SMART IRRIGATION SYSTEM FOR A SMALL INDOOR GARDEN

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Submitted by

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ACKNOWLEDGEMENT

The completion of this project titled as “Smart irrigation system for a small indoor garden” in DIY Lab gives us much pleasure. The final outcome of this project required guidance and supervision. We owe our deep gratitude to our project guide Dr. Amit Kumar Dutta for all his support, valuable suggestions and guidance which helped us complete the project duly. Without his inspiration, encouragement and guidance it would not have been possible to carry out this project work.

We are fortunate enough to get an opportunity to do this team project. We are grateful to our institute, IIT Kharagpur for giving us an opportunity to learn through this project work.

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We would not forget to remember Nainit sir for his suggestions and guidance during presentation.

We are immensely grateful to all our friends and family members for their motivation and support. We would also like to extend our gratitude to all those who have directly and indirectly helped us.

With sincere thanks,

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1. INTRODUCTION AND PROBLEM STATEMENT

India is an agricultural based country. Agriculture is a water intensive activity. Many parts of our country face water scarcity. In such areas water needs to be used judiciously. However the current irrigation techniques such as sprinkler irrigation, furrow irrigation leads to huge water wastage. These techniques do not take into consideration the amount of water present in the soil and continue to water crops unless turned off manually. If the farmer forgets to turn off the motor it can lead to huge water wastage. This can also lead to various adverse effects such as water clogging and can also be detrimental to the crop. This also results in energy wastage while pumping the water. So there is a need to irrigate crops based on some feedback mechanism from the soil depending on the moisture content such that the pump gets turned off after the moisture reaches a particular optimum moisture level as required by the crop.

Technology is probably a solution to prevent the loss of the precious natural resource and this project can be a strong way to tackle such a situation. It is proposed to create a smart irrigation system for a small indoor garden using Arduino UNO and soil moisture sensor with water pump.

2. MOTIVATION AND OBJECTIVES

2.1 Motivation

In the absence of residents of a home, it is necessary to have an automatic system to keep the indoor plants well irrigated. For this purpose, we need an irrigation system which will be “smart”, that is, it will be able to monitor the level of soil moisture using sensors and when the reading is below a threshold, it will trigger a water pump to carry water stored in a small tank to sprinkle on the plants and the soil until the moisture level reaches optimal level.

2.2 Objectives

Main objective of this system is to incorporate the technology into agricultural domain in order to conserve the valuable natural resource like water and boost the production of crops.

This will also save effort and time on farmer’s side by developing a smart irrigation system.

It is proposed to develop a simple prototype for the smart irrigation system which will be able to monitor the level of the soil moisture using sensors. When the reading is below the threshold set, it will trigger a water pump to carry water stored in a tank to sprinkle on the plants and the soil. It will also continuously monitor the soil moisture using sensor and turn off the water pump when the soil moisture level reaches an optimal level (threshold value set by user).

3. BLOCK DIAGRAM AND SCHEMATIC

3.1 Block Diagram

The block diagram of the system is shown below in figure 1.

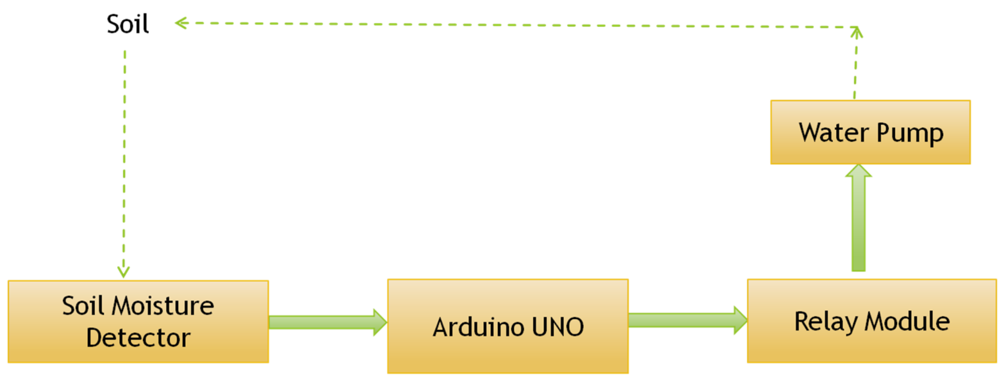

Figure 1: Block diagram of the system

Block Diagram Description

Soil moisture sensor detects the level of the moisture in the soil.

Arduino UNO Input/Output pin reads this input value corresponding to soil moisture level and compares with the threshold value set by the user.

If soil moisture level is below the threshold level set by user, soil is comparatively dry. Hence a relay is turned ON by Arduino UNO board. Else the relay is turned OFF.

