terms of water consumption and yield of crop and collect data.
- Use the obtained data to develop a machine learning module that is precise enough to replace the sensors on the field.

The rest of the paper is organized as follows. Literature review presented in section II. Methodology is presented in section III. Experimental results are presented in section IV. Concluding remarks are given in section V. Acknowledgement in section VI.

II. LITERATURE REVIEW

IoT and Neural Network based water pumping control system for smart irrigation [1] proposes a smart irrigation system consisting of environmental sensors like temperature, moisture and soil moisture sensors that transmit data to an Arduino UNO which then sends data to a cloud system for processing. The data is used to train a Multi Layer Perceptron (MLP) neural network to obtain the irrigation requirement state of a region in the field. The results are sent back to the Arduino which then controls the motor to irrigate the appropriate regions. Remote XY app is used to provide an electronic cloud and display regional data to the user. The neural network gives out water requirements in states like full operation, half operation and water pump off. When a selected region is under the full irrigation state, the motor is turned on till it crosses the half operation state and the pump closes.

IoT based approach for Smart Irrigation System suited to multiple crop cultivation [2] proposes a model that divides a given agricultural field into sections where each section denotes a plot where a unique type of crop is grown. Each section will have its own on-field module consisting of sensors and an automated valve controlled by a digital pump system. These field modules are connected to a master router through Wi-Fi modules. The sensor data collected from each on-field module is sent to a cloud system via the master router. In the cloud system, the field data set is compared with standard data values for the crop already existing in the cloud to generate optimum values for water requirements suited for each crop. These values are sent back to the digital pump system which controls and coordinates the water supply to each section accordingly.

IoT based crop field Monitoring and Irrigation Automation System [3] proposes an IoT based crop field monitoring and automated irrigation system that comprises of wireless temperature and soil moisture sensors spread across the field all responding in real time to an MCU which collects these data values and sends it over to the web server designed to analyze process this data. The analysis of the data is done using algorithms written in python and JavaScript and tools built on MATLAB and a web dashboard is built to provide aesthetic portrayal of data to the user. A Solid State Relay (SSR) is used to control the state of the motor. The SSR state is decided by the water requirement output given by the web server and this process automates irrigation with minimal to no human intervention. The control and behavior of the SSR, sensors and other hardware components used in the system is coded using the Arduino IDE with the help of its vast set of library functions.

IoT based Irrigation System [4] proposes an IoT based intelligent system which aims at automating irrigation processes while not compromising yield and profit. The model comprises a set of soil moisture and temperature sensors, a raspberry pi microcontroller, and a smart pump system. Farmers are given the option to choose the crop(s) that they want to grow on their plot from a serialized list of crops. Irrigation data of each crop in the list is already fed into the system and when the farmer selects his list, the system variables are initialized as per the appropriate crop(s) chosen for that particular crop cycle. Then by continuously monitoring the sensor data and correlating with the standard values initialized, the microcontroller communicates with the smart pump system which irrigates the crops accordingly.

IoT based low cost and intelligent module for smart irrigation system [5] proposes an intelligent system that can micro manage water needs of one type of crop or even multiple kinds of crops grown simultaneously. It comprises a Unified Sensor Pole (USP), an irrigation unit (IU) and a Message Queue Telemetry Transport (MQTT) broker. The USP is initially in an admin mode where certain input values for a crop that decides its water needs like soil type, and other mathematical terms are given by the user. Then the system goes into a one-time setup mode that calculates some other mathematical coefficients necessary to train its Neural Network module and goes into monitoring mode. In the monitoring mode, the crops are actively monitored by the IU which parses and writes incoming data from USP to correct port and turn water ON? OFF for the required zone. The water needs are correlated and satisfied by the trained Neural Network of the crops grown. The MQTT broker manages incoming and outgoing data from a sensor information unit and helps in smoothing remote data sensing.

III. METHODOLOGY

a. Device Setup: A suitable plot with desired area is selected and the transmission unit(s) is/are installed. A solar panel is used to power the circuit in the transmitting station during the day. A power bank is used to store the charge and supply the power at night time. The receiving unit is installed near the motor used to supply water for irrigation. The unit is made to control the power supply switch to the motor. It is powered up by the power supply given to the motor. A router is placed in an area within the range of the two units to establish a connection to the network.

b. Communication:

Communication is a two level process, which includes:

1. Transmitter Module,
2. Receiving Module.

1. **Transmitter Module:** The sensors, the decision making module and the data collector comprises the Sensing module.The data is recorded and sent to the receiving station by WIFI. There can be n transmitter stations the data will be logged at the receiver side. The transmitter station is placed for a 30mx30m land, almost every part of the field can be watered separately. So when a particular part of the field is having low moisture below the set threshold value the transmitter station sends the signal to turn on the water pump. After sometime when the soil moisture level is more than the maximum threshold value the water pump is switched off.

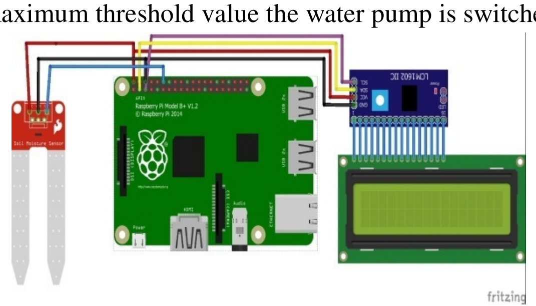


Figure 3.1: The transmitter module.

