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Automated Irrigation System for Perishables Crops

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Key Words: GSM, Communication, Automated, Hardware, Software, Microcontroller Irrigation System, Wireless Control.

Abstract

The fast growing information technologies simplifies the daily life of users everywhere, thus applying these technologies in the field of irrigation is a must in the present times. The GSM based automated spray irrigation system provide a simple approach to automated irrigation. This project makes use of the GSM (Global System for Mobile Communication) to provide the wireless control and to inform the user about extreme field condition. The objective of this study is to design and develop a GSM based automated instrumentation system utilizing microcontroller, flow meter and moisture sensor via wireless system in addition to design and develop spray irrigation system to be integrated to the proposed instrumentation system. The proposed GSM based automated spray irrigation system prototype consists of two main components hardware and software. The hardware consists of two components instrumentation system and spray irrigation system. Instrumentation system based on microcontroller, flow meter, moisture sensor, LCD and GSM. Spray irrigation system that consists of spray nozzles system, irrigation piping, solenoid valve and a wooden box to plant inside it. The software consists of a C++ code to link the various components together. The main component is the microcontroller which links the various materials used conducting the signals which operates the spray irrigation system and the GSM based wireless control.

Introduction

Irrigation system refers to the operation of the system with no or just a minimum of manual intervention beside the surveillance.

Almost every system (drip, sprinkler, surface) can be automated with help of timers, sensors, computers or mechanical appliances. It makes the irrigation process more efficient and workers can concentrate on other ant farming tasks. There is a great need to modernize agricultural practices for better water productivity and resource conservation. Efficient water management is a major concern in precision irrigation practices. The use of automated irrigation systems can provide water on a real-time basis at the root zone, based on the availability of soil water at the crop root zone, which also leads to saving of water (Ojha et al., 2015). Although the majority of crops are grown with irrigation systems, drip and sprinkler irrigation are increasing in popularity because of superior water application efficiency and more precise irrigation management.

Automated irrigation systems allow for high-frequency irrigation, thus maintaining the soil water potential (SWP) relatively constant, compared to conventional irrigation systems. Many methods have been described and sensors developed to manage irrigation systems effectively (Yildirim, 2018). Irrigation scheduling remains a reliable technique for applying the required amount of water at the appropriate time, and automated irrigation systems based on crop water needs can maximize WUE (Munoz-Carpena et al., 2005). The Technology Committee of the Irrigation Association (Irrigation Association, 2011) defines 'smart controllers' as the technologies that estimate or measure the depletion of soil moisture in order to replenish water as needed. Smart irrigation controllers (SICS) can integrate information from numerous sources to significantly improve crop production and resource management (Norum and Adhikari, 2009). ET controllers are also used to automate irrigation and crop needs.

This technology, sometimes referred to as 'smart technology' (McCready et al., 2009), provides irrigation based on actual water requirements and crop use and also takes weather factors into account. There are generally 2 types of smart controllers: climatologically controllers, also called evapotranspiration (ET) controllers, and soil moisture sensor controllers (Dukes, 2102). Irrigation scheduling is a technique designed to water crops in a timely and accurate fashion (Schlegel et al., 2012). Irrigation scheduling tools allow producers to effectively manage water resources for crop production (Hayashi et al., 2012). Recent developments in agricultural technologies, such as wireless sensor networks which have sensing, data processing, communication and control capabilities (Zhang et al., 2013), are improving real-time irrigation efficiency (Smarsly, 2013). To be beneficial, these tools need to be accurate, complete and relatively reliable (Mun et al., 2015). However, the use of more efficient technologies often increases, rather than decreases, water consumption (Whittlesey, 2003). Efficient irrigation management is challenging owing to the number of factors that need to be considered, including climate, crop type, irrigation method and system parameters (Dabach et al., 2013). Improved irrigation scheduling can reduce irrigation costs and increase crop quality. Irrigation scheduling based on the crop water status is more advantageous as crops respond to both the soil and aerial environments (Yazar et al., 1999).

Drip irrigation has been practised for many years as it effectively reduces soil surface evaporation. Uniform water application in drip irrigation is affected by field topography and by the hydraulic design parameters of the drip system, such as the energy losses in the laterals and the emitter characteristics (Zhu et al., 2009).

A sprinkler irrigation system can play a significant role in increasing the water productivity of wheat in arid and semi-arid regions (Motazar and Sadeghi, 2008). An automated irrigation system is integrated with electronic controllers and uses microclimate data to schedule water irrigation. The aim of the technique is to save water and reduce non-point-source pollution (Nautiyal et al., 2010). Automated irrigation technologies were evaluated in Dookie, Egypt, and were shown to result in water conservation of up to 38% over that of conventional irrigation (Dassanayake et al. 2009).

The current trend in techniques for conserving water and energy in agriculture is to switch from a manual system to automatic operations in a pressurised system (Yildirim and Demirel, 2011). Through the use of sensors, different variables can be measured in real time, eliminating the problem of discontinuous field measurements (Acevedo-Opazoet et al., 2010), which is a key issue in precise irrigation management. Irrigation scheduling using new technology contributes to higher water savings and water use efficiency in comparison with conventional irrigation scheduling methods, when it is designed, maintained and used properly (Mulas, 1986). Automated irrigation systems also facilitate high-frequency and low-volume irrigation (Abraham et al., 2000), and reduce human error (Castanon, 1992). An automatic irrigation control system can potentially optimise water management by sensing soil water conditions and site-specifically controlling irrigation methods (sprinkler vs. drip irrigation). Recent technological advances have made soil water sensors available for the efficient and automatic operation of irrigation systems (Dukes et al., 2010).

A number of studies have focused on increasing irrigation efficiency in automated irrigation systems (MuñozCarpena and Dukes, 2005). In the past 10 years, electrical irrigation controllers have been developed by a number of manufacturers and have been promoted by water purveyors in an attempt to reduce overirrigation (Davis and Dukes, 2016). There are several irrigation controllers that can compute the amount of water applied based on ET and climate conditions (McCready et al., 2009). These systems differ in their accuracy and reliability; however, they all depend on modern electronic sensors, which are capable of collecting and analyzing data, and making decisions on when to start/stop irrigation. These devices transmit the decisions to electronic controller devices, which control the sprinkler or drip irrigation system. This study investigated the effectiveness of automated irrigation systems for improving water saving and crop yield for wheat and tomato crops using both sprinkler and drip irrigation systems.

