IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Soil And Water Testing With Irrigation Control

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Abstract— **"Agriculture" The main source of livelihood for more than 69% to 70% of people resident in India depends on gross production which is the necessary source of Income. The agricultural practice differs from involved person to person. Practices dependent on agriculture from dairy products to viticulture and food sources for domestic consumption of our country's population. But, with the increasing population, land degradation and unfavourable weather and climatic conditions. To feed more than 1.3 billion some steps has to be taken, this is where smart technologies comes in handy. And the most famous out of all is IoT-based systems. These IoT-based systems are more than capable of monitoring as well as analyzing the crop environment based on its requirements such as temperature, moisture, mineral content, water requirement and climatical conditions. This will be the easiest and low-cost approach to lend a hand to solve the obstacles of the farmer to increase the crop yield and saves time, power as well as money.**

The idea behind this paper is to present and explain soil water testing and irrigation control an IoT-based approach for solving water distribution (drip Irrigation) and soil (different types of soil support growth of different crops) based problems. The objectives of this paper are to study and investigate the main purpose of using Arduino UNO, LM35, DHT11, and Rain Sensor devices which will be used to collect real-time data and process the data which will automatically water and fertilize the plants using the drip irrigator and organic fertilizer mixer with the help of two-way storage tank. The study's primary focus is on small-scale farming and gardening. If this technology is used on a large scale, its restrictions might be quite costly. For test purpose, **a plant soyabean requires a sensor installation since it is necessary to understand the soil's state. For viewing the test results the testing kit should be connected with the Bolt iot application with the help of which we can determine when to supply the water. The finding of this paper is based on the previous researches done. The paper's conclusion is based on the main objective and the test cases using a virtual arrangement of the hardware kit.**

Keywords— Use of sensors, Arduino UNO, LM35, DHT11, Soil and Water analysis, IOT in agriculture, feature Irrigation

I. INTRODUCTION

India is a Country of agriculture in which most of the population is dependent on this occupation. The analysis states that 23% of our population is work in the agriculture sector. County's economy is contributed to by the agricultural sector on a great deal. It contributes almost 16.89% to 21.34% approximately to the total Gross Domestic Production (GDP). If these cutting-edge, practical methods and technology are not applied, the agriculture sector will always lag behind other industries. Hence, a more intelligent management strategy is required to increase agricultural productivity, both in terms of crop growth and quality. This strategy should make use of the Internet of Things (IoT) and data analysis techniques. Agriculture, however, is not a simple endeavour. It must deal with issues including inadequate water supplies, deteriorating soil quality, a lack of market demand, lack of knowledge, and need for labour, among others. In addition, many farmers still lack complete control over their crops. Unpredictable weather, heavy rain or a shortage of water, misuse of the same plot of land, mining operations, and irresponsible management of agricultural fields, soil mineral content, and water supply all contribute to the damage or destruction of large numbers of crops.

Fig.I.1: Soil Types within state of Maharashtra

Even in a single state, the land of Maharashtra different districts have different soil types and water distribution thresholds. For this testing we are considering black soil and crops such as cotton and soyabean, which are the crops commonly found in all over the state.

Crop Specifications:

Conditions	Cotton	Soyabean
Fertilizer requirement	High (N-P-K) 80-120 pounds/acr	High (N-K20-Gypsum)100-120 pounds/acr
Affected by weather	Yes	Yes (But not Much)
Total Time till harvest	160 - 170 Days	70 - 90 Days
Water ribbon length	>=500mm from germination till ball formation	<=350mm from plantation to seed formation.

Table.I.1: Crop specification for Cotton and soybean

II. METHODOLOGY

To accelerate development, it is necessary to make some adjustments to the agricultural pattern and to acquire and employ information techniques. Despite irrigation having been used locally for many generations, it frequently requires technological intervention in the agricultural system. New technologies necessitate new maintenance and operation procedures. Based on the required water capacity, location, and type of vegetation, the zones should be chosen. Water is spread throughout the field by overland flow in a variety of irrigation techniques referred known as "surface irrigation" in general. A flow is started at one field boundary and eventually spreads across the entire area.

