# Automatic Irrigation System by using Smart IoT Sensors

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***Abstract*—Traditional ways of manual irrigation are more time consuming and requires lot of human efforts. In order to reduce time, efforts and cost, modern techniques need to be integrated in farming. In this study one such modern solution has been proposed to minimize human efforts and reduce the time by automating the process of watering the plants when it is required. In the proposed technique the soil moisture and water level in the tank is sensed by using smart IoT devices and water is supplied to the plants when it is required. The soil moisture sensor monitors the actual level of water in the soil. When the moisture level of the soil reduces to the predefined threshold value, it switches on the water pump automatically if there is sufficient water in the tank. Further, the system is also integrated with a smart mobile application where farmer can monitor moisture level of soil, water level in the tank and auto On/Off the switch of water pump as per requirement. In case if farmer want to On/Off the pump manually, such facility is also integrated in the smart mobile application. The smart integrated model developed and tested successfully on different soils having different level of moisture and by varying the level of water in the tank.**

***Keywords—Smart irrigation, soil moisture sensor, ultrasonic sensor, agriculture, IoT***

## I. INTRODUCTION

Introduction of modern tools and techniques opens up the doors for research in different sectors, especially in the field of agriculture where most of the things are done manually. There is a wide scope for automating different processes of farming which will not only reduces the human efforts but also will help to reduce production cost. One such process is watering the plant precisely as per the need of the crop. Watering the plants in the farm that to in time by checking the moisture level present in the soil and by physically checking the water level in the tank becomes overhead for the farmers. It also needs their lot of attention and it always needs the human's physical presence in the farm. But smart IoT devices may help to automate all these processes. One such process is to automate a farm irrigation process which is one of the most important processes in farming. The automation may be carried out using IoT device and these devices may be controlled manually from distance using mobile application.

During farming, checking the water requirement of the plant manually is nothing but guessing it at time and applying the prior knowledge about plant water requirement. However, instead of guessing the requirement of water, checking actual moisture level in the soil which can be obtained by sensing real time soil moisture level using IoT sensors may help the farmers to understand the requirement of water in time. Further, to provide the water to the plants, there must be sufficient water present in the water storage tank. So, checking the water level before turning the water supply ON is again the manual work which can be easily done by using IoT sensors. In addition, the smart android application integrated with the system also facilitate monitoring the water level in tank from the distance. Thus, the proposed integrated system automates the process of watering the plant by monitoring the water level in the storage tank and soil moisture level. The decision of turning On/Off water pump has been automated using smart android application considering soil moisture level and available water in the tank. The prior knowledge about the requirements of water according to the soil moisture levels is used to write the decision-making program to turn On/Off water pump.

Though everything is automated, human control is must over the system and that is provided by building a smart mobile application. The mobile application facilitates data visualization, data monitoring and decision taking in real time. Further, the application also provides manual control to switch On/Off water pump manually in case, if required. Thus, the proposed integrated system provides full solution to automate the process of watering the plant and monitoring the status of soil moisture level and water present in storage tank from the distance.

## II. LITERATURE SURVEY

Agriculture is one of the most important sectors, especially in developing countries like India. A lot of research is continuously going on to improve crop yield and reduce the total production expenditure. In order to reduce the cost and time, IoT is playing a very important role in automating the processes and reducing human efforts. Various researchers ([4], [5], [6], [8]) have proposed the IoT based solution to automate the different farming processes. Once such process of watering the plants in time and precisely requires a lot of human efforts and time which can be reduced by automating the process. In recent studies ([1], [2], [3], [7]) researchers have proposed different methods and IoT devices to automate this process.

[1] proposed a system to check the moisture level of soil, humidity and temperature using the soil sensor and DHT sensors. Further, the data collected is used for the controlling of irrigation systems in farms. The system is also integrated with the Blynk mobile application for the end users. This application is used to display the values sensed by the sensors. However, using the Blynk application has limitations of number of users and the subscription-based services of the application cost the user for the usage which is a cost overhead to the farmers.