Methodology

The objective of this project is to design and develop a GSM based automated instrumentation system to be integrated to spray irrigation system. Instrumentation system was based on microcontroller, flow meter and moisture sensor via wireless system while the spray irrigation system consists of spray nozzles, irrigation piping, solenoid valve and wooden box as cultivation field. The wireless control system uses the mobile phone SMS service via a GSM installed in the system.

System Development Life Cycle

Waterfall approach was first SDLC Model to be used widely in Software/Hardware Engineering to ensure success of the project. In "The Waterfall" approach, the whole process of software development is divided into separate phases. In this Waterfall model, the outcome of one phase acts as the input for the next phase sequentially (tutorialspoint.com, 2022).

The following illustration is a representation of the different phases of the Waterfall Model.

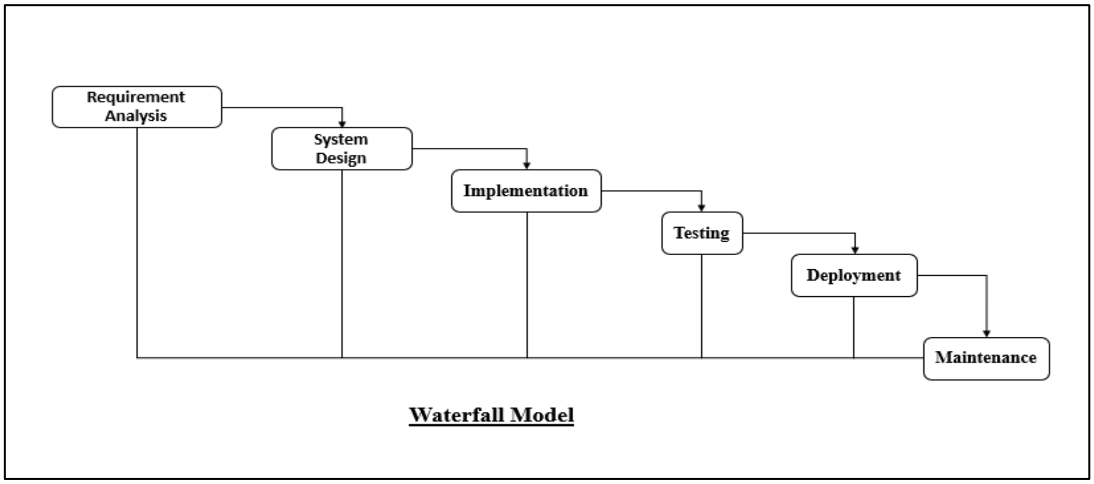

Figure .1: water fall model

The sequential phases in Waterfall model are:

- Requirement Gathering and analysis: All possible requirements of the system to be developed are captured in this phase and documented in a requirement specification document.
- System Design: The requirement specifications from first phase are studied in this phase and the system design is prepared. This system design helps in specifying hardware and system requirements and helps in defining the overall system architecture.
- Implementation: With inputs from the system design, the system is first developed in small programs called units, which are integrated in the next phase. Each unit is developed and tested for its functionality, which is referred to as Unit Testing.
- Integration and Testing: All the units developed in the implementation phase are integrated into a system after testing of each unit. Post integration the entire system is tested for any faults and failures.
- Deployment of system: Once the functional and non-functional testing is done; the product is deployed in the customer environment or released into the market.
- Maintenance: There are some issues which come up in the client environment. To fix those issues, patches are released. Also, to enhance the product some better versions are released.

Maintenance is done to deliver these changes in the customer environment.

All these phases are cascaded to each other in which progress is seen as flowing steadily downwards (like a waterfall) through the phases. The next phase is started only after the defined set of goals are achieved for previous phase and it is signed off, so the name "Waterfall Model". In this model, phases do not overlap.

System Description

Firstly, we are providing power supply voltage which is regulated with the help of voltage regulator IC7805 as it is shown in fig.(a). Indicator which is usually a LED will indicate whether the circuit is in ON/OFF condition. Moisture sensor will detect the moisture content from the soil and provide the output in both analog and digital form as well.

GSM is connected to the microcontroller with the help of MAX 232 IC or UART. It provides the serial communication between microcontroller and PC for the programming purpose and also the communication between user and system. Level sensor is used as water level detector in the water tank. Relay is used as a switch for connecting the motor or a pump. Microcontroller will control the switching ON and OFF of motor depending upon the conditions detected by the respective sensors.

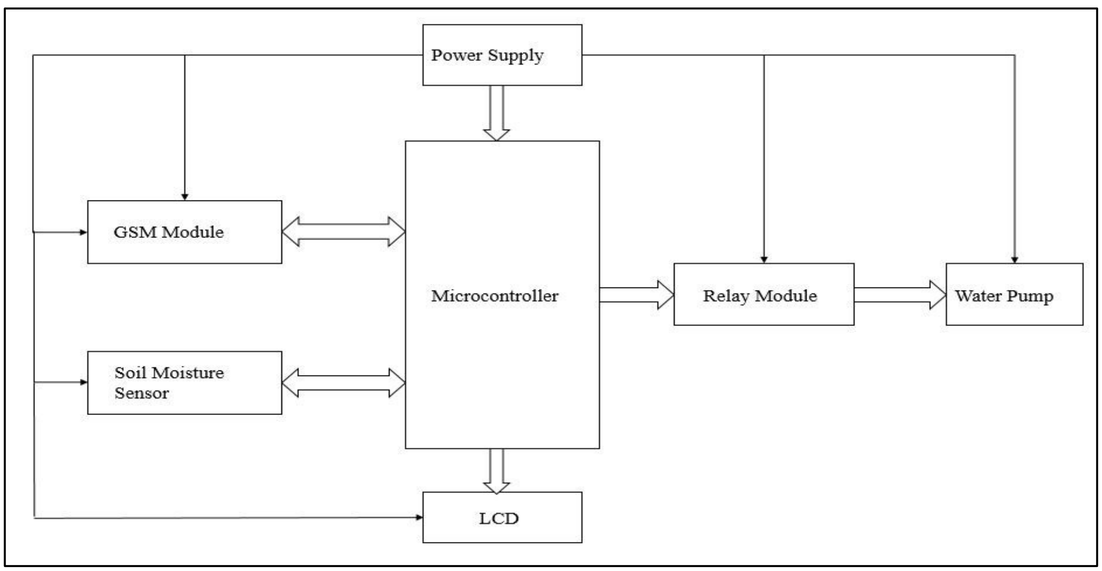

Figure2. : block diagram

Feasibility Study

This feasibility report presents findings of the due diligence carried out for perishables irrigation system in jos plateau state. This system was selected as a core subproject for upgrading, rehabilitation, modernizing as part of the project preparatory technical assistance for Automated Irrigation System.