The difference between the discharge into the field and the accumulated infiltration into the soil determines the rate of coverage (advance) nearly entirely. Field slope, surface roughness, and the geometry or form of flow cross-section are secondary factors. An automated irrigation system operates primarily or entirely without human intervention, excluding observation. The irrigation system's main supply pipe branches distribute freshwater to many zones. For all these processes systems need various tools and techniques.

i. *Soil Types and Testing Tools:*

In India, there are primarily 4 different types of soil: clay, sand, and sandy (arid soil). They vary from each other based on characteristics including ribbon length, restriction on root growth, water-holding capacity, and particle size. For collecting the relative data sensors like moisture, temperature, and rain sensors.

ii. *Mineral content and Water supply:*

The water storage tank will be divided into a ratio of 2:5 which will contain water and required organic fertilizers according to the need of the crop and the soil type present.

iii. *Solar Cell and Power Storage:*

The power supply device that will be utilized to power the solenoid valves of the water tank and irrigator will store the solar energy that the solar cell collects.

iv. *Digital Display and Command Device:*

Signals converted through the Arduino will be displayed on the digital device connected to the system. For the digital display and command device Blynk This application can perform or give services like Buttons, serial tank control, and system on-off as well as instant termination.

v. *Irrigation supply with a Solenoid Valve:*

Since two water tanks are used at the same time one for fertilizer and one for water storage. Their flow has to be controlled according to the requirements for that reason solenoid valves are used.

They are made of sturdy material, and manual flow control is an optional feature that enables adjustment of the desired flow. The valve can usually be manually opened if necessary; most models have this feature.

vi. *Soil hardware components:*

- *Arduino* Uno: Arduino is our microcontroller, we are using it for receiving and data collection by sensors and sending signals to the command box.
- *LDR* (Light Dependent Resistor): This is used for measuring the intensity of light from the sun and timely cooling down the temperature of the overall system before power overflow and permanent tripping of connection from the fuse.
- *Fuse:* If in case there is a power outage and the cooling function didn't work. The system can be stopped with just one command from the control box.
- *Solar Panel*: It is used as the power source and supply for the system instead of using simple electricity as in case of power shortage, solar can keep the system running.
- *Sensors* (DHT11, Rain sensor and LM35): For this system, we are using LM35 universal sensors for soil moisture as well as the mineral contents within the soil and water.
- *Motor:* Mini DC12V water oil pump is used for pumping out the water for the solenoidal valves which can be automated for the outlet of the tank. The motor mini DC12V Micro Brushless water oil pump is used for this system. This motor is small as compared to the other regular-use motors but pumps out water for irrigation with the same efficiency.
- *Filter*: It serves as drip irrigation's brain. To avoid nozzles and holes being clogged with suspended contaminants and blocking drip irrigation, a filter unit removes them from the irrigation water. The kind of filtration required depends on the emitter type and the quality of the water. Usually, a two-stage filter unit is required.

A. Soil Water content and threshold for irrigation:

Soil water thresholds are specific values of SWC (soil water content) indicating water availability for plant consumption. These thresholds for the specific plant or crop group are used to determine accurately what and how much % of water is required for irrigating the land before and after the plantation.

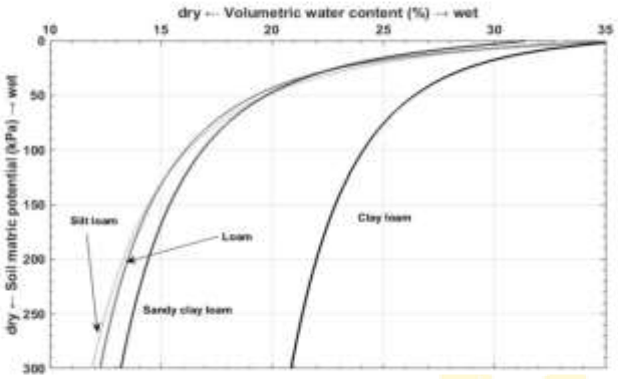


Fig.II.1. Water Threshold Distribution

Water thresholds are used as a scientific measure of the accurate amount of water that is supposed to be used or is required for the water distribution and consumption.