In another study [2], author has proposed the solution for the automation of irrigation process for improving the time required for production, reduction in cost and effective use of resources. It is microcontroller based system which works along with soil moisture sensor and water level sensor. In

another similar study [3] author has provided the IoT based irrigation system with soil moisture sensor and temperature, humidity sensors. Water level in reservoir is also considered using ultrasonic sensor. The complete setup has been designed using ESP8266 microcontroller. Further, a study [4] based on the wireless sensor network found its application in monitoring the soil parameters such as humidity, pH, etc. Author's provision of data collection is mainly useful in agriculture sector for pest management, irrigation management and soil management. Agricultural monitoring with data analysis has been proposed with wireless sensors network.

In order to reduce the cost of the system [5] author come up with the low-cost soil sensor which is based on mutual inductance and that could be used for more than one type of soils. Different parameters of soil are studied on multiple soil samples to find the low-cost soil moisture sensor. Looking in to modernizing current traditional irrigation technique author [6] proposed a smart irrigation technique to control irrigation for vegetable crops and it is employed with the smart phone based remote control over the IoT setup near the vegetable crops. The setup has been implemented using the wireless IoT sensors for detecting soil moisture, air humidity and temperature. Further, in order to automate the irrigation mechanism, author [7] worked on switching On/Off water pump automatically by detecting the moisture content of the agricultural land using the soil moisture sensor without the direct involvement of labor. Automation in irrigation system has been implemented using an ESP8266 board which provides remotely controlled system operated via internet. In another study, [8] used ultrasonic sensors for determining water level in water tank which is equally important in any irrigation system. In order to visualize the data and control the overall system, it is further integrated with android application. Further, amount of water present in the water storage tank has been checked and controlled automatically using the ultrasonic sensor. The detected water level present in the tank may be useful in many cases such as to avoid overflowing of the water storage tank which leads to wastage of water, and to check the water level before utilizing that water. Thus, the study proposed a workable solution for automating irrigation mechanism by confirming the presence of sufficient water in storage tank, before supplying water to the irrigation setup. Similarly, author [9] used ultrasonic sensor to design a low-cost mobile robot for mapping. Here, author has proposed to use the low-cost ultrasonic sensor HC-SR04 instead of an expensive laser sensor. A prototype of a mobile robot suitable for mapping has been designed by avoiding the use of expensive laser sensor. Further, author [10] proposed a different use case where the ultrasonic sensors can be used to automate the things. The study provides the ways to use the ultrasonic sensor that can be the integral part of a larger and complex projects such as smart cities and smart control systems. In another study [11] ultrasonic sensor is the main component of the microcontroller-based systems where distance measurement is needed.

Considering the detailed review of earlier work and looking in to importance of automation in agricultural sector, the modern IoT sensors are playing a very vital role. Various authors provided solutions in part. In this study a complete automated solution integrated with free mobile application has been proposed which monitors soil moisture level, water level in the tank and also facilitates auto On/Off system along with manual control if required.

## III. METHODOLOGY

The overall design of the proposed smart irrigation system is shown in Fig.1 and component connection setup is shown in Fig. 2.

### *A. Components' Setup*

To automate the irrigation system, the IoT devices are the more obvious option which may be used to get the data in real time from the environment. Further, the predefined processing may be performed on the collected data and after performing the defined process, the resultant output related actions may be directly performed on the environment again. Furthermore, using IoT devices one can get access to both the hardware and software components of the system. Fig. 1 shows that the major IoT devices required for the proposed project setup. It includes ESP8266 microcontroller, soil moisture sensor and ultrasonic sensor. The central component of the system is ESP8266 which connects all the sensors and actual database storage which connects the IoT setup with the mobile application where user can get all the updates regarding the system in real time. The decision of providing water supply to the plants is based on different factors such as, presence of moisture in soil and availability of water in the storage tank.