Water pump is connected to the relay which is turned ON/OFF in order to sprinkle the water in the soil as per the requirement.

To build this system following tasks are performed.

i) Interfacing soil moisture sensor to detect amount of moisture in the soil

ii) Turning relay ON or OFF depending on level of moisture in soil

iii) Controlling water pump using relay

3.2 Schematic Diagram of the System

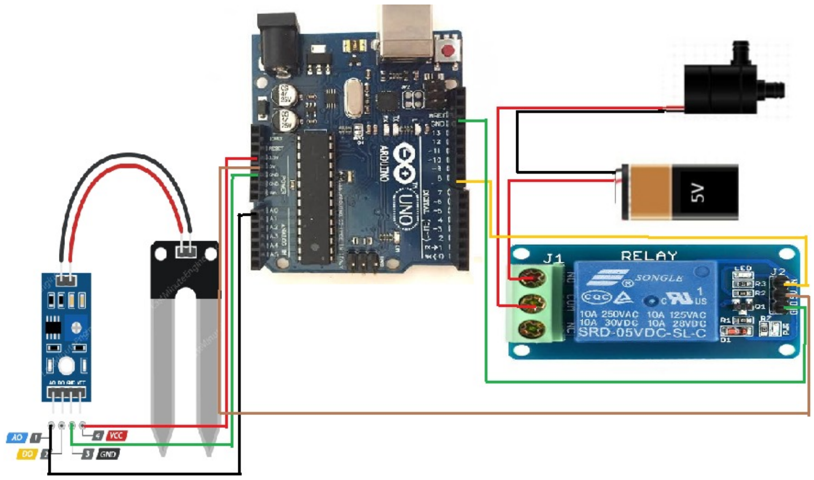

Figure 2: Schematic Diagram of the system

Figure 2 shows schematic diagram of the project.

Pin no A0 of the Arduino UNO board is connected to the Moisture sensor input pin.

Pin no 8 of the Arduino UNO board is connected to the relay input pin.

Supply voltage and ground pin of the sensor and relay are connected to the respective pins on the Arduino UNO board.

Relay is used to drive the water pump further. So water pump is connected to the battery through relay.

4. HARDWARE

Following hardware modules are required to implement this system.

- Arduino UNO Board
- Soil Moisture Sensor (HW103)
- Relay
- Water pump
- Battery
- Connecting Wires

Description

4.1 Arduino UNO Board

The Arduino Uno is an open-source microcontroller based on the Microchip ATmega328P microcontroller and developed by ‘Arduino’.

The board is equipped with sets of digital and analog input/output (I/O) pins that can be interfaced to various expansion boards and other circuits.

The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins and it is programmable with the Arduino IDE (Integrated Development Environment).

Arduino UNO board has an EEPROM of 1KB, the SRAM of 2KB size and the clock speed of 16 MHz.

The operating voltage is 5 V and the input voltage range is 7 to12 V.

Figure 3: Arduino UNO board

4.2 Soil Moisture Sensor

This soil moisture sensor module (HW103) shown in figure 4 is used to detect the moisture in the soil. It measures the volumetric content of the water inside the soil and gives us the moisture level as output. The module has digital and analog output pins and a potentiometer to adjust the threshold level.

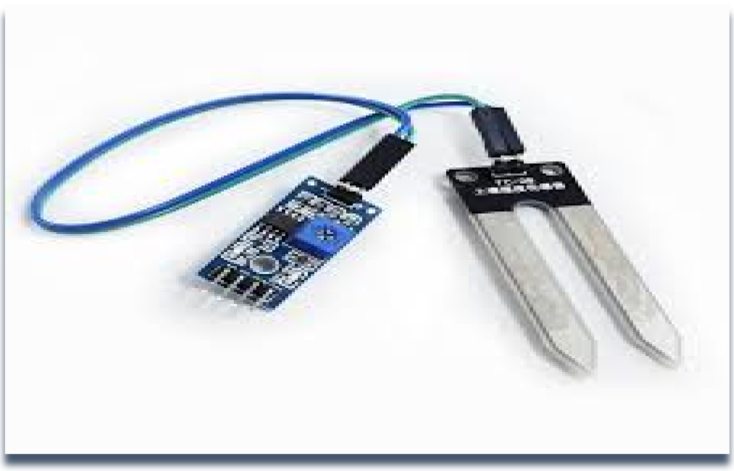

Figure 4: Soil moisture sensor (HW103)

A typical soil moisture sensor has two components:

1. The Probe

The sensor contains a fork shaped long probe with two exposed conductors together acting as a variable resistor. It is kept in the soil where moisture level is to be measured. Higher amount of water in the soil leads to the better conductivity between the probes and results in a lower resistance causing a lower voltage output at analog output pin.

2. The Electronic Module

The sensor also contains an electronic module that connects the probe to the Arduino board.

The module produces an output voltage according to the resistance of the probe and is made available at an Analog Output (AO) pin.

The same signal is fed to LM393, a high precision comparator to digitize it and it is made available at Digital Output (DO) pin.

The module has a built-in potentiometer for sensitivity adjustment of the Digital Output (DO).

The specifications of the soil moisture sensor module are given below.

- Operating voltage: 3.3V to 5V DC
- Operating current: 15 mA
- Output Digital: 0V to 5V
- Output Analog : 0V to 5V
- Small, cheap and easily available

Soil moisture sensor pinout:

The soil moisture sensor has 4 pins to connect.

1. AO (Analog Output)

This pin gives us an output voltage signal in the range of the supply voltage to 0V. It is connected to one of the analog inputs on Arduino UNO board.

2. DO (Digital Output)

This pin gives digital output of internal comparator circuit.

3. VCC

This pin supplies power for the sensor. It is recommended to power the sensor with voltage between 3.3V to 5V.

4. GND

This is a ground connection for the electronic circuit.

4.3 Relay

Relay is an electromagnetic switch. It is used in the systems to turn on and off a circuit by using a low power signal or where several circuits need to be controlled by one signal.

A relay uses an electric current to open or close the contacts of a switch. This is usually done using a coil that attracts the contacts of a switch and pulls them together when activated. A spring pushes them apart when the coil is not energized.

There are two advantages of this system.

1. The current required to activate the relay is much smaller than the current that relay contacts are capable of switching.

2. The coil and the contacts are galvanically isolated. There is no electrical connection between them. So the relay can be used to switch mains current through an isolated low voltage digital system like a microcontroller.

Power requirement of the relay used in this project is 5V.

Relay pin description:

1. IN

   This pin takes digital output from the Aurdino UNO board. Upon receiving it the common terminal is connected to either NO (Normally Open) or NC (Normally Close) terminal depending on whether the input is high or low.
2. GND

   This pin provides ground connection to the relay.
3. VCC

   This pin provides power to the relay from the Aurdino board.

In addition to this, a relay also has three more block terminals.

1. COM

   This terminal is connected to the power supply.
2. NO

   This terminal is normally open and it gets connected to the COM terminal when triggered by the input signal from IN pin.
3. NC

   This terminal is normally closed and is connected to the COM terminal. It gets opened when triggered by the input signal from IN pin.

Figure 5: Single Channel Relay

5. SOFTWARE

Arduino UNO uses Arduino IDE to write and upload programs to Arduino UNO board in order to communicate with the hardware.

5.1 Arduino IDE (Arduino Integrated Development Environment)

It contains software platform application (for windows and Linux OS) and provides software library and input output procedures. It employs a program to convert an executable code into hexadecimal file while uploading the program.

Arduino IDE includes following modules.

1. Text editor for writing code

It has features for cutting/pasting and for searching the text.

2. Message area

It displays errors and messages while saving the files.

3. Text console

It displays the text output.

4. Toolbar with buttons for common functions

This helps to verify and upload the programs, create, open and save the sketches and open the serial monitor.

5.2 Flowchart

Following figure shows flowchart of the program written in Arduino IDE for the smart irrigation system project.

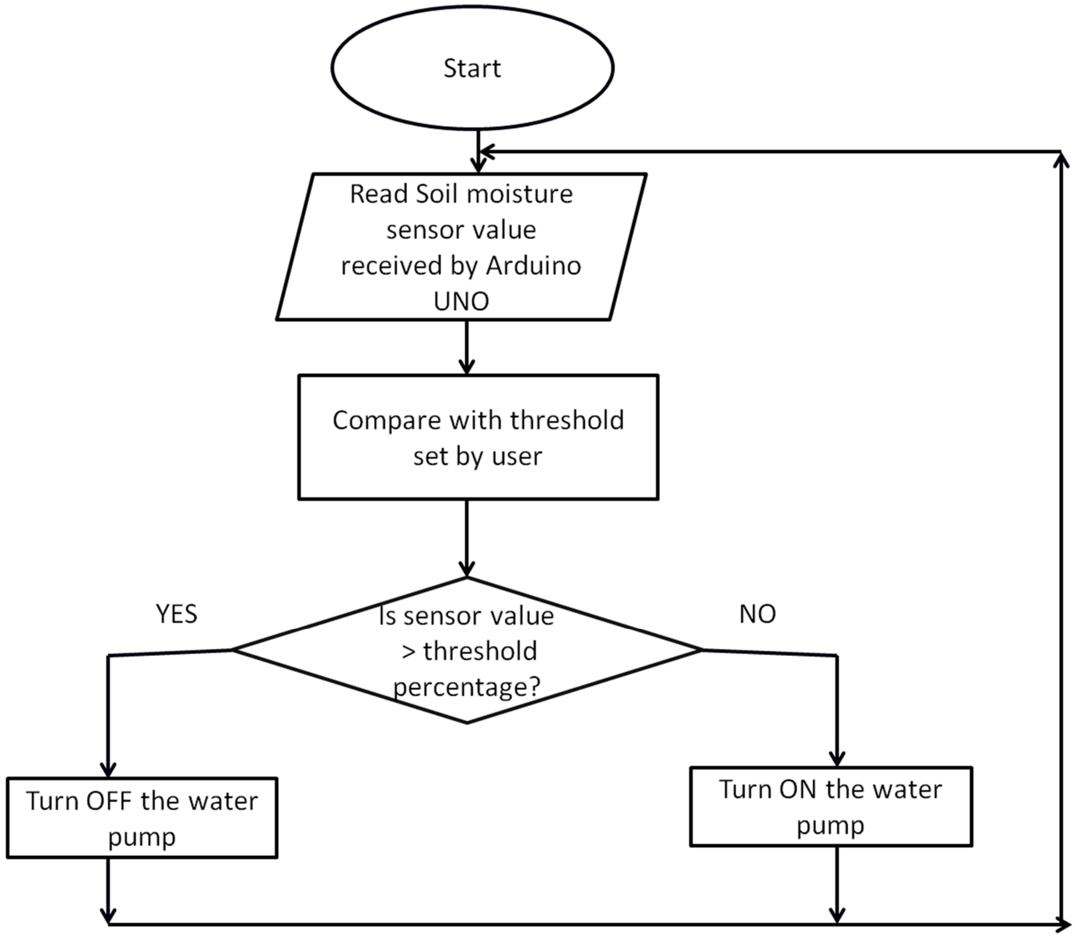

Figure 6: Flowchart of smart irrigation system for small indoor garden

5.3 Algorithm

This code contains two functions, setup ( ) and loop ( ).

Following are the steps involved while developing the code for the project work.

void setup( )

1. Configure digital I/O pin A0 as input pin and analog I/O pin 8 as output pin.

2. Set Baud rate= 9600 bits per second

3. Threshold = 50 %

void loop ( )

1. Read moisture sensor value from pin A0 of Arduino UNO

2. Map the value onto percentage scale (0 to 100 %)

3. Display sensor value onto serial monitor.

4. Is value > threshold ? If yes relay=OFF else relay=ON

6. Repeat

6. RESULTS

6.1 Experimental Setup

Figure 7: Experimental setup

Figure 7 shows set up used for experimentation.

Pin no A0 of the Arduino UNO board is connected to moisture sensor input pin. Pin no 8 of Arduino UNO board is connected to the relay. Supply voltage and ground pin of the sensor and relay are connected to the respective pins on the Arduino UNO board. Relay is used to drive the water pump further.

6.2 Results

Serial monitor displays percentage moisture level found in the soil sample. It also displays ON/OFF status of the water pump.

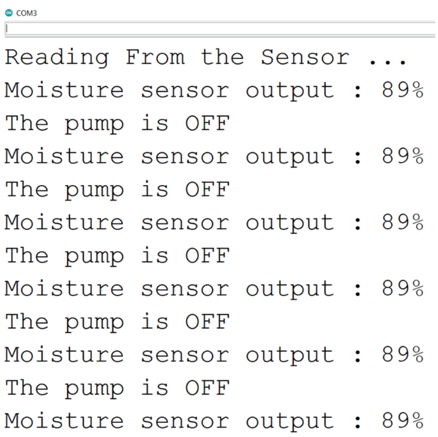

Figure 8: Serial monitor displaying the message for wet soil sample

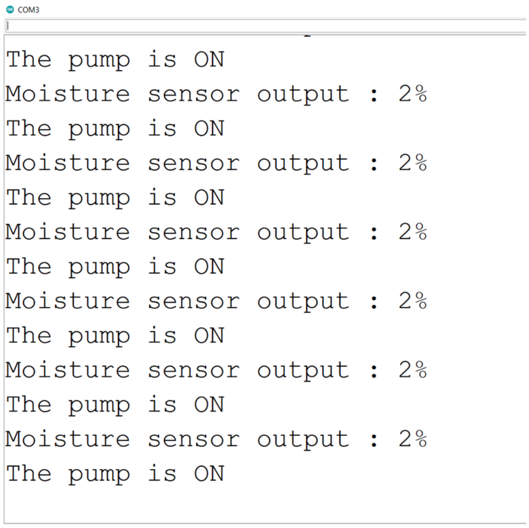

Figure 9: Serial monitor displaying the message for dry soil sample

When the soil moisture sensor is placed in the wet soil sample the water pump is turned OFF as shown in figure 10.