A wireless sensor-based irrigation system with ethernet communication and mobile IoT can be considered a viable method to raise yields in areas with varying water availability while maximizing water use efficiency availability throughout the seasons, due to different weather conditions and soil characteristics and crop water needs with site-specific irrigation control valves. A Decision-making process with the controls within our hands can be viewed as a commendable option for determining at what time and where to irrigate, and how much is the need for water and fertilizer. An irrigation controller is used for the water outlet from the serially connected water and fertilizer tank and applies drip watering to plants when the set range of water content within the field is observed to be the substrate drops below a set point.

B. Soil Texture and Quality:

The texture is one of the most commonly used features by scientists and farmers to describe soils. Texture refers to the construction, weight, or size of the soil, the soil which is present can be sand, silt, loam, and clay. The classification system for determining the soil texture is determined by the sum of all particles < or == to 2mm is equal to 100 percent and is named 'fine–earth fractions'. There are a lot of different soil classification methods such as soil particle size, water absorbing capacity, and different structure construction. Soil quality is related to the use of soil and the specific requirements for crop and land tolerance.

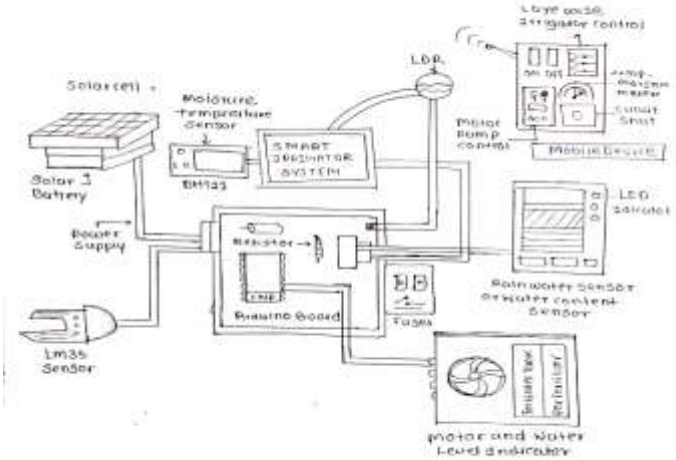


Fig.II.2: System Architecture

To improve the performance of the system two different setups are to be assembled. One is the Arduino Unit and the other part is the irrigation setup. Within the Arduino Unit, the data collected through the universal sensor will directly go to the cloud-connected with the digital device which will likely store all the past data related to crop production, it's up and down within the last years. The Irrigation System which is to be used is a drip irrigator. Each unit of the system does its separate work but is being commanded by the same application.

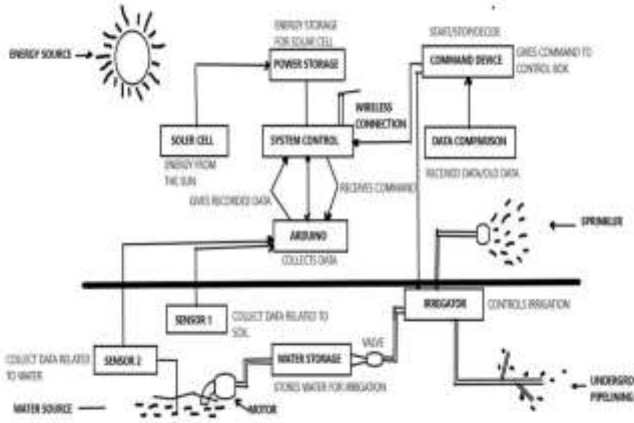


Fig.II.3: Flow Diagram for the Proposed System

C. High-level design

This high-level design flow outlines a smart irrigation system framework. The universal sensors, Arduino Uno chip, Cloud Storage, Bolt IoT mobile application, and digital display are the framework's major components. Soil moisture and humidity data are continuously collected using the universal LM35 sensor. These data records are sent to the Arduino Uno chip, This testing kit sends the data to a centralized cloud which is directly connected to the mobile device.

