

## SMART IRRIGATION SYSTEM USING IOTAND ML

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### ABSTRACT

The Smart Irrigation System Using IoT and Machine Learning (ML) is designed to automate and optimize the irrigation process by monitoring soil and environmental conditions in real time. Conventional irrigation methods often lead to excessive water consumption because irrigation is generally performed at fixed intervals without considering the actual moisture requirements of crops. The proposed system uses IoT-enabled sensors to collect parameters such as soil moisture, temperature, humidity, and water level. An IoT controller, such as an ESP32, processes the sensor data and controls a water pump automatically.

Machine Learning is incorporated to analyze the collected environmental and soil data and predict whether irrigation is required. Based on the predicted requirement, the system can automatically switch the pump ON or OFF. The sensor data and system status can also be monitored remotely through an IoT platform or mobile application. The proposed system aims to reduce water wastage, minimize manual intervention, improve irrigation efficiency, and support data-driven agricultural practices.

**Keywords:** Dht11, Soil moisture, Blynk, Esp 32, Relay, Internet of Things.

### I.INTRODUCTION

Agriculture is one of the major consumers of freshwater, and efficient water management is essential for sustainable crop production.

In traditional irrigation systems, farmers often depend on manual observation or fixed irrigation schedules. These methods may result in over-irrigation or under-irrigation,

especially when weather and soil conditions change.

The development of Internet of Things (IoT) technology provides an opportunity to monitor agricultural fields remotely using sensors and connected controllers. Soil moisture sensors can determine the moisture content of the soil, while temperature and humidity sensors provide information about environmental conditions.

Machine Learning can further improve the irrigation process by identifying patterns in historical sensor data and predicting irrigation requirements. By combining IoT-based sensing, automatic control, cloud monitoring, and ML-based prediction, a smart irrigation system can make irrigation more responsive to actual crop and soil conditions.

The main objective of this project is to develop an intelligent irrigation system that automatically determines when water is required and operates the irrigation pump accordingly.

### **III. EXISTING SYSTEM**

In the existing irrigation system, farmers generally depend on manual observation and traditional irrigation methods to supply water to crops. In many cases, irrigation is carried out at fixed time intervals without accurately considering the actual moisture content of the soil or the environmental conditions. This can result in over-irrigation when sufficient moisture is already present in the soil, leading to unnecessary water consumption. Similarly, insufficient irrigation may occur when the crop requires

more water than the scheduled amount. Traditional systems also require regular human intervention to operate and monitor the water pump. Since there is limited real-time monitoring and no intelligent prediction mechanism, it is difficult to make irrigation decisions based on changing soil and weather conditions. Therefore, conventional irrigation systems may not provide efficient water utilization and automated crop water management.

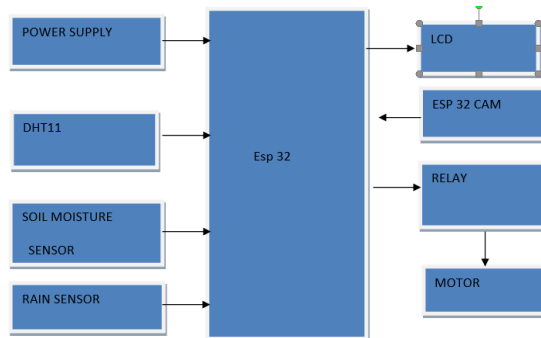
### **IV. PROPOSED SYSTEM**

The proposed Smart Irrigation System Using IoT and Machine Learning is developed to overcome the limitations of conventional irrigation methods by providing automated and intelligent water management. The system uses IoT-enabled sensors to continuously monitor important parameters such as soil moisture, temperature, humidity, and water availability. An ESP32 or similar microcontroller collects the sensor data and transmits it through the internet to an IoT platform for real-time monitoring.

Machine Learning is incorporated to analyze the collected sensor data and identify the conditions under which irrigation is required. The trained ML model can predict the irrigation requirement based on parameters such as soil moisture and environmental conditions. According to the prediction, the controller automatically operates the water pump through a relay. When the required soil moisture level is achieved, the pump can be switched OFF automatically. The system also allows farmers to remotely monitor sensor readings, irrigation status, and other parameters through an IoT dashboard or mobile application. Thus, the proposed system combines real-time sensing, IoT connectivity, ML-based prediction, and automatic pump control to

improve irrigation efficiency and reduce unnecessary water consumption.