2. **Receiving Module:** Based on the decision taken by the Transmitter station, the receiving module controls the electronic relay placed to turn the motor off and on. The time when the irrigation is initiated is recorded, and is calculated with the termination time to get an accurate number on the volume of water used for irrigation. The time is calculated and the pipe diameter is known so the amount of water can be tabulated easily.

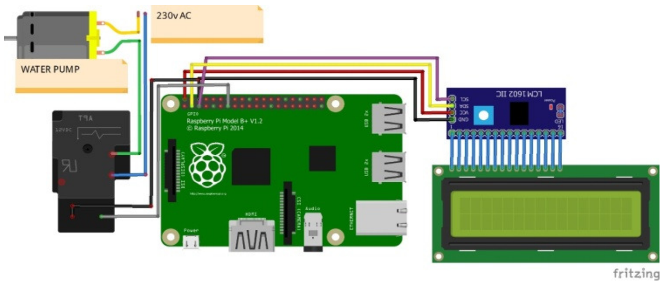
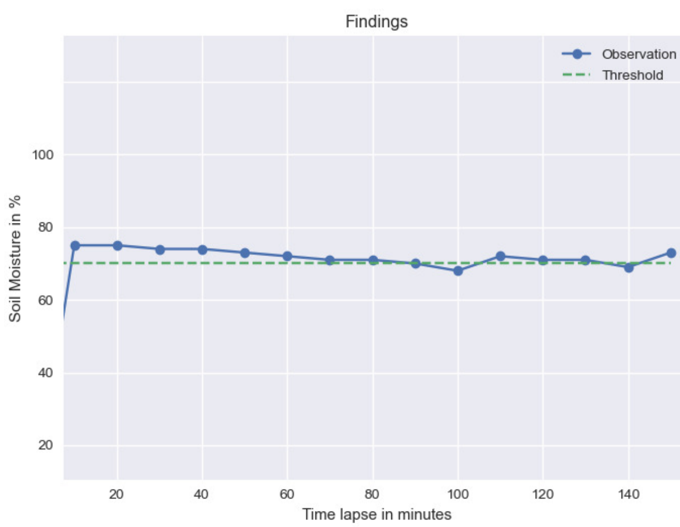


Figure 3.2: The receiving module.

The data logged at the transmission module is pushed to Google sheets to analyze the statistics over time, which can be accessed globally over the cloud for further analysis and research to correct the accuracy and get the most optimal yield for the particular crop. Both the modules possess a LED Screen to monitor the values in real time. This method succeeds in avoiding approximated manual irrigation and is automated.

IV. EXPERIMENT AND RESULT

a. Findings: Here we can observe how the decisions are being made after considering the obtained value of moisture in water. The sensor reading is logged every 10 minutes and the calibrated moisture value is plotted against the time lapsed to compare with threshold value. This is how soil moisture varies with respect to time when monitored by our system. We can easily use the obtained data for further analysis and optimization.



b. Current Status: A transmission unit has been deployed in one of the agricultural plots of the KSSRDI without the receiving unit for testing purposes. The tests of transmission unit include power related issues, sensor related issues, data logging related issues, and other issues. It is being run using solar energy stored in a battery as electrical energy. This has been tested to facilitate running of the raspberry pi at all times on a sunny day. The soil moisture sensing is going smoothly with values being updated at requested intervals. The calibration of these values to match the scale of the crop is done. After continued testing and confirming the transmission unit has been working as per expectation, the receiving module with the control relay has been installed. The whole model works in synchronization with no relevant issues. The data is being collected and used to further analyze and improve the accuracy of the automated system.

c. **Proposed Work:** Now being able to see the variations based on the different environmental parameters, this data will be used to create a Artificial intelligence based machine learning module that will be capable of predicting the volume of water required for irrigation in correlation to yield and other parameters such as temperature, season, type of crop, geographical location. This will help us get accurate predictions to maximize yield with managed irrigation. The advantages this will pose is the fact that even without a standalone fully blown out sensor and decision module for live data, the prediction model will be able to do the same thereby cutting costs to the farmer to get an automated irrigation system in place, with unmatched accuracy.

V.CONCLUSION

The immediate future goal of this project is to obtain as much real time data as possible to feed to the machine learning module. The communication between the two stations has been initiated. The main communication that will take place between the transmitter and receiver will depend on the soil moisture threshold. If the soil moisture sensor reading drops below the threshold, the transmitter should properly notify the receiver and the receiver must acknowledge the message by turning ON the water supply. Once the soil moisture sensor reading goes above the threshold, the transmitter should send a stop request to the receiver and the receiver should acknowledge it by turning off the water supply. Observations made from the current model is that the sensors placed in the field can obstruct other agricultural activities and another threat being the security of the system out in the open field.Other goals that are in the project include building a web based front end application to monitor data reports providing a better user interface in doing so, figuring out the range of the soil moisture sensor and connect it to the internet for remote configuration and maintenance, and optimizing costs of unit making it easier to replicate many models at lower prices. Once all of the units are deployed, the water consumption is analyzed and compared with the corresponding values of manual drip irrigation. If the system is found to be optimal in terms of resource minimization and feasible in terms of implementation, the next phase will be to replicate the entire project on a large scale, to collect more data of varying conditions.

VI. ACKNOWLEDGEMENT

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The Transmitter module installed in the field

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