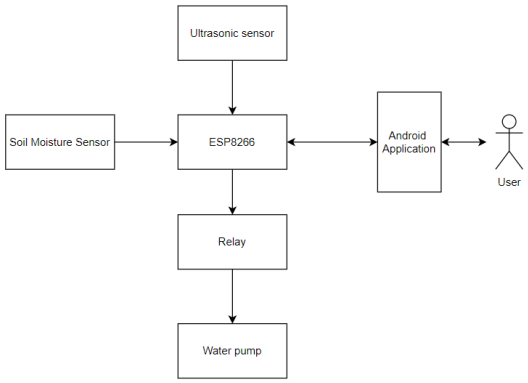


Fig. 1. Components connection diagram

### *B. Working of proposed System*

The working of the proposed system begins with sensing the actual moisture content from the soil with the help of soil moisture sensor [1]. The sensor is dipped inside the soil near the root of the plants from where actual moisture level of the soil may be obtained and the analog output from the sensor is given to ESP8266 [3]. The availability of water in the water storage tank has been monitored with the help of ultrasonic sensor [10]. The ultrasonic sensor, mounted on the top of the tank measures the distance between the top of the tank and the water level in the tank, which help to identify the actual water level in the tank. Further, the value of level of water in the tank has been sent to the ESP8266.

Further, based on the data and considering the factors which affect the decision of water supply, the pump may be handled by giving this data as input. This data acts like the input for the program module into the ESP8266. ESP8266 is programmed such that it takes the decision of turning On /Off the water supply pump on the basis of the input data which is supplied by these smart IoT sensors. The output of the ESP8266 is used to turn On/Off water pump using the relay as switch in between them which is connected to the output pin of the ESP8266. The pump is switched ON only when the water level in the storage tank is more than the predefined minimum level and moisture level in soil is less than the

predefined level. If both the conditions are satisfied, pump gets ON and plants get watered automatically, Fig. 2. Here, in this study, pump is switched ON automatically when the moisture level of the soil is less than 20% and switched OFF automatically when soil moisture level exceeds 60%. However, these values may be changed on the basis of crop and type of the soil. Further, in order to control the system manually, the mobile application also facilitate user to switch On/Off the pump manually when the soil moisture level lies between 20% to 60%, if required.

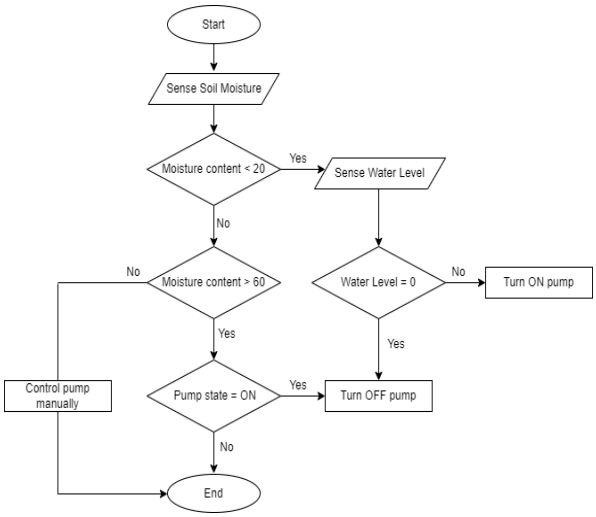


Fig. 2. Working flow of system

### C. *Features of Android Application*

The smart mobile application is an important part of the proposed system. Though we have automatic system of watering the plants, farmer should also have control on all these activities. For that purpose, the facility of controlling the pump is provided to the user with the help of mobile application which provides more comfort to handle everything remotely from anywhere [8]. Mobile application also provides the facility of turning the pump On/Off manually. The mobile application is designed in such a way that user can visualize all the data on the screen in tabular and user friendly format. User gets the updates regarding the live moisture level and water level in tank. Along with this live data, the past data of moisture level and pump status is also stored and displayed with respective date and time. This past data is mostly useful for monitoring and analysis purpose. Further, the notification feature of mobile application notifies the user when the current state of pump On/Off gets changed.