The desired state values can be monitored such as humidity, moisture, water flow, and fertilizer amount by the mobile device which gives them direct command as well as ability to set values specific to a crop. If the actual humidity and soil moisture value lag behind the specific range set for that crop the irrigation process automatically gets started.

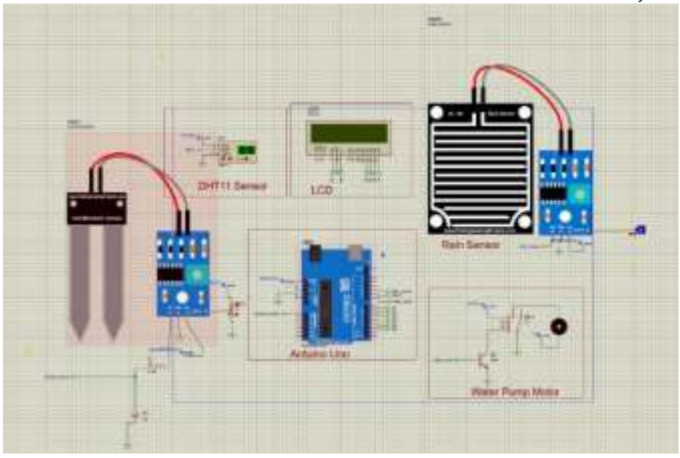


Fig.II.4: Virtual assembly of the system

D. *Implementation of System*

The working of this System is divided into two parts One is irrigation and the second one is the Arduino Part. The Irrigation system used is Drip irrigation which will have water storage of its own, with a solenoidal valve for water outlet control. The crop considered for the testing and investigation is cotton and soybean. For the water storage tank, we are going to implant 2 tanks with sizes in a ratio of 1:3, the smaller tank will be for organic fertilizer and the other part will store water. Solar Panel is used instead of electricity for power generation. With the use of solar cells, power can be stored and generated at any time. And accidents or problems related to electricity can be avoided. The Arduino part is for controlling, collecting, and monitoring the data and devices used as one system. Arduino Uno is used for automation purposes and instead of Arduino any Arduino-related modules can be used as well. System control compares the data feed within the system and the data collected by the Arduino and commands the operations within the whole system.

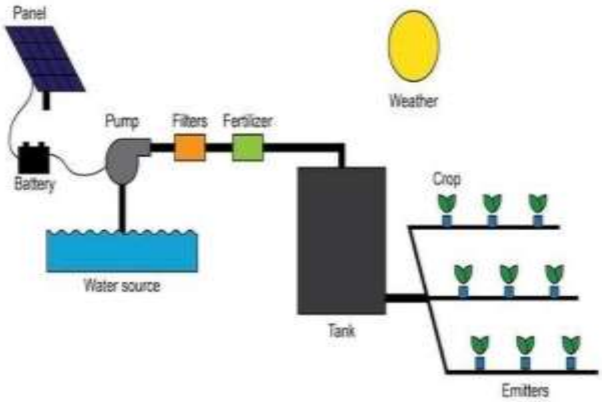


Fig.II.5. Solar-powered Irrigation system

E. *Simulations*

- *Arduino:* An ARDUINO is a silicon chip board-based ATMEL AVR microcontroller. These microcontrollers can collect and transfer data at the same time with just one-time programming and processing for a particular system. The Arduino consists of Analog and Digital pins which allow other devices to get connected with the Arduino and maintain the Circuit involved within themselves

- *IoT-based Irrigation System:* using the LM35, LDR and indicator Module, and DHT11 Sensor. Makes the system not only automatic but makes the irrigating of the water based on the moisture level in the soil also easy and sends the recorded Data to the mobile Application to keep track of the land condition.