1. Technical Aspects

- **Technical issues on irrigation service and drainage:** in the system can all be resolved in a more-than-satisfactory manner for system as a whole, but not in parts. What is outlined hereafter is to be done in full to have benefits to all and spread out over system to all users and corners. This includes Section lamingo - having considerable potential with lands already leveled and having experienced farmers.

- **Water availability** will not be a significant issue as hydrological assessment showed sufficient water at intake to irrigate 200% .
- **Water productivity** (in $/m^3) for vegetables is approximately double of rice, pointing to the need to promote these non-rice crops as these generate more income and uses less water as compared to just rice-rice for 2 crops on 100% of the areas. However growing vegetable crops are labor intensive and farmers are required to be full time at the fields caring of the crops.
- **Strict construction quality monitoring on specifications** for all structures and canals and drainage earth works to be improved or provided is required.
- **Focus on combining water and on non-water agro-inputs** in crop production process, with support of District Agriculture, is required, in view of reaching not just increased cropping intensities, but also significant increased yields. **Use of Early Seed varieties (90-100 days)** is key – essential to be made available and to be used.

2 . **Economic Aspects:** The economic evaluation indicates that the subproject will yield tangible and intangible economic benefits. The subproject will address crop productivity and diversification in the command area contributing to sustained growth of the agricultural and rural economy. Two tangible benefits that were quantified and valued are

- incremental increase in production of paddy rice and other crops and
- savings from avoided crop damages due to flooding.

The economic analysis undertaken for the subproject shows that the rehabilitation of the irrigation system in JOS will increase the planted areas from the present 3,618 ha during wet season and 493 ha during dry season to 8,882 ha and 9,869 ha, respectively.

3. **Finance Aspects:** The Financial Management Assessment (FMA) of the proposed project financial management arrangements in Executing Agency and the Implementing Agency was done in accordance with ADB's Guidelines. This has resulted in an overall risk rating of "Moderate" which is expected to become "Low" with mitigating measures. Lack of capacity in project financial management and internal auditing is currently being addressed through the government's ongoing comprehensive Public Financial Management Reform Program (PFMRP).

Method of Data Collection

Survey

Three set-ups were used in conducting the study. Plants was prepared for each set-up. There were four different time of watering in all. The plants were watered with lapses of time first the first set-up which will used drip irrigation will be watered in the morning and afternoon same time as the third set-up then, the second set-up will be watered 12:00 noon and the specific sun-set of the day. The plants will be measure using a ruler after the last day of study. A stopwatch will also be used to measure the time of watering between the first and the second set-ups. The time will be stop after the five liter containers become empty.

Survey analysis

T-test will be used because of there were three set-ups which had two independent variables which was the time consumption and the water conservation. However, only two of the set-up is needed to compare to get the first Specific Question. This was used to test if there was a significant difference among the two set-ups in time consumption.

Analysis of the existing system

System Design

- The system architecture of the automatic irrigation system. From Fig. 2, it is shown that the process starts from the soil moisture sensor. The sensor detects the level of moisture from the soil, and the measured data is sent to Arduino to be processed. Next, the moisture level and the status of the DC pump from Arduino is sent to the LCD screen to be displayed. At the same time, the data will also be sent to relay to signal the water pump to switch on or off.

