Smart Agriculture Irrigation System

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Abstract:

In Bangladesh, most farmers still water their crops manually, which often wastes water and takes extra effort. Modern smart irrigation systems are available, but they are expensive and depend on the internet or GSM, which is not practical in many rural areas. In this project, we designed a low-cost, offline Smart Agriculture Irrigation System using ESP32, a soil moisture sensor, DHT11, a relay, and a small water pump. The pump turns on automatically when the soil becomes dry and stops when the soil has enough moisture. All data (temperature, humidity, and soil condition) is shown on an OLED display. The system is simple, affordable, and can help small farmers and gardeners save water and time.

Introduction:

Irrigation is one of the most important tasks in farming, but in Bangladesh, most of it is still done manually. Farmers usually water their crops by guessing or by following a fixed schedule. This causes either too much water or too little water, both of which affect crop growth. Smart irrigation systems exist in other countries, but they mostly need the internet and are costly. We aimed to create a system that fits Bangladesh's reality: cheap, offline, and easy to use. With just a few sensors, a microcontroller, and a pump, our system can water crops on its own without internet. It also shows live data on a display so that farmers can see the condition of their soil and weather instantly.

Background Study:

While studying, we found that most research on smart irrigation focuses on IoT and remote monitoring. For example, the IRJET paper (2021) shows a system where sensors send data to a mobile app through GSM/Wi-Fi, and the motor is controlled remotely. Although this works well in advanced setups, it costs more and always needs the internet. In Bangladesh, rural farmers cannot always afford GSM modules or Wi-Fi connections. They need something simpler—an offline system that just does the job. That gap in existing solutions motivated us to design a project that is practical and affordable.

Motivation:

The motivation came from seeing how farmers around us struggle with irrigation. Many have to spend hours watering their crops, often at odd times of the day. We also noticed water being wasted because irrigation was not done at the right time. Expensive IoT systems are not realistic for small farmers here. So we thought—what if we build something small and smart that can do this job automatically without internet? This became the core inspiration for our project.

Contribution:

Sadia Afrin Sraboni: Component collect, Circuit design, Literature review, and Report writing
Masud Mia: Software coding, Connection and Presentation.
Mehzabin Nower: wire, block diagram and collecting water and plant.
Mst Fatema Akter: troubleshooting and collecting soil.
Sifat Khan: Coding, Implementation and Documentation.

Literature Review:

Source	Approach	Limitation	Gap Identified
THE SMART IRRIGATION SYSTEM USING IOT	IoT irrigation using GSM/Wi-Fi, mobile app	Internet dependency, high cost	Not practical for rural Bangladesh
Automated Irrigation	GSM-based irrigation system that sends SMS alerts	High installation and maintenance costs	Small-scale farmers cannot afford GSM modules
Smart Irrigation System	Smart irrigation with soil moisture and weather prediction	Complex algorithm, high cost	Too sophisticated for small farms
System-IoT Based Approach	IoT-based smart irrigation system with remote monitoring	Requires internet connectivity	Not practical for rural areas with unreliable internet

Objectives:

Create a low-cost smart irrigation system that works without internet. Automatically turn on the pump when soil is dry and stop when soil is moist enough. Display real-time information on soil condition, temperature, and humidity on an OLED display.
Provide a practical system for small farmers and gardeners in Bangladesh.

Components Used:

- ESP32
- ARDIUNO UNO
- Relay Module
- DHT11 Temperature & Humidity Sensor
- Soil Moisture Sensor
- OLED Display
- Rechargeable Battery
- Jumper Wires
- Breadboard
- Water Pipes
- DC Water Pump

Block Diagram:

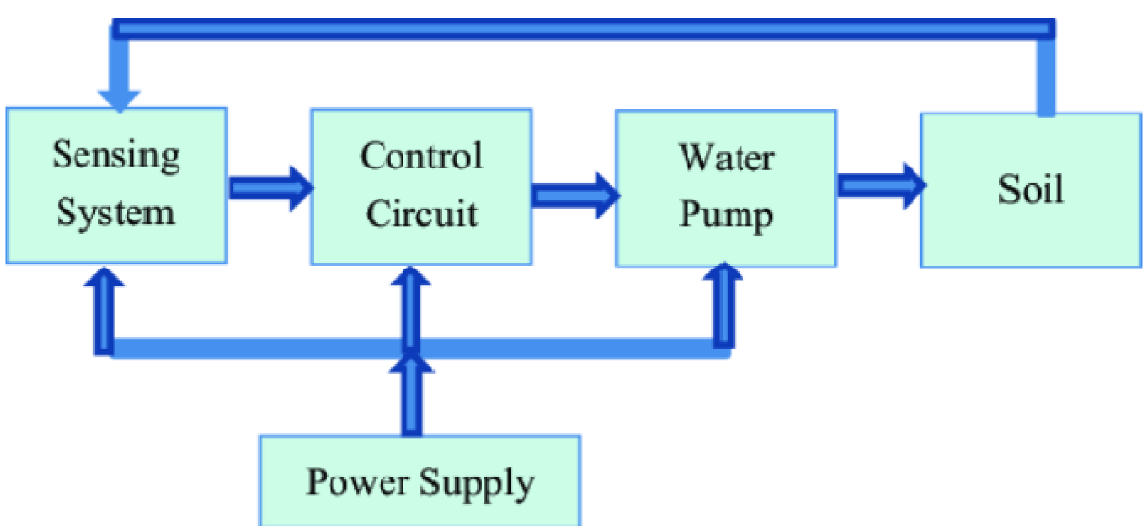

FIG: Block Diagram

Hardware Design:

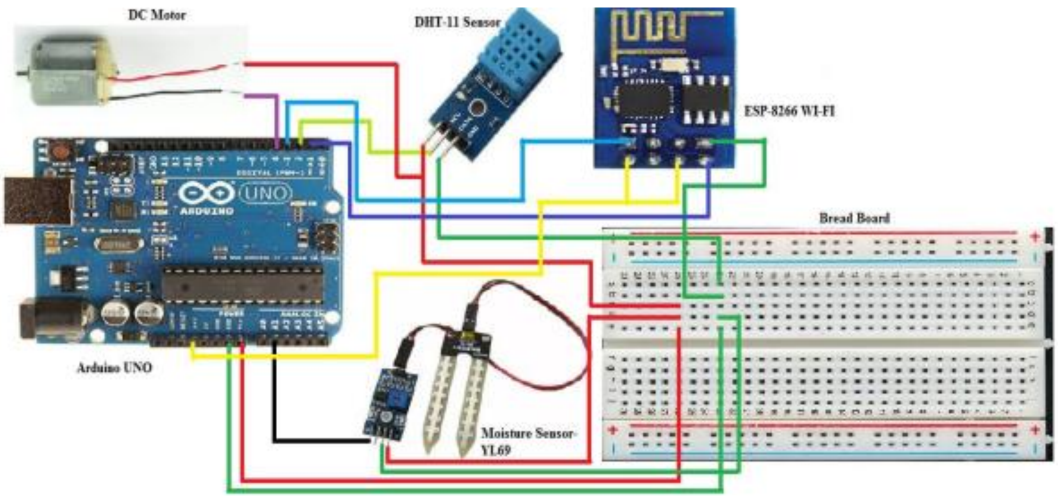

FIG: Connection with Arduino

Software Design:

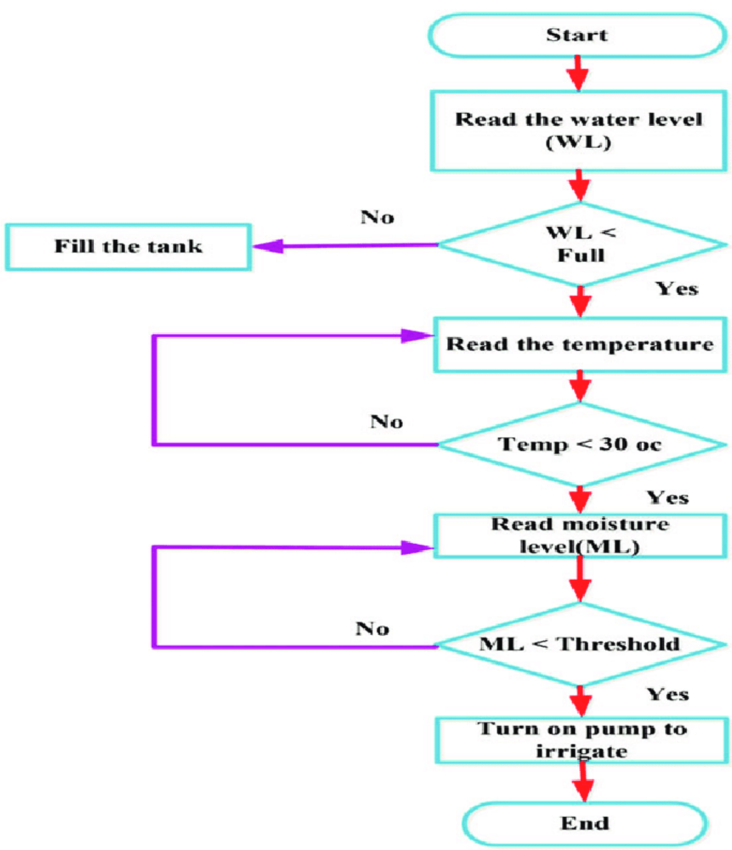

FIG: Workflow chart

We used Arduino IDE to write the code. The program constantly checks soil moisture. If the dryness level goes below a set threshold, the pump is turned ON, otherwise it is OFF. The OLED screen is refreshed to show current readings and pump status. Everything works offline, so there is no dependency on the internet.

Implementation:

Step by step, we connected the ESP32 and Arduino with the sensors, relay, and OLED display. Then we uploaded our code and tested it. The system worked successfully—the pump turned on automatically when the soil dried and stopped when it was moist again. The OLED display showed all sensor readings clearly.

