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Design and Implementation of an IOT Based Greenhouse Monitoring and Controlling System with Renewable Energy system

By
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BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

Department of Electrical and Electronic Engineering

INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

DECEMBER 2020

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A project
submitted as partial fulfillment of the requirement for the degree of

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

Department of Electrical and Electronic Engineering

INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

DECEMBER 2020

CERTIFICATE OF APPROVAL

The project entitled as “**Design and Implementation of an IOT Based Greenhouse Monitoring and Controlling System with Renewable energy system”** submitted by **Mohammad Minhaj Uddin Murad**, bearing Matric ID: **ET 161025** and **Mohammad Abdul Mazid**, bearing Matric ID: **ET 161029** of session **Autumn 2019**, to the Department of Electrical and Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of Science in Engineering and approved for the examination held on**, December 2020.**

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DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this thesis/project has been submitted elsewhere for the award of any degree or diploma.

MURAD

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A. Mazid

Mohammed Abdul Mazid

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Authors

ABSTRACT

Internet of Things (IOT) based greenhouse monitoring and controlling system has been developed with renewable energy system. This project is designed and implemented to provide required environment inside a greenhouse for small plants like Tomatoes and Strawberries. Microcontroller is used for programming purposes. IOT is implemented to monitor and control temperature, humidity and soil moisture required for Tomatoes and Strawberries remotely by website. The storage system has been arranged to be charged through a renewable energy system and found the system well. The renewable energy system will produce power that is free from pollution and will provide a clean nature for growing Tomatoes and Strawberries. The system can build an atmosphere all year round to collect unseasonal crops like tomatoes & strawberries and the system can be regulated from anywhere in the world by IOT. This greenhouse system will be managed and monitored to provide a helping hand for those regions where crops such as strawberries and tomatoes are not easily grown. The renewable energy sources will be easily implemented and independent of the national electricity grid and traditional gas heating systems.

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LIST OF ABBREVIATIONS

IC	Integrated Circuit
LCD	Liquid Crystal Display
DHT-11	Digital Temperature and Humidity Sensor - 11
DC	Direct Current
ICSP	In Circuit Serial Programming
IDE	Integrated Development Environment
IOT	Internet of Things
GDP	Gross domestic product
PWM	Pulse Width Modulation
I/O	Input/output
Tx, Rx	Transmit and Receive
r.p.m	Revolutions per minute
LED	Light-Emitting Diode
PV	Photovoltaic

CHAPTER 01

INTRODUCTION

1.1 Introduction

A greenhouse is a frame composed of walls and a translucent roof intended to sustain balanced climatic conditions. These structures are used to grow trees, fruits, and vegetables that require a certain amount of sunshine, temperature, humidity, and soil humidity. The growing demand for the production and quality of crops has greatly expanded the use of high-quality greenhouses. The increased needs of the population for significant quantities of crop production [1]. In the greenhouse, we can grow crops that need certain unique environmental conditions. The renewable energy system will help the people of those area where power from electric grid is not available and people of those area can get proper power supply without any polluted substances through renewable energy system. The hydro and the solar power supply are two of them. The energy supply of hydroponic greenhouses focused on renewable energy system sources, independent of the national electricity grid and traditional gas heating systems. The project presents the key elements of the hydroponic greenhouse, the technical methodology, the renewable energy system-based solution for electrical and heating systems, and also the management framework for such applications. Operating the greenhouse is the function of the management system. The Greenhouse Atmosphere Monitoring and Controlling Project, focused on IOT and Arduino, is planned to sustain these conditions in the greenhouse. The IOT-based greenhouse monitoring and control system was developed to provide small plants with a good environment inside a greenhouse. Heater, cooling fan and pump motor is used to adjust the environment inside greenhouse. Micro controller is used for programming purpose. The IOT is applied remotely via the website to track and regulate temperature, humidity and soil moisture. Hardware-based infrastructure has been developed and the technology functions well. There is a continuing growth in demand for technologies for food processing. Agricultural methods can meet the need for food production. But attributable to climatic isotropic conditions. This eventually impacts the production of plants. There are several other concerns associated with it as well. Overcoming this crisis. The supply of water includes pests and pathogens, and extremes of drought, humidity, light and temperature, and irrigation. Greenhouses shield seeds from too much heat or cold, protect plants from storms of dust and help keep pests out. Regulation of light and temperature helps greenhouses to become ideal sites for plant production. An show of plant cultivation under controlled conditions. For growing herbs, vegetables and fruits, greenhouses are also sometimes used. Greenhouses shield seeds from too much heat or cold, protect plants from storms of dust and help keep pests out. Regulation of light and temperature helps greenhouses to become ideal sites for plant production. The show of plant cultivation under controlled conditions. For growing herbs, vegetables and fruits, greenhouses are also sometimes used. Greenhouse-based horticulture is mainly concerned with the optimum control of the greenhouse ecosystem in order to conform with economic and environmental criteria. A greenhouse is an unusually built building of a homestead structure to provide a more controllable atmosphere for improved harvest generation, crop protection, seeding and transplanting of products. This project outlines the creation and installation of a Greenhouse Climate Tracking wireless sensor network.