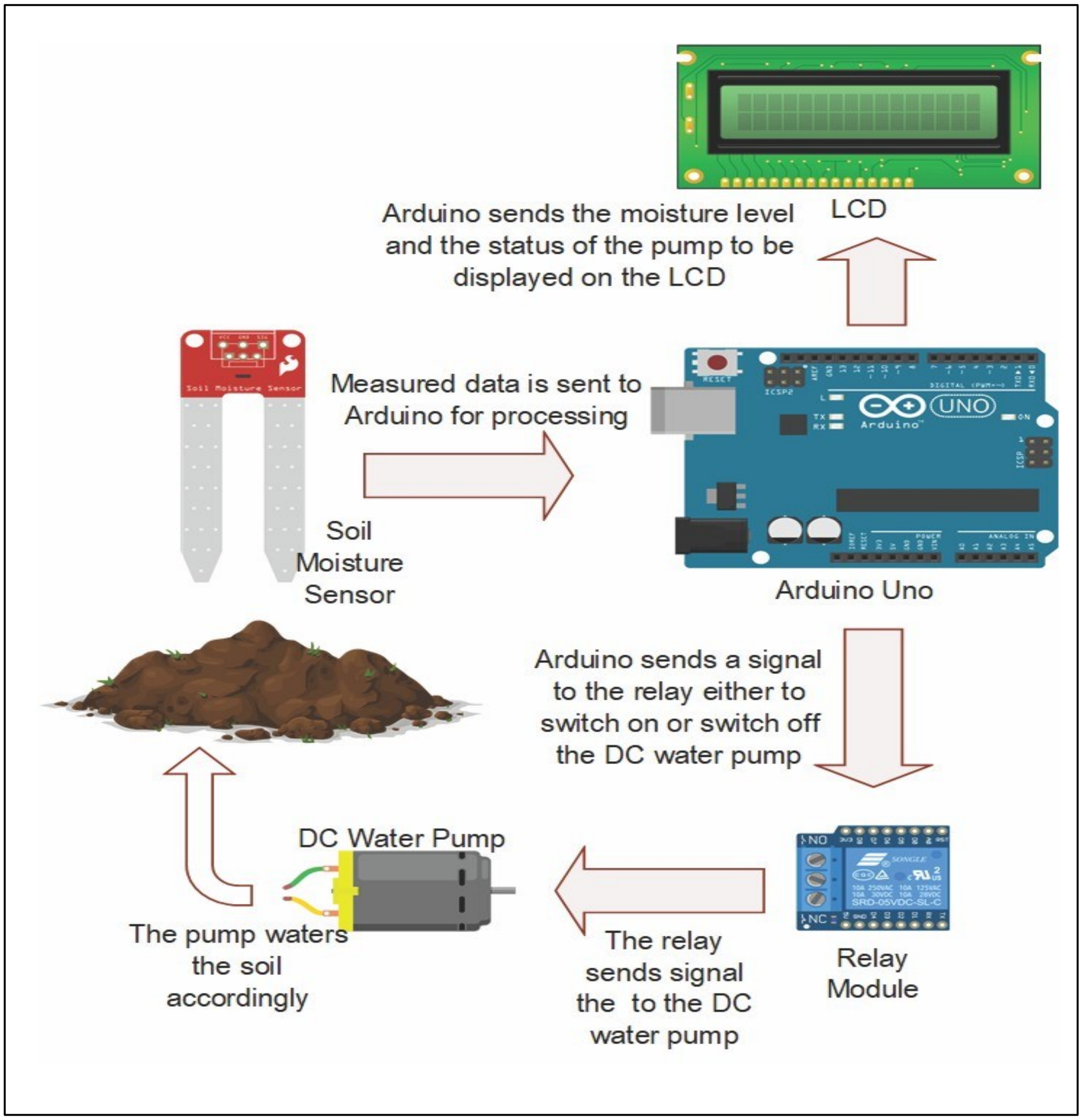

Figure3: system design architecture

- System flow diagram

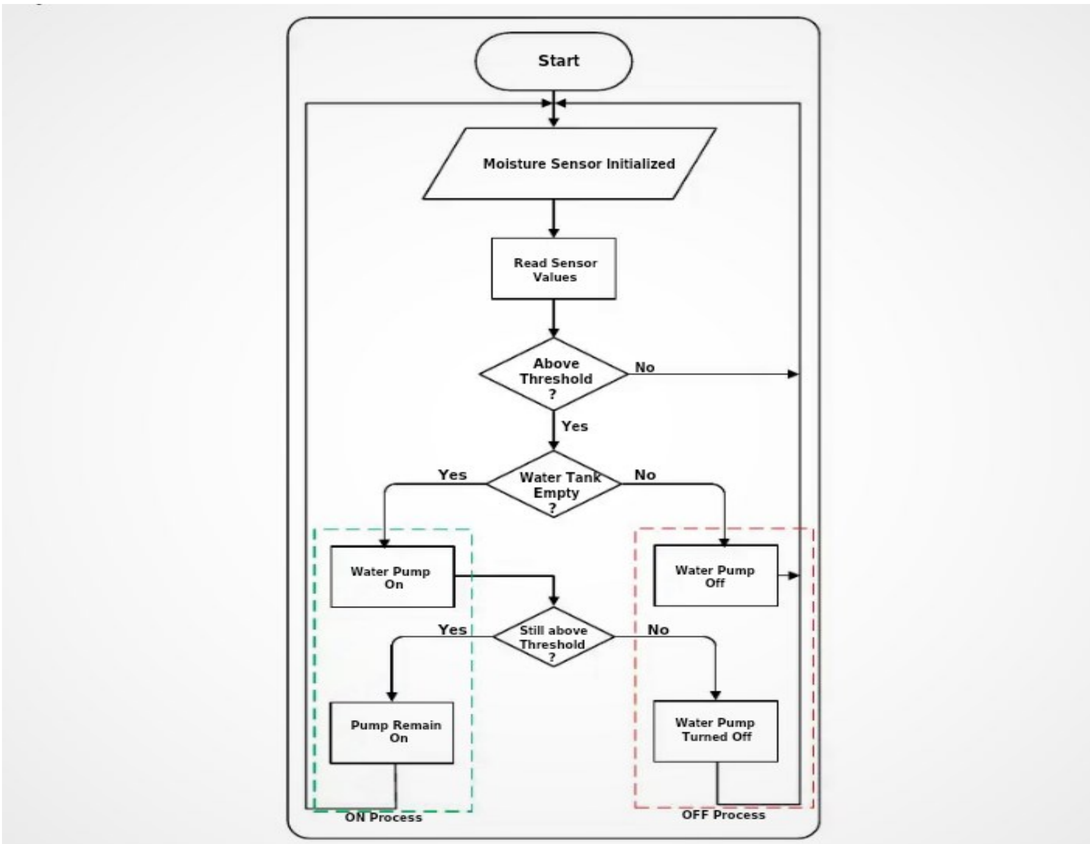

Figure.4: System flow chat

The main working principle behind this system is in connecting the soil moisture sensor, which was previously embedded into the plant, to the Arduino microcontroller, which is also connected to other electronic components listed above as shown in Figure 1. Measurement of soil moisture is done by the sensor which forwards the information and parameters regarding the soil moisture to the microcontroller, which controls the pump. If the level of soil moisture drops below a certain value, the microcon-troller sends the signal to the relay module which then runs a pump and certain amount of water is delivered to the plant. Once the enough water is delivered, the pump stops doing its work. Power supply has a task to power the complete system and the recommended voltage should re- spect the input supply range for the microcontroller, that is, from 7V to 12V. Relay module is a simple circuit con- sisting of a single transistor, several resistors, diodes and a relay and it is controlled digitally by microcontroller. Since the complete system should be embedded in a small box, Arduino Nano is a perfect microcontroller for this purpose because of its dimensions and its work performance. Soil moisture module is consisting of the two parts: amplifier circuit and probes. This module has digital and analog outputs, where digital output is set to logical 1 when the threshold is activated. The threshold is set by potentiometer. Analog output gives the real time information regarding the moisture in the plant and this output is used in the system. Water pump is connected to the relay module and it only works when the relay module gets a command from the microcontroller, whose working principle is described via flow chart diagram Block diagram of the proposed system

System Requirement

Figure 3 shows the complete hardware schematic of the proposed system which includes the Arduino board and all the necessary attached hardware.

