SOROTI UNIVERSITY

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Department of Electronics and Computer Engineering

BACHELOR OF ENGINEERING IN ELECTRONICS AND COMPUTER ENGINEERING

EEE 3108: WIRELESS SENSORS NETWORKS

ASSIGNMENT 2: LITERATURE REVIEW AND METHODOLOGY

BY

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1. SDG OVERVIEW

The project is centered on SDG 2- Zero Hunger of the United Nations Sustainable Development Goals. Goal 2 seeks to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture by 2030. Despite progress in some areas, hunger and food insecurity have been rising since 2015 due to conflict, climate change, inequalities, and the pandemic.

By 2023, nearly 1 in 11 people faced hunger, and over 2.3 billion experienced moderate to severe food insecurity, which is an increase of 383 million since 2019. Children remain highly affected in 2024, 23.2% suffered stunted growth, and 6.6% of under-fives were wasted [1].

Hunger reduces productivity, increases vulnerability to disease, and traps people in poverty. As part of a vicious cycle, hunger can also fuel conflict. Urgent global action is needed to ensure access to safe, nutritious, and sufficient food for all [2].

1.1. PROBLEM IDENTIFICATION

1.1.1. DESCRIPTION

Agriculture is the backbone of food security. Farming, as part of agriculture, is crucial for feeding people worldwide. It gives billions of people food and money. A sound farming system makes sure everyone gets healthy and safe food [3]. Yet, millions of smallholder farmers still rely on traditional farming methods, including manual watering and flood irrigation. These methods are inefficient because they either over-irrigate, resulting in water wastage and reduced soil fertility, or under irrigate, leading to crop stress and low yields. These low crop yields, in turn, lead to hunger in communities and, consequently, across the world.

Since 70% of global freshwater withdrawal is used for agriculture [4], this usage shows that there is a certain level of water wastage majorly by practicing poor irrigation practices which strain water resources, especially in drought-prone regions. The lack of real-time soil and environmental data means farmers make decisions by guesswork rather than evidence thus resulting into under or over irrigation.

This project addresses this gap by designing an intelligent irrigation system using soil moisture and temperature sensors. The system automatically irrigates crops only when necessary and in right proportions, reducing water wastage and ensuring healthier plant growth. Such a system can support SDG 2: Zero hunger by improving crop yields, reducing resource wastage, and making agriculture more sustainable.

1.2. SCOPE

Smart irrigation systems for rural farms in Uganda. Our system is developed to maintain agricultural sustainability in Uganda.

1.3. STAKEHOLDERS

The key stakeholders in this project are farmers, local communities, the government, and researchers. Each plays a role in the adoption, use, and scaling of intelligent irrigation systems to achieve SDG 2: Zero Hunger.

1.4. CURRENT GAPS

Farmers lack real-time monitoring tools, so farming decisions like irrigation are based on guesswork rather than soil and environment data. Traditional irrigation methods are inefficient, often wasting water through over-irrigation or stressing crops through under-irrigation. Many farmers, especially in developing regions, lack access to modern technology, sustainable farming techniques, and the necessary infrastructure to implement them [5].

2. LITERATURE REVIEW

The 2030 Agenda for sustainable Development adopted by the United Nations member states in 2015, at it's heart, are the 17 sustainable Development Goals which are an urgent call for action by all member countries [6]. The UN under sustainable goal 2 [Zero Hunger] [1], states that a cycle of hunger creates a trap that impacts economies, health, education and by this it is noticed that most SDGs cannot be realized without efficiently solving hunger.

The Design of an intelligent solar powered irrigation pump for horticultural production in northern Uganda. O.Bonny, O.Vicent, E.Muhoozi, O.G. Rackara [7] mentioned that one of the major problems in agriculture is non-optimal usage of water. It is estimated that 40% of the fresh-water used for agriculture in developing countries is lost, either by evaporation,spills,or absorption by the deeper layers of the soil, beyond the reach of plants roots.

Table 2.1: Showing a comparative landscape table of different studies based on smart irrigation systems.