1.2 Motivation

The main motivation of this project is to grow plenty of crops for our country and far beyond our country. Many countries of the world are highly depended on agriculture. And it is mandatory to keep pace with some features like temperature, soil moisture, humidity etc. for those agricultural country to grow crops. But for many reasons these features are not always in a suitable level for crops growing. As many places of the world are out of electricity as there is not sufficient production or for other cases. Especially where growing plants and crops are not so easy and where there is not enough power supply, there we can produce more crops by the help of sustainable energy system. Our main motivation is to grow a suitable weather where these crops (tomatoes and strawberries) can grow with better quality. It saves our time and reduces labor cost. Through IOT based system the working procedure of this project can be monitored and controlled easily by entering the web address.

1.3 Objectives

The key targets of the Greenhouse System are:

- Plan a greenhouse of natural energy where there is no electricity grid.
- Focus on temperature, humidity and soil moisture management to improve the productivity of the production of tomatoes and strawberries and reduce the environmental effects on the production of plants.
- Track the ambient conditions within the greenhouse on the website and use the IOT-based device to monitor the greenhouse from distant locations.

1.4 Project Overview

The remaining part of this venture is structured as follows:

Chapter 2 represents the **greenhouse system & component**

Chapter 3 represents the **renewable energy**

Chapter 4 represents the **literature review**

Chapter 5 represents the **methodology**

Chapter 6 represents the **implementation and results**

Chapter 7 represents the **cost analysis**

CHAPTER 02

AN OVERVIEW OF GREENHOUSE SYSTEM COMPONENTS

2.1 Introduction

In the world there are many countries depended on agriculture. There's an agrarian economy in Bangladesh. Agribusiness is the single largest supply sector of the economy as it constitutes over 30 percent of the GDP of the nation and uses over 60 percent of the labor force. Tomatoes and Strawberry are the two important crops of many countries. But these products cannot be found all the years around for different climate condition. But for huge demand of these two crops it is necessary to make a module that will create a weather in which we can produce these products all the years around. To date, many countries have adopted traditional methods of agricultural systems, while developing countries use automated systems to monitor their agricultural economy to produce more goods than before using the same land and conditions, Although moderate weather conditions often encourage us to grow numerous plants at different seasons, it does not enable us to increase crop production without hindering the control and monitoring of the Greenhouse system by natural destructionist-based crops has become a common module to make this impossible to occur. Besides that, there is not enough supply of electricity in our country as most rural areas are not getting enough supply from grid. So the power supply from hydro and solar power source will add a helping hand to the people of those area to implement green house for agriculture without the supply from grid.

The temperature sensor detects the temperature of the ambient atmosphere and controls the temperature on a constant basis. If the temperature inside the greenhouse reaches the cap set for temperature control, a fan will be automatically turned on as a coolant to reduce the temperature. The fan is immediately turned off until it reaches the target temperature. We also monitor the fan speed according to temperature fluctuations using the Pulse Width Modulation (PWM) technique. But a radiator will be turned on to set the temperature within the optimal range if the temperature decreases below the optimum temperature. Soil moisture is tracked continuously by the soil sensor. Moisture indicator for soil moisture monitoring.

2.2 Hardware specifications

- Arduino Nano
- LCD
- Relays
- Power Supply Unit
- Wi-Fi Module
- Humidity Sensor
- Moisture Sensor
- Heater
- Cooling Fan
- Water Pump
- Hydro power supply system
- Solar power supply system

