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Department of Electrical & Electronic Engineering

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'Microcontroller Based Irrigation System for Rooftop Gardening'
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Declaration

We hereby declare that this thesis is based on the results found by ourselves. Materials of work found by other researchers are mentioned by reference. This thesis, neither in whole nor in part, has been previously submitted for any degree.

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Abstract:

Planting is a healthy hobby that brings us closer to nature and it is also profitable for both mind and fitness. But in our day-to-day busy lives, it is so difficult to establish a small Rooftop Garden to connect with nature [1]. That's why we introduce a microcontroller-based automatic system, which actively senses the soil's moisture level, opens a water pump when water moisture is below a threshold and stops when the cutoff level has reached.

This sensor can monitor a single plant or an entire area. If we did use this system, which will save us time, save money, save water, save our energy and make good environment in the world. Where we fulfill our daily needs, we can adorn the whole world with the fragrance of flowers and Rooftop Garden or farm [2].

Table of Contents:

Chapter-1: Introduction

In Bangladesh, the rapid urbanization has led to the loss of green spaces, resulting in environmental challenges such as air pollution, heat islands, and a decline in biodiversity.

A rooftop garden is not just a flower garden, it has farming associated with it which fulfills the needs of our daily lives and spreads the fragrance of its flowers in the world. To make it easier to integrate it with our lives, we are working on a system that is **‘Microcontroller Based Irrigation System for Rooftop Gardening’.**

We don't always have enough time or energy to watering our Rooftop gardening plants. **'Microcontroller Based Irrigation System for Rooftop Gardening'** It is our small attempt to make your leisure-time hobby easier, more enjoyable, and smarter. We are introducing 'Microcontroller Based Irrigation System for Rooftop Gardening' where you will find smart ways to water your plants [3].

Chapter-2: Literature Review

Due to the urbanization, our city has become hot, dusty, dirty, oxygen-poor and lacking in food. Through rooftop garden or agriculture, we can turn our cities into greener with enough oxygen and good health.

Rooftop gardens or agriculture present a viable solution to these issues by transforming unused rooftop spaces into lush, green sanctuaries. The concept of rooftop gardens is not new, but it has gained significant momentum in recent years due to the growing awareness of environmental sustainability and the benefits of urban agriculture.

Why Does Need of Rooftop Gardening-

Gardening is not limited to just flower gardens. It could also be a rooftop farm. Where we can produce fresh food for our daily lives.

As the population of our country is increasing and the demand for food and expenditure on food is also increasing. But the resource is scarce as agricultural land is converting to residential, commercial or industrial land uses. It reduces the possibility of increasing more and more agricultural food products.

Again, food contamination such as harmful chemical usage to ripe fruits, hazardous or inorganic fertilizer and pesticide use to increase production, etc.

In these circumstances, to solve these problems and find a way out, initiation of rooftop gardening or farming can be a possible and potential solution. Rooftop gardening or farming can benefit society by improving air quality, reducing carbon in the atmosphere, thereby creating a healthy environment. Moreover, the people will get pesticide free vegetables with their own efforts.

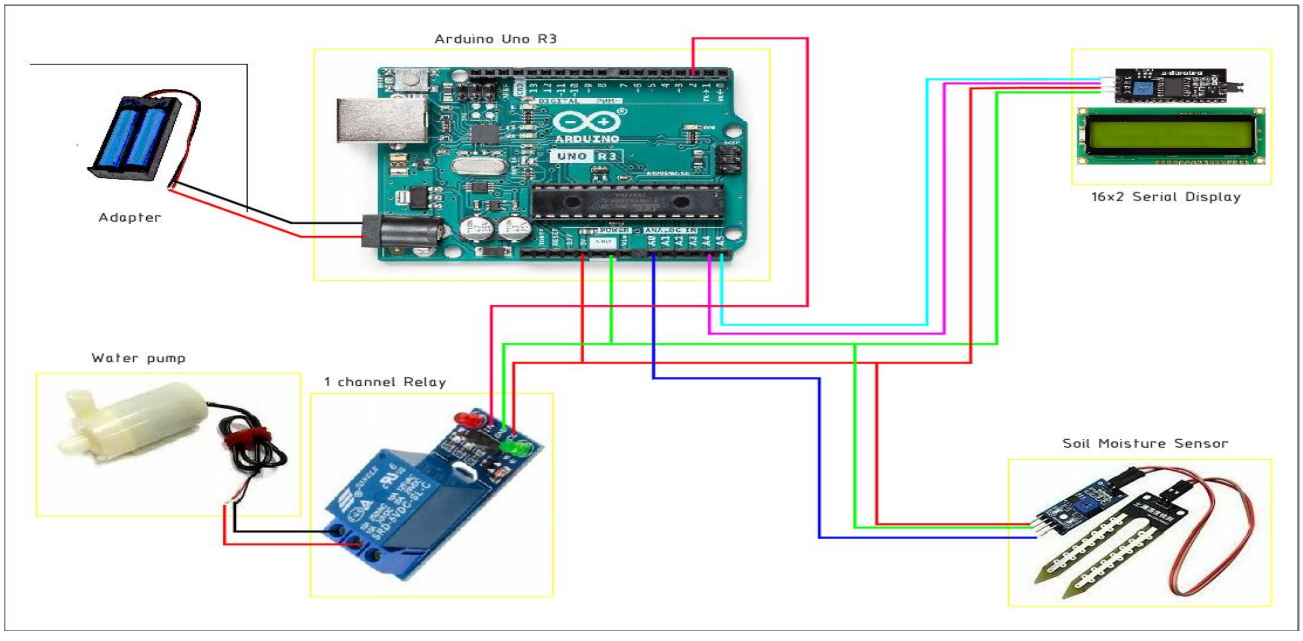
Rooftop gardening to make it easier to integrate it with our lives, we are working on a system that is **‘Microcontroller Based Irrigation System for Rooftop Gardening’.**

We are introducing 'Microcontroller Based Irrigation System for Rooftop Gardening' where you will find smart ways to water your plants.

Our Existing System: Primary investigation we did collect the existing approaches, Understanding the wants, developing an abstract for the system.

Soil moisture humidity sensors placed at roots of a plant and the data is given to Arduino Uno R3 system. The value of Soil moisture humidity sensors is given to micro controller Arduino Uno R3 system to control relay to water pump. The display is showing the water pump and soil moisture detection sensor working status.

Smart Irrigation System on Sensing Soil Moisture, intension is to create an automated irrigation process which turns the water motor ON and OFF on detecting moisture of the earth of Plants tub. These sensors will find the various situation of moisture of the earth Plants tub or the land gets automatically irrigated. It means when field needs water then automatically motor will get ON and it will get OFF when it's got enough. This smart Irrigation system will display pump status values and moisture detection status [4].



Chapter-3: Required Components

To accomplish the whole system, some components are needed.

They are listed in Table I.

Sr. No	Components	Quantity
I	Arduino Uno R3.	1
II	YL-69 Soil Hygrometer humidity & Soil Moisture Detection Sensor.	1
III	Submersible 3v DC Water pump.	1
IV	5v Relay board module.	1
V	16x2 Serial LCD Module display for Arduino assembled.	1
VI	3.7v 18650 Rechargeable Battery.	1
VII	18650 Lithium Battery Holder 2s	1
VIII	Male to Female Jumper wires.	Not Specific

A short definition for components that using in system prototype is given below:

I. Arduino Uno R3

The Arduino Uno R3 with cable is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital Input/output pins (of which 6 can be used as PWM outputs) 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, a reset button [5].

Power- Operating voltage-5V. The board can be supplied with power either from the DC power jack (7~12V), The USB connector (5V), The VIN pin of the board (7~12V).

Memory- The ATmega328 has 32 KB. It also has 2 KB of SRAM an 1 KB of EEPROM.

Input/Output- Each of the 14 digital pins on the Uno can be used as an input or output using pinmode(), digitalwite(), and digitalread() functions.

Communication-The Uno R3 has a number of facilities for communicating with a computer, another Arduino or other microcontrollers. The ATmega328 provides UART TTL Serial communication.

The ATmega328 also supports I2C and SPI communication.

Programming- The Uno R3 can be a program with the Arduino software download. The ATmega328 on the Uno R3 comes pre burn with a bootloader that allows to upload new code to it without the use of an external hardware programmer.

Automatic Software reset- Rather than requiring a physical press button before an upload the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer.

USB Overcurrent Protection- The Arduino Uno has resettable polyfused that protects your computer USB port from short and overcurrent.

II. YL-69 Soil Hygrometer humidity & Soil Moisture Detection Sensor

Features

1. Dual Output mode, analog output more accurate
2. A fixed bolt hole for easy installation
3. With power indicator (red) and digital switching output indicator (green)
4. Having LM393 comparator chip, stable [6].

III. Submersible 3v DC Water pump

Features

This DC 3V mini micro submersible water pump is a small size submersible pump motor that can be operate from a 2.5V~5V power supply. It can take up to 80~120 liters per hour with a very low current consumption of 130~220mA. Outlet outside diameter 7.5mm and Inside diameter 5mm. Just connect the tube pipe to the motor outlet, submerge it in water and power it.

IV. 5v Relay board module.

Features

It is a 1 channel 5v relay board module. The relay normally open interface maximum load AC 250V/10A, DC 30V/10A. It has a trigger current of 5mA and module working voltage of DC 5V. Each channel of the module can be triggered by a jumper to set a high level or a low lever. Fault tolerant design even if the control line is disconnected the relay will not move. With status power green 1 channel relay status indicator red. All module size interface can be directly connected through the terminal block, which is convenient and practical [7].

V. 16x2 Serial LCD Module display for Arduino assembled.

Features

1. I2C reduces the overall wirings
2. 16 character wide and 2 rows
3. I2C adapter allows flexibility in connections
4. White text on the blue background
5. Single LED backlight included can be dimmed easily with a resistor or PWM
6. Arduino IIC/I2C interface was developed

VI. 3.7v 18650 Rechargeable Battery.

Features

This 18650 Li-ion Rechargeable battery lithium-ion battery gives value for money. It is a single cell, compact and powerful battery cell with 1550 mAh capacity. It is very convenient to install in any project to fulfill a 3.7V requirement with high capacity.

VII. 18650 Lithium Battery Holder of 2s

Features

This 18650 Li-ion Rechargeable battery holder plastic box. This battery holder case is perfect for the devices need a 7.2 V external battery.

VIII. Male to Female Jumper wires

Features

1. Compatible with 2.54mm spacing pin headers
2. High quality and in good working condition
3. Easy to install and use

Chapter-4: Methodology

'Microcontroller Based Irrigation System for Rooftop Gardening' solution provides comfortable gardening and agricultural field watering [10]. It is a sophisticated technology that is reachable from any location on Earth.

We first measured the soil moisture using a soil moisture sensor and the Arduino Uno R3, an open-source of microcontroller platform. The irrigation system we are using various equipment's like 3.7v 18650 DC battery, 5v Relay board module, Submersible 3v DC Water pump, YL-69 Soil Hygrometer humidity & Soil Moisture Detection Sensor, 16x2 Serial LCD Module display for Arduino assembled, Jumper wiring and Arduino Uno R3 system.

Smart Irrigation System on Sensing Soil Moisture, intension is to create an automated irrigation process which turns the water motor ON and OFF on detecting moisture of the earth of Plants tub. These sensors will find the various situation of moisture of the earth Plants tub or the land gets automatically irrigated. It means when field needs water then automatically motor will get ON and it will get OFF when it's got enough. This smart Irrigation system will display pump status values and moisture detection status.

Finally, our irrigation system is equipped to water both large agricultural regions and any rooftop gardening or balcony garden [8].

Fig. Block Diagram

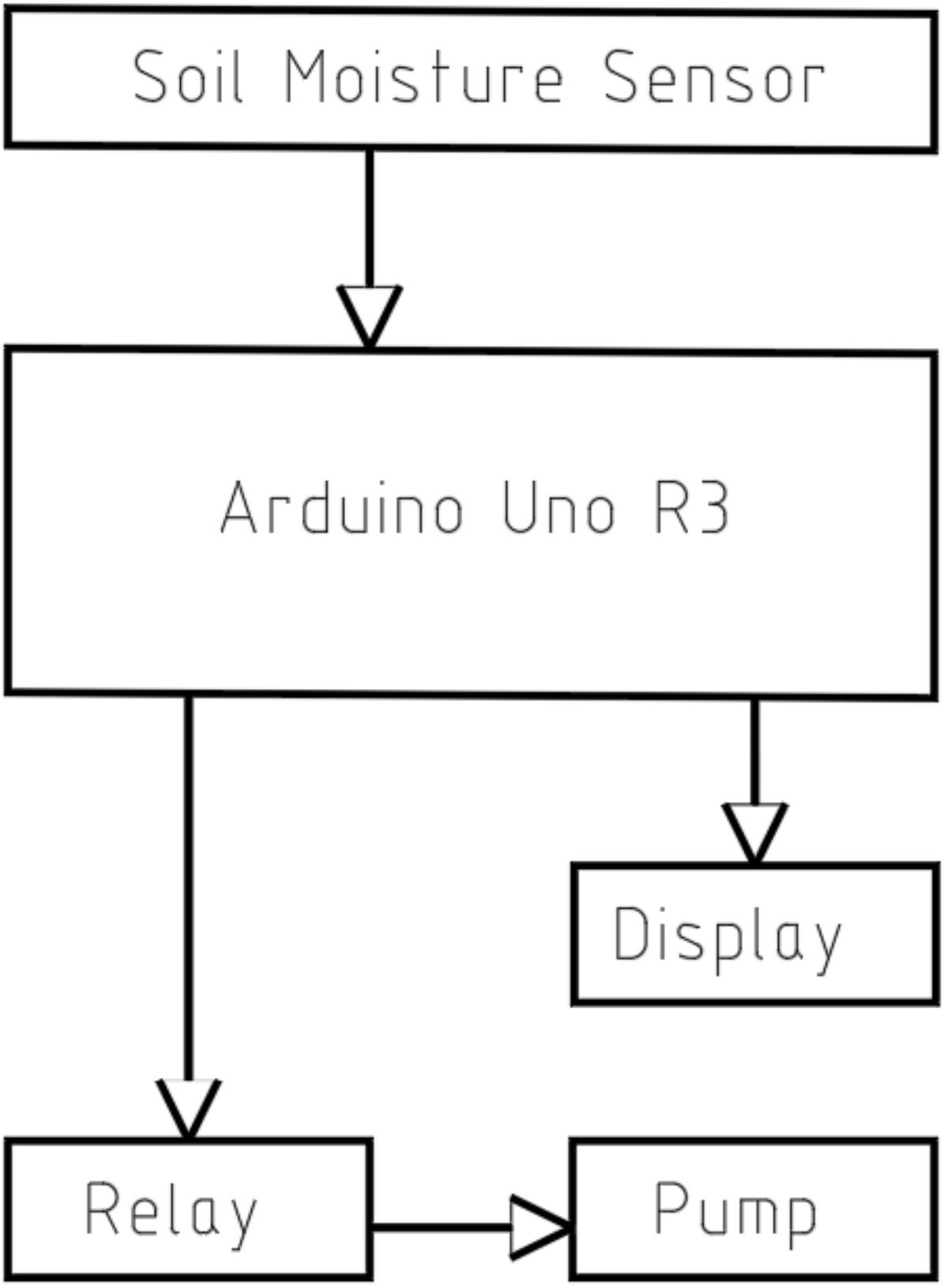


Fig. Flowchart

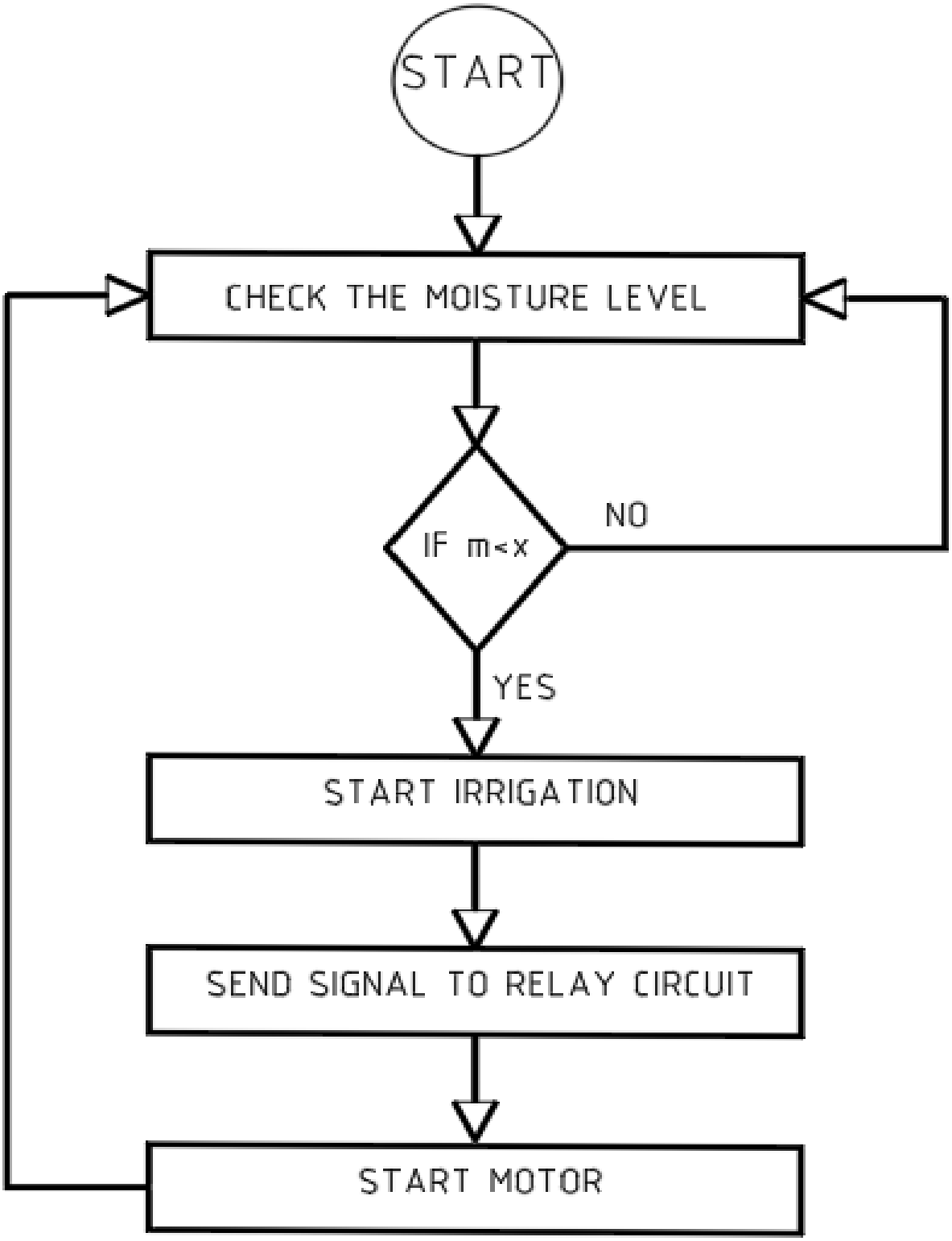
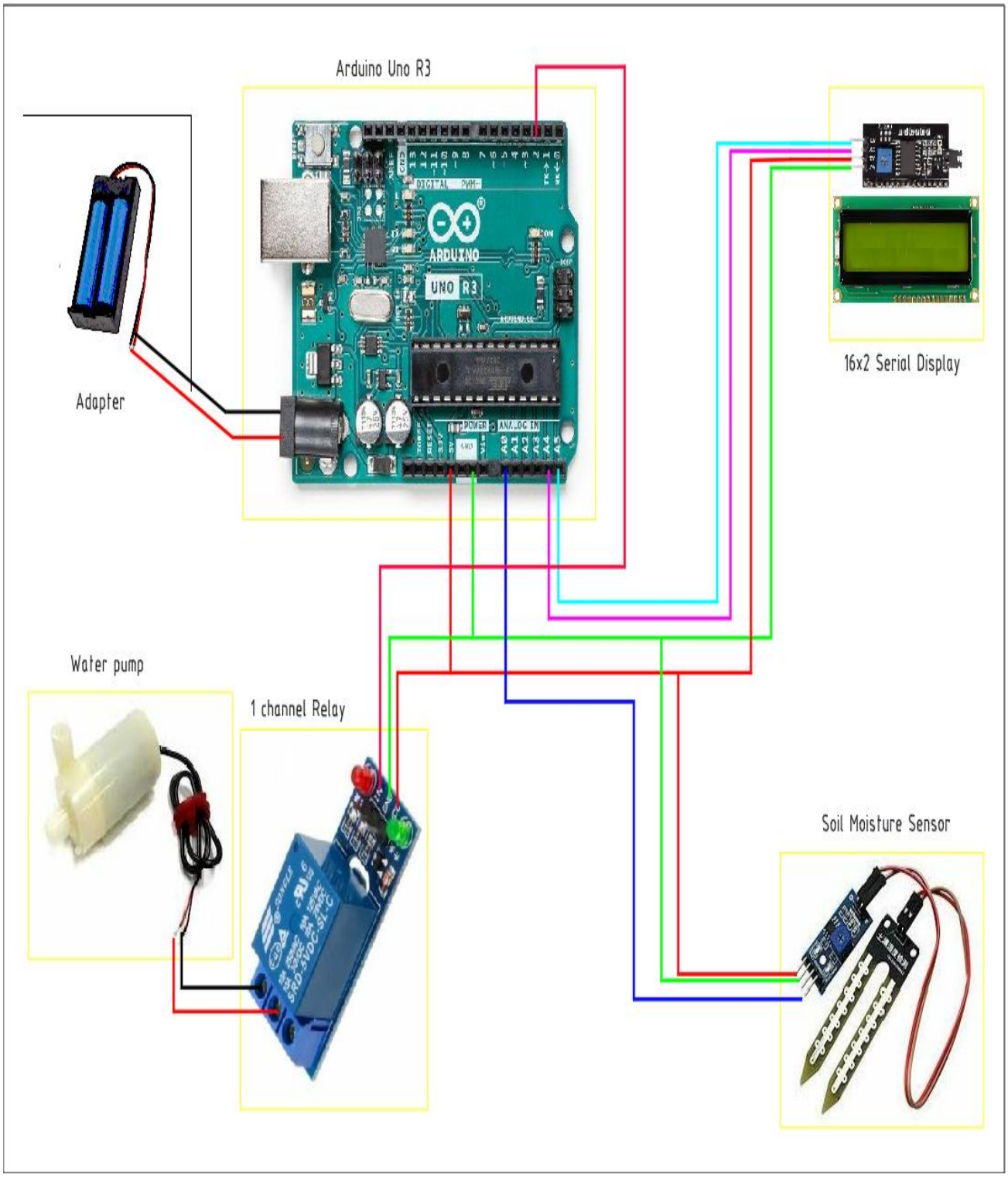


Fig. Circuit Diagram



Chapter- 5: Implementation & Result Picture

Wiring Connection

Power Supply- 18650 Li-ion Rechargeable battery lithium-ion battery 3.7 X 2 Volt connected Arduino Uno R3 microcontroller.

Soil Moisture Sensor-

A0 Analog to A0 Arduino Uno R3 connected

GND to GND Arduino Uno R3 connected

VCC to 5V Arduino Uno R3 connected

1 Channel Relay-

10A 30VDC to Water pump connected.

N.O to Water pump connected.

VCC to 5V Arduino Uno R3 connected

GND to GND Arduino Uno R3 connected

IN to D2 Digital Arduino Uno R3 connected

Display –

GND to GND Arduino Uno R3 connected

VCC to 5V Arduino Uno R3 connected

SDA to Analog A4 Arduino Uno R3 connected

SCL to Analog A5 Arduino Uno R3 connected

Fig. Final Module of the System During Pump ON

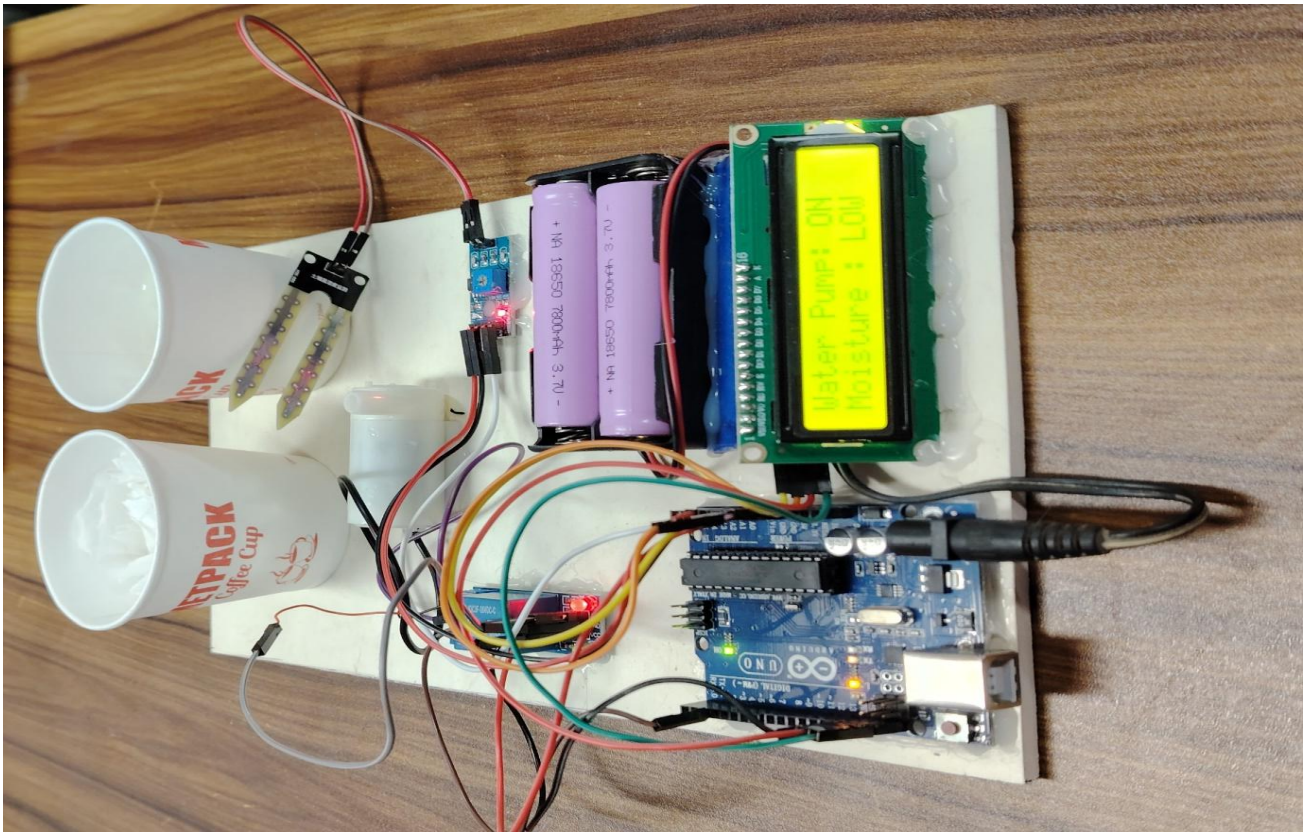
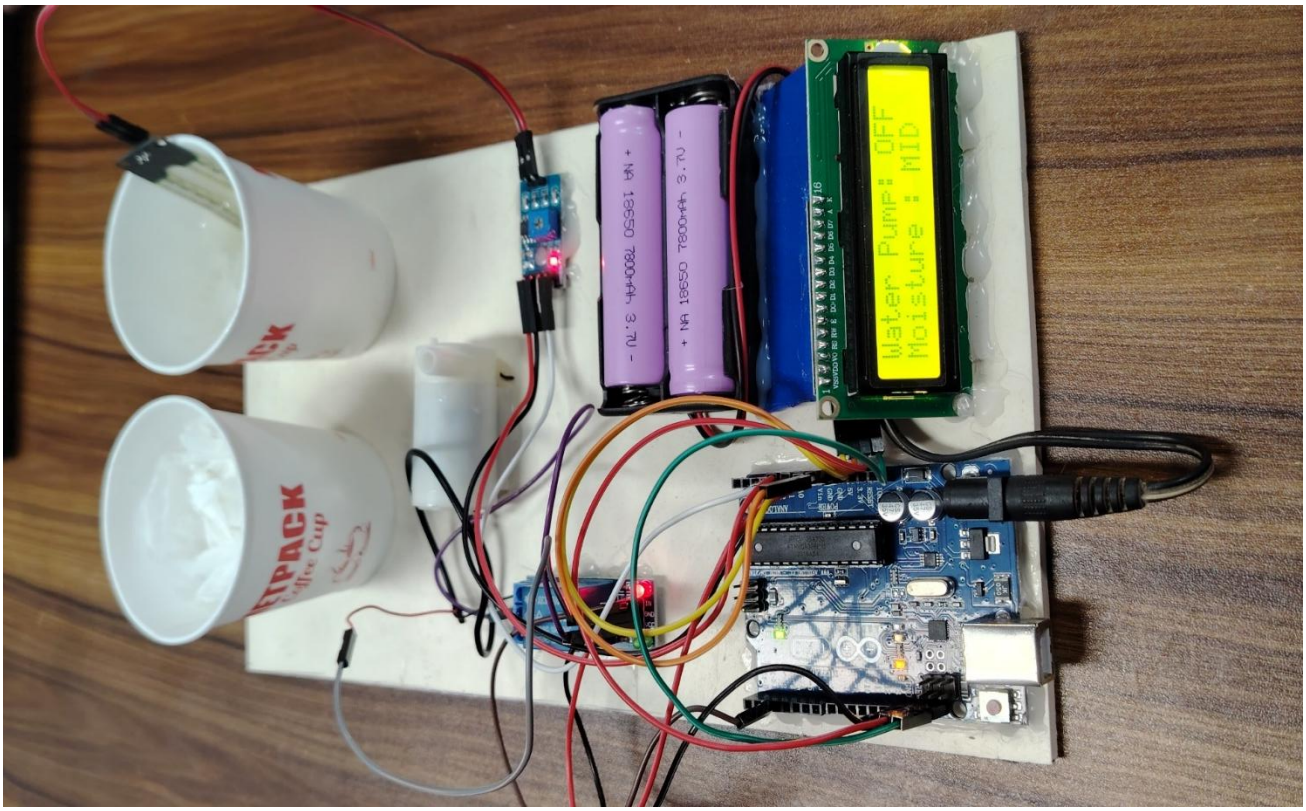


Fig. Final Module of the System During Pump OFF



Discussion

The software part comprises a programming language that is developed utilizing C++ programming. The codes are focused on Arduino UNO to be gathered and transferred. The equipment and programming are actualized and incorporated to structure and build up the automatic irrigation system.

In the proposed system, the wetness sensing element provides analog voltage output therefore it should be connected with Arduino UNO's analog input pins. That is given power from the board. Arduino UNO drives the relay and the motor is connected with the relay. The relay is employed to modify ON/OFF The motor or pump. It's connected between the "NO" (Normal Open) terminal and therefore the circuit ground. A power source or a battery is also needed to operate the whole system. The microcontroller, sensors and the motor will perform by the flow of energy from the source. When the sensors will detect low wetness or dryness it will send data to the microcontroller (Arduino UNO) then the microcontroller will turn on the motor with the help of a relay. When it seems that the water level is sufficient then sensors will send data again and by the same process, the motor will be turned off [9].

Software Information

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);

void setup() {
  Serial.begin(9600);
  lcd.init();
  lcd.backlight();
  lcd.clear();
  pinMode(2, OUTPUT);
  digitalWrite(2, HIGH);
  delay(1000);
  lcd.setCursor(0, 0);
  lcd.print("IRRIGATION");
  lcd.setCursor(0, 1);
  lcd.print("SYSTEM IS ON ");
    lcd.print("");
    delay(3000);
  lcd.clear();
}

void loop() {
  int value = analogRead(A0);
  Serial.println(value);
  if (value > 950) {
```

```
    digitalWrite(2, LOW);
    lcd.setCursor(0, 0);
    lcd.print("Water Pump is ON ");
  } else {
    digitalWrite(2, HIGH);
    lcd.setCursor(0, 0);
    lcd.print("Water Pump is OFF");
  }


  if (value < 300) {
    lcd.setCursor(0, 1);
    lcd.print("Moisture : HIGH");
  } else if (value > 300 && value < 950) {
    lcd.setCursor(0, 1);
    lcd.print("Moisture : MID ");
  } else if (value > 950) {
    lcd.setCursor(0, 1);
    lcd.print("Moisture : LOW ");
  }
}
```

Chapter- 6: Rooftop Gardening Advantage & Disadvantage:

Rooftop Gardening Advantage-

a. Green roofs can help in the absorption of carbon dioxide and help reduce air pollutions.
b. Storm water runoff, flooding and water pollution can be reduced
c. The building and surrounding area's aesthetics will be enhanced and property value could be increased
d. Economically, there are no additional land costs
e. Temperatures around the building can be lowered in the summer
f. A building can be further insulated from the cold in the winter
g. The roof life can be extended by protecting it from various weather conditions
h. Heating and cooling bills will be reduced
i. The rooftop garden space can be used for food production

Rooftop Gardening Disadvantage-

a. The terrace has to be properly waterproofed before setting up the terrace garden or else there may be leaks in the roof.
b. The wind speed will be high in the terrace when compared with the ground level, hence proper protection must be given to the plants to prevent it from getting damaged.
c. Frequent maintenance and cleaning might be required as there will be shedding of dry leaves.

Chapter- 7: Conclusion

We have made an effort to simplify the gardeners' jobs. People who don't have time to garden or who wish to perform research on plants or crops will greatly benefit from this platform. It is simpler to monitor and modify your watering plan thanks to these systems **'Microcontroller Based Irrigation System for Rooftop Gardening'.**

Sensors can be utilized with these systems to monitor soil and humidity levels, allowing you to water your plant just when it actually needs it. Additionally, you don't have to bother about manually turning them on or off because they may be set to turn on and off automatically. Additionally, you may set up these systems to alert you if the soil is too dry or if it is too hot or cold for your plants. Our developed system offers a fantastic resource for people who wish to plant trees, learn how to take care of them, prevent plant illnesses, and discover the soil's mineral composition.

Finally, we believe that our 'Irrigation System for Rooftop Gardening' powered by the 'Microcontroller Based' plays an enormous role to eliminate guesswork from daily activities of farming, particularly in gardening watering.

Chapter- 8: References

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Appendix A1