Study	**Technologies Used**	**Findings**	**Limitations/Gaps**	**Solution presented**
Sensor based Automated Irrigation System with IOT: A Technical Review [7].	WSN(GSM) and Soil moisture sensor	Depends on mobile network due to use of GSM	GSM consumes high power	Uses LoRa modules, which operate independently of telecom providers and have low power consumption.
Development of a Solar Powered Smart irrigation control system kit [8].	Drip irrigation kit	Saves water and is associated with low weed growth	Suitable for vegetables, fruits, and orchards and is associated with a higher setup cost	Combines a drip and sprinkler irrigation kit, making the system suitable for all crop types.
Development of a Wireless Sensor Network and IoT-Driven Smart Irrigation System [9].	DS18B20 temperature sensor	The sensor has multiple sensors on a single line.	Higher cost and complex wiring of the DS18B20	Uses DHT11, which is more affordable, thereby lowering costs. It is simple to connect with microcontrollers.
Design of an Intelligent Solar Powered Irrigation Pump [10].	Soil moisture sensor	The sensor helps to quantify crop and plant water needs.	Use of soil moisture sensor as a stand alone does not provide enough and accurate information for quantifying crop and plant water needs hence leading to water wastage as a resource.	Combines both soil moisture and temperature sensors hence allowing the system to adapt to irrigation cycles based on soil and environmental conditions leading to healthier crops and efficient water use.

3. METHODOLOGY

3.1. Hardware requirements

- Arduino Uno: The brain of the system, processes sensor data and controls the pump.
- Soil Moisture Sensor: Detects soil dryness and provides data to trigger irrigation.
- DHT22/DHT211 Temperature and humidity sensor; Adds context for decision-making useful for data analysis and crop stress monitoring.

- Breadboard and Jumper Wires: Allow easy circuit assembly without soldering.
- Relay Module: Acts as a switch to safely control the pump using the microcontroller.
- USB Power Bank: Powers the system reliably.
- Water Pump: Delivers the water to the plant when triggered.
- Plant Pot, Soil, Tubing, and Reservoir: Simulate real-world farming conditions in a small demo setup.

3.2. Software Requirements

- Arduino IDE: Platform to write and upload code to the microcontroller.
- Analog Input Functions: Convert soil sensor voltage into digital values the microcontroller can process.
- Cloud Tools (ThingsBoard): Visualize data remotely, show scalability of Wireless Sensor Network.
- LoRa Modules: Gateway uploads to the cloud over 4G or internet.

3.3. DATA PROCESSING

The system uses temperature sensor and soil moisture sensors which continuously detect soil moisture and temperature values and read by the sensor node. The ESP32 node compares the sensor values to the set thresholds of both temperature and soil moisture sensor.

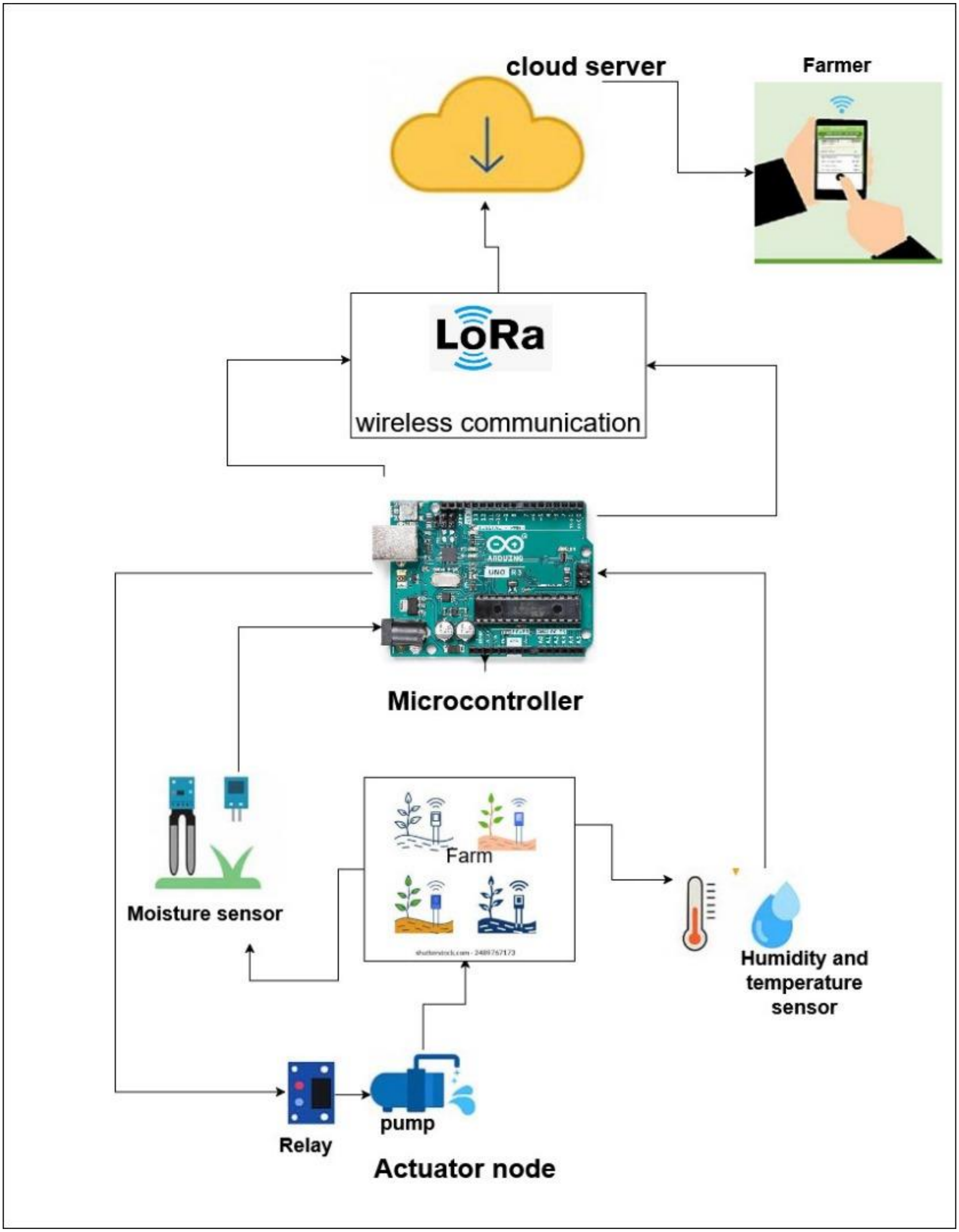
If the soil moisture is less than the threshold and temperature is less than the threshold the relay is activated and water pump is switched on. The pump runs until soil moisture is greater or equal to 50% is reached.

The sensor reading and the pump status is transmitted via the LoRa modules to the LoRa gateway which forwards to the cloud ThingsBoard, where readings are logged, visualized and analyzed.

When the thresholds are breached, the mobile notifications are pushed to the farmers mobile phone, for instance " Soil dry, temperature low, Pump activated".

3.4. NETWORK ARCHITECTURE

The smart irrigation system is designed using star topology, where multiple sensor nodes communicate directly with a single LoRa gateway. The gateway connects to the cloud for data storage and farmer notifications.


cloud server
Farmer
LoRa
wireless communication
Microcontroller
Farm
Moisture sensor
Humidity and temperature sensor
Relay
pump
Actuator node

4. FEASIBILITY CHECK

4.1. BUDGET

ITEM	Quantity	Unit Cost(UGX)	Total (UGX)
Arduino Uno board	1	85,000	85,000
Capacitive soil moisture sensor	1	60,000	60,000
Temperature and humidity sensors.	1	10,000	10,000
Water pump	1	30,000	30,000
TOTAL			185,000

4.2. ETHICAL ISSUES

The system will be deployed upon farmer's consent.

The system is aimed at resource conservation mostly water as a natural resource

4.3. PROJECT PLAN

Task	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8
Research and defining the problem								
Gather Materials								
Assemble hardware								
Integrate the pump and relay								
Test prototype								
Data analysis and report preparation.								

5. CONCLUSION

The Smart irrigation using WSNs enables efficient water use, improved crop yields and real-time farmer alerts. The star topology adopted guarantees low power consumption, long range connectivity and scalability making the system suitable for small holder farmers who often face limitations and infrastructure hence directly supporting SDG 2 (Zero Hunger).

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