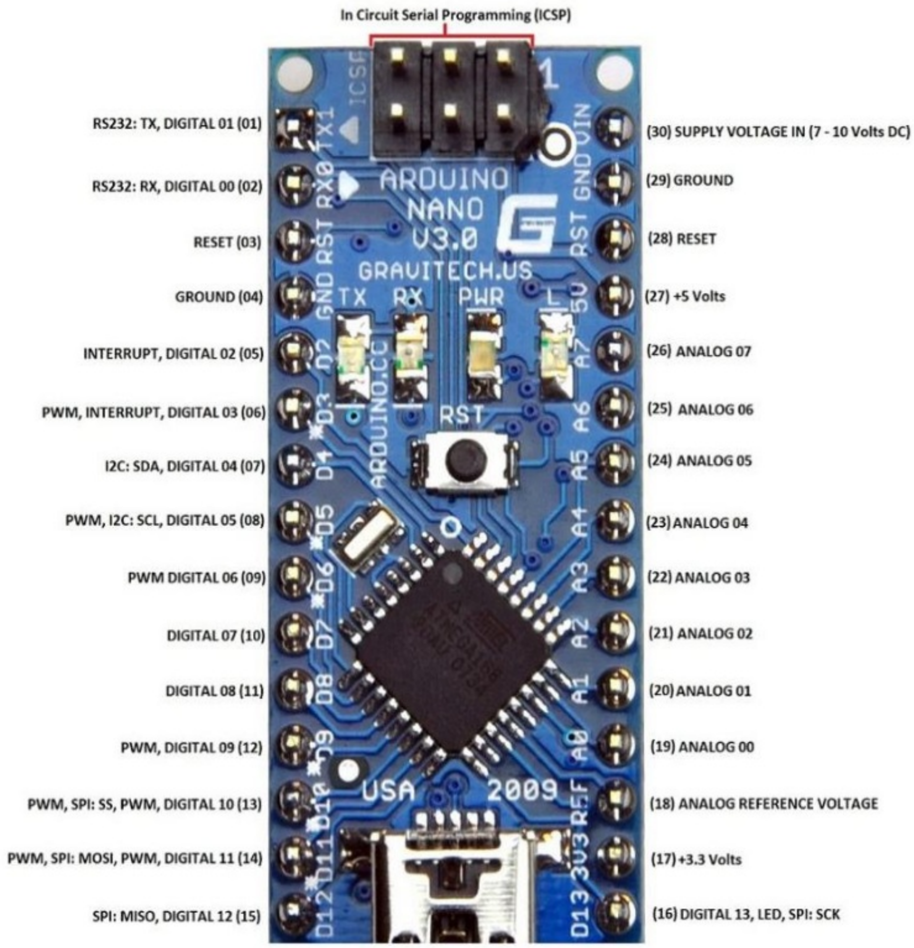
2.3 Arduino Nano

The Arduino Nano, based on the ATmega328 (Arduino Nano 3.x) or ATmega1688, is a lightweight, full, and breadboard-friendly board (Arduino Nano 2.x). It has the same features as the Arduino Duemilanove, more or less, but in a separate box. It just lacks a DC power port, which operates instead of a normal one with a Mini-B USB cable. Through a Mini-B USB link, 6-20V uncontrolled external power supply (pin 30) or 5V operated external power supply, the Arduino Nano can be driven (pin 27). The highest voltage source is immediately chosen from the power source. It is also possible to configure the Arduino Nano with Arduino IDE software. Pin 13 is also led by the Nano. The same software is obviously used for the Arduino Nano. But the user may try different programs which are provided in Arduino software's built-in examples. Make sure that we have chosen the right board and port under the tools menu before exporting the software to Nano.

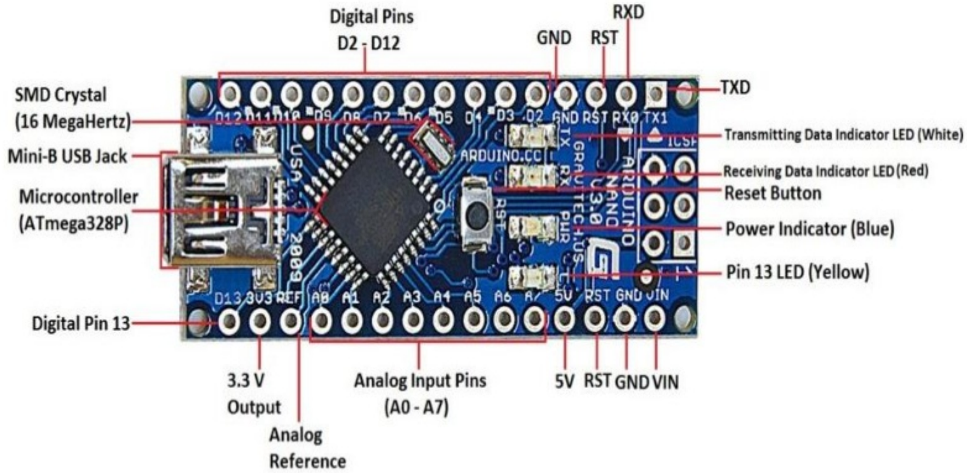
```
void setup() {

PinMode(13, OUTPUT);// initialize digital pin 13 as an output.
}
Voidloop()// the loop function runs over and over again forever {
```

```
DigitalWrite (13, HIGH);   // turn the LED on (HIGH is the voltage level)
Delay(1000);               // wait for a second
DigitalWrite(13, LOW);     // turn the LED off by making the voltage LOW
Delay(1000);               // wait for a second
}
```



Arduino Nano V3 pin Description
Fig. 2.1: Arduino Nano IC. [2]



Arduino Nano V3.0 Pinout

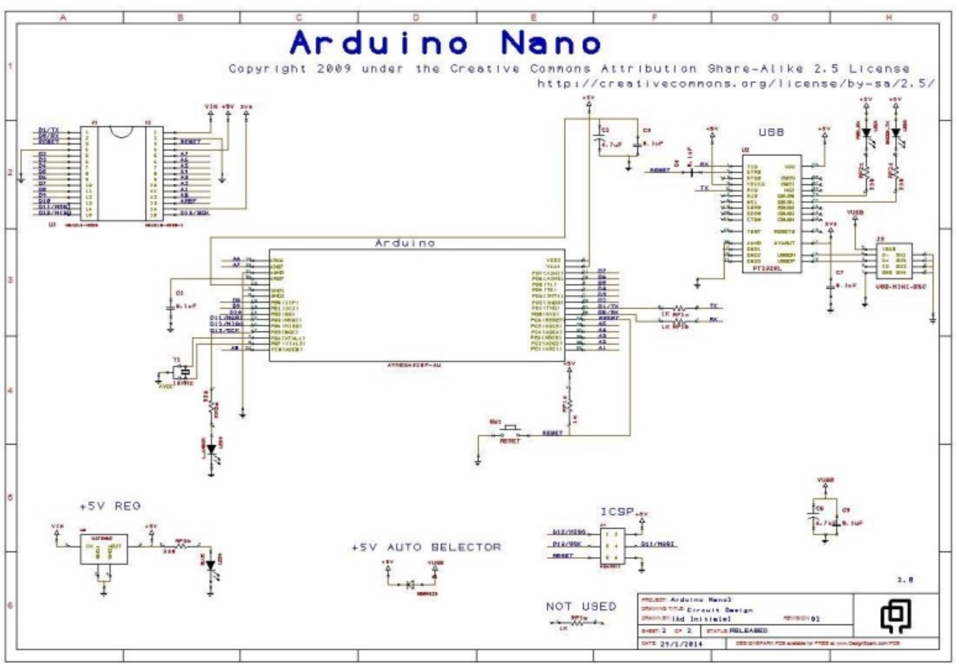


Fig. 2.2: Block Diagram of Arduino Nano [3,4]