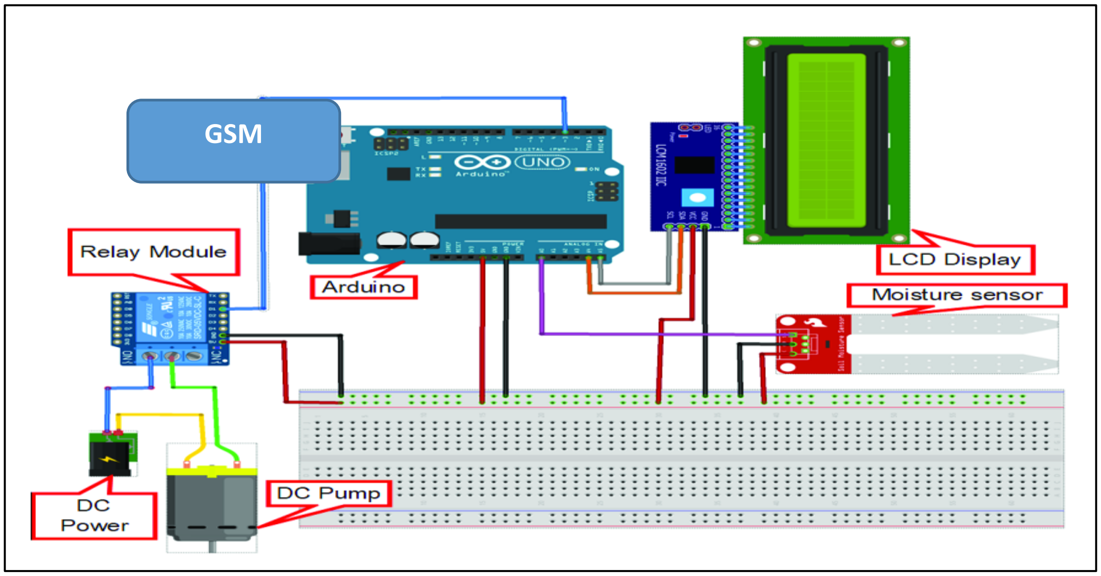

Figure5: Hardware requirement

• **Arduino:**The Arduino is an open source microcontroller board which based on the ATmega328P architecture. An Arduino board contain 14 digital input/output pins, 6 analog inputs, a USB connection, and ICSP header, a power jack, a 16MHz quartz crystal and a reset button. The Arduino is the central core of this project as it controls all the hardware that are attached to it. It contains a platform for coding when connecting it to a computer with a USB cable with a self-download software named Arduino IDE.

• **Soil Moisture Sensor YL-69:** This sensor is used to detect the moisture level of the soil. When the soil is having water shortage, the module output is at high level, otherwise the output is at low level.

• **Liquid Crystal Display (LCD**): It is a flat panel display that uses light modulating properties of liquid crystals. The backlight will produce the screen images for showing the content that comes from the coding in the Arduino. In this project, the LCD screen is used to show the moisture level of the soil and the pump status which is set it early in the Arduino board through coding.

• **Relay Module:** The relay module is a switch that controlled by an electromagnet. It is used to control the on and off of the DC watering pump by opening or closing the electric path that passes to the watering pump. It is controlled by the code from the Arduino.

• **DC Water Pump:** The DC water pump used in this project is H-Bridge type. It is used to water the plant by sucking the water from the source and push out the water from the second hole to make the water process complete. It is controlled by the relay module which can be switch on and off automatically based on the signal sent from the Arduino.

- **GSM module:** The project uses a wireless system(GSM, SIM900A Italy). the GPRS module is a break outboard and minimum system of SIM900Quad-band/SIM900ADual-band GSM/GPRS module. It can communicate with controllers via AT commands (GSM 07.07

,07.05 and SIMCOM enhanced AT Commands). This module supports software power on and reset.

Software requirement

Arduino has a special app which is very simple to use by anyone. A C++codeis written which includes all the orders which operate the system and then uploaded into the Arduino. The code is attached in the appendix. The programs are written in the Arduino Integrated Development Environment (IDE).Arduino IDE is a special software running on your system that allows you to write sketches (synonym for program in Arduino language) for different Arduino board.

For the IDE to install and run, the system is required to have 256MB RAM on top of the requirements for the operating system, CPU with Pentium 4 or above.

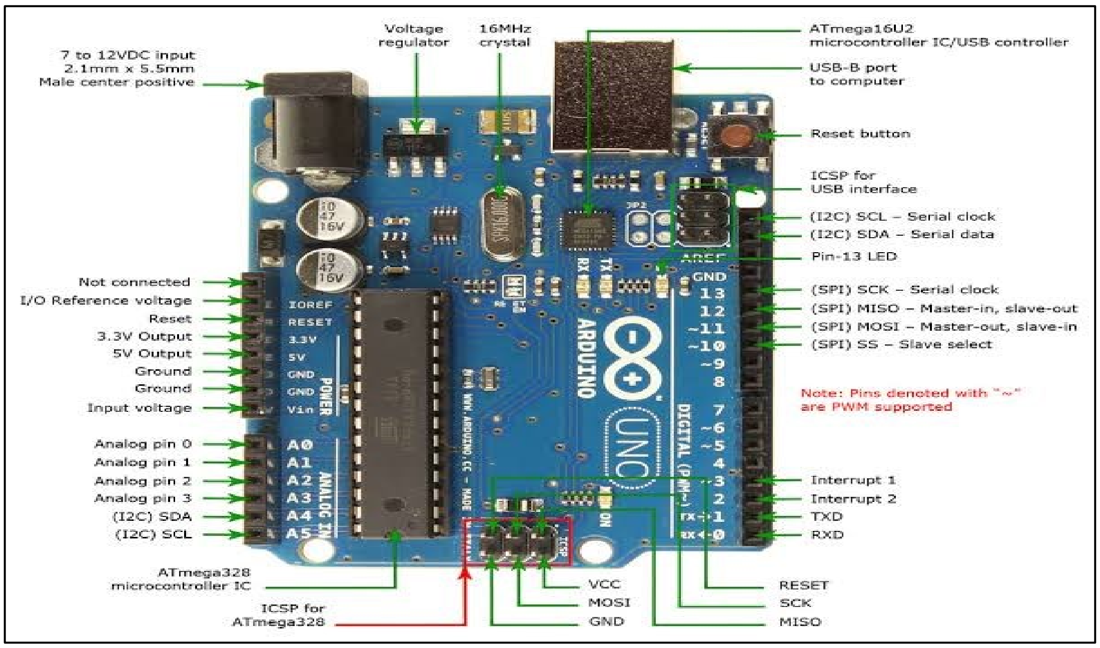

Figure:6: Aduino board

Adopted Programming Language

C++ (pronounced "C plus plus") is a high-level general-purpose programming language created by Danish computer scientist Bjarne Stroustrup as an extension of the C programming language, or "C with Classes". The language has expanded significantly over time, and modern C++ now has object-oriented, generic, and functional features in addition to facilities for low-level memory manipulation. It is almost always implemented as a compiled language, and many vendors provide C++ compilers, including the Free Software Foundation, LLVM, Microsoft, Intel, Embarcadero, Oracle, and IBM, so it is available on many platforms.

Implementation

This section makes use of an UML diagram to describe how the implementation of the project works.

