Smart Irrigation System with Soil Moisture Detection and Automatic Plant Watering

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Abstract- India follows traditional agricultural methods in irrigation practices. Irrigation is a foremost factor in determining crop yield and largely varies with the geographical, climatic, and topological factors. Farmers primarily depend on personal monitoring and their experience in irrigating the fields, and as a result, irrigation becomes largely inefficient and eccentric. India, therefore, requires a simple irrigation solution on which the farmers can depend indefinitely, which can habituate to the local climatic conditions, and accurately forecast the quantity of water required by the crops for judicious utilization of water resources, and additionally a better crop yield. This paper describes our attempt to innovate an automatic but smart irrigation system that can detect soil moisture content and facilitate automatic watering to the plants along with a buzzer system. This application will help save the water resources judicially and give the farmers the comfort to monitor the plants digitally. Our outcome involves a full proof android application to facilitate the overall understanding of automatic irrigation involving minimal human intervention. We intend to incorporate our readings, research and results into this paper explaining the complete system thoroughly.

Keywords – ***Smart Irrigation system, Home Gardening System, Soil Moisture Detection, Automatic Plant Watering, Buzzer System, Arduino, Mobile Application***

I. INTRODUCTION

Agriculture plays a consequential role within the economy and its contribution is based on quantifiable crop yield which is very dependent upon irrigation. Agriculture is largely predicated on the unorganized sector in India, hence irrigation techniques and patterns followed are inefficient and often lead to nonessential wastage of water. This calls for the desideratum of a system that can provide an efficient and deployable solution. The main concern in India isn't water shortage but water wastage, and poor utilization of the resources thanks to lack of vigilance, facilities, and infrastructure. Due to wastage of water, the country has already suffered through immense drought conditions, varied rainfall patterns, and immensely colossal economic losses due to the eradication of crops.

The manual process of watering considers two important aspects: when and how much to water. In order to minimize manual activities and make gardener's work easier, we have created an automatic plant watering system. By adding an automated plant watering system to the garden or agricultural field, you will help all of the plants reach their fullest potential as well as conserving water. Using sprinkler drip emitters, or a combination of both, we have designed a system that is ideal for every plant in the yard. For the implementation of automatic plant watering systems, we have used a combination of sprinkler systems, pipes, and nozzles. This will help the farmers to judge the condition of the plants from anywhere with the help of their phones. It will also help the farmers decide when the plants should be irrigated the next time. We'll try to make our model intelligent by storing previous scanned values in a database on the basis of historic values which would have been stored in the learning phase of the working model.

Traditional automatic irrigation systems are not opportune for India, as they cannot adapt to the altering rainfall patterns and do not respond well to geographical changes. In this paper, we have described how our application has been programmed to sense moisture levels of plants at particular instances of time. If the moisture content is less than the specified threshold, for which the water level is predefined for a particular plant, then desired amount of water is supplied till it reaches a threshold. Generally, the plants have to be watered twice a day, morning and evening. Our system is designed in such a way that it reports its current state as well as reminding the user to add water to the tank. All these notifications are made through a mobile application.

In our daily life, people often forget to water their plants regularly, thus it becomes difficult for them to keep their plants alive and healthy. For farmers also, it is a challenge to maintain their large fields and manage the watering of plants during the shortage of water. Based on the above situational facts, we thought that it is important to innovate an automated system that will take care of plants taking into consideration all the different criteria of the home gardening system (for a system based on household purpose) as well as a larger landscape (for the system based on agricultural farms) and help them to grow healthily.

We staunchly believe that technology plays an important role in helping people in cultivating plants, by both automation and also through digital communications, in order to alert the user with the current status and well-being of the plant. Therefore, our project aims to implement an intelligent system using automatic irrigation, watering a small potted plant or crop with minimal human intervention. We have attempted to make an intelligent model for the overall understanding of the system and also make an android application to facilitate the use of the system. Through this paper we intend to put forward our work so that it can be referred to, used and advanced with an intention to improve the irrigation practices for the betterment of Indian agriculture.

