SMART IRRIGATION SYSTEM USING IOT TECHNOLOGY

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ABSTRACT

As there is rapid increase of population now-a-days need of water consumption increases which leads to the depletion of water resources, so we are opting IoT-based water management systems to limit the usage of water. In the case of traditional irrigation system, water saving is not considered. Since, the water is irrigated directly in the land, plants under go high stress from variation in soil moisture, therefore plant appearance is reduced.. A systemto monitor moisture levels in the soil was designed.

IoT water management systems use sensors, controllers, meters, and other devices connected to system, and data processing and analysis tools to efficiently manage water supply, monitor water quality. This system reduce the energy and cost. Also irrigation systems that use soil moisture sensors to optimize water usage. These systems can be applied in various sectors, including agriculture, urban management, and water treatment plants.

The system can be used to switch on/off the watering system/pump according to set soil moisture levels. It controls the irrigation of plants automatically where the need of human intervention can be reduced. So, to monitor soil moisturecontent during its dry and wet conditions, a soil moisture sensor is used which is controlled by Arduino Uno micro controller. The automated system utilizes a soil moisture sensor to continuously monitor the moisture level in the soil. Once the moisture level falls below a predefined threshold, the sensor triggers the Arduino Uno to activate a water pump, ensuring timely and precise irrigation for plants or crops.

***Keywords**: Arduino Uno Mirco Controller, Relay Module, Smart Irrigation, Soil Moisture Sensor,Submersible water pump.*

1. INTRODUCTION

India is the country of villages and agriculture plays an important role for development of country.Inourcountry,agriculturedependsonthe monsoonswhichhasinsufficientsourceof water. So the irrigation is used in agricultural field In Irrigation system, depending upon the soiltype,waterisprovidedtoplant.Nowadays,forirrigation,differenttechniquesareavailable which are used to reduce the dependency of rain. And mostly this technique is driven by electricalpowerandon/offscheduling.Inthistechnique,antemperatureandhumiditysensors areplacedneartheplantandnearthemoduleandgatewayunithandlesthesensorinformation and transmit data to the controller which in turns the control the flow of water through the pump.

In the domain of farming, utilization of appropriate means of irrigation is significant. The benefitofemployingthesetechniquesistodecreasehumaninterferenceandstillmakecertain appropriate irrigation.Theproposed modelconsistsofthreestages: Firstly,sensing theland's moisture levels. Second stage is the determination of its status: dry or wet. The last and third stageisMotorcontrol.Withtheadvancementofautomationtechnology,lifeisgettingsimpler and easierin all aspects.

2. OBJECTIVES

- Optimize Water Conservation
- Improve Irrigation Efficiency
- Enable Remote Monitoring and Control
- Enhance Data-Driven Decision-Making
- Reduce Operational Costs

3. METHODOLOGY

1. **Sensor Integration**
   - Soil moisture sensors, temperature/humidity sensors, rain gauges, and weather APIs.
2. **Automated Irrigation Control**
   - Actuators (valves, pumps) triggered by sensor data to start/stop irrigation.
3. **Real-Time Data Transmission**
   - IoT protocols (e.g., LoRaWAN, MQTT, Wi-Fi, or cellular networks) for sensor-to-cloud communication.
4. **User Interface**
   - Mobile/web dashboard for monitoring sensor data, setting schedules, and manual overrides.
5. **Predictive Analytics**
   - Algorithms to forecast irrigation needs using historical data and weather predictions.
6. **Alert System**
   - Notifications for leaks, low battery, sensor malfunctions, or extreme weather.
7. **Integration with External Systems**
   - Compatibility with farm management software, drones, or satellite imagery.

Non-Functional Requirements

1. **Energy Efficiency**
   - Low-power sensors and solar-powered devices for remote deployments.
2. **Scalability**
   - Modular design to add/remove sensors or expand coverage area.
3. **Data Security**
   - Encryption (SSL/TLS) for data transmission and secure user authentication.
4. **Reliability**
   - Robust hardware to withstand outdoor conditions (heat, rain, dust).
5. **Usability**

- Intuitive interface with multilingual support for non-technical users
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6. **Cost-Effectiveness**
   - Affordable hardware and minimal maintenance costs.