2.3.1 Pin descriptions of Arduino Nano

Digital Pins

Pins - 1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, and 16

Arduino Nano has 14 digital I/O pins, as stated previously, that can be used either as digital input or output. The pins run at a limit of 5V voltage, i.e. the digital high is 5V and the digital low is 0V. A current of 20mA can be given or obtained by each screw, and has a pull-up resistance of about 20-50k ohms. Using pinMode(), digitalWrite(), and digitalRead() keys, any of the 14 digital pins on the Nano pinout can be used as input or output.

The digital pins have some extra features as well, rather than the digital input and output controls [2].

Serial Communication Pins

Pins - 1, 2

1 - RX and 2 - TX

These two RX-receive and TX-transmit pins are used for the communication of TTL serial data. The RX and TX pins are connected to the corresponding USB-to-TTL Serial chip pins [1].

PWM Pins

Pins - 6, 8, 9, 12, 13, and 14

Each of these digital pins supplies an 8-bit resolution Pulse Width Modulation signal. You will produce the PWM signal with the analogWrite() function [2].

External Interrupts

Pins - 5, 6

If we need to supply another processor or controller with an external interrupt, we will use these pins. These pins can be used to allow INT0 and INT1 interrupts, respectively, by using the Interrupt () connect function. These pins may be used to cause three types of interrupts, such as a low value interrupt, a dropping or rising edge interrupt, and a value interrupt update [2].

SPI Pins

Pins - 13, 14, 15 and 16

You can use these Serial Peripheral Interface pins when you do not want the data to be transmitted asynchronously. Synchronous communication with SCK as the synchronizing clock is supported by these pins. Even though the hardware has this functionality, by default, the Arduino program does not have it. So, to use this feature, you have to include a library called the SPI library [2].

LED

Pin - 16

If you remember your first Arduino code, the LED flashing, then you're definitely going to come across this Pin16. The blinking LED on the board is connected to pin 16 [2].

Arduino Nano Analog Pins

Pins - 18, 19, 20, 21, 22, 23, 24, 25, and 26

UNO has 6 analog input pins as stated earlier, but Arduino Nano has 8 analog inputs (19 to 26), marked A0 through A7. This implies that for processing, you can connect *8 channel analog sensor inputs. Each of these analog pins has an inbuilt 1024-bit resolution ADC (so it will give 1024 values). By default, from ground to 5V, the pins are measured. If you want the reference voltage to be 0V to 3.3V, we can use the analog Reference() function to give 3.3V to the AREF pin (18th Pin). Similar to Nano digital pins, analog pins also have some other functions [2].

I2C

Pins 23, 24 as A4 and A5

Since SPI communication also has its drawbacks, such as 4 essential pins and within a device, it is limited. We use the I2C protocol for long distance communication. I2C with only two wires supports multi master and multi slave. One for the clock (SCL) and one for details (SDA). We need to import a library named Wire Library to use this I2C functionality[2].

AREF

Pin 18

As already mentioned, the AREF- Analog Reference Pin is used for the ADC conversion as a reference voltage for the analog input [2].

Reset

Pin 28

In Arduino, reset pins are active LOW pins, meaning that if we make this pin value LOW, i.e. 0v, the controller will be reset. Typically used as a reset button to be attached to switches. [2].

ICSP

ICSP stands for In Circuit Serial Programming, and is one of the Arduino board programming methods available. An Arduino bootloader software is usually used to program an Arduino module, but ICSP can be used instead if the bootloader is disabled or disabled. ICSP can be used to repair a boot loader that is missing or disabled.

Typically, each ICSP pin is cross-connected to another Arduino pin with the same feature or name. For eg, MISO is connected to MISO / digital pin 12 (Pin 15) on the Nano's ICSP header; MOSI is connected to MOSI / digital pin 11 (Pin 16) on the ISCP header; and so on. The rest of the SPI gui is made up of Note, MISO, MOSI, and SCK pins.

Using this ICSP, we will use one Arduino to program another Arduino [2].

Arduino as ISP	**ATMega328**
Vcc/5V	Vcc
GND	GND
MOSI/D11	D11
MISO/D12	D12
SCK/D13	D13
D10	Reset

RESET

Pins 3, 28 and 5 in ICSP [2].

Power

Pins 4, 17, 27, 28, 30 and 2 & 6 in ICSP [2].

The regarding tables are given below:

Table-2.1: Technical Specification of Arduino Nano.