II. Related Works

Based on our project, several works were studied and looked upon by us for references, motivation and suggestions which gave us insight into the current developments in the industry in a similar area. One of the papers studied presents the applying of metric capacity unit techniques to optimize irrigation water usage by predicting the longer-term soil wetness of a field in an associate IoT driven good irrigation framework [1]. Another study uses IoT to form devices employed in the system speak and connect on their own, with capabilities like admin mode for user interaction, one-time setup for irrigation schedule estimation, neural-based deciding for intelligent support and remote knowledge watching [2].

This analysis referred to, proposes a sensible irrigation system that helps farmers water their agricultural fields victimisation the worldwide System for Mobile Communication [3]. This main focus is on the automated Irrigation System, followed by associate applicable downfall prediction rule which will facilitate the US verify that crops square measure favourable to grow in an exceedingly explicit space [4]. The objectives of this paper square measure to research the thought of a sensible irrigation system victimisation IoT, to develop a system victimisation associate Arduino Mega 2560 that processes the information from the soil detector that mechanically water the plant and to analyse the period condition of the soil of the plants via the smartphone that's connected to the net [5]. This project uses a straightforward system, employing a microcontroller to alter the irrigation and watering of little potted plants or crops with the smallest manual interventions [6]. This system consists of a solar-powered pump at the side of associate automatic water flow management employing a wetness detector [7].

A system to observe wetness levels within the soil was designed and also the project provided a chance to review the present systems, at the side of their options and downsides [8]. This paper covers the applying of Sensor-based Irrigation systems through wireless detector networks, that uses renewable energy as a supply [9]. This project has given a brand new style of pump management for the event of a sensible irrigation system coupled with a mobile application [10]. This paper presents an associate ASCII text file technology-based good system to predict the irrigation necessities of field victimisation the sensing of ground parameters like soil wetness, soil temperature, and environmental conditions at the side of the forecasting knowledge from the net [11]. This projected system is intended to extend the potency of water and power by star panels to form it eco-friendly. Additionally, this will be enforced on giant or little scales [12].

III. Methodology

There are two functional components in our project, mentioned in the paper. They are moisture sensor and a motor/pump. The Arduino board is programmed using the Arduino IDE software. A humidity sensor is used to detect the soil moisture content. Motor/pump is used to supply water to plants. Soil moisture and temperature predetermined range is set particularly for specific plants requirement, and according to that system is being operated. The microcontroller (ATmega328), is the brain of the system. Both humidity and temperature sensors are connected to the controller's input pin. Pump and servo motor coupled to the output pin. In case if soil moisture value is less than the threshold, the system automatically triggers the water pump until the sensor meets the threshold and then sets off automatically. The overall activity is reported to the user using the mobile application. We have created a small model related to the above-stated ideology. Rather than using a motor pump, we have installed a led indicator and a buzzer which will help us to know the soil is ready to water up.

3.1 Automatic Watering to the Plant and Buzzer System–

On receiving the logic high signal, Arduino will notify the user by turning on the first buzzer. In this work, we have used an Arduino piezo electric buzzer in combination with a relay control switch to control the motor and overall functioning. The motor may be driven by an external 9V battery with interfacing to a microcontroller.