### V.BLOCK DIAGRAM



### ESP 32

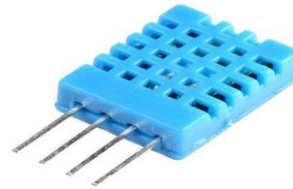


ESP32 based boards come in a variety of shapes and sizes and pinout of each board is different to other. Also, not all pins of the ESP32 Microcontroller SoC will be available on a development board as some pins might be permanently tied to a dedicated function. One such case is the Flash Memory. We know that all ESP32 boards come with 4 MB of Flash Memory to store the programs. So, some of the GPIO Pins (6 to be specific) are connected to SPI Flash IC and those pins cannot be used as regular GPIO Pins.

Hence, it is important to understand the pinout of popular ESP32 boards so that you

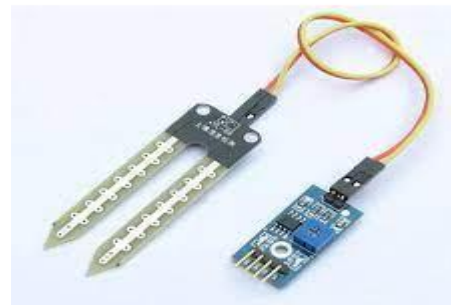
will know what pins are available for use in projects.

### HUMIDITY SENSOR



DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form.

### SOIL MOISTURE SENSOR



The moisture of the soil plays an essential role in the irrigation field as well as in gardens for plants. As nutrients in the soil provide the food to the plants for their growth. Supplying water to the plants is also essential to change the temperature of the plants. The temperature of the plant can be changed with water using the method like transpiration. And plant root systems are

also developed better when rising within moist soil. Extreme soil moisture levels can guide to anaerobic situations that can encourage the plant's growth as well as soil pathogens. This article discusses an overview of the soil moisture sensor, working and its applications.

### WATER LEVEL SENSOR



**Level sensors** detect the level of substances that flow, including liquids, slurries, granular materials, and powders. Fluids and fluidized solids flow to become essentially level in their containers (or other physical boundaries) because of gravity whereas most bulk solids pile at an angle of repose to a peak. The substance to be measured can be inside a container or can be in its natural form (e.g., a river or a lake). The level measurement can be either continuous or point values. Continuous level sensors measure level within a specified range and determine the exact amount of substance in a certain place, while point-level sensors only indicate whether the substance is above or below the sensing point. Generally the latter detect levels that are excessively high or low.

### RELAY



A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

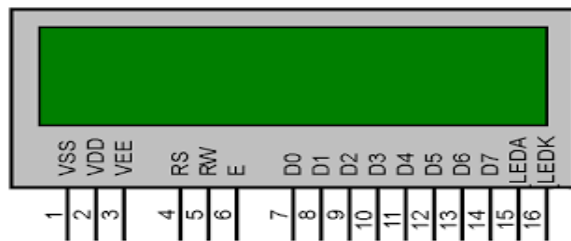
### AC MOTOR



As the name suggests, a submersible pump, also known as an electrical submersible

pump, is a water pump that is completely submerged in the water and can be used for a variety of applications. The electric motor used in the process is hermetically sealed and also close-coupled to the pump. One of the major advantages of a submersible pump is that it does not require priming because it has already been submerged in the liquid.