Microcontroller	Atmel ATmega168 or ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	8
DC Current per I/O Pin	40 Ma
Operating Temperature	40 to 85(°C)
Flash Memory	16 KB(ATmega168) or 32 KB(ATmega328)
SRAM	1 KB(ATmega168) or 2 KB(ATmega328)
EEPROM	512 bytes(ATmega168) or 1 KB(ATmega328)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	18 mm
Width	45 mm
Weight	18 g
CPU Type	8-Bit AVR
Performance	20MIPS at 20 MHz
Maximum operating Frequency	20MHz

Table-2.2: Pin description of Arduino Nano

Pin no	**Pin Name**	**Type**	**Function**
1	D1/TX	I/O	Digital I/O Pin Serial TX Pin
2	D0/RX	I/O	Digital I/O Pin Serial RX Pin
3	RESET	Input	Reset (Active Low)
4	GND	Power	Supply Ground
5	D2	I/O	Digital I/O Pin

Pin no	Pin Name	Type	Function
6	D3	I/O	Digital I/O Pin
7	D4	I/O	Digital I/O Pin
8	D5	I/O	Digital I/O Pin
9	D6	I/O	Digital I/O Pin
10	D7	I/O	Digital I/O Pin
11	D8	I/O	Digital I/O Pin
12	D9	I/O	Digital I/O Pin
13	D10	I/O	Digital I/O Pin
14	D11	I/O	Digital I/O Pin
15	D12	I/O	Digital I/O Pin
16	D13	I/O	Digital I/O Pin
17	3V3	Output	+3.3V Output (from FTDI)
18	AREF	Input	ADC reference
19	A0	Input	Analog Input Channel 0
20	A1	Input	Analog Input Channel 1
21	A2	Input	Analog Input Channel 2
22	A3	Input	Analog Input Channel 3
23	A4	Input	Analog Input Channel 4
24	A5	Input	Analog Input Channel 5
25	A6	Input	Analog Input Channel 6
26	A7	Input	Analog Input Channel 7
27	+5V	Output or Input	+5V Output (From On-board Regulator) or +5V (Input from External Power Supply
28	RESET	Input	Reset (Active Low)
29	GND	Power	Supply Ground
30	VIN	Power	Supply voltage

Table-2.3: Description of ICSP Pins

ICSP Pin Name	Type	Function
MISO	Input or Output	Master In Slave Out
VCC	Output	Supply Voltage
SCK	Output	Clock from Master to Slave
MOSI	Output or Input	Master Out Slave In
RST	Input	Reset (Active Low)
GND	Power	Supply Ground

2.4 LCD Display

An LCD (Liquid Crystal Display) panel is an electronic display module and a vast range of applications can be found. A 16x2 LCD monitor is the simplest module and is very commonly used in numerous applications and circuits. Over these units, seven segments and other multi-segment LEDs are preferred. The factors are: inexpensive LCDs; conveniently programmable; not limited to viewing special and even personalized characters (as opposed to seven segments), animations, etc. A 16x2 LCD means it is possible to display 16 characters per line and there are 2 such lines. Each character is displayed on this LCD in a matrix of 5x7 pixels. For this LCD, there are two registers, respectively Command and Data. The command register stores the directions with the command issued to the LCD [7]. A command is an instruction to execute a predefined procedure on the LCD, such as initializing it, clearing the screen, setting the cursor position, manipulating the monitor, etc. The data log records the information on the LCD to be viewed. The ASCII value of the character to be displayed on the LCD is the data. Tap here to learn more about the LCD's internal structure [5].

2.4.1 Pin Diagram & Pin Description

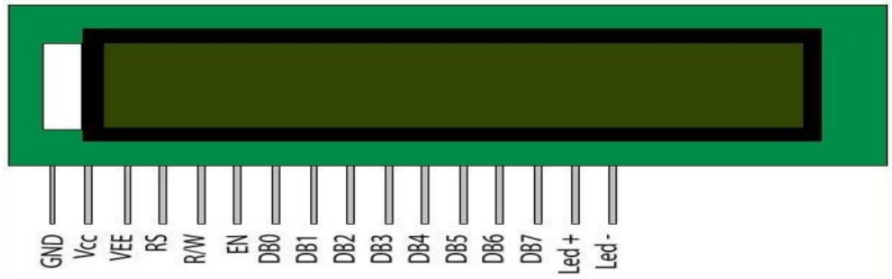


Fig. 2.3: Pin Diagram of LCD Display [5]

Table 2.4: Pin Description of LCD Display

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7

2.5 Relay

A relay is an electrically powered switch. To operate a switch mechanically, often relays use an electromagnet, while other operating principles are also used, such as solid-state relays. Relays are used where a low-power signal is required to control a circuit (with complete electrical isolation between control and controlled circuits) or when several circuits have to be controlled by one signal. The first relays were used as amplifiers in the long-distance telegraph circuits: the signal from one circuit came in repeatedly and was relayed to another circuit. Relays were commonly used in telephone exchanges and early computers to perform logical operations. A contactor is considered a type of relay that can handle the high power required for an electric motor or other loads to be closely operated. Solid-state relays track power circuits with no moving parts instead of using a semiconductor chip to perform switching. In current electrical control systems, relays with calibrated operating features and sometimes many operating coils are used to shield electrical circuits from overload or faults, these functions are performed by digital instruments still known as 'protective relays.'