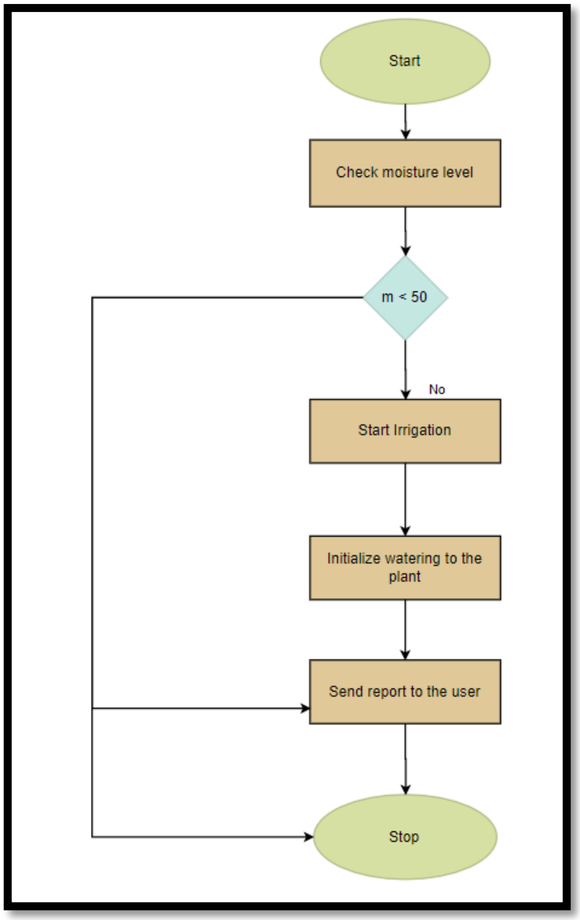

Figure 1. Workflow of the System

3.2 System Detecting Moisture Content –

This will be achieved by the soil moisture sensor. They are connected to an Arduino microcontroller board. The Arduino board is programmed using the IDE software. The humidity sensor senses to indicate that the plant needs watering humidity levels in the soil, and sends the signal to the Arduino.

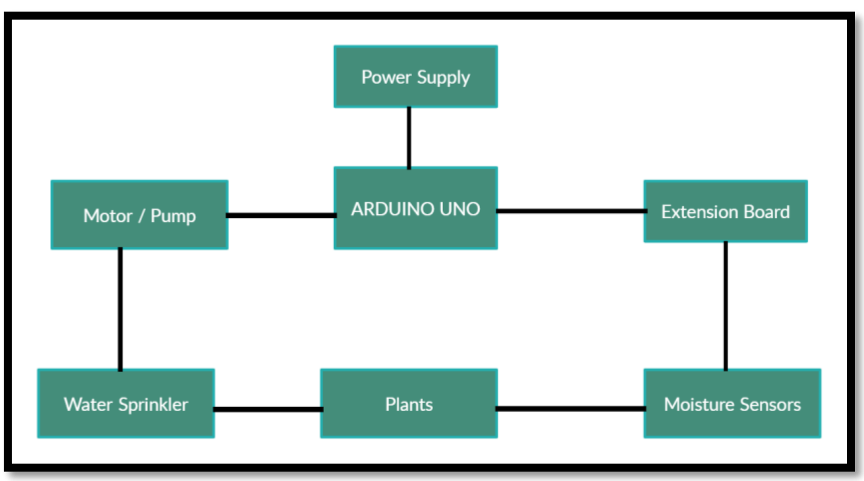

Figure 2. Block Diagram for Detecting Moisture Content

3.3 Build System Relay –

We create connections to the solid-state relays, Arduino, and small fountain pump system, Arduino allows the pump to open or close automatically. A striped cut through the inner tube of the pump segment insulated wire, only half. Install the new cut wire, there are two output relays at both ends. We put on the bare electrical tape. Finally, the ground relay is connected to the Arduino ground and relay input to the Arduino digital pins.

3.4 Build-up System Reservoir –

The submerged pump supplies the desired amount of water needed by the plant in order to work properly. Automating this process, we use a float valve, which needs to be opened whenever needed, then close the connection when the water level rises and water hoses. Drilling is high enough to ensure that the float valve chamber is sufficient to accommodate the width of the tank float.

3.5 Build System tubing and connect –

Connection to plastic lob feed pumps and drilling small holes through which water droplets.