## IV. Results and Discussion

The proposed automated system is tested for real time test cases and the results are recorded in table I. Here, the readings are recorded by using the moisture sensor at different time having different level of moisture in the soil. Similarly, the readings of water level in the tank from ultrasonic sensor are also recorded at different time. Based on the soil moisture level and level of water in the tank the status of pump On/Off is shown in Table I along with the state of operation i.e., either automatically or manually. Further, smooth changeover status of pump from ON to OFF and vice versa, based on sensor reading is also tested successfully.

TABLE I. Pump Status According to Live Data

| Sr. No. | Sample Measures | | |
|---|---|---|---|
| | ***Moisture Level (%)*** | ***Water Level (%)*** | ***Pump Status*** |
| 1 | 9 | 80 | Automatic ON |
| 2 | 65 | 50 | Automatic OFF |
| 3 | 15 | 5 | Pump OFF |
| 4 | 15 | 90 | Automatic ON |
| 5 | 50 | 70 | Manually OFF |
| 6 | 30 | 70 | Manually ON |

Fig. 3 shows screen shot of soil moisture level displayed in mobile application where in option for manual pump control along with current pump status may be observed.

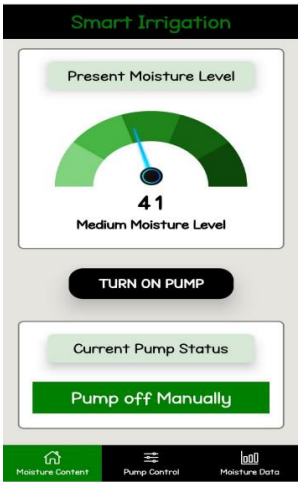


Fig. 3. Display of data in mobile application

Fig. 4 shows water level in tank displayed in mobile application and option for manual pump control is also provided with current pump status.

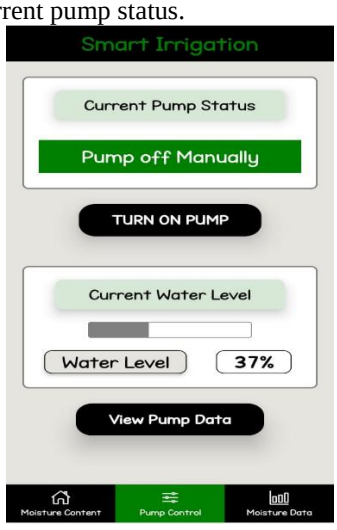


Fig. 4. Display of water level

Fig. 5 shows the snapshot of mobile application showing status of pump displayed with date and time in tabular and user friendly format.

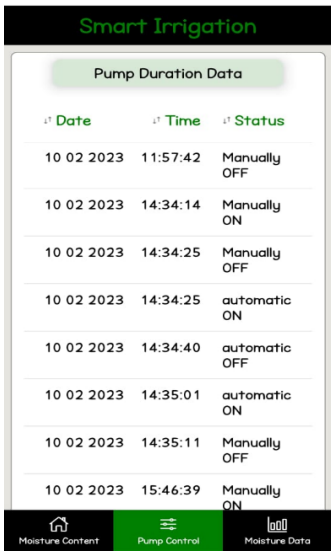


Fig. 5. Past recorded data

## V. Conclusion and Future Scope

The proposed automatic system provides an efficient and complete solution to the traditional time-consuming irrigation system with the help of modern tools and techniques. The system also considers all factors such as soil moisture level, water level in the tank, etc. The system is found extremely efficient and useful considering high human efforts and cost.

The testing experience on real time data represents high sensor accuracy of sensing the soil moisture and level of water in the tank. The auto On/Off of the pump based on sensor data is also tested successfully on live sensor data. The manual operations of forced switching On/Off the pump also tested successfully. Further the notifications provided by the mobile application are also tested considering sensor data which works accurately as per specification and found useful for updating the user time to time. In addition, the option for analyzing the past data of moisture and pump status is also provided in the mobile application.

In future, modifications may be done in the system by taking consideration of other environmental factors like weather and rain for watering the plants. Weather factors such as temperature and humidity can also be considered to make irrigation smart and more efficient. In addition, it can also be extended to monitor the need of fertilizers based on the detection of pH and nutrients values from soil using supporting IoT sensors.

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