7. **Compliance**
   - Adherence to local water-use regulations and data privacy laws (e.g., GDPR).

4. MATERIALSUSED

- **Arduino Uno Micro controller:** The Arduino Micro controller is a versatile and widely used platform for building electronicprojects. Itis based on theArduino board, which typicallyincludesa micro controller,input/output(I/O) pins, and various other components that facilitate the development of interactive electronic devices.

Fig 1 : Arduino Uno Micro Controller

- **UltrasonicWater Level Sensor:**The WL705 Ultrasonic water level sensor uses the latest ultrasonic distance measuring technologyforaccurateresultsofwaterlevelmonitoring.Itisanindustrystandardcompliance 4-20m a output transducer. It requires no programming and calibration. It can be used in irrigation water supply applications for monitoring water level in tanks and open channels. If the soil is dry, theArduino checks the availability of water using a water level sensor.

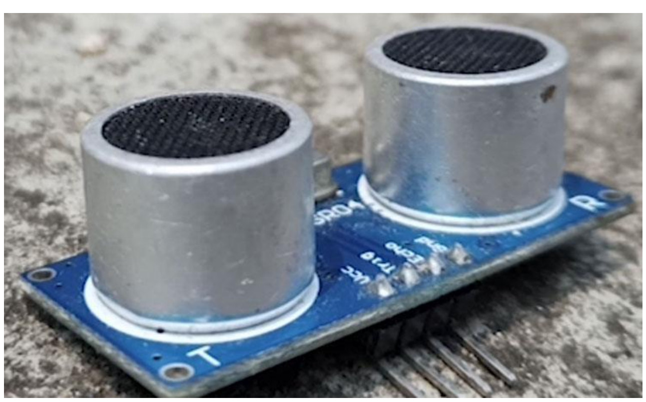

Fig 2: Ultrasonic Water Level sensor

- **Soil Moisture Sensor:** A soil moisture sensor that is used to measure the moisture in the sand. When the sensor determinesalackofwaterinthefield,themodule'soutputishigh;otherwise,itislow.Along with measuring the soil's moisture content, this sensor also informs the user to water their plants. It finds extensive usage in gardening for medicinal purposes as well as irrigation in agriculture.The working of the soil moisture sensor is very easy to understand. It has 2 probes with exposed contacts that act like a variable resistor whose resistance varies according to the watercontentinthesoil.

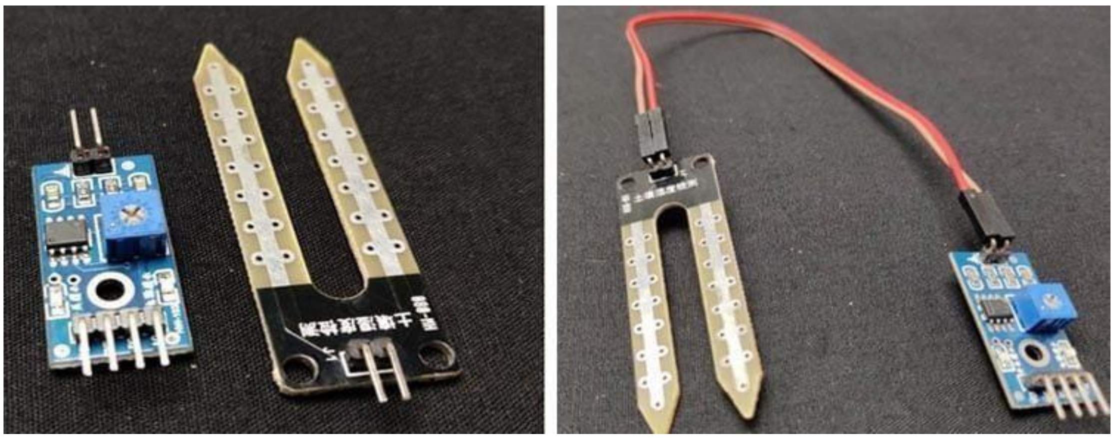

Fig 3: SOIL MOISTURE SENSOR

- **Relay Module:**When thesoil moisture level falls below a certain threshold (e.g., 50%), the controller board activates the relay. The relay, in turn, switches on the water pump, allowing water to be sprinkled on the land. Once the moisture level reaches the desired level (e.g., 55%), the relay turns off the water pump.