3.6 Code–

An automated plant watering system is programmed using Arduino IDE software. The Arduino microcontroller checks soil moisture level, if low, triggering a water pump until the sensor reaches the threshold. After this, the system will re-check the soil moisture between periodic intervals to see if you need more water. If the water in the initial inspection, no water or comment, the system waits 24 hours and repeats the process.

The components used for the project are listed are follows along with an explanation of their working and usage:

3.7 Arduino UNO –

Arduino/Genuino Uno is a microcontroller board based totally on the ATmega328P (datasheet). It has 14 virtual enter/output pins (of which 6 may be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a strength jack, an ICSP header and a reset button. It carries everything needed to support the microcontroller; genuinely join it to a laptop with a USB cable or strength it with a AC-to-DC adapter or battery to get started.

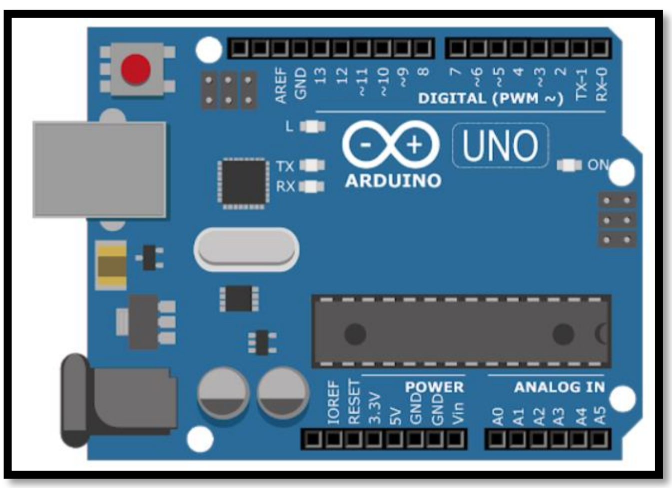

Figure 3. Arduino UNO Model

3.8 Moisture Sensor –

Soil moisture sensors measure the volumetric water content material in soil. Since the direct gravimetric dimension of loose soil moisture requires disposing of, drying, and weighing of a sample, soil moisture sensors degree the volumetric water content material in a roundabout way by using a few other assets of the soil, along with electric resistance, dielectric steady, or interplay with neutrons, as a proxy for the moisture content.

The relation among the measured property and soil moisture have to be calibrated and might vary depending on environmental elements together with soil kind, temperature, or electric powered conductivity. meditated microwave radiation is tormented by the soil moisture and is used for far flung sensing in hydrology and agriculture. portable probe units may be used by farmers or gardeners.

Soil moisture sensors generally confer with sensors that estimate volumetric water content.

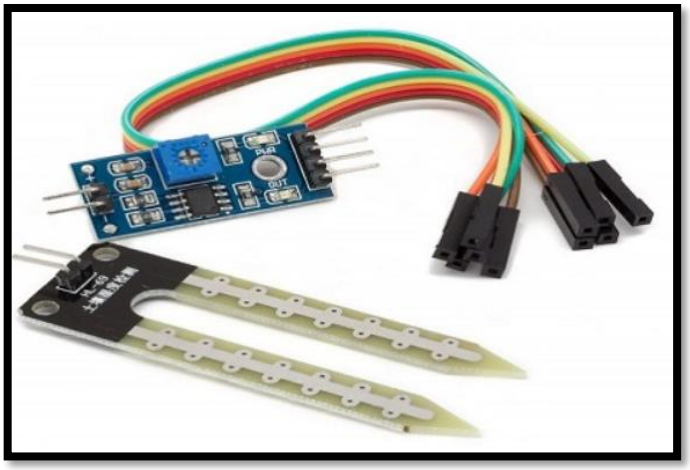

Figure 4. Moisture Sensor Model

3.9 DHT11 Basic Temperature-Humidity Sensor –

The DHT11 is a basic, ultra low-price digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to degree the encompassing air, and spits out a virtual sign on the statistics pin (no analog enter pins needed). Its pretty simple to use, however requires cautious timing to seize facts.