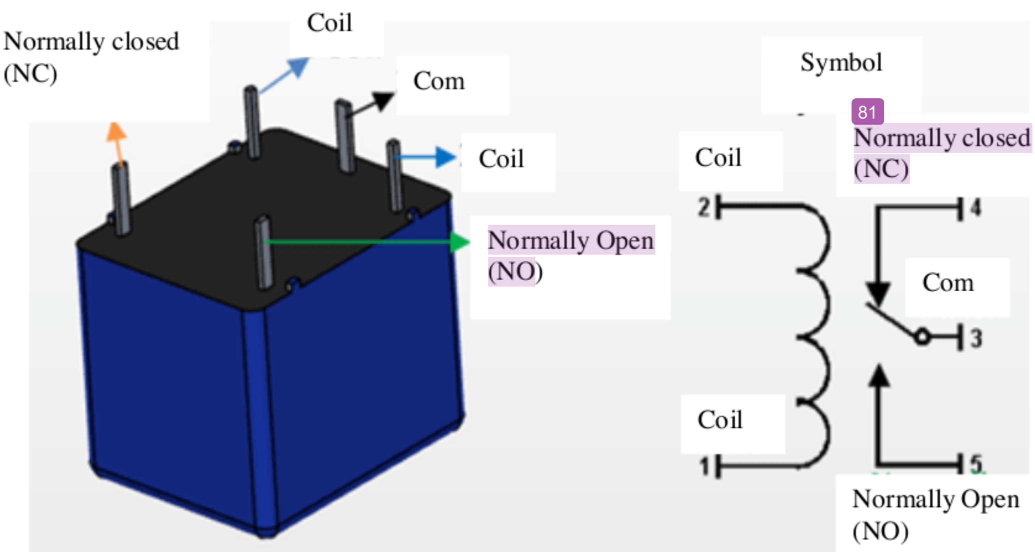


Fig. 2.4: Relay [6]

2.6 Power Supply Unit

The 12V DC, which comes from a 12V battery, is the power supply unit that was used in this project.

2.7 Wi-Fi Module

ESP8266 Wi-fi Module | ESP8266 ESP01 | ESP 01ESP8266 esp01 is a low-cost Wi-Fi chip manufactured by the Chinese manufacturer Espressif Systems, based in Shanghai, with complete TCP/IP stack and therefore MCU (micro-controller unit) capabilities. With the ESP 01 row, the chip first came to Western manufacturers' attention in August 2014 (ESP 01). AI-Thinker is, thus, a third party supplier. So, this tiny module helps microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at the time, there was almost no English-language documentation of the chip and the commands it accepted. So, very low costs and the fact that the module had very few external parts, which meant that it could theoretically be very inexpensive [7].

Fig.2.5: Wi-Fi Module [7]

2.8 DHT-11 Temperature and Humidity Sensor

The DHT11 temperature & humidity sensor highlights a temperature & stickiness sensor complex with a balanced optical signal input. By the use of the limited computerized sign securing system and temperature & dampness sensing advancement, it guarantees high efficiency and excellent long-term stability. This sensor integrates a resistive-sort moisture estimation section and a portion of NTC temperature estimation and a high-execution 8-bit microcontroller, providing fabulous efficiency, fast reaction, hostile to obstruction capacity and adequacy of expense. In the laboratory, each part of DHT11 will be fully balanced, which will be to a large extent accurate for dampness adjustment. In the OTP memory, the change coefficients are set as projects that are used by the system to discern the sensor's inner symbol. The single-wire serial interface allows device reconciliation simple and convenient.

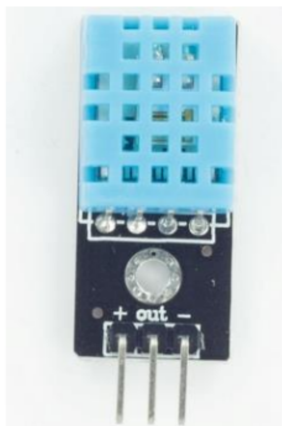


Fig. 2.6: DHT11 Temperature and Humidity Sensor [8].

Its small scale, low power consumption and up to 20 meters of signal transmission make it the perfect alternative for diverse applications, including the most demanding ones. A 3-pin package of single line pins is the portion. It is advantageous to associate and unique packages can be given in response to common demand [8].

2.8.1 Control Structure

Exhaust fans will freshen up and drag outside air through the back vent to transfer a large amount of the humid plant sales outlet. For a good, they're extreme, as full sun on a hot summer day will cause temperatures to overheat within the nursery. The power of a gases fan must be to pull this freshen up, or the temperatures will begin to increase. In combination with soil connection warmth, overhead infrared warming equipment provides a restricted plant atmosphere that allows plants to thrive despite the fact that the air is at a lower than normal temperature. As space radiators or as part of a restricted air framework, electric resistance-sort warmers are used.

2.9 Soil Moisture

This moisture sensor may be used to identify the dampness of the soil or judge whether there is water outside the sensor, let the plants connect inside the greenhouse for human assistance. It can be interesting to use them just to embed them in the dirt and then decipher them. With the help of this sensor, it will be feasible to make the plant recall: thirsty now, need some water [9].

Fig. 2.7: Soil Moisture sensor [9].

Table 2.5: Soil Moisture Sensor Readings

Soil Condition	Transducer Optimum Range
Dry	0V
Optimum Level	1.9-3.5V
Slurry Soil	>3.5V

2.10 12V DC pump motor

In a number of means of transferring air, DC driven pumps use direct current from the motor, battery, or solar power. Usually, motorized pumps run on DC power at 6, 12, 24, or 32 volts. When exposed to sunlight, solar powered DC pumps use photovoltaic (PV) panels with solar cells that create direct current. The greatest benefit of DC (direct current) pumps over AC (alternating current) pumps is that they can operate directly from a battery, making them more convenient and lightweight. They are easier to manage and track, because AC systems typically need a controller to monitor speed. DC pumps also tend to be more reliable. However, AC pumps are usually designed for quicker speeds and higher bursts of power. They still have a longer lifespan of service than DC pumps [10].