Figure 10: Image shows sensor is placed in wet soil sample

The water pump is turned OFF

Figure 11 shows that when the soil moisture sensor is placed in the dry soil sample, the water pump is turned ON in order to sprinkle water into the soil.

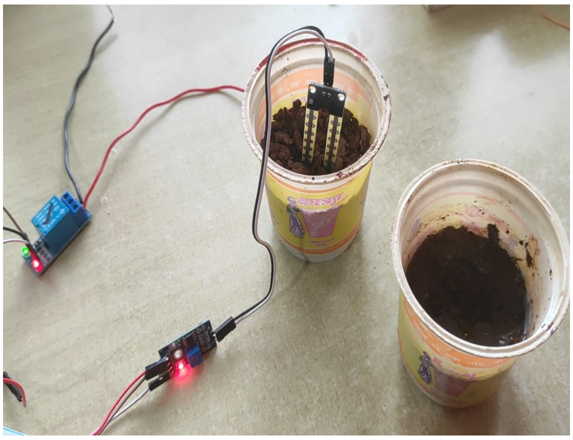

Figure 11: Left side image shows sensor is placed in dry soil sample
Right side image shows that water pump is turned ON

6.3 Week wise Planning of the Project Work

- **Week 1:**

We started by doing some research on the specification of the equipment required. Then we ordered all the components for the project. Finally, we did some study on the currently existing solutions for smart irrigation.

- **Week 2:**

We interfaced the soil moisture sensor to the Arduino UNO board and programmed the Arduino to read the soil moisture level and trigger an output when the reading falls below a particular threshold.

- **Week 3:**

We interfaced the relay with the Arduino and a water pump and then assembled the water tank, pump and the pipe.

- **Week 4:**

In the week 4 of our project work, we combined the parts which we had created in week 2 and week 3 and also prepared a video demonstration of the small irrigation system that has been created.

7. APPLICATIONS AND ISSUES

Advantages of this system are listed below.

- Less human efforts are required in this smart irrigation system.
- This system consumes low power.
- Irrigation process starts and stops exactly when it is required. This conserves the water.
- Crop oriented water supply can be given using this system.
- The system has high efficiency.
- The system is relatively simple to design and install.
- This system gives peace of mind as it can make decisions independently if the farmer/gardener is away from crop/plants.
- The system can work at night also to minimise the water loss due to evaporation.

Applications of the system are listed below.

1. This model can be extended on a large scale in agricultural areas to irrigate crops.
2. On a small scale it can be used in household indoor gardens.
3. It can also be used to spray fertilizers to the crops.

Following are the issues/limitations of this smart irrigation system.

- Skilled manpower is required in order to use the system.
- This system is less reliable as repairing electronic components is difficult.
- Moisture sensor may corrode after continuous use. Non availability of equipment can create a problem.
- Battery has to be replaced after certain intervals of time. Proper maintenance is needed.

8. CONCLUSION

The smart irrigation system is successfully implemented as a prototype for a small indoor garden and it fulfils the desired objective. The hardware and software used in the project performed their functions properly to produce desired result in the irrigation. The soil moisture level is automatically monitored and turning ON and OFF of the water pump is controlled depending on soil moisture level.

This system is comparatively cheaper and requires low power. The system will help the farmers and gardners to do the irrigation process in night also. The system designed does not require physical presence of the farmers in the fields during irrigation.

The primary applications of this project are for farmers and gardeners who do not have enough time to water their crops/plants. It also covers those farmers who waste water during irrigation. As water supplies become scarce and polluted, there is a need to irrigate the field more efficiently in order to minimize the water use. Recent advances in soil water sensing make the commercial use of this technology possible to automate irrigation management for crops. However, research indicates that different types of sensors perform well when compared to the traditional practices under all conditions with no negative impact on crop yields with reduction in water use as high as 70%.

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Drive Links for Project Video Demonstration

Project- Video Demonstration submitted by Kaushal Jadhav (20EC30019)

https://drive.google.com/file/d/1aqYHBGdT0riEy5EiTo9R3b66ygiQl6Vl/view?usp=sharing