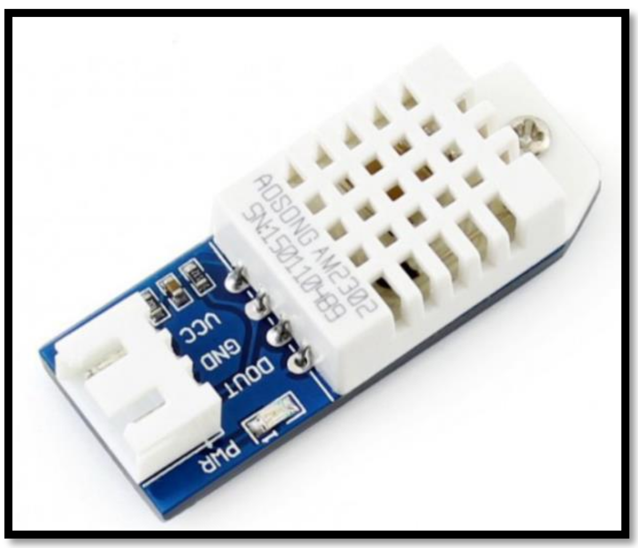

Figure 5. DHT11 Temperature-Humidity Sensor

3.10 Arduino IDE Tool –

The Arduino included improvement environment - or Arduino software program (IDE) - includes a textual content editor for writing code, a message region, a textual content console, a toolbar with buttons for common features and a sequence of menus. It connects to the Arduino and Genuino hardware to upload packages and communicate with them.

Figure 6. Arduino IDE Tool

3.11 Buzzer –

A buzzer is a small but efficient thing to add sound capabilities to our challenge/machine. it's miles very small and compact 2-pin structure subsequently may be without problems used on breadboard, Perf Board and even on PCBs which makes this a broadly used component in most digital applications.

Figure 7. Buzzer

3.12 The Penman Moneith Equation –

The Penman equation, which takes into account the climatic parameters of temperature, solar radiation, wind speed, and humidity, is used to measure the reference rate, ET_0.
The FAO has published a variant of equation (1).

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)} \quad (1)$$

In (1),

- reference evapotranspiration [mm day-1] assumed as ET_o,
- net radiation at the crop surface [MJ m-2 day-1] assumed as R_n,
- soil heat flux density [MJ m-2 day-1] assumed as G,
- air temperature at 2 m height [°C] assumed as T,
- wind speed at 2 m height [m s-1] assumed as u_2,
- saturation vapour pressure [kPa] assumed as e_s,
- actual vapour pressure [kPa] assumed as e_a,
- saturation vapour pressure deficit [kPa] as e_s - ea,
- slope vapour pressure curve [kPa °C-1] assumed as D,
- psychrometric constant [kPa °C-1] assumed as g

3.13 Estimating the Water Requirements of the Crop –

ET_0 represents the maximum, or potential, evapotranspiration rate that can occur. However, the water requirement of the crop is usually less than ET_0, as there are factors of the crop itself that have to be taken into account.

These include the growth stage of the plant, the leaf coverage that provides shade to the ground, and other particulars of the crops that make them vary from each other. With these considerations in mind, the crop-specific coefficient, K_c, is used to convert ET_0 to ET_c. ET_c represents the evapotranspiration rate of the crop under standard conditions (no stress conditions).When calculating ET_c, one must identify the growth stages of the crop, their duration and select the proper K_c coefficient that needs to be used. Climatic effects are incorporated into ET_0, while the effect of the crop characteristics is incorporated into K_c.