Fig 2.8: 12V DC pump motor [9]

2.11 Exhaust Fan

Greenhouse production can be a problem throughout the summer. High levels of solar radiation and the resulting warmer temperatures of the air make it harder to sustain proper growth conditions. Excessive greenhouse temperatures contribute to slow growth of plants, the need for constant irrigation and fans that appear to work all the time, raising the monthly energy bill. Here are a few tips that are going to help us strengthen our system.

Fig 2.9: 12V Exhaust Fan [11].

2.12 Arduino IDE Software

The Arduino Integrated Development Environment (IDE) is a cross-platform framework which is written in the Java programming language (for Windows, macOS, Linux). It is used to write and upload programs to compatible Arduino boards, but also to other vendor production boards with the assistance of 3rd party cores.

Version 2 of the GNU General Public License opens the IDE source code. To endorse the C and C++ languages, the Arduino IDE uses special code structuring laws. The Arduino IDE, which includes some traditional input and output procedures, provides a software library from the Wiring project. User-written programming involves only two key functions to start the sketch and the main program loop, compiled and linked with a stub main program into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE uses the avrdude software to translate the hexadecimal encoding executable code to a text file loaded onto the Arduino board via a board firmware loader program.

2.13 IoT

The common concept of the Internet of Things is known as:

The Internet of Things is a network of physical artifacts (IOT). Not only is the internet a computer network, it has also a network of gadgets of all shapes and sizes, vehicles, tablets, home computers, sports, cameras, medical devices Industrial networks, animals, people, households, all related, all information contact and exchange based on stipulated protocols to carry out smart reorganizations, positioning, tracing, safe & control & also personal online surveillance, online upgrade, control & administration of processes [12].

As below, we classify IOT into three classifications:

The Internet of Things is a three-dimensional Internet: (1). People to people, (2) People to machines/things, (3) Things/machines to things/machines, Internet connection.

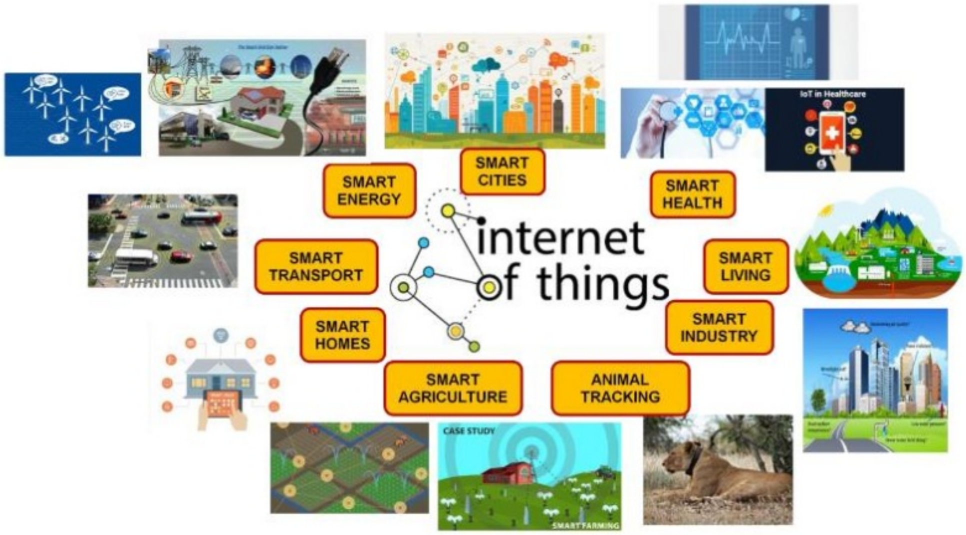


Fig 2.10: Internet of Things (IOT) [12].

2.13.1 Greenhouse Monitoring and Controlling Based on IOT

The machine would track the different conditions of the climate, such as humidity, humidity of the soil and temperature. A notification will be sent to the registered number via the ESP8266 Wi-fi Module if any condition exceeds those limits. If the soil moisture is below a specific amount, the microcontroller can automatically turn the motor on.

Via various sensors, temperature, humidity and soil moisture can be tracked. This can then be attached to networks that cause warnings or automate processes such as water and air control. Greenhouse monitoring with wireless sensor technology and Inside a greenhouse, IOT includes a low cost tracking parameter. Farmers can effectively track it from a remote location by placing distinct sensors such as light sensors, humidity sensors, etc. If the farmer does not visit the greenhouse, an automation mechanism like irrigation can be started.

Table 2.6: Greenhouse table

Green house controller	-	Required Condition
Temperature	-	80F-85F
Humidity	-	50%-70%
Soil Moisture	-	60%-80%

2.13.2 Setting Temperature, Soil moisture and Humidity Set point for growing Tomatoes and Strawberry

As it is known from the several sources that Tomatoes and Strawberry are not found all the years due to temperature, soil moisture and humidity variant. The proper and optimum temperature for growing tomatoes is 21^{0}C to 27^{o}C in daytime and 17^{0}C-18^{0}C in nighttime. But for the year around the best temperature range is 18^{0}C-25^{0}C for growing Tomatoes. The humidity should have been between 60%-85% and the soil moisture should have been between 70%-80% to get the proper production. Another plants we are harvesting through Green house is Strawberry. The temperature for growing Strawberry is between 19^{0}C$^-$24^{0}C. The proper and optimum temperature for growing Strawberry is 17^{0}C to 27^{o}C in daytime. The humidity should have been between 60%-80% and the soil moisture should have been between 65%-80% to get the proper production of Strawberry. Here we set the Greenhouse temperature, humidity, soil moisture to get the exact weather condition that we wanted for growing our desired crops.

Table 2.7: Tomatoes and strawberries suitable condition for growing best [13].

Temperature variation	Crops Condition	Moisture variation	Crops Condition	Humidity variation	Crops Condition
<16	Not good	<60	Dry leafs and crops	>80	Not good pollination
>30	Fruit doesn't color	>90	Fruits Destroyed	<60	pollination lows
20-25	Perfect good	65-80	Fruits good	60-80	perfect pollination

CHAPTER 03

RENEWABLE ENERGY

3.1 Hydro power supply panel

Many hydroelectric power stations have a water tank, a gate or valve to regulate how much water flows from the reservoir, and an outlet or position where after flowing downward, the water ends up. Water Gains Potential Energy as water flows, potential energy is transformed into kinetic energy. The water can be used to transform a turbine's blades to produce power, which is transmitted to the DC battery [14]. The higher the water flow pressure, the more the DC motor gains voltage. Hydropower or water power is generated primarily from the energy of falling or fast-running water, which can be harnessed for useful purposes. Hydropower from many kinds of watermills has been used since ancient times as a source of renewable energy systems for irrigation and the operation of various mechanical devices that generate compressed air from falling water is often used to power other machinery from a distance [15].

The idea is to build a dam that has a significant drop in elevation on a large river. The dam collects a lot of water in the reservoir behind it. The water source is at the bottom of the dam wall. Gravity allows the penstock inside the dam to drop into it. There is a turbine propeller at the end of the penstock, which is tipped over by the flowing water. The shaft goes up into the generator from the rotor, which generates the electricity. Power lines that bring electricity to the home are attached to the generator. In the tailrace, the stream continues past the propeller into the channel after the dam. By the way, playing in the river just below a dam as water is released is not a smart idea [16].

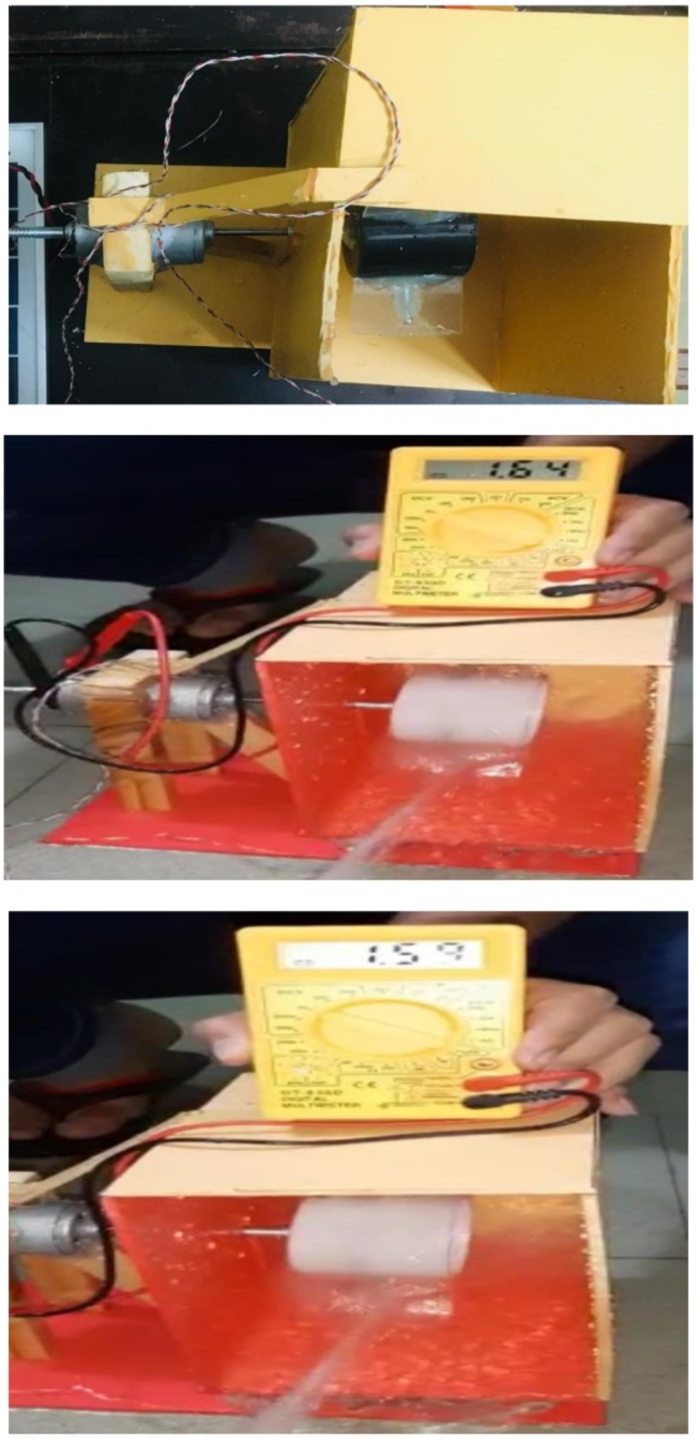


Fig.3.1: power from hydro

3.2 Solar Power Supply Panel