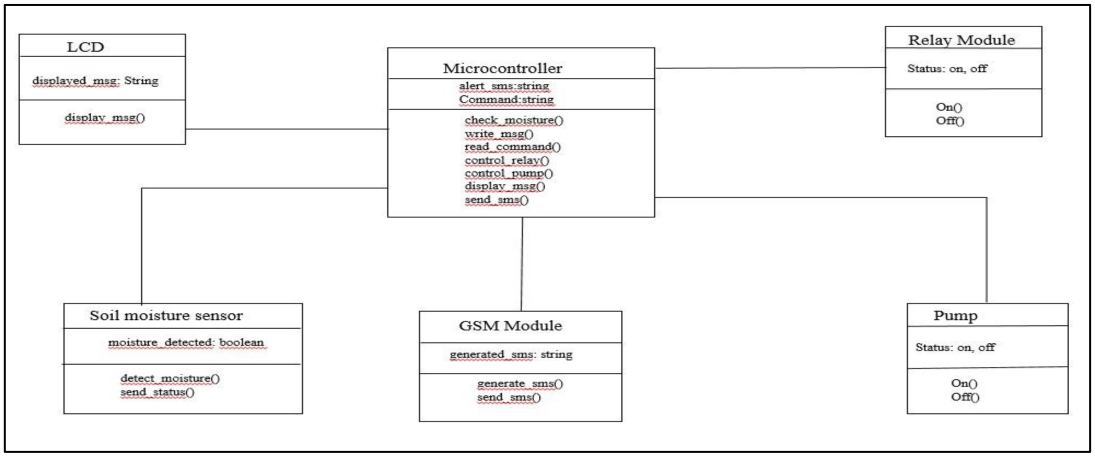

Figure 7: UML diagram for the proposed system

The above UML diagram gives a simple analogy of how the system was implemented. The soil moisture sensor was used to measure the soil moisture content in the active root zone before a scheduled irrigation, when the soil moisture is below the set threshold value, it sends data to the microcontroller, which processes the data and proceeds to take the necessary action, which is to send signal to the relay which in turn switches on the pump so that the soil can be properly irrigated. And the GSM module sends an SMS notifying the user concerned.

Results

After all the necessary testing was done, the project revealed that; the soil moisture sensor was able to ascertain the soil moisture level. Depending on the level of soil moisture content, the system will make its decision. In the case whereby, the soil moisture content is below the set threshold, the system seeks to perform proper irrigation on the soil and then notifies the user concerned.

Test case 1: Check if the soil moisture sensor is working properly
- Input: Dry soil
- Expected output: Sensor detects low moisture level and sends a signal to the system

Test case 2: Check if the system can receive signals from the soil moisture sensor
- Input: Signal sent by the soil moisture sensor
-Expected output: System receives the signal and processes it

Test case 3: Check if the system can activate the irrigation system based on the moisture level
- Input: Low moisture level signal received by the system
- Expected output: Irrigation system is activated and water is supplied to the plants

Test case 4: Check if the system can deactivate the irrigation system when the moisture level is sufficient
- Input: High moisture level signal received by the system
- Expected output: Irrigation system is deactivated and water supply is stopped

Test case 5: Check if the system can send notifications to the user via GSM module
- Input: Low moisture level signal received by the system

- Expected output: System sends a notification to the user's mobile phone indicating low moisture level in the soil

Test case 6: Check if the system can handle power failures and resume operation

- Input: Power failure and subsequent restoration
- Expected output: System resumes operation and continues monitoring the soil moisture level

Discussion of Results

The following result of the system were discussed after testing was concluded, are as follows:

1. The soil moisture sensor worked properly and accurately detected the moisture level in the soil. Which ensures that the system receives accurate data for irrigation control.
2. The system successfully received signals from the soil moisture sensor. This indicates that the communication between the sensor and the system is functioning correctly.
3. The system effectively activated the irrigation system based on the moisture level detected by the sensor. It ensures that water is supplied when the soil moisture level is low.
4. The system successfully deactivated the irrigation system when the moisture level is sufficient. This prevents overwatering and ensures that water is not wasted.
5. The system sent notifications to the user via the GSM module. It allows the user to receive real-time updates on the soil moisture level and take necessary actions if needed.
6. The system handled power failures and was able to resume operation once power was restored. This ensures that the system continues to monitor and control irrigation even in the event of a power outage.

Overall, the results indicated that the system is functioning effectively and reliably. It provides accurate monitoring of soil moisture levels and controls irrigation accordingly, while also allowing for real-time notifications to the user. The system is capable of handling power failures, ensuring uninterrupted operation.

System Testing

The aim of testing is often to demonstrate that a device works by showing that it has no errors. The basic purpose of testing phase is to detect the errors that may be present in the program. Hence one should not start testing with the intent of showing that a program works, testing is therefore the process of executing a program with the intent of finding errors.

Table 1: Testing Process

S/N	TEST CASE	TEST ACTIVITY	TEST RESULT
1	Microcontroller	Processes the input from the sensor	Successful
2	Soil Moisture sensor	Sense the soil moisture content level	Detected
3	GSM Module	Send SMS to user	SMS sent
4	Relay Module	Switch on/off the pump	Successful
5	Pump	Pump water to the soil	Successful
6	LCD	Display the processes on the screen	Displayed

Conversion

It is very important to bear in mind that the system seeks a whole of workload required in irrigation. To enhance the change-over from the existing manual system to the new automated system for this project, the direct method of conversion was as it is used directly to replace the manual way of irrigation to an automated one.

Documentation

Title: Automated Irrigation System Using Soil Moisture Sensor with GSM Module

1. **Introduction**

   An automated irrigation system is a system that uses technology and sensors to automatically water plants or crops without the need for manual intervention. It typically consists of sensors to monitor soil moisture levels, a controller to control the irrigation process, and actuators such as valves or pumps to deliver water to the plants. Monitoring soil moisture levels is important for several reasons. Firstly, it helps ensure that plants receive the correct amount of water they need for optimal growth. Overwatering or under-watering can be detrimental to plants, and monitoring soil moisture levels allows for precise watering based on the specific needs of the plants. Secondly, monitoring soil moisture levels helps in conserving water. By only watering when necessary and avoiding unnecessary water usage, an automated irrigation system can help conserve water resources and reduce water wastage.