- *Drip irrigator:* For irrigation, we are employing a subsurface drip irrigator. These irrigation systems can operate on solenoid valves extremely well and can release water when instructed to do so by the control device.

- *Storage cloud:* The cloud storage is directly connected to the mobile device which will continuously record the data

- *Pump/ motors:* Water is pumped by irrigation pumps from one level to another, where it runs through channels to the crops that need irrigation (lift operation).

- *Filter*: It serves as drip irrigation's brain. To avoid nozzles and holes being clogged with suspended contaminants and blocking drip irrigation, a filter unit removes them from the irrigation water. The kind of filtration required depends on the emitter type and the quality of the water. Usually, a two-stage filter unit is required.

- *Rain Sensor:* Rain sensors are commonly used as weather indicators. It can directly show the climatic temperature increase, decrease and water ribbon arrangements for that time period. In Machine Learning data from the rain sensors are used as the real-time data for weather prediction models.

III. RESULTS AND DISCUSSIONS

The results were based on normal irrigation and drip irrigation using the module. They were noticeable after conducting a comparison test with this Automated system and a traditional setup within garden pots. The experiment was done till sprouting and rooting (1 month). In the case of the traditional setup, seed germination took time and roots were shorter and less in number, and in the case of our testing kit seed germination was faster comparatively and roots were more in number, sturdy and longer.

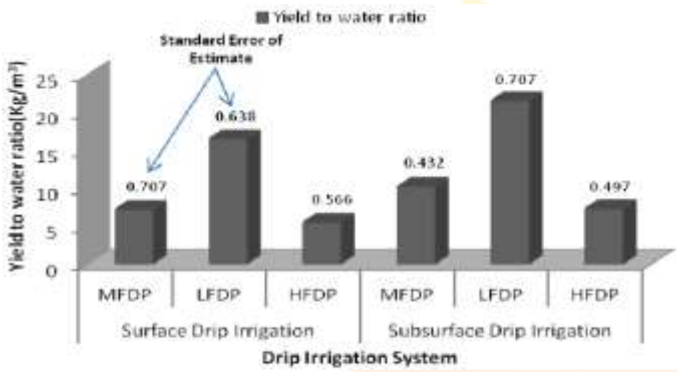
Fig.III.1.: Testing kit

Since we are considering soybean as the experimental crop It is very important to know that with the process of photosynthesis, soybean performs nitrogen fixation (a process by which atmospheric nitrogen is assimilated into organic compounds, by certain microorganisms as part of the nitrogen cycle). In soybean, this process is done by the microorganisms present in the roots. Therefore as longer the roots as better the process.

Automation enhances the efficiency in the use of water, soil, use of fertilizers and the use of water from various sources. This automated drip irrigation process only runs when necessary, minimizing energy consumption and the wastage of water. It saves time and labour through irrigation and the sensor prevents pointless over-watering. Solar panel use makes it a one-time expenditure, making it cost-effective. Though as a limitation can be said as it can get expensive if we are supposed to use it at a large area. Preventing water wastage leads to effective slurry management. Data linked to growing crops is maintained on this cloud platform and the weather prediction model, due to which the use of drip irrigation, we can revise the water flow in response to weather changes.

IV. CONCLUSION

According to the above parameters we tried to estimate the water ribbon lengths of soil types (black soil) and the crops that are grown on it. We also tried to initiate an attempt to supply nutrients that are to be added to the crop in form of liquid. The efficiency of this automated weather prediction model is 80-85%. From the below bar graph, it can be concluded that drip irrigation is the best practice within the area of low water distribution.



We feel our adoption of agriculture systems and IoT-based technology can be intricate and challenging to operate manually. Our study combines recently obtained data with historical data that has been collected throughout time and kept in order to reduce conditional errors and increase favourability for crop production and other agriculturally related domains. The proposed system which is implemented can decrease the latency rate and increase productivity without changing the production steps. It will lead to the fact this new way of agriculture will develop and increase crop production without causing any damage to the farming land.

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