### LCD

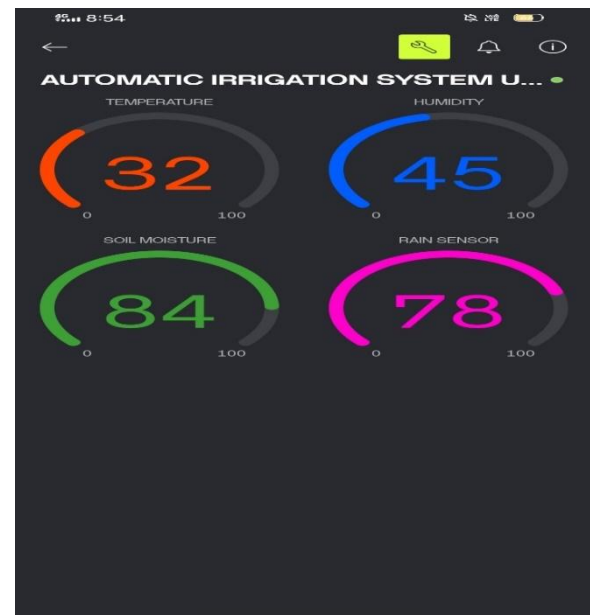
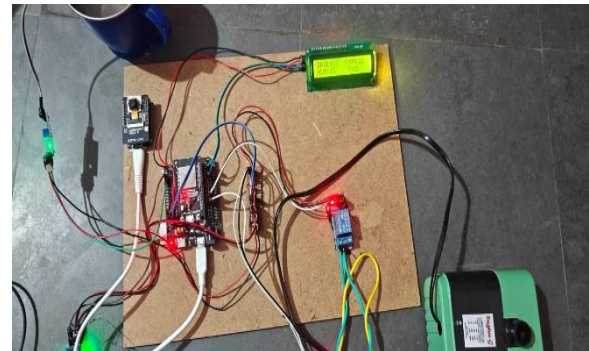


It is called Liquid Crystal Display. We are going to use 16x2 characters LCD. This will be connected to microcontroller. The job of LCD will be to display all the system generated messages coming from the controller. LCD will provide interactive user interface. This unit requires +5VDC for its proper operation. This module is used for displaying the present status of the system.

### VI.EXPERIMENTAL RESULT

Irrigation becomes easy, accurate and practical with the same soil sample impossible. Because of the idea above shared and can be implemented in agricultural difficulties of accurately measuring dry soil and water fields in future to promote agriculture to next level. The Volumes, volumetric water contents are not

usually output from moisture sensor and level system plays major determined directly. Role in producing the output.



### VI.ADVANTAGES

- Saves water by providing irrigation only when required.
- Automatically controls irrigation based on soil moisture.
- Uses ML to predict irrigation requirements.
- Enables real-time monitoring of field conditions.

- Allows remote monitoring and control through IoT.
- Reduces manual effort and labor costs.
- Improves crop growth and productivity.
- Provides efficient use of water resources..

## VII.APPLICATIONS

- Agricultural Farms – Automatically controls irrigation based on soil moisture, weather conditions, and crop requirements.
- Greenhouses – Maintains suitable soil moisture and environmental conditions for plants.
- Gardens and Lawns – Automates watering and prevents unnecessary water usage.
- Precision Agriculture – Uses ML to determine the appropriate amount and timing of irrigation for different crops.

## VIII. CONCLUSION

The Smart Irrigation System Using IoT and Machine Learning provides an automated approach to agricultural water management. By continuously monitoring soil and environmental conditions, the system can determine irrigation requirements more effectively than conventional fixed-time irrigation.

The integration of IoT enables real-time monitoring and remote control, while Machine Learning provides the capability to analyze historical data and predict irrigation

requirements. Automatic pump control can reduce unnecessary irrigation and manual intervention.

## IX. FUTURESCOPE

The proposed system can be further improved by integrating additional technologies and agricultural parameters. Weather forecasting data can be incorporated into the system to predict rainfall and avoid irrigation when natural rainfall is expected. More advanced Machine Learning and Deep Learning algorithms can be trained using larger datasets to improve irrigation prediction for different crops, soil types, and climatic conditions. The system can also be extended to monitor multiple agricultural fields and provide crop-specific irrigation recommendations.

In the future, camera modules and computer vision techniques can be integrated to monitor plant growth and detect diseases or nutrient deficiencies. Solar power can be incorporated to operate the system in remote agricultural areas where conventional power sources may not be easily available. A dedicated mobile application can provide real-time notifications, historical data analysis, pump control, and water-consumption reports. The system can also be extended to support automated fertigation, where fertilizers are supplied along with irrigation water. These improvements can transform the system into a more comprehensive AI- and IoT-based precision agriculture platform.

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