   The benefits of using a GSM (Global System for Mobile Communications) module for remote control in an automated irrigation system are as follows:

   a. Remote control: A GSM module allows the user to remotely control the irrigation system from anywhere using a mobile device or computer. This eliminates the need for physically being present at the location to manually control the system, providing convenience and flexibility.

   b. Real-time monitoring and alerts: With a GSM module, the system can continuously monitor soil moisture levels and send real-time updates or alerts to the user's mobile device. This allows for effective monitoring of the system and quick response to any issues or changes in soil moisture levels.

   c. Energy efficiency: A GSM module enables energy-efficient operation of the irrigation system. The system can be programmed to operate during specific time slots based on the user's preferences or the most ideal conditions for the plants. This helps optimize energy usage and reduce operational costs.

   d. Scalability: A GSM module allows for easy scalability of the automated irrigation system. Additional sensors or actuators can be added to the system as needed, and the system can be easily integrated with other smart agricultural technologies or tools.

   Overall, using a GSM module for remote control in an automated irrigation system enhances convenience, efficiency, and effectiveness in managing the irrigation process, leading to improved plant health, water conservation, and cost savings.

2. **System Components**

   - Soil moisture sensor: A soil moisture sensor is a device that measures the level of moisture in the soil. It typically consists of two electrodes inserted into the soil. The sensor measures the electrical resistance between the electrodes, which is influenced by the moisture content in the soil. As the soil gets drier, the resistance increases, and as it gets wetter, the resistance decreases. The working principle of a soil moisture sensor is based on the fact that water is a good conductor of electricity, while dry soil acts as an insulator. As the moisture level changes, the electrical conductivity between the electrodes changes, allowing the sensor to measure the soil moisture.

- GSM module: A GSM module is a device that enables communication over the GSM network. It allows for wireless communication using cellular networks. The GSM module is typically connected to a microcontroller or microprocessor, such as an Arduino board, to control and send/receive data. The GSM module can communicate via SMS (Short Message Service) or GPRS (General Packet Radio Service). It operates by inserting a SIM card, similar to how it is used in mobile phones, which enables the module to establish a connection to the cellular network. It can send and receive data or commands through SMS, allowing for remote control and monitoring. It can also establish a GPRS connection to send data packets, enabling real-time data transmission and communication.
- Microcontroller: An Arduino board is a microcontroller board that can be programmed to control various electronic devices and systems. It can be used in an automated irrigation system to control and manage the irrigation process based on the inputs from sensors such as soil moisture sensors. By connecting the soil moisture sensor and GSM module to the Arduino board and programming it, the board can read data from the soil moisture sensor to determine the moisture level in the soil. Based on predefined conditions or user preferences, it can activate or deactivate the irrigation system. The Arduino board can also communicate with the GSM module to send and receive data, enabling remote control and monitoring of the irrigation system using SMS or GPRS. The board can also perform additional functions such as logging data, sending alerts, or integrating with other sensors or actuators in the system.
- Water pump: Activated based on moisture level readings
- Power supply: Provides power to the system components

3. System Architecture

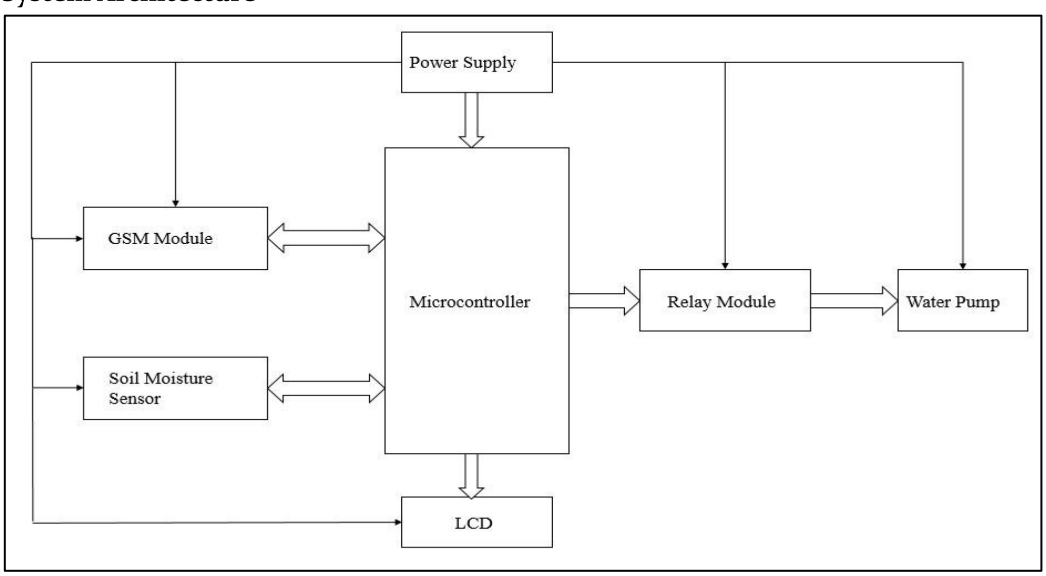

Figure 2: Block diagram of the system.

1. Soil Moisture Sensor: This sensor measures the moisture level in the soil. It provides input to the microcontroller based on the soil's moisture content.
2. Microcontroller (ATMEGA328): The microcontroller receives input from the soil moisture sensor and processes the data. It is responsible for controlling the irrigation system based on predefined conditions and user-defined parameters.
3. GSM Module: The GSM module enables communication with the irrigation system using the GSM network. It allows for remote control and monitoring of the system through SMS or GPRS communication protocols.
4. Actuators: These are components that control the irrigation system, such as valves or pumps. The microcontroller sends commands to the actuators to open or close valves or control the water flow based on the moisture level detected by the soil moisture sensor.

In this system, the soil moisture sensor continuously measures the moisture level in the soil. The microcontroller receives this data and compares it with predetermined thresholds or user-defined moisture levels. If the moisture level falls below a certain threshold, indicating the need for irrigation, the microcontroller sends a command through the GSM module to activate the actuators, which control the water flow to the plants. The GSM module allows remote monitoring and control of the irrigation system. Users can receive real-time updates on soil moisture levels or even manually trigger irrigation based on their requirements by sending commands via SMS or GPRS communication. Overall, this automated irrigation system ensures efficient watering of plants by monitoring soil moisture levels, processing the data through a microcontroller, and controlling the irrigation system using a GSM module.

System operation

- Initialization process and setup of the system
- Reading and interpreting soil moisture level data from the sensor
- Controlling the water pump based on moisture level thresholds
- Sending notifications to the user via the GSM module

Implementation Steps

- Step-by-step guide on assembling the hardware components
- Programming the microcontroller or Arduino board
- Configuring the GSM module for communication
- Calibrating the soil moisture sensor for accurate readings

Testing and Results

The system was tested under several test cases to ensure its functionality and operational. After the thorough testing was done, the system designed was functional and operational.

