Android Operated Smart Gardening with Automated Watering

by

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A comprehensive project report has been submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology

in

ELECTRONICS & COMMUNICATION ENGINEERING

Under the supervision of

Mrs. Moumita Deb

Asst. Proff. in the department of IT

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May,2018

CERTIFICATE OF APPROVAL

This is to certify that the project titled "**Android Operated Smart Gardening with Automated Watering**" carried out by

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for the partial fulfillment of the requirements for B.Tech degree in **Electronics and Communication Engineering** from **Maulana Abul Kalam Azad University of Technology, West Bengal**is absolutely based on his own work under the supervision of Mrs**. Moumita Deb**. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

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DECLARATION

"We do hereby declare that this submission is our own work conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute and that, to the best of our knowledge and belief, it contains no material previously written by another neither person nor material (data, theoretical analysis, figures, and text) which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text."

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CERTIFICATE of ACCEPTANCE

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Name of the Examiner Signature with Date

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ACKNOWLEDGEMEMT

First of all we are thankful to our college RCC INSTITUTE OF INFORMATION TECHNOLOGY for providing necessary guidance concerning projects implementation and being a constant support.

We also extend our sincere gratitude towards Mrs. Moumita Deb, Asst. Prof. Dept of IT, for guiding us throughout, helping us with the understanding of the microcontroller part and justifying our work. Without her knowledge and experience, the Project would lack in quality of outcomes, and thus her backup has been essential. We express our sincere thanks and regards to her, for devoting her time and knowledge in the implementation of this project.

CONTENTS

LIST OF FIGURES

INTRODUCTION

Home automation is the automatic control and monitoring of house hold appliances and also for garden watering. The system uses Android application to control and monitor the appliances and Bluetooth technology as a communication protocol to connect system components. Depending upon the moisture level of garden soil the system can detect the appropriate time of water supply to the plants. The analog data received from the sensor are transmitted as digital signal via Bluetooth module to the Controller board. The system is able to notify the user that the water shortage arises in the main water supply and user can also communicate with the system by sending command to water the plants.

1.1 Problem Definition: The project aims in designing an Android based application that, via Bluetooth connectivity, informs the user about the levels of the water content of the soil thereby helping him/her save those plants by providing automatic water supply without the user having to worry about physically doing it . The schematic diagram of the proposed system has been given in Fig. 1. The system comprises of an android phone, which is used to provide the user with the details of the garden soil moisture level. Watering system, attached to a servo motor waters the plants automatically as soon as the levels go hostile. This report deals with the development of the Hardware as well as the Software part and their Synchronous interconnection which helped us arrive at the desired results.

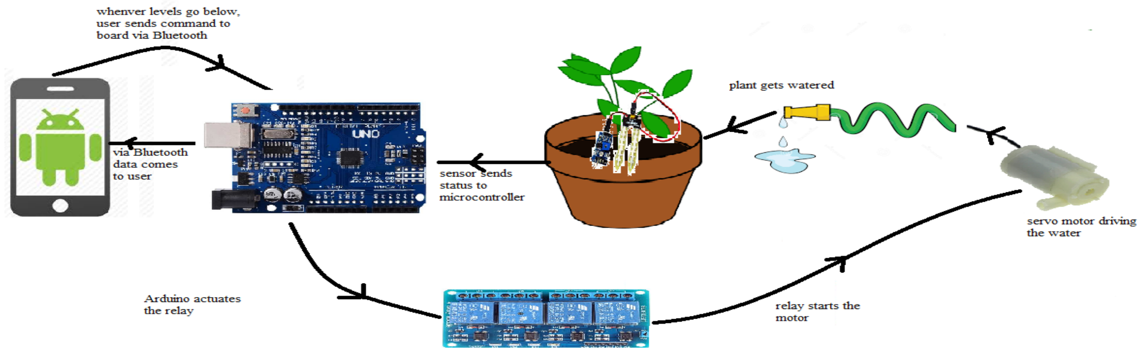


Fig. 1: Block diagram of the automatic watering system

1.2 Problem Statement:

To water the plants whenever the moisture level goes below 5% and send the analog data via Bluetooth to the user’s smartphone.

FUNDAMENTAL WORKING BASICS

2.1 Analysis:

The controlling device of the whole system is an Arduino Uno board, Bluetooth module, soil moisture sensor, 4-channel relay board and servo motor. The data received from the sensor is transferred to the smart phone using the wireless Bluetooth module. The command hence given by the user is sent to the microcontroller and eventually the watering starts.

The main objectives of the project are:

1. Connecting the microcontroller enabled Bluetooth module to the user’s smart phone
2. Sending periodic status of the soil moisture as obtained from the soil moisture sensor to the user’s phone
3. Alerting the user as soon as the levels of water go below the threshold
4. Actuating the servo motor for watering.

2.2 Technologies Exploited

Google’s Android Open Source Technology: Android is a mobile operating system developed by Google, based on the Linux kernel and designed primarily for touch-screen mobile devices such as smart-phones and tablets. Android's user interface is mainly based on direct manipulation, using touch gestures that loosely correspond to real-world actions, such as swiping, tapping and pinching, to manipulate on-screen objects, along with a virtual keyboard for text input. In addition to touch-screen devices, Google has further developed Android TV for televisions, Android Auto for cars and Android Wear for wrist watches, each with a specialized user interface. Variants of Android are also used on game consoles, digital cameras, PCs and other electronics.

Android's source code is released by Google under an open source license, although most Android devices ultimately ship with a combination of free and open source and proprietary software, including proprietary software required for accessing Google services. Android is popular with technology companies that require a ready-made, low-cost and customizable operating system for high-tech devices. Its open nature has encouraged a large community of developers and enthusiasts to use the open-source code as a foundation for community-driven projects, which deliver updates to older devices, add new features for advanced users or bring Android to devices originally shipped with other operating systems.

The main hardware platform for Android is the ARM (ARMv7 and ARMv8-A architectures), with x86, MIPS and MIPS64, and x86-64 architectures also officially supported in later versions of Android. Android applications run in a sandbox, an isolated area of the system that does not have access to the rest of the system's resources, unless access permissions are explicitly granted by the user when the application is installed.

Bluetooth Wireless Technology: Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). Invented by telecom vendor Ericsson in 1994 it was originally conceived as a wireless alternative to RS-232 data cables.

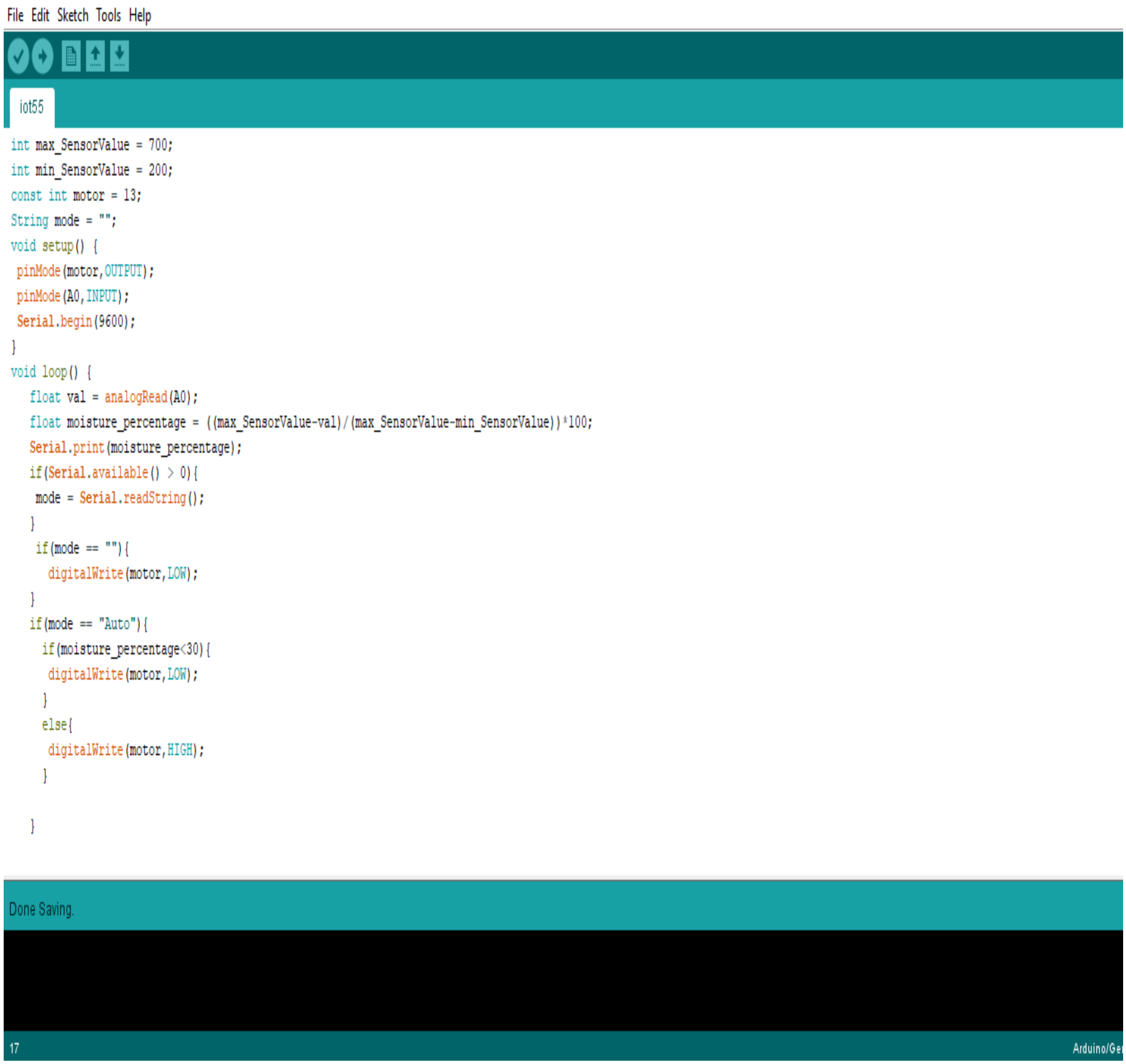
The development of the "short-link" radio technology, later named Bluetooth, was initiated in 1989 by Nils Rydbeck, CTO at Ericsson Mobile in Lund, Sweden, and by Johan Ullman. The purpose was to develop wireless headsets, according to two inventions by Johan Ullman, SE 8902098-6, issued 1989-06-12 and SE 9202239, issued 1992-07-24. Nils Rydbeck tasked Tord Wingren with specifying and Jaap Haartsen and Sven Mattisson with developing. Both were working for Ericsson in Lund. The specification is based on frequency-hopping spread spectrum technology.

Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 30,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. The IEEE standardized Bluetooth as IEEE 802.15.1, but no longer maintains the standard. The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks. A manufacturer must meet Bluetooth SIG standards to market it as a Bluetooth device. A network of patents applies to the technology, which are licensed to individual qualifying devices.

Embedded C programming: Embedded C is a set of language extensions for the C programming language by the C Standards Committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations.

Though C and embedded C appear different and are used in different contexts, they have more similarities than the differences. Most of the constructs are same; the difference lies in their applications.

C is used for desktop computers, while embedded C is for microcontroller based applications. Accordingly, C has the luxury to use resources of a desktop PC like memory, OS, etc. While programming on desktop systems, we need not bother about memory. However, embedded C has to use with the limited resources (RAM, ROM, I/Os) on an embedded processor. Thus, program code must fit into the available program memory. If code exceeds the limit, the system is likely to crash. Embedded C requires compilers to create files to be downloaded to the microcontrollers/microprocessors where it needs to run. Embedded compilers give access to all resources which is not provided in compilers for desktop computer applications. Embedded systems often have the real-time constraints, which is usually not there with desktop computer applications. Embedded systems often do not have a console, which is available in case of desktop applications.



```
File Edit Sketch Tools Help
iot55
int max_SensorValue = 700;
int min_SensorValue = 200;
const int motor = 13;
String mode = "";
void setup() {
 pinMode(motor,OUTPUT);
 pinMode(A0,INPUT);
 Serial.begin(9600);
}
void loop() {
   float val = analogRead(A0);
   float moisture_percentage = ((max_SensorValue-val)/(max_SensorValue-min_SensorValue))*100;
   Serial.print(moisture_percentage);
   if(Serial.available() > 0){
    mode = Serial.readString();
   }
    if(mode == ""){
      digitalWrite(motor,LOW);
   }
   if(mode == "Auto"){
     if(moisture_percentage<30){
      digitalWrite(motor,LOW);
     }
     else{
      digitalWrite(motor,HIGH);
     }

   }
Done Saving.
17                                                        Arduino/Ge
```

Fig. 2:*Arduino* Code

MAJOR BUILDING BLOCKS

Microcontroller board (Arduino Uno): Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),[1] permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

Fig 3 : *Arduino uno*

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

Servo motor: A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft. The motor is paired with some type of encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops. The very simplest servomotors use position-only sensing via a potentiometer and bang-bang control of their motor; the motor always rotates at full speed (or is stopped). This type of servomotor is not widely used in industrial motion control, but it forms the basis of the simple and cheap servos used for radio-controlled models.

More sophisticated servomotors use optical rotary encoders to measure the speed of the output shaft and a variable-speed drive to control the motor speed. Both of these enhancements, usually in combination with a PID control algorithm, allow the servomotor to be brought to its commanded position more quickly and more precisely, with less overshooting.

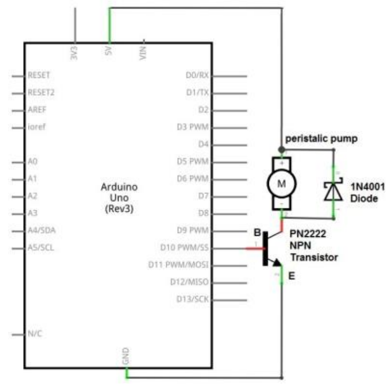


Fig 4 : *Servo motor* connection to *Arduino*

Android smart phone: A ***smartphone*** is a handheld personal computer with a mobile operating system and an integrated mobile broadband cellular network connection for voice, SMS, and Internet data communication; most if not all smartphones also support Wi-Fi. Smartphones are typically pocket-sized, as opposed to tablets, which are much larger than a pocket. They are able to run a variety of third-party software components("apps") from places like the Google Play Store or Apple App Store, and can receive bug fixes and gain additional functionality through operating system software updates. Modern smartphones have a touchscreen colour display with a graphical user interface that covers the front surface and enables the user to use a virtual keyboard to type and press onscreen icons to activate "app" features. They integrate and now largely fulfil most people's needs for a telephone, digital camera and video camera, GPS navigation, a media player, clock, news, calculator, web browsing, handheld video games, flashlight, compass, an address book, a note-taking application, digital messaging, an event calendar, etc. Typical smartphones will include one or more of the following sensors: magnetometer, proximity sensor, barometer, gyroscope or accelerometer. Since the early 2010's, smartphones have adopted integrated virtual assistants, such as Apple Siri, Google Assistant, Amazon

Alexa, Microsoft Cortana, BlackBerry Assistant and Samsung Bixby. Most smartphones produced from 2012 onward have high-speed mobile broadband 4G LTE, motion sensors, and mobile payment features.

Android is a mobile operating system founded by Andy Rubin, now owned and developed by Google, and backed by an industry consortium known as the Open Handset Alliance.It is an open source platform with optional proprietary components, including a suite of flagship software for Google services and the application and content storefront Google Play. Android was officially introduced via the release of its inaugural device, the HTC Dream (T-Mobile G1) on 20 October 2008. As an open source product, Android has also been the subject of third-party development. Development groups have used the Android source code to develop and distribute their own modified versions of the operating system, such as CyanogenMod, to add features to the OS and provide newer versions of Android to devices that no longer receive official updates from their vendor. Forked versions of Android have also been adopted by other vendors, such as Amazon.com, who used its "Fire OS" on a range of tablets and the Fire Phone. As it is a non-proprietary platform that has shipped on devices covering a wide range of market segments, Android has seen significant adoption. Gartner Research estimated that 325 million Android smartphones were sold during the fourth quarter of 2015, leading all other platforms. Samsung Electronics, who produces Android devices, was also the top smartphone vendor across all platforms in the same period of time. Android is the top-selling smartphone OS in 2016. Android Pay is available on Android software.

Bluetooth module: Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). Invented by telecom vendor Ericsson in 1994 it was originally conceived as a wireless alternative to RS-232 data cables.

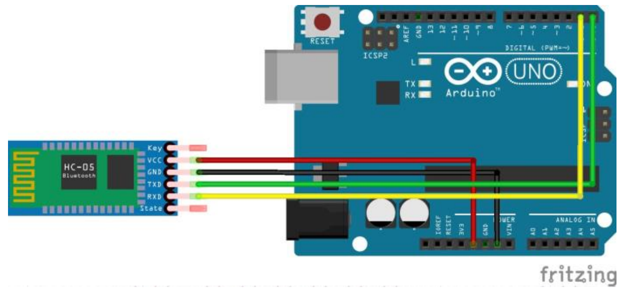


Fig 5: *Bluetooth module* connection to *Arduino*

Bluetooth operates at frequencies between 2402 and 2480 MHz, or 2400 and 2483.5 MHz including guard bands 2 MHz wide at the bottom end and 3.5 MHz wide at the top. This is in the globally unlicensed (but not unregulated) industrial, scientific and medical (ISM) 2.4 GHz short-range radio frequency band. Bluetooth uses a radio technology called frequency-hopping spread spectrum. Bluetooth divides transmitted data into packets, and transmits each packet on one of 79 designated Bluetooth channels. Each channel has a bandwidth of 1 MHz. It usually performs 800 hops per second, with Adaptive Frequency-Hopping (AFH) enabled. Bluetooth low energy uses 2 MHz spacing, which accommodates 40 channels.

Bluetooth is a packet-based protocol with a master/slave architecture. One master may communicate with up to seven slaves in a piconet. All devices share the master's clock. Packet exchange is based on the basic clock, defined by the master, which ticks at 312.5 µs intervals. Two clock ticks make up a slot of 625 µs, and two slots make up a slot pair of 1250 µs. In the simple case of single-slot packets the master transmits in even slots and receives in odd slots. The slave, conversely, receives in even slots and transmits in odd slots. Packets may be 1, 3 or 5 slots long, but in all cases the master's transmission begins in even slots and the slave's in odd slots. The above is valid for "classic" BT. Bluetooth Low Energy, introduced in the 4.0 specification, uses the same spectrum but somewhat differently.

4-Chanel Relay Board: This relay module allows you to combine the processing power of the Arduino to devices that use higher current and voltage. It does so by providing four relays that are rated for 7A at either 28VDC or 10A at 125VAC.

Each relay has a Normally Open (NO) and a Normally Closed (NC) contact.

With these relays you can control:

- Appliances
- Motors
- Lights
- Other Relay

The module is supplied with power via the pin labeled VCC and ground via the pin labeled GND.

The relays are energized with low inputs to the IN1, IN2, IN3 and IN4 inputs.

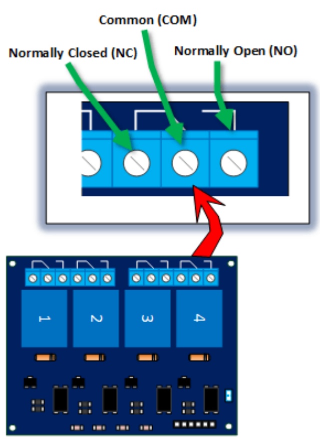


Fig 6(a) :Relay input pinout

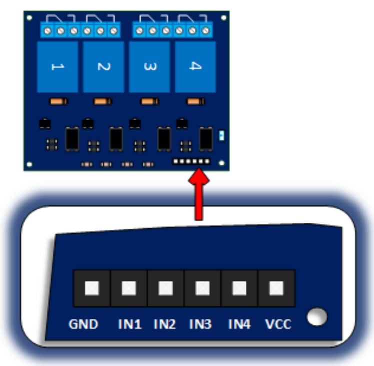


Fig 6(b): Relay output pinout

Soil Moisture Sensor: The Moisture sensor is used to measure the water content (moisture) of soil when the soil is having water shortage, the module output is at high level; else the output is at low level. This sensor reminds the user to water their plants and also monitors the moisture content of soil. It has been widely used in agriculture, land irrigation and botanical gardening. The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium. In soil, dielectric permittivity is a function of the water content. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil. The sensor averages the water content over the entire length of the sensor. There is a 2 cm zone of influence with respect to the flat surface of the sensor, but it has little or no sensitivity at the extreme edges. The Soil Moisture Sensor is used to measure the loss of moisture over time due to evaporation and plant uptake, evaluate optimum soil moisture contents for various species of plants, monitor soil moisture content to control irrigation in greenhouses and enhance bottle biology experiments.

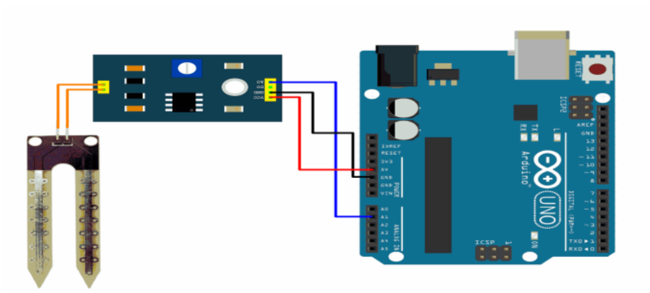


Fig 7 :*Soil moisture* connection to *Arduino*

RESULTS

The project particularly deals with the water content of the soil and whenever it goes below 45% automatic watering starts. Below is given the real time setup of the entire arrangement.

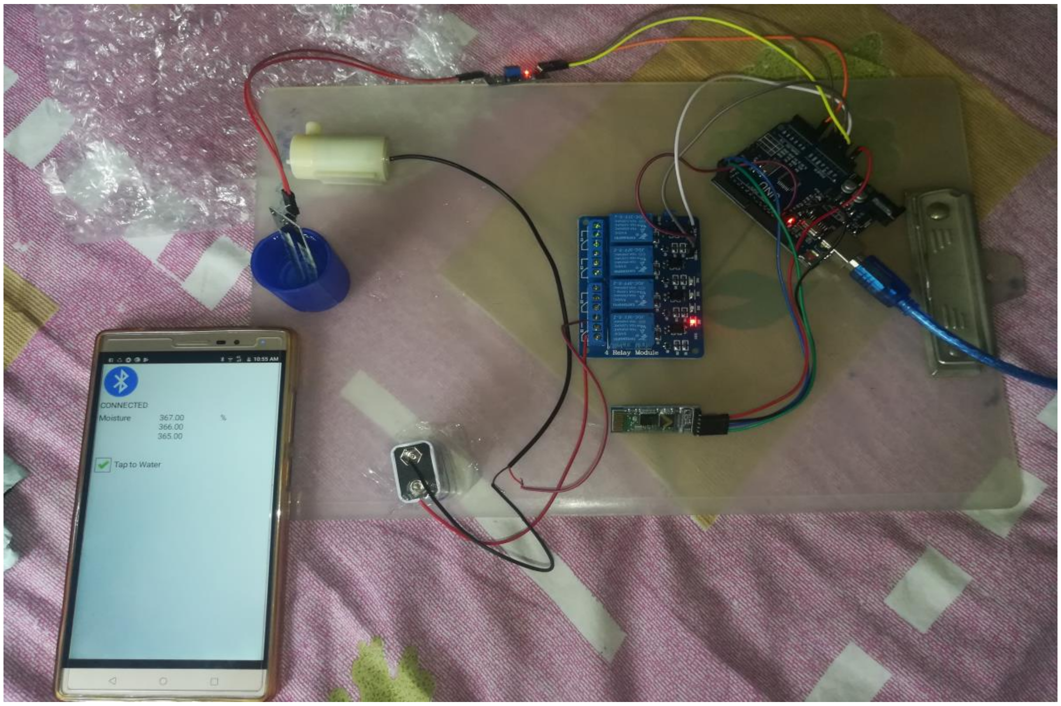


Fig. 8: Real time image of the project

3.1 Outcomes:

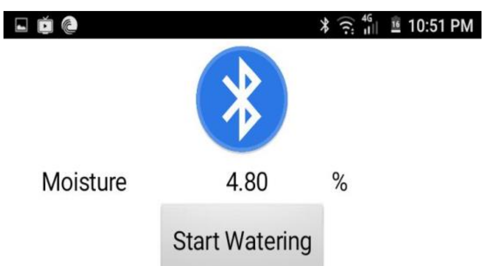


Fig 7(a): Dry Soil moisture content

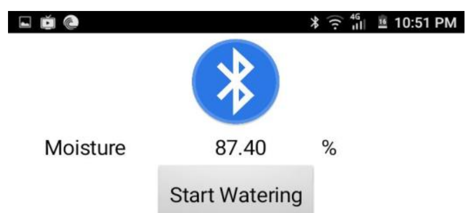


Fig 7(b): Wet Soil moisture content

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