$$ET_c = K_c * ET_0 \quad (2)$$

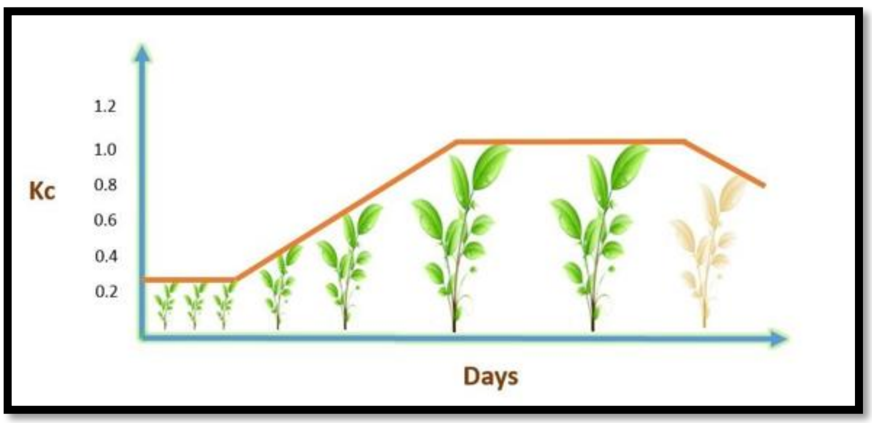

Figure 8. Plotted graph between K_c and No. of days of plant growth

III. Result and Discussion

From the work described, we can control the moisture content of soil present on the cultivated land. According to the soil moisture in plant or crop, water will be pumped through the motor and accordingly it will turn on and off automatically. This saves water, while the water level is often obtained during a preferred aspect of the plant, thereby increasing the productivity of crops. Servo motor from vegetation water uniformly dispersed in water, so as to make sure the utmost utilization of absorption through. Thus, there is minimal waste of water. The system also allows the delivery of water to the plant according to its need, based on the type of plant, soil moisture content, and observed temperature. The proposed work minimizes the efforts of irrigating major agricultural regions and the process becomes easy. Many aspects of the proposed system can be customized which would help in fine-tuning the requirements of the plant. The result is a scalable, supporting technology. Using this sensor, we will see that the soil is wet or dry. If it's dry, the motor will automatically start pumping water. This system designed is an astute irrigation solution predicated on artificial astuteness which makes utilization of the soil moisture content and the moisture requisites of the crop to make the entire process of irrigation automatic. The core benefit of the system is its efficiency in terms of reducing water wastage and minimizing the efforts in irrigating the agricultural field and also its economic feasibility.

IV. Conclusion and Future Scope

Our proposed solution for smart irrigation constitutes different modules that are responsible for different functioning of the system as the first module is the sensor network, which is required to sense parameters influencing the water need. We have used sensors DHT11, Soli moisture model to sense temperature, soil moisture, and humidity in air. Currently, our system does not employ any algorithm for decision-making, but intelligent data-extracting techniques can also be used for decision-making. Hence the above proposed irrigation system can be reproduced in the future by using other decision-making techniques, to enhance the functionalities, such as random forest algorithm. We have tried to facilitate the traditional irrigation system by the buzzing technologies and we will continue to iterate again towards helping agriculture and hence the economical structure of our society.

This system has enormous potential and can be used in various other ways, due to its cheap and cost-efficient design. We have some plans to improve it further and make it even more efficient by adding the following complex features to the present model.

- We can use AI to predict rainfall patterns and turn it into a better decision making system.
- We can use it as a home automation controller.
- More historic data can be generated for interpretation of better results.
- We can also add a float switch in a tank to the whole system, so that it automatically shuts the pump down, once the reservoir is full.
- Usage of advanced IoT microcontrollers and API's find out the exact atmospheric conditions.

V. Acknowledgement

We are grateful to VIT University for encouraging and giving us the opportunity to perform this project. We would like to convey our special thanks of gratitude to our professor Mr. Pramod Kumar Maurya for his continued support and advice behind ideating and implementing the project and writing the paper. His guidance and words of help played a major role in the timely and successful completion of the work. We thank him for constantly encouraging us to pursue the best results. The completion of this project is attributed to everyone’s combined effort.

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