Conclusion

Summary and benefits of automated irrigation system:

An automated irrigation system is a technology-driven system that automatically waters plants or crops based on specific parameters and conditions. It offers several benefits, including:

i. Efficient water usage: An automated irrigation system uses sensors to monitor soil moisture levels and only waters when necessary, ensuring optimal water usage and conserving water resources.
ii. Precision watering: By monitoring soil moisture levels and delivering water based on the specific needs of the plants, an automated irrigation system provides precise and targeted watering, promoting healthy plant growth and reducing the risk of overwatering or under-watering.
iii. Time and labor-saving: With automation, the need for manual intervention in the irrigation process is significantly reduced. The system can be programmed to handle the watering tasks, saving time and labor for farmers or gardeners.

System Maintenance.

To ensure the smooth functioning of the system, regular maintenance is crucial. Here are some key maintenance tasks:

1. Check sensor accuracy: Periodically verify the accuracy of the soil moisture sensor readings by comparing them with manual measurements or using a calibration method. If the sensor readings are consistently inaccurate, consider replacing or calibrating the sensor.
2. Clean the sensor: Over time, the soil moisture sensor can accumulate dirt, dust, or other debris, leading to inaccurate readings. Clean the sensor regularly using a soft brush or cloth to remove any buildup.
3. Inspect the wiring connections: Inspect the wiring connections between the soil moisture sensor, the GSM module, and the microcontroller. Check for loose connections, damaged wires, or corrosion. Repair or replace any faulty wiring to maintain uninterrupted system functionality.
4. Confirm GSM module connectivity: Periodically test the GSM module's connectivity by sending test messages or commands. Ensure that the GSM module is properly connected to the network and is functioning correctly. Troubleshoot any connectivity issues promptly.
5. Monitor power supply: Ensure a stable power supply for the system. Check the voltage levels regularly and ensure that the power source is reliable. Consider using a backup power source or surge protection to prevent damage from power fluctuations.
6. Update software and firmware: Stay up to date with the latest software and firmware updates for the microcontroller, GSM module, and other components. These updates often include bug fixes, performance improvements, and new features.
7. Record and analyze data: Maintain a record of sensor readings, system performance, and any maintenance activities performed. Analyze the data over time to identify patterns, optimize irrigation schedules, and make informed decisions for system improvements.

By following this comprehensive maintenance plan, the proposed system can function reliably and efficiently, leading to healthier plants and reduced water wastage.

Conclusion

Automated Irrigation Systems work by continuously monitoring the soil moisture content and wirelessly activating the pipeline valves to open when the moisture level drops below the minimum threshold for the cultivated crop, causing the land to be irrigated. When the moisture level rises above the maximum threshold, the system deactivates the irrigation pipeline valves, causing them to close and ceasing land irrigation. The automated irrigation system can be customized for different types of irrigation and existing systems can be upgraded to automated irrigation systems. Future work includes construction, implementing, testing and characterization of a prototype of the automated irrigation systems, as well as the rigorous characterization of the soil moisture requirements for various agricultural crops.

Recommendation

The following recommendations should be carried on:

- In real size fields the control should be done on pumps and solenoid valves could be used to control different water requirements on the same field.
- This system could be used as a replacement of the hanging system by the addition of wheels to make it mobile.
- The addition of pH, humidity and other sensors to maximize the precision of the irrigation system.
- The hydraulic research center in Medan has a project that notifies farmers about the scarcity of water in the field using satellite messages. The addition of the GSM based automated irrigation system can be utilized in the control over these fields.

Reference

Akkaşa A, & D.L Clement. (2017) proposed a system where the greenhouse data readings are transmitted wirelessly from nodes to a base station. Conference Series,1028, -6596.

Boimau, I., & Endarko. (2018). Designing a Telemetry System of Temperature and Soil Moisture for Irrigation Control. Applied Mechanics and Materials,771, 38-41. doi:10.4028/www.scientific.net/amm.771.38

Gill, S., R.A. Cloyd, J.R. Baker, D.L. Clement, and E. Dutky(2017). Pests & Diseases of Herbaceous Perennials: The Biological Approach. Ball Publishing Co., Batavia, IL.

Gondosubroto, R. (2018). Implementing Consumer-based, IoT-based Environmental Monitoring Systems within Smart Spaces. International Journal of Innovation in Enterprise System,2(01). doi:10.25124/ijies.v2i01.36

Jayasuriya, Y. P., Elvitigala, C. S., Wamakulasooriya, K., & Sudantha, B. (2018). Low Cost and IoT Based Greenhouse with Climate Monitoring and Controlling System for Tropical Countries. 2018 International Conference on System Science and Engineering (ICSSE). doi:10.1109/icsse.2018.8519997012051. doi:10.1088/1742.

Kiran Sahu, Susmita Mazumdar (2017). Digitally Greenhouse Monitoring and Controlling of System based on Embedded System. International Journal of Scientific & Engineering Research, Volume 3, Issue 1, ISSN 2229-5518.

Leong Boon Tik, Chan Toong Khuan, Sellappan Palaniappan(2019). Monitoring of an Aeroponic Greenhouse with a Sensor Network. International Journal of Computer Science and Network Security.Vol.9.

M. Krishna Mohan, JakkulaLikhitha, TejaswyYamarthi, Ka-githaSravani, "Greenhouse Monitoring System Using IoT," IJMTST, vol: Three, Special issue No: 02, March 2017.

Prof. Wali et al (2017) designed a system that uses a low power, cost efficient chip, microcontroller based circuit to monitor and record the values of humidity 38-41 doi:10.25124/ijies.v2i01.36

Rahmawati, D., Ulum, M., & Setiawan, H. (2018). Design of Android Base Fuzzy Wireles Sensor Network for mini Smart Green House. Journal of Physics: Conference Series,1028, -6596/1028/1/012051.

S.U. Zagade, R.S. Kawitkar (2017). Wireless Sensor Network for Greenhouse. International Journal of Science and Technology, Volume 2 No.3, ISSN 2224-3577.

Stipanicev D., Marasovic J. (20017). Network embedded greenhouse monitoring and control. Proceedings of 2003 IEEE Conference on Control Applications.

Yusof, Y. M., Islam, A. M., & Baharun, S. (2018). An experimental study of WSN transmission power optimisation using MICAz motes. 2018 International Conference on Advances in Electrical Engineering (ICAEE). doi: