FINAL YEAR PROJECT REPORT ON

IOT Based Solar Powered Smart Irrigation System

Project submitted to

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY

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CERTIFICATE

This is to certify that the project report of B.tech final year, entitled '**IOT Based Solar Powered Smart Irrigation System**' is being carried out by Sayan Tah (Roll - 16900316062), ADITYA BHATTACHARYA (Roll - 16900317021), SUVAM RAY (Roll - 16900316031), SUBHAJIT GHOSH (Roll - 16900316045) and SUBHADIP DUTTA (Roll - 16900316047) under my guidance and supervision. This satisfies the criteria of partial fulfillment of the BACHELOR OF TECHNOLOGY IN ELECTRONICS AND COMMUNICATION ENGINEERING at ACADEMY OF TECHNOLOGY, under Maulana Abul Kalam Azad University of Technology (MAKAUT).

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ABSTRACT

Solar energy is the most abundant source of energy in the world. Solar power is not only an answer to today's energy crisis but also an environment friendly form of energy. Photovoltaic generation is an efficient approach for using the solar energy. Solar panels (an array of photovoltaic cells) are nowadays extensively used for running street lights, for powering water heaters and to meet domestic loads. The cost of solar panels has been constantly decreasing which encourages its usage in various sectors. One of the applications of this technology is used in irrigation systems for farming. Solar powered irrigation system can be a suitable alternative for farmers in the present state of energy crisis in India. This is a green way for energy production which provides free energy once an initial investment is made. In this paper, we propose an automatic irrigation system using solar power which drives water pumps to pump water from bore well to a tank and the outlet valve of tank is automatically regulated using controller and moisture sensor to control the flow rate of water from the tank to the irrigation field which optimizes the use of water.

CHAPTER 1

INTRODUCTION

Solar energy is the most abundant source of energy in the world. Solar power is not only an answer to today's energy crisis but also an environmental friendly form of energy.

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One of the applications of this technology is used in irrigation systems for farming. Solar powered irrigation system can be a suitable alternative for farmers in the present state of energy crisis in India. This is a green way for energy production which provides free energy once an initial investment is made. In this project we propose an automatic irrigation system using solar power which drives water pumps to pump water from bore well to a tank and the outlet valve of tank is automatically regulated using controller and moisture sensor to control the flow rate of water from the tank to the irrigation field which optimizes the use of water.

The paper is divided into 5 sections discussing: -

1) Review of previous work.
2) Theoretical background
3) Design/simulation
4) Result and discussion or in other words performance review
5) Future work and conclusions.

In this IoT project we are going to Monitor Humidity and Temperature over the internet using ThingSpeak where we will show the current Humidity & Temperature data over the Internet using the ThingSpeak server. It is accomplished by the data communications between Arduino, DHT11 Sensor Module, ESP8266 WIFI module and LCD. Celsius scale thermometer and percentage scale humidity meter displays the ambient temperature and humidity through a LCD display and also sends it to ThingSpeak server for live monitoring from anywhere in the world.

CHAPTER 2

REVIEW OF PREVIOUS WORK

There has been some notable work on Smart Irrigation System. Here is some brief overview of those works: -

2.1 Smart farming: This setup has a new irrigation method – one that uses just as app: -

Farming – as we know it – may be one of the most difficult and stressful occupation in India.

Water scarcity, patchy water supply and dearth of labor have consistently led to poor yield, echoing a much larger crisis that continues year that continues year after year. The burden of loan on farmers further augments the cycle of hardship.

One of the biggest farming problems in India is irrigation. Farmer's generally use drip or sprinkler systems, which typically wastes water and can often over-irrigate crops, affecting the yield. To help farmers sustain themselves against the pervasive shortage of water and use existing sources efficiently, the Bangalore based startup introduced an ingenious method of irrigation – one that can be programmed and controlled using just an app.

Avanijal developed an automated system - termed 'Nikash' – that leverages IOT and wireless technology to control irrigation motors and valves in the field. The low cost system consists of a controller that is connected to an app, wireless sensor nodes that are embedded into the soil and repeaters that establish communication between the controller and the nodes.

Using the app, farmers can ensure that the field is irrigated on time and constantly monitor the condition of the field without physically being present there. Drip irrigation on the other hand, will require the farmers to directly monitor the supply, which includes switching the motor ON/OFF and opening/closing of the valves. With irrigation activities getting only a few hours' time, most of the work happens overnight.

With the help of Nikash, however, farmers can adopt 'Precision Irrigation' based on time, volume of water available and even soil moisture. The system has also been designs to take voltage functions into consideration, so that time and volume of water is automatically adjusted during the events of power outages. This means that when electricity is available, the controller – which is connected to the wireless sensor nodes in the ground – automatically switches ON the motor when it is scheduled by the farmer. It stops when one portion of the land gets stipulated amount of water, and then moves on to the next portion – as programmed on the app. At the end of the cycle, the irrigation wraps up for the day.

2.1 Set-up of IOT and app based farming

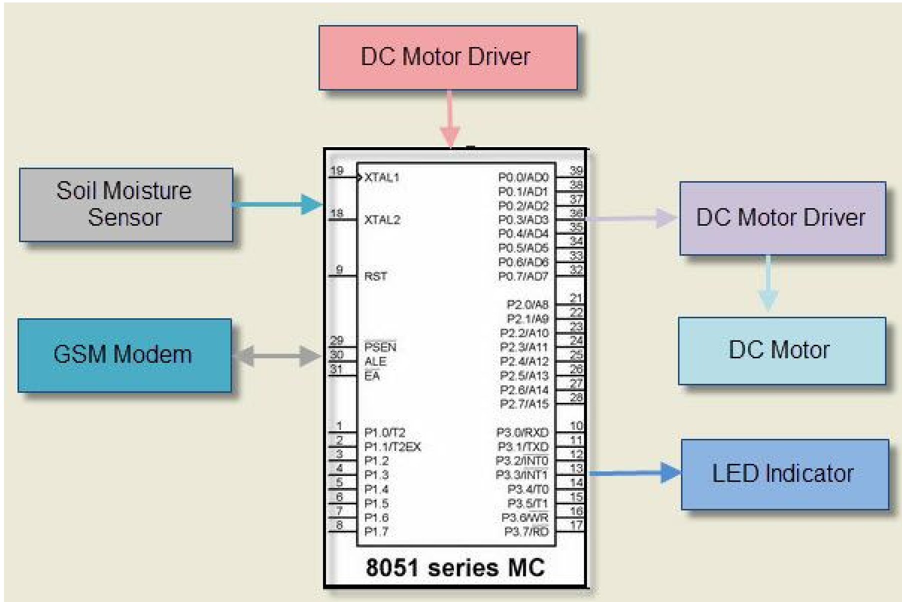
2.2 1. Automatic Irrigation System on Sensing Soil Moisture Content:

The automatic irrigation system on sensing soil moisture project is intended for the development of an irrigation system that switches submersible pumps on or off by using relays to perform this action on sensing the moisture content of the soil. The main advantage of using this irrigation system is to reduce human interference and ensure proper irrigation.

The Microcontroller acts as a major block of the entire project, and a power supply block is used for supplying power of 5V to the whole circuit with the help of a transformer, a bridge rectifier circuit and a voltage regulator. The 8051 microcontroller is programmed in such a way that it receives the input signal from the sensing material which consists of a comparator to know the varying conditions of the moisture in the soil. The OP-AMP which is used as comparator acts as an interface between the sensing material and the microcontroller for transferring the moisture conditions of the soil, viz. wetness, dryness, etc.

Once the microcontroller gets the data from the sensing material – it compares the data as programmed in a way, which generates output signals and activates the relays for operating the submersible pump. The sensing arrangement is done with the help of two stiff metallic rods that are inserted into the agricultural field at some distance. The required connections from these metallic rods are interfaced to the control unit for controlling the operations of the pump according to the soil moisture content.

This automatic irrigation system can be further enhanced by using advanced technology that consumes solar energy from solar panels.



2.2 Block Diagram of Soil Moisture Content Based Irrigation

3. GSM Based Automatic Irrigation System:

Nowadays farmers are struggling hard in the agricultural fields round the clock. They do their field work in the morning section and irrigate their land during night time with intermittent intervals. The task of irrigating fields is becoming quite difficult for the farmers due to lack of regularity in their work and negligence on their part because sometimes they switch on the motor and then forget to switch off, which may lead to wastage of water. Similarly, they even forget to switch on the irrigation system, which again leads to damage to the crops. To overcome this problem, we have implemented a new technique by using GSM technology, which is explained below.

The GSM Based automatic irrigation system is a project in which we get update status of the operation carried out in the agricultural fields via SMS with the help of a GSM modem. We can also add other systems such as LCD displays, web cam and other smart controlled devices. In this project, we are using LEDs for indication purpose. In this project, we are using soil moisture sensor which is used to sense the moisture level in the – to know whether it is dry or wet. The moisture sensor is interfaced with the microcontroller. The input data signals from the moisture sensor are sent to the microcontroller and based on that it activates the DC Motor and switches the motor on with the help of a motor driver. After the soil gets wet, the Motor gets switched off automatically. The status of the agricultural fields can be known from the indication of the Light Emitting Diode (LED) or through the message sent to the GSM modem placed at the field. Simultaneously it is possible to send messages through a mobile to kit through the GSM modem. Thus, the irrigation motor can be controlled by using a mobile and a GSM modem. These are the three irrigation systems that use different technologies, which are useful for the persons working hard in agricultural fields.

2.3 GSM Based Automatic Irrigation System

CHAPTER 3

THEORETICAL_BACKGROUND

According to the survey conducted by the Bureau of Electrical Energy in India in 2011, there are around 18 million agricultural pump sets and around 0.5 million new connections per year is installed with average capacity of 5HP. Total annual consumption in agricultural sector is 131.96 billion KWh (19% of total electricity consumption). As cited in paper solar powered smart irrigation technique is the future for the farmers and a solution for energy crisis. So for the proposed solar powered system, we are using in this is analyzed in this project and modified. Since PWM technique has been used for inverter operations for minimum harmonics as given in paper which further increases the efficiency of the system. The rating of the system was calculated corresponding to the pump specifications referring to this project.

In recent days, agriculture field farmers are facing many problems in watering their plants to keep their crops green in summer season. It's because they don't have correct idea about the availability of the power. Even if the power is available, they have to wait until the pitch is properly watered. Thus this process restricts them to stop doing other deeds. But, there is a solution, i.e., automatic solar submersible pump control panel for irrigation. In the trial of solar based plant irrigation using submersible pumps. These batteries produce power for the system operation. A submersible pump controller is used to pump water from a boor well to a storage water tank. Then, the water is drawn by a submersible pump at the slope's toe, where the installed sprinklers water the crops or plants.

3.1 WHAT is IOT?

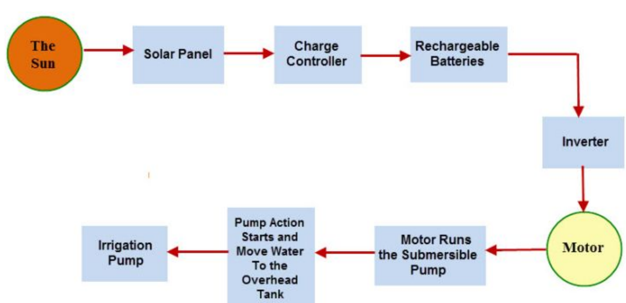
The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect and exchange data creating opportunities for more direct integration of the physical world into computer-based systems, resulting in efficiency improvements, economic benefits, and reduced human exertions.

A growing portion of IoT devices are created for consumer use, including connected vehicles, home automation/smart home, wearable technology, connected health, and appliances with remote monitoring capabilities. Costs of operation in all infrastructure related areas. Even areas such as waste management can benefit from automation and optimization that could be brought in by the IoT.

3.2 Working Principle:

In the figure, the power amplifier utilities are required to operate the system. As an extension to the system, this system uses solar panels to power the circuit. In agricultural field, the proper usage of automatic irrigation method is very vital due to some shortcomings of the real world like scarcity of land reservoir water and scarcity of rainfall. The water level (the ground water table) is getting reduced due to continuous extraction of water from the ground and thus gradually resulting in water scarcity in the agricultural zones slowly turning them into barren lands.

In the irrigation system, solar energy generated from the solar panels is used for operating the irrigation pump. The circuit comprises moisture sensors built by using OP-AMP IC. The OP-AMP is used as comparators. Two stiff copper wires are inserted into the soil to know whether soil is wet or dry. A charge controller circuit is used to charge the photovoltaic cells for supplying the solar energy to the whole circuit.



3.1 Block diagram of the System

A moisture sensor is used for sensing the soil condition – to know whether the soil is wet or dry, and the input signals are then sent to the microcontroller, which controls the whole circuit. When the soil condition is 'dry', the microcontroller sends commands to the relay driver and the motor gets switched on and supplies water to the field. And, if the soil gets wet, the motor gets switched off.

The signals that are sent from the sensors to the microcontroller through the output of the comparator operate under the control of a software program which is stored in the ROM of the microcontroller. The LCD displays the condition of the pump (on or off) interfaced to the microcontroller.

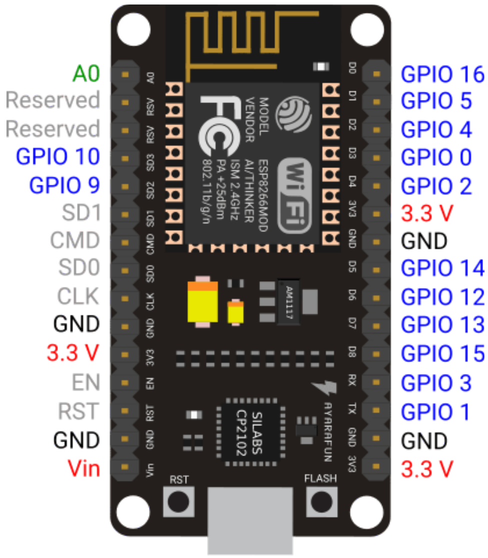
This automatic irrigation system can be further enhanced by using GSM technology to gain control over the switching operation of the motor.

3.3 DESCRIPTION OF HARDWARE COMPONENTS:

3.3.1 NODEMCU:

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware, it is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266 pin single row pin package. Convenient connection and special packages can be provided according to users need.

NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems began production of the ESP8266. The ESP8266 is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core widely used in IoT applications (see related projects). NodeMCU started on 13 Oct 2014, when Hong committed the first file of nodemcu-firmware to GitHub. Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9 Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform, and committed to NodeMCU project, then NodeMCU was able to support the MQTT IoT protocol, using Lua to access the MQTT broker. Another important update was made on 30 Jan 2015, when Devsaurus ported the u8glib to NodeMCU project enabling NodeMCU to easily drive LCD, Screen, OLED, even VGA displays.



3.2 pin diagram of Node MCU

3.3.2 RELAY MODULE

A relay is an electromagnetic switch. It is activated when a small current of some microampere is applied to it. Normally a relay is used in a circuit as a type of switch, an automatic switch. There are different types of relays and they operate at different voltages. When a circuit is built the voltage that will trigger it has to be considered. In this system, the relay circuit is used to turn the appliances ON/OFF. The high/low signal is supplied from the Node MCU. When a low voltage is given to the relay of an appliance it is turned off and when a high voltage is given it is turned on. The relay circuit to drive four appliances in the Home automation system is shown below. The number of appliances can be modified according to the user's requirements.

3.3 Relay module

3.3.3 ARDUINO UNO R3:

The Arduino Uno R3 is a microcontroller board based on a removable, dual-inline-package (DIP) ATmega328 AVR microcontroller. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs). Programs can be loaded on to it from the easy-to-use Arduino computer program. The Arduino has an extensive support community, which makes it a very easy way to get started working with embedded electronics. The R3 is the third, and latest, revision of the Arduino Uno.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to serial driver chip. Instead, it features an ATmega16U2 programmed as a USB-to-serial converter. This auxiliary microcontroller has its own USB bootloader, which allows advanced users to reprogram it.

3.4 Arduino Uno

3.3.4 Solar Panel:

The term solar panel is used colloquially for a photo-voltaic (PV) module. A PV module is an assembly of photo-voltaic cells mounted in a frame work for installation. Photo-voltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV Panel, and a system of Panels an Array. Arrays of a photovoltaic system supply solar electricity to electrical equipment. The most common application of solar energy collection outside agriculture is solar water heating systems.

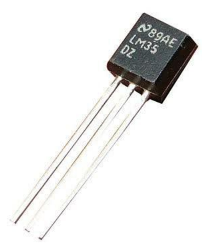
Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. Most modules use wafer-based crystalline silicon cells or thin-film cells. The structural (load carrying) member of a module can be either the top layer or the back layer. Cells must be protected from mechanical damage and moisture. Most modules are rigid, but semi-flexible ones based on thin-film cells are also available. The cells are connected electrically in series, one to another to a desired voltage, and then in parallel to increase amperage. The wattage of the module is the mathematical product of the voltage and the ampere rating of the module. A PV junction box is attached to the back of the solar panel and functions as its output interface. External connections for most photovoltaic modules use MC4 connectors to facilitate easy weatherproof connections to the rest of the system. A USB power interface can also be used. Module electrical connections are made in series to achieve a desired output voltage or in parallel to provide a desired current capability (ampere rating) of the solar panel or the PV system. The conducting wires that take the current off the modules are sized according to the capacity and may contain silver, copper or other non-magnetic conductive transition metals. Bypass diodes may be incorporated or used externally, in case of partial module shading, to maximize the output of module sections still illuminated. Some special solar PV modules include concentrators in which light is focused by lenses or mirrors onto smaller cells. This enables the use of cells with a high cost per unit area (such as gallium arsenide) in a cost-effective way. Solar panels also use metal frames consisting of racking components, brackets, reflector shapes, and troughs to better support the panel structure.

3.5 Solar panel

3.3.5 Temperature Sensor:

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes. There are many different types of temperature sensors. Some temperature sensors require direct contact with the physical object that is being monitored (contact temperature sensors), while others indirectly measure the temperature of an object (non-contact temperature sensors).

Non-contact temperature sensors are usually infrared (IR) sensors. They remotely detect the IR energy emitted by an object and send a signal to a calibrated electronic circuit that determines the object's temperature.



3.6 Temperature Sensor

3.3.6 Humidity Sensor:

A humidity sensor (or Hygrometer) sense, measures and reports both moisture and air temperature. The ratio of moisture in the air to the highest amount of moisture at a particular atmospheric temperature is called relative humidity. Relative humidity becomes important factor when looking for comfort.

Humidity sensors work by detecting changes that alter electrical currents and temperature in the air.

There are three basic types of humidity sensors: -

- Capacitive
- Resistive
- Thermal

3.7 Humidity Sensor

3.3.7 Moisture Sensor:

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners. Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential; these sensors are usually referred to as soil water potential sensors and include tensiometers and gypsum blocks.

3.8 Moisture Sensor

3.4 Description of Software components:

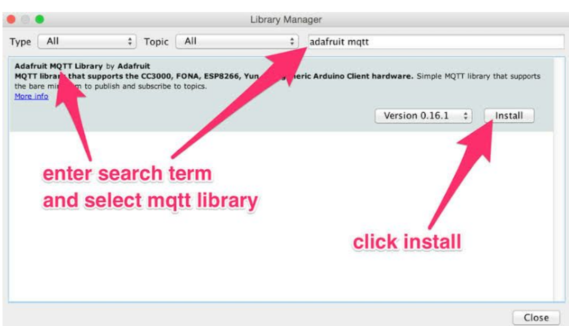
3.4.1 Arduino IDE:

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux). It is written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, syntax highlighting It also provides simple one-click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus. The source code for the IDE is released under the GNU General Public License, version 2.

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

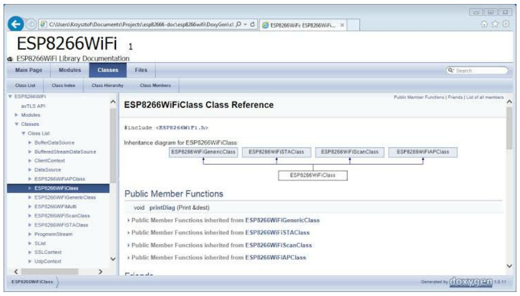
LIBRARY USED IN ARDUINO IDE

❖ **Adafruit MQTT Library:** MQTT, or message queue telemetry transport, is a protocol for device communication that Adafruit IO supports. Using a MQTT library or client you can publish and subscribe to a feed to send and receive feed data.



3.9 Adafruit MQTT Library

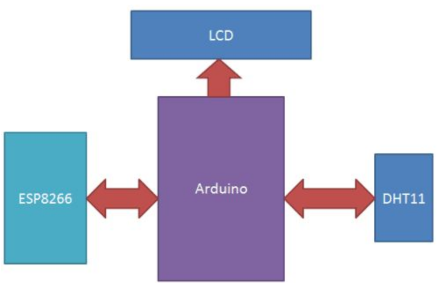
❖ **ESP8266 Wifi Library:** ESP8266WiFi library has been developed basing on ESP8266 SDK, using naming convention and overall functionality philosophy of the Arduino Wifi Shield library. Over time the wealth Wi-Fi features ported from ESP8266 SDK to this library outgrew the APIs of Wifi Shield library and it became apparent that we need to provide separate documentation on what is new and extra.



3.10 ESP8266 Wifi Library

3.4.2 ThingSpeak Setup:

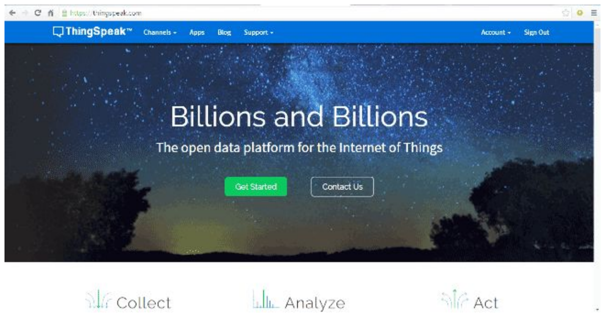
This IoT based project having four sections, firstly Humidity and Temperature Sensor DHT11 senses the Humidity and Temperature Data. Secondly Arduino Uno extracts the DHT11 sensor's data as suitable number in percentage and Celsius scale, and sends it to Wi-Fi Module. Thirdly Wi-Fi Module ESP8266 sends the data to ThingSpeak's Sever. And finally ThingSpeak analyses the data and shows it in a Graph form. Optional LCD is also used to display the Temperature and Humidity.



3.11 Arduino LCD ESP2866 and DHT11 interfacing

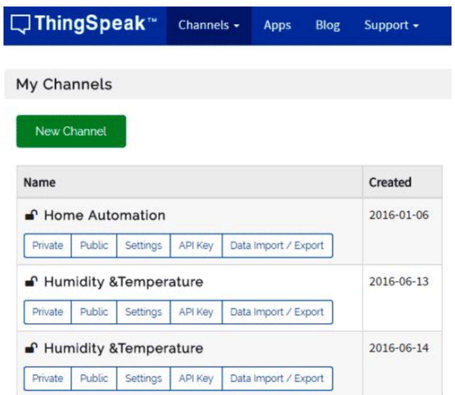
ThingSpeak provides very good tool for IoT based projects for Arduino. By using ThingSpeak site, we can monitor our data over the Internet from anywhere, and we can also control our system over the Internet, using the Channels and webpages provided by ThingSpeak. ThingSpeak 'Collects' the data from the sensors, 'Analyze and visualize' the data and 'Acts' by triggering a reaction. Here we are explaining about How to send Data to ThingSpeak server by using ESP8266 WIFI Module:

- First of all, user needs to create an Account on ThingSpeak.com, then Sign In and click on Get Started.



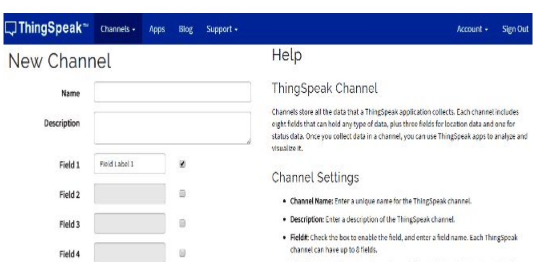
3.12 Starting ThingSpeak

- Now go to the ‘Channels’ menu and click on New Channel option on the same page for further process.



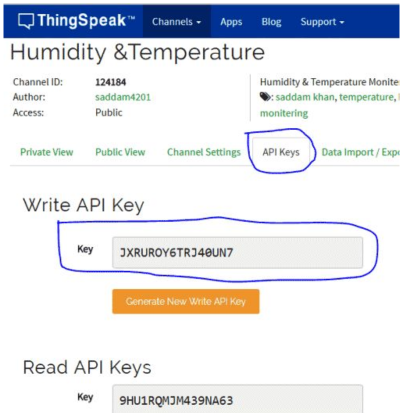
3.13 New Channel

- Now you will see a form for creating the channel, fill in the Name and Description as per your choice. Then fill ‘Humidity’ and ‘Temperature’ in Field 1 and Field 2 labels, tick the checkboxes for both Fields. Also tick the check box for ‘Make Public’ option below in the form and finally Save the Channel. Now your new channel has been created.



3.14 Creating the channel

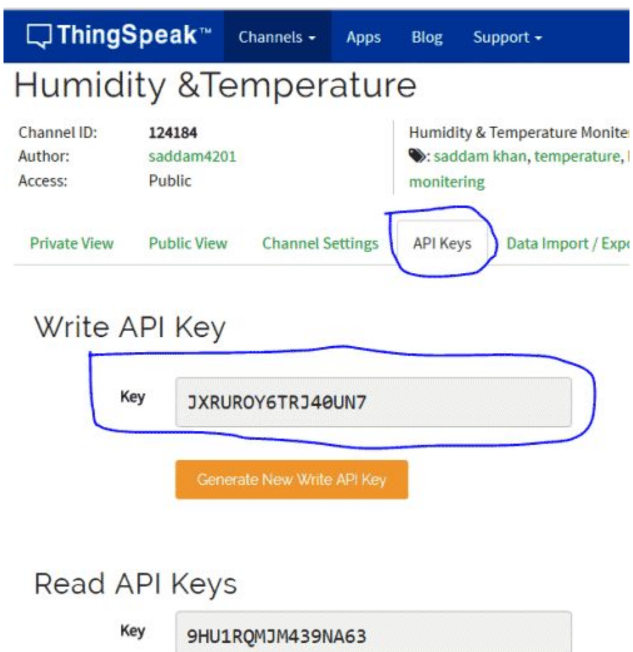
- Now click on ‘API keys’ tab and save the Write and Read API keys, here we are only using Write key. You need to Copy this key in char *api_key in the Code.



3.15 Saving the code

- After it, click on 'Data Import/Export' and copy the Update Channel Feed GET Request URL, which is:

https://api.thingspeak.com/update?api_key=SIWOYBX26OXQ1WMS&field1=0



3.16 input data

- Now user need to open "api.thingspeak.com" using the httpGet function with the postUrl as "update?api_key=SIWOYBX26OXQ1WMS&field1=0" and then send data using data feed or update request address.

Before sending the data, user needs to edit this query string or postUrl with temperature and humidity data fields, like shown below. Here we have added both parameters in the string that we need to send via using GET request to server, after it we have used httpGet to send the data to server.

Working of this project is based on single wire serial communication for fetching data from DHT11. First Arduino sends a start signal to DHT module and then DHT gives a response signal with containing data. Arduino collects and extracts the data in two parts first is humidity and second is temperature and then send it to 16x2 LCD and ThingSpeak server. ThingSpeak displays the Data in form of Graph as below:

3.17 Output

CHAPTER 4

DESIGN AND SIMULATION

4.1 DESIGN OF SMART IRRIGATION SYSTEM

The system design consists of two main categories:

I. Hardware Design: In our model, we are demonstrating watering of only one pot, so a single moisture sensor and temperature sensor is used. Depending on the number of pots, the number of moisture sensor and temperature sensor to be interfaced with the board will vary. When the soil moisture sensor is interfaced with the board , the sensor reports values of resistances of the soil in which it is immersed into. As soil moisture sensor is analog, an inbuilt ADC in Arduino is used to convert into its digital form (0-1023), which represents resistance. Dry soil will have the maximum resistance and wet soil will have least resistance. Similarly, The temperature sensor (RTD) reports values of temperature in terms of resistance. If the temperature of the soil is high, then the sensor reports high value of resistance and vice versa. The servo motor is programmed to rotate from 0 to 180 degree. It is a 3.3V motor and does not require any driver. The rotating platform is attached on the motor to provide a base for the movement of the pipe. If the soil is dry, temperature sensor and moisture sensor values will be high, so the pump is turned on using a relay and switched off when the values reach a threshold. The vice versa is applicable for moist soil.

II. Software Design: The software used in our project is Arduino. It provides a number of libraries to make programming simple. In our prototype, the controller AtMega328 is programmed in Arduino. The program in Arduino designates a preset range of resistance value in digital format (ranging from 0 to 1023) for both the moisture and the temperature sensor. Any aberration from the set range switches on/off the pump, to water the plants.

CIRCUIT DESIGN AND CONNECTIONS

The **circuit connections** are made in the following steps which are as follows:

STEP-I: Pin A0 of nodeMCU is connected to **Pin A0** of soil moisture sensor module.

STEP-II: Pin D3 of nodeMCU is connected to **Signal pin (2)** of DHT11 sensor.

STEP-III: Pin D0 of nodeMCU is connected to **Signal pin(1)** of Relay Module.

STEP-IV: GND pin of nodeMCU is connected to **GND pin** of soil moisture sensor module.

STEP-V: VCC pin of nodeMCU is connected to **VCC pin** of soil moisture sensor module.

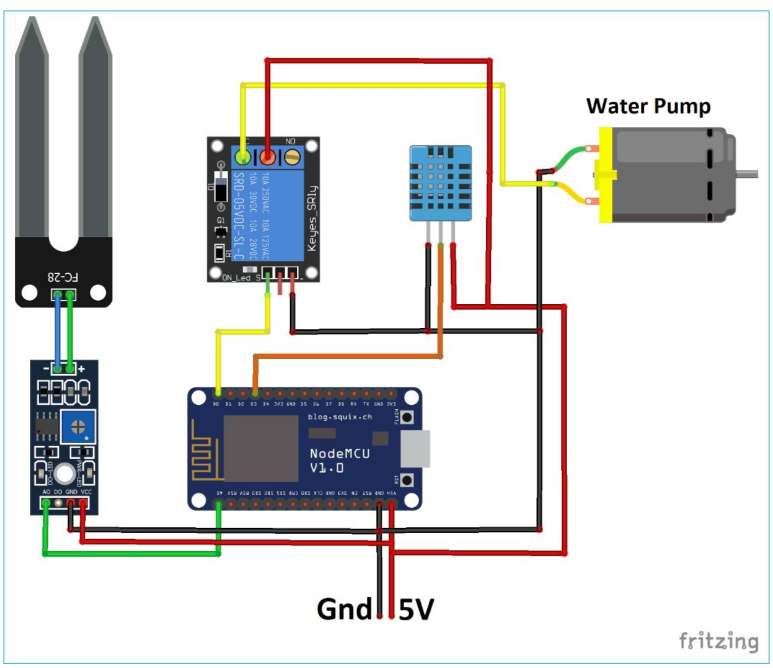


Fig 4.1: Circuit diagram of Smart Irrigation System

4.2 WORKING OF SMART IRRIGATION SYSTEM USING IOT

In the agriculture field, sensors are used like soil moisture. The information received from the sensors is sent to the Database folder through the Android device. In the control section, the system is activated using the application, this is finished using the ON/OFF buttons in the application. Also, this system is automatically activated when the soil moisture is low, the pump is switched ON based on the moisture content.

The application has a feature like taking some time from the user and water the agriculture field when the time comes. In this system, there is a switch used to turn off the water supply if the system fails. Other parameters such as the moisture sensor demonstrate the threshold price and the level of water in the soil.

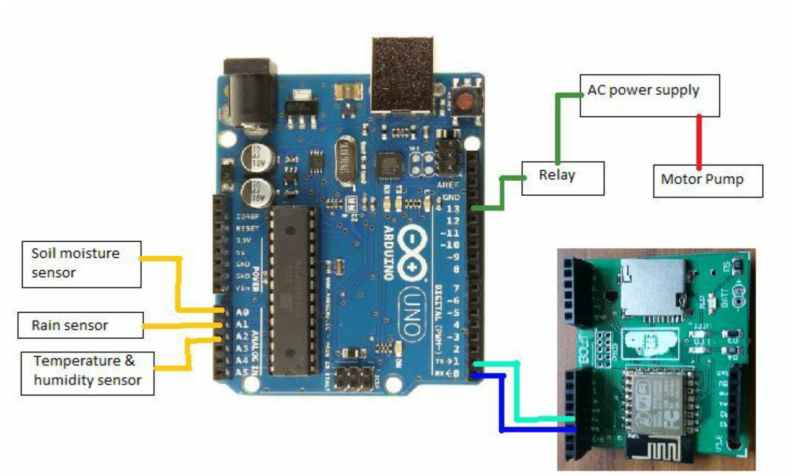


Fig. 4.2 : Smart Irrigation System using IoT

Further, this project can be enhanced by designing this system for large acres of soil. Also, this project can be incorporated to make sure the value of the soil and the expansion of harvest in each soil. The microcontroller and sensors are successfully interfaced and wireless communication is attained between a variety of nodes.

Also, further this proposed system can be enhanced by adding up machine learning algorithms, which are capable to study and recognize the necessities of the crop, this would aid the agriculture field to be an automatic system. The inspections and outcomes tell us that this result can be executed for a lessening of water loss and decrease the manpower necessary for a field.

From the above information, finally, we can conclude that the hardware components of this system interfaces with all the sensors. The system is powered by a power source, and the system has been checked for watering an agriculture field.

4.3 IMPLEMENTATION OF SMART IRRIGATION SYSTEM USING IOT

In India, agriculture in villages plays an essential role in developing the country. Basically, agriculture depends on the monsoons which have not enough water source. To overcome this problem, the **irrigation system** is employed in the field of agriculture. In this system, based on the soil type, the water will be provided to the agricultural field. In agriculture, there are two things, namely, the moisture content of the soil as well as the fertility of the soil. At the present time, there are several types of techniques available for irrigation to reduce the need for rain. This type of technique is driven by on/off schedule using electrical power. This article discusses the implementation of a smart irrigation system using IoT

The Model works as follows:

The results of the moisture, temperature and threshold level can be calculated through the sensors used in the project. Analysis of soil parameters can be done and the needed nutrients can be calculated for the soil. The need of water supply of the soil can be calculated and hence appropriate irrigation is done through smart techniques.

Featured experimental result and analysis

System configuration:

This module is used to configure all hardware devices. Soil moisture sensor, Temperature and Humidity sensor, Pump all are connected to major component arduino with Bluetooth connectivity.

Soil moisture and temperature sensing:

In this module we analyze the moisture content in the soil and it's temperature. According to the sensor values further decision are taken.

Send the results on Arduino serial monitor:

Once the values of temperature and moisture are generated on serial monitor. The threshold can also be notified on serial monitor itself. And if result of Moisture, Temperature and Humidity goes below the threshold value the pump will automatically turn ON and if the level of Moisture, Temperature and Humidity increase upto threshold level of field then pump will automatically turn OFF.

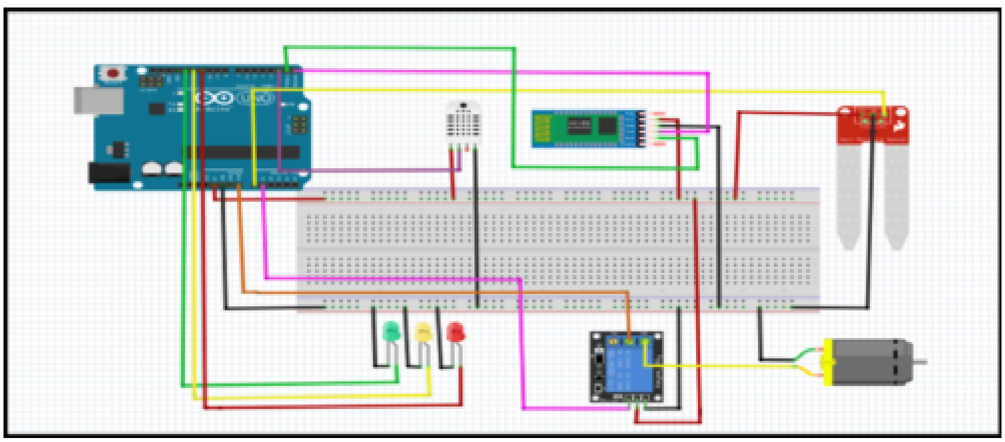


Fig 4.3 : Schematic diagram of Smart Irrigation System using IOT

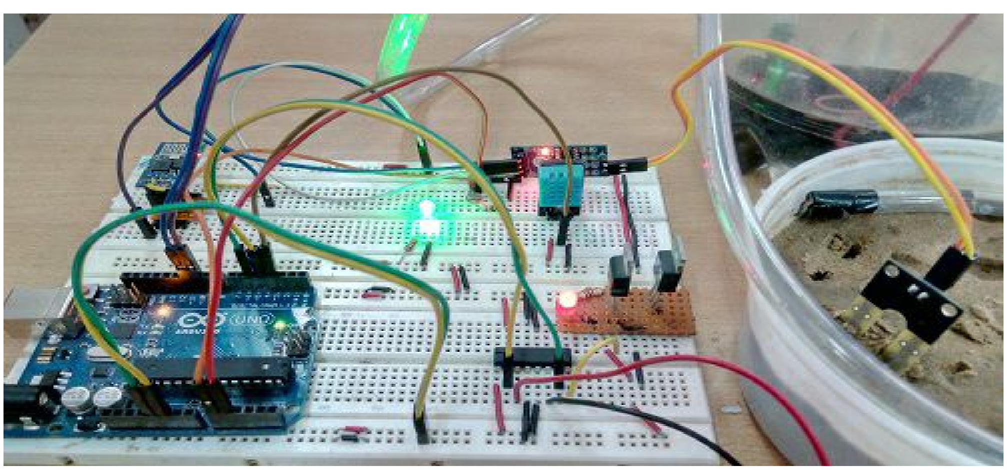


Fig 4.4 : Complete Simulation of Smart Irrigation System using IOT

SIMULATION OF SMART IRRIGATION SYSTEM

**Due to some unavoidable circumstances we are not been able to work with the hardware part of this project. Although we have studied about it and have done some software work i.e. the coding part which we will give in the appendix part. But we have done a small part of the hardware using an online simulator named “TINKERCAD”. So, we have designed a virtual circuit on behalf of it. But we have used Arduino Uno Board, instead of ESP8266 wifi module nodeMCU, as the module was not available at “TINKERCAD”. Also, our project was solar powered, but due to unavoidable circumstances, its high cost and problems of setting it, we are unable to purchase solar panels. So, as a substitute for testing, we have used 12V-2A power supply.

4.4 TINKERCAD

Tinkercad is a free, online 3D modeling program that runs in a web browser, known for its simplicity and ease of use. Since it became available in 2011 it has become a popular platform for creating models for 3D printing as well as an entry-level introduction to constructive solid geometry in schools.

Tinkercad uses a simplified constructive solid geometry method of constructing models. A design is made up of primitive shapes that are either "solid" or "hole". Combining solids and holes together, new shapes can be created, which in turn can be assigned the property of solid or hole. In addition to the standard library of primitive shapes, a user can create custom shape generators using a built-in JavaScript editor.

Shapes can be imported in three formats: STL and OBJ for 3D, and 2-dimensional SVG shapes for extruding into 3D shapes. Tinkercad exports models in STL or OBJ formats, ready for 3D printing.

Tinkercad also includes a feature to export 3D models to Minecraft Java Edition, and also offers the ability to design structures using Lego bricks.

APPENDIX

4.5 Working with the code (Appendix Part of this work):

Step 1: First of all, we start with including necessary library.

```
#include <DHT.h>

#include <ESP8266WiFi.h>
```

Step 2: Since we are using the ThingSpeak Server, the API Key is necessary in order to communicate with server.

```
String apiKey = "X5AQ445IKMBYW31H

const char* server = "api.thingspeak.com";
```

Step 3: The next Step is to write the Wi-Fi credentials such as SSID and Password.

```
const char *ssid =  "CircuitDigest";

const char *pass =  "xxxxxxxxxxx";
```

Step 4: Define the DHT Sensor Pin where the DHT is connected and Choose the DHT type.

```
#define DHTPIN D3

DHT dht(DHTPIN, DHT11);
```

Step 5: The moisture sensor output is connected to Pin A0 of ESP8266 NodeMCU. And the motor pin is connected to D0 of NodeMCU.

```
const int moisturePin = A0;

const int motorPin = D0;
```

Step 6: We will be using *millis()* function to send the data after every defined interval of time here it is 10 seconds. The *delay()* is avoided since it stops the program for a defined delay where microcontroller cannot do other tasks. Learn more about the [difference between delay() and millis() here]().

```
unsigned long interval = 10000;

unsigned long previousMillis = 0;
```

Step 7: Set motor pin as output, and turn off the motor initially. Start the DHT11 sensor reading.

```
pinMode(motorPin, OUTPUT);

digitalWrite(motorPin, LOW); // keep motor off initally

dht.begin();
```

Step 8: Try to connect Wi-Fi with given SSID and Password and wait for the Wi-Fi to be connected and if connected then go to next steps.

```
WiFi.begin(ssid, pass);

  while (WiFi.status() != WL_CONNECTED)

  {

    delay(500);

    Serial.print(".");

  }

  Serial.println("");

  Serial.println("WiFi connected");

}
```

Step 9: Define the current time of starting the program and save it in a variable to compare it with the elapsed time.

```
unsigned long currentMillis = millis();
```

Step 10: Read temperature and humidity data and save them into variables.

```
float h = dht.readHumidity();

float t = dht.readTemperature();
```

Step 11: If DHT is connected and the ESP8266 NodeMCU is able to read the readings then proceed to next step or return from here to check again.

```
if (isnan(h) || isnan(t))

  {

    Serial.println("Failed to read from DHT sensor!");

    return;

  }
```

Step 12: Read the moisture reading from sensor and print the reading.

```
moisturePercentage = ( 100.00 - ( (analogRead(moisturePin) / 1023.00) * 100.00 ) );

  Serial.print("Soil Moisture is  = ");

  Serial.print(moisturePercentage);

  Serial.println("%");
```

Step 13: If the moisture reading is in between the required soil moisture range, then keep the pump off or if it goes beyond the required moisture then turn the pump ON.

```
if (moisturePercentage < 50) {

    digitalWrite(motorPin, HIGH);

  }

   if (moisturePercentage > 50 && moisturePercentage < 55) {

    digitalWrite(motorPin, HIGH);

  }
```

```
 if (moisturePercentage > 56) {

   digitalWrite(motorPin, LOW);

  }
```

Step 14: Now after every 10 seconds call the *sendThingspeak()* function to **send the moisture, temperature and humidity data to ThingSpeak server.**

```
  if ((unsigned long)(currentMillis - previousMillis) >= interval) {

    sendThingspeak();

    previousMillis = millis();

    client.stop();

  }
```

Step 15: In the *sendThingspeak()* function we check if the system is connected to server and if yes then we prepare a string where moisture, temperature, humidity reading is written and this string will be sent to ThingSpeak server along with API key and server address.

```
if (client.connect(server, 80))

    {

      String postStr = apiKey;

      postStr += "&field1=";

      postStr += String(moisturePercentage);

      postStr += "&field2=";

      postStr += String(t);

      postStr += "&field3=";

      postStr += String(h);

      postStr += "\r\n\r\n";
```

Step 16: Finally the **data is sent to ThingSpeak server** using *client.print()* function which contains API key, server address and the string which is prepared in previous step.

```
client.print("POST /update HTTP/1.1\n");

      client.print("Host: api.thingspeak.com\n");

      client.print("Connection: close\n");

      client.print("X-THINGSPEAKAPIKEY: " + apiKey + "\n");

      client.print("Content-Type: application/x-www-form-urlencoded\n");

      client.print("Content-Length: ");

      client.print(postStr.length());

      client.print("\n\n");

      client.print(postStr);

        Serial.print("Moisture Percentage: ");

    Serial.print(moisturePercentage);

    Serial.print("%. Temperature: ");

    Serial.print(t);

    Serial.print(" C, Humidity: ");

    Serial.print(h);

    Serial.println("%. Sent to Thingspeak.");

  }

}
```

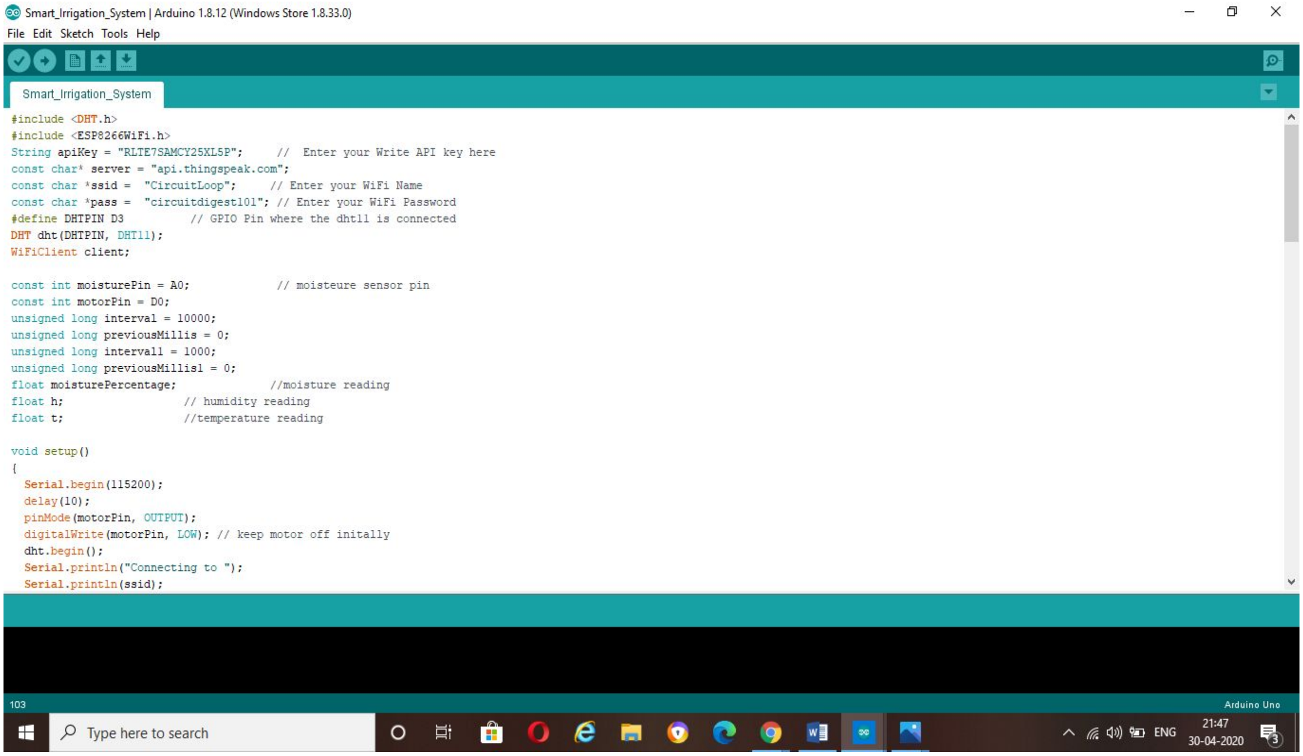


Fig 4.5 : Including library function and describing the pins in Arduino

4.6 SIMULATION IN TINKERCAD

When the motor turns ON, the green LED light glowse, indicating that water is required by the plants as the soil sensed by the soil moisture is dry. This will happen automatically.

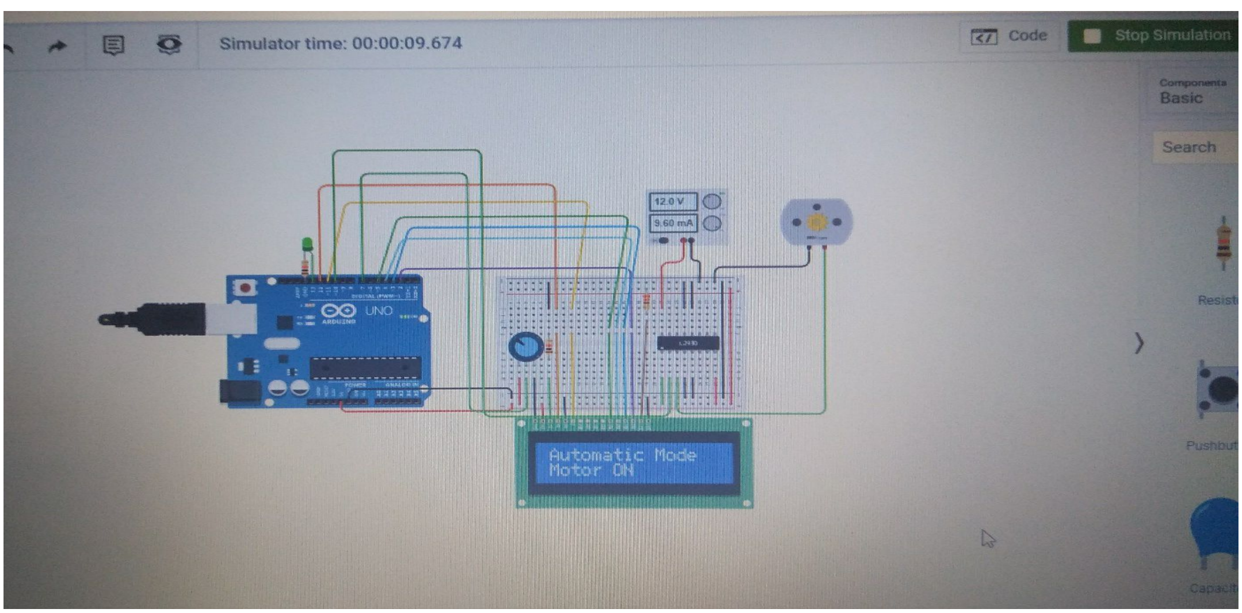


Fig 4.6 : When the motor is ON, the green LED glows

When the motor turns OFF, the green LED light stops glowing, indicating that enough water is already present in the soil, sensed by the soil moisture sensor, and hence water pumped from motor should immediately stop.

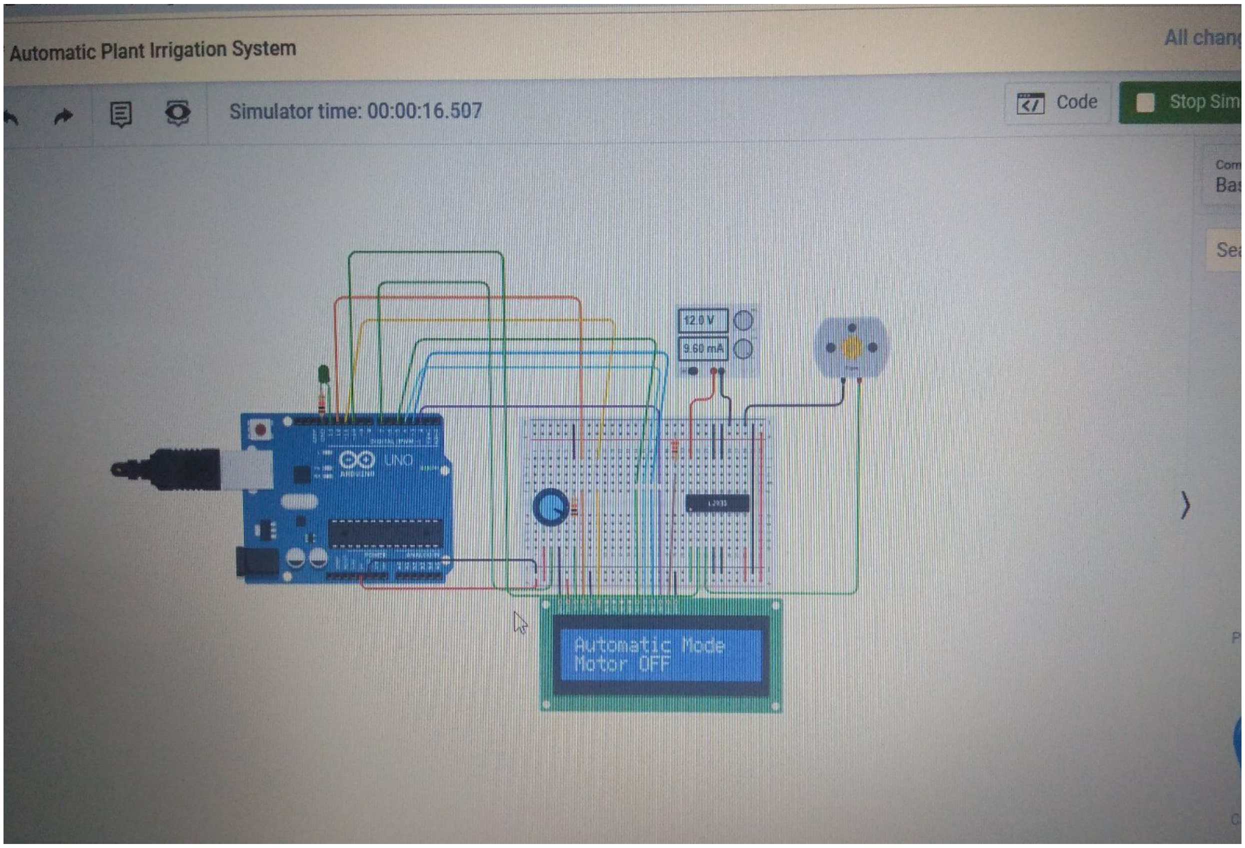


Fig 4.7 : When the motor is OFF, the green LED stops glowing

CHAPTER 5

RESULTS AND DISCUSSION

After finishing with the coding part, this is how our data looks on ThingSpeak Dashboard.

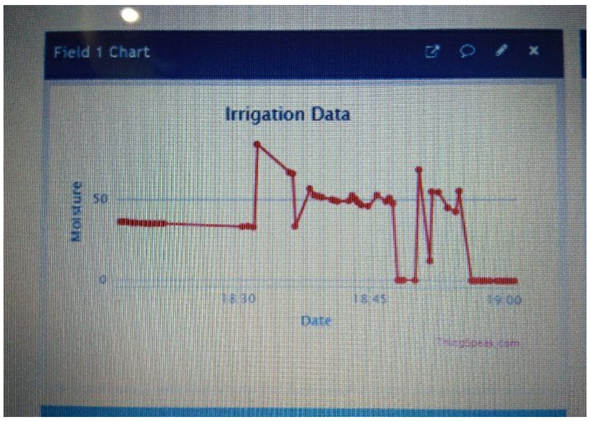


Fig 5.1 : Irrigation data for Moisture

Fig 5.2 : Irrigation Data for temperature

Fig 5.3 : Irrigation data for humidity

After checking the irrigation data on ThingSpeak dashboard, we get the following readings and results based on the data.

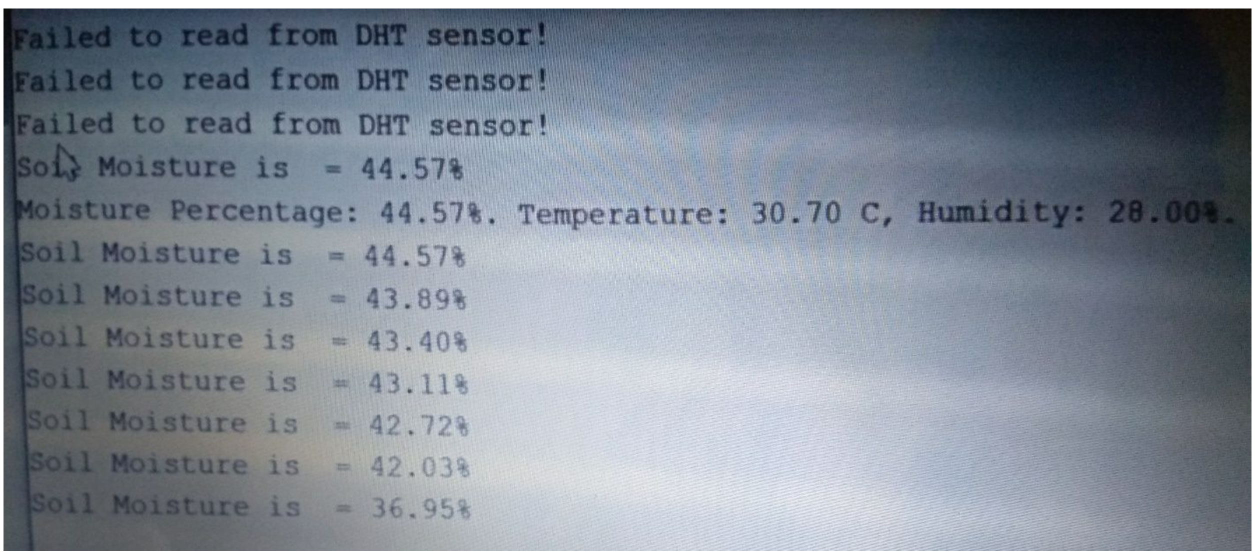


Fig 5.4 : Results we get based on the irrigation data.

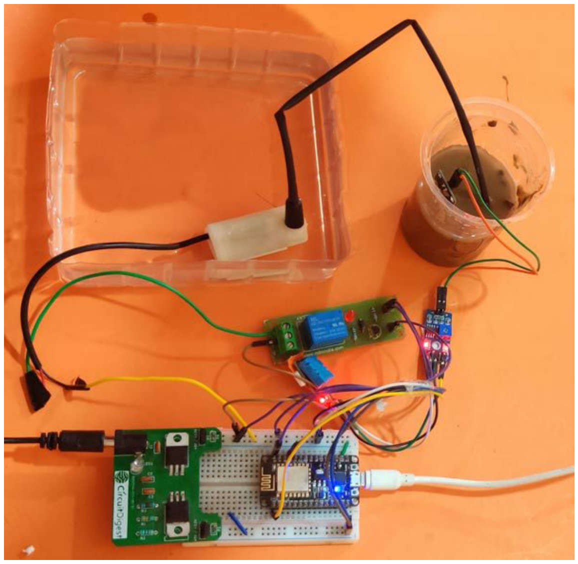


Fig 5.5 : Final working of Smart Irrigation System

DISCUSSION

The report presented here is based on the project work carried by us. This project is an implementation of IOT based Solar powered Smart Irrigation System. But since our hardware part is incomplete due to unavoidable circumstances and there is currently no solar panels with us, so we have used power supply which is of 12V-2A. We have done the hardware part virtually on Tinkercad simulator and got the output accordingly. The system works properly and sensed the soil moisture, rain and the control unit act accordingly to sensed data and control the water pump. Although the hardware part is left incomplete due to unavoidable circumstances, we will try to finish it as soon as the lockdown is over. The software part of the project is complete. However, there may be some minute errors in the output which we need to check (if any).

CHAPTER-6

FUTURE WORK AND CONCLUSION

Future Scope for Smart Irrigation

We can interface LCD screen in order to display the current status of the soil moisture content levels, percentage of water utilized to water the plant, duration of time for which the water pump is ON, etc. We can also show the graphical representation of the moisture content levels in the soil. To improve the efficiency and effectiveness of the system, the following recommendations can be put into consideration. Option of controlling the water pump can be given to the farmer. The farmer may choose to stop the growth of crops or the crops may get damaged due to adverse weather conditions. In such cases farmer may need to stop the system remotely.The idea of using IOT for irrigation can be extended further to other activities in farming such as cattle management, fire detection and climate control. This would minimize human intervention in farming activities.

The automated irrigation system implemented was found to be feasible and cost effective for optimizing water resources for agri-culture production. This irrigation system allows cultivation in places with water scarcity thereby improving sustainability. The irrigation system helps the farmer by making his work smarter. As the demand for water increases, along with the need to protect aquatic habitats, water conservation practices for irrigation need to be effective and affordable. As multiple sensors are used water can be provided only to the required area of land. This system reduces the water consumption to greater extent. It needs minimal maintenance. The power consumption has been reduced very much. The crop productivity increases and the wast-age of crops are very much reduced. The extension work is to make user interface much simpler by just using SMS messages for notifications and to operate the switches. In future more sensors will be implemented for controlling the water pump and for collection of different climatic condition data for analysing and improving the farming.

CONCLUSION

By implementing the proposed system there are various benefits for the government and the farmers. For the government a solution for energy crisis is proposed. By using the automatic irrigation system, it optimizes the usage of water by reducing wastage and reduce the human intervention for farmers.The excess energy produced using solar panels can also be given to the grid with small modifications in the system circuit, which can be a source of the revenue of the farmer, thus encouraging farming in India and same time giving a solution for energy crisis. Proposed system is easy to implement and environment friendly solution for irrigating fields. The system was found to be successful when implemented for bore holes as they pump over the whole day.Solar pumps also offer clean solutions with no danger of borehole contamination. The system requires minimal maintenance and attention as they are self starting. To further enhance the daily pumping rates tracking arrays can be implemented. This system demonstrates the feasibility and application of using solar PV to provide energy for the pumping requirements for sprinkler irrigation. Even though there is a high capital investment required for this system to be implemented, the overall benefits are high and in long run this system is economical.

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