Fig 4:Relay Module

- **Submersible Pump:**submersiblepumpmotoritrequiresapowersupplythatisbetween2.5and6voltstofunction. Witha220mAcurrentconsumptionandapumpingcapacityofupto120litresperhour.Simply attach the tube pipe to the motor port, put it in water, and turn it on . A submersible pump is designed to be submerged in water (usually a well or borehole) and is used to lift water to the surface. It consists of an electric motor, impeller, and housing.

Fig 5: Submersible Pump

- **Battery:** Anelectricbatteryisasourceofelectricitycomposedofoneormoreelectrolyticcellconnected totheoutsideworld.Whenabatteryissupplyingpower,thecathodeandanodearethenegative and positive terminals, respectively. The charged particles that will commute to the positive electrode via an outer electric circuit will originate at the negative terminal.

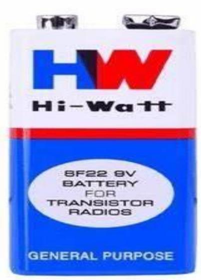

Fig 6: Battery

- **LCD Display:**We come across LCD displays everywhere around us. Computers, calculators, television sets,mobilephones,digitalwatchesusesomekindofdisplaytodisplaythetime.AnLCD is an electronic display module which uses liquid crystal to produce a visible image. The 16×2LCDdisplayisaverybasicmodulecommonlyusedinDIYsand circuits.The16×2 translates a display 16 characters per line in 2 such lines.

Fig 7: LCD Display

- **Jumper Wires:** Jumper wires typically come in three versions: male-to-male, male-to-female and female-to female. The difference between each is in the end point of the wire. Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with bread boards and other prototyping tools in order to make it easy to change a circuit as needed.