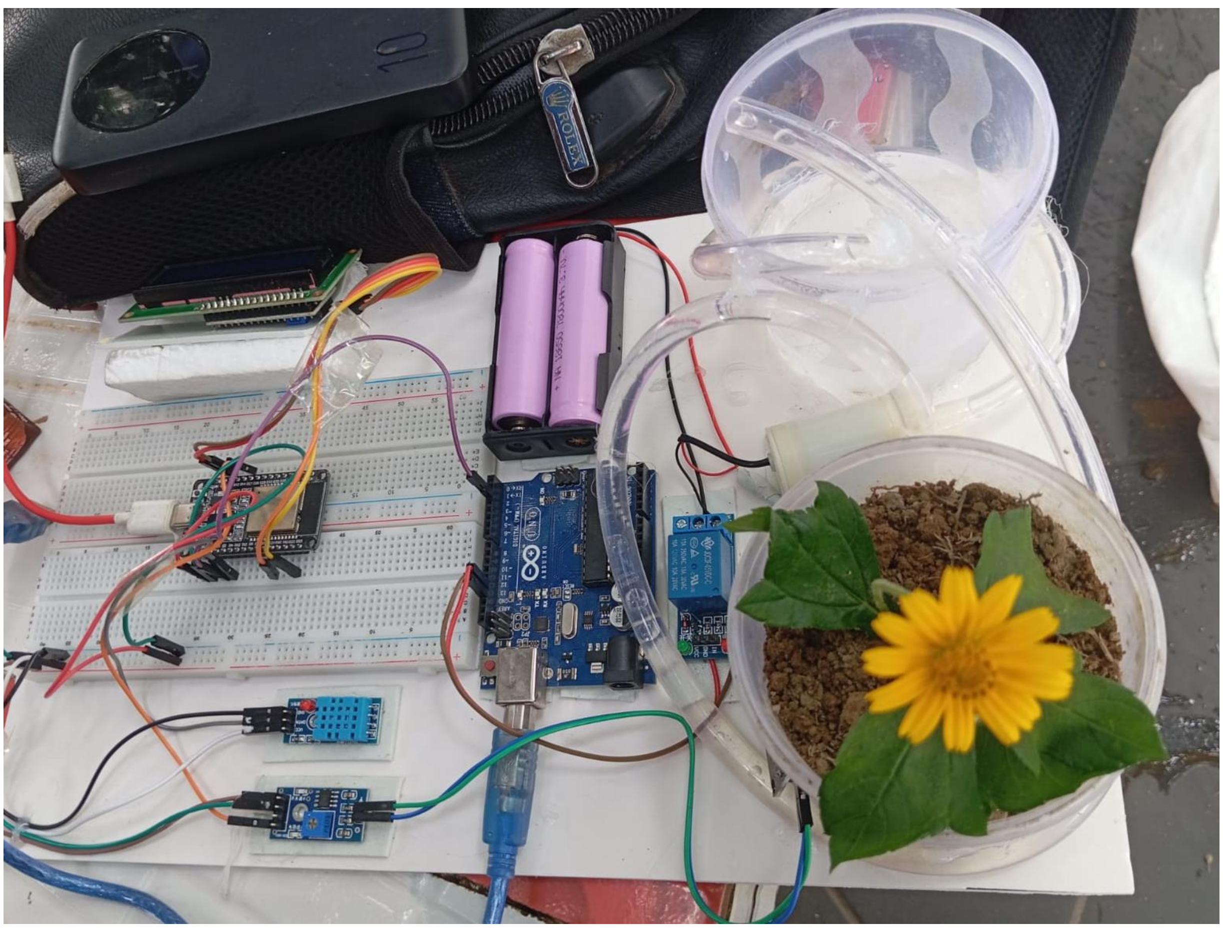

FIG: Smart Irrigation System

Results: (Manual vs Auto):

Aspect	Manual Irrigation	Smart Auto Irrigation
Water Usage	Often wasted	Controlled and efficient
Labor	Needs farmer presence	Fully automatic
Accuracy	Based on guess	Based on sensor data
Monitoring	No feedback	Real-time OLED data
Reliability	Not always consistent	Reliable automation

Our test results showed that the smart system saves water, reduces farmer workload, and provides real-time useful data.

Challenges :

Sensor Calibration: Different soils in Bangladesh (clay, sandy, loamy) gave different readings, so we had to adjust thresholds.
Power Supply: Keeping a stable supply for outdoor use was tricky.
Coding & Debugging: As beginners, we faced errors in Arduino code.
Circuit Issues: Loose breadboard connections caused problems during testing.

Even though these were challenges, we learned a lot by solving them.

Future Scope:
This project can be further expanded such as the app can suggest what type of crop can be produced in the field based on the soil type and the water resource used for irrigation, source of availability of seeds, organic manures to be used for the best yield, methods for preserving the produce till marketing and so on.

Conclusion:
We successfully built an offline smart irrigation system that is low-cost, simple, and practical for Bangladeshi farmers. It saves water, reduces human effort, and shows real-time information. Compared to existing IoT models like the IRJET system, our design is more suitable for Bangladesh because it avoids high cost and internet dependency. With future upgrades, this project can evolve into a complete smart farming solution that everyone—from small farmers to gardeners—can afford to use.

Once this idea gets implemented, we can save the water wasted unnecessarily. The various moisture, temperature, rainfall and humidity values are monitored using the various sensors. The moisture value is compared with the threshold, and the water pump is automated when the moisture value is lower than the threshold value. The information is sent to the user through the Android application. Thus, we can save our natural water bodies for future generations.