Fig 8: Jumper Wires

- **All hardware Components:**

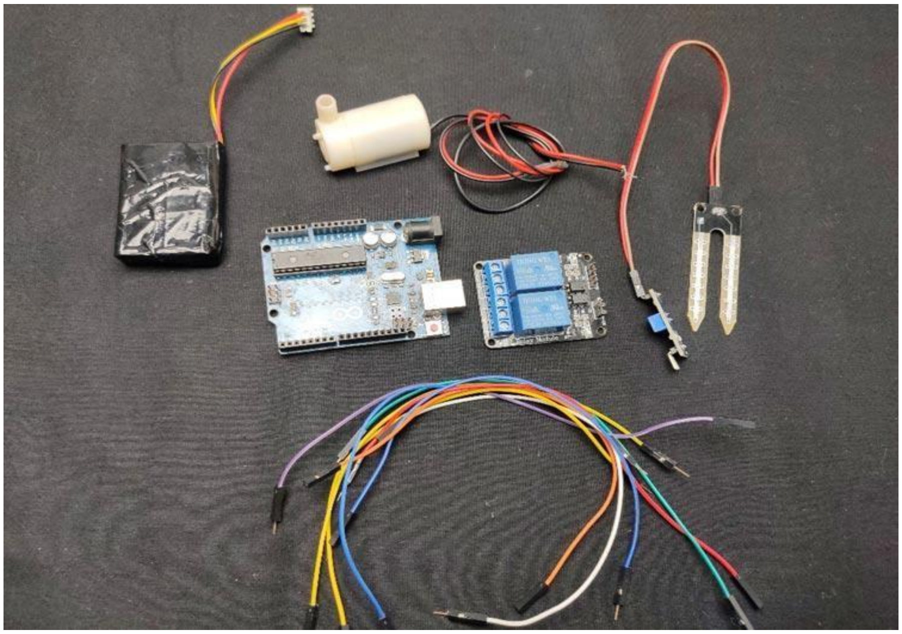

Fig 9: All Hardware Components

- **Connections of All The Parts:**

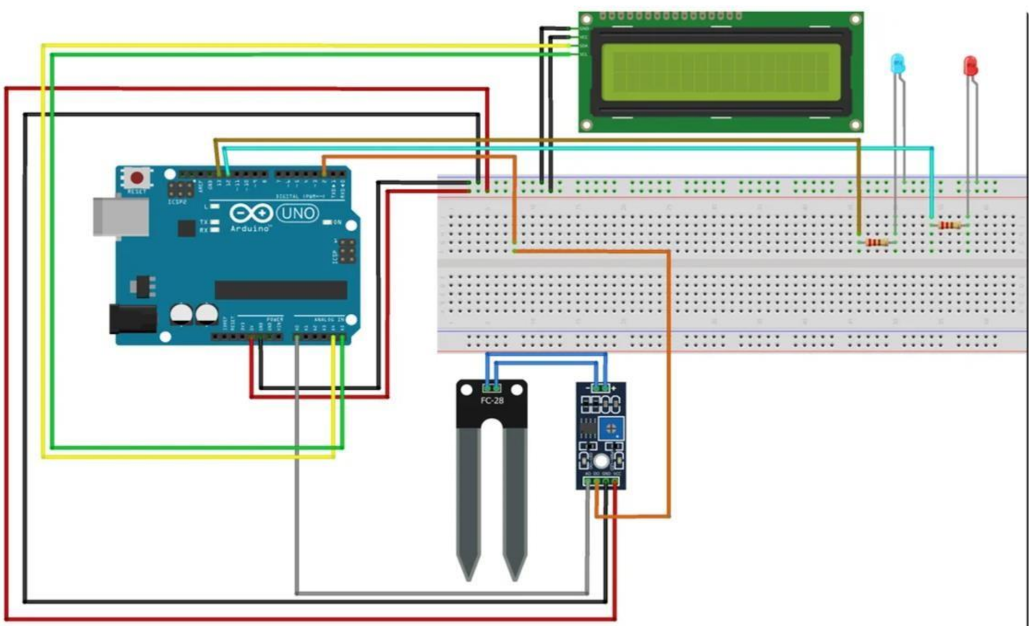

Fig 10: Connections of All The Parts

5. RESULTS

1. Thepercentageof soilwaterholding capacityofPaddy fieldsoil = 76%
2. Thepercentageof soil waterholding capacity ofRoadsidesoil =56%
3. Thepercentageof soilwaterholding capacity ofRed soil = 52%

Both soil moisture sensors and water holding capacity of soil are valuable tools for assessing soil moisture levels, but they serve different purposes and have their own strengths and limitations.

Soil moisture sensors provide real-time data on the actual moisture content of the soil at a specific point in time. These sensors measure the electrical conductivity or dielectric constant ofthesoil, which correlateswith the moisture content. They offer immediatefeedback on soil moisture levels, allowing for timely irrigation decisions. However, soil moisture sensors may notalwaysaccuratelyrepresenttheoverallmoisturestatusofthesoil,astheymeasuremoisture content only at the specific location where they are placed.

On the other hand, water holding capacity (WHC) of soil refers to the maximum amount of water that the soil can retain against gravitational drainage. It is influenced by factors such as soil texture, structure, organic matter content, and compaction. While WHC does not provide real-timedatalikesoilmoisturesensors,itoffersvaluableinformationaboutthesoil'sinherentabilitytoholdwater.UnderstandingtheWHCofsoilcanhelpinplanningirrigationschedules and estimating the water needs of plants over time.

In terms of accuracy for finding the percentage of moisture, both soil moisture sensors and WHC have their own merits. Soil moisture sensors are more precise for immediate measurementsatspecific locations,whileWHCprovidesabroaderunderstandingofthesoil's water retention capacity. Ideally, using both methods in conjunction can provide a more comprehensiveassessmentofsoilmoisturedynamicsandhelpoptimizeirrigationpracticesfor improved crop health and water efficiency.

6. CONCLUSION

- The choice between moisture sensors and WHC depends on the specific needs and objectivesof the user.
- Soil moisture sensors are suitabe for immediate,localised,measurements.
- The automated irrigation system implemented was found to be feasible and cost effective for optimising water resources for agriculture production.
- This irrigation system allows cultivation in places with water scarcity thereby improving sustainability.
- As multiple sensors are used water can be provided only to the required area of land.
- The crop productivity increases and the wastage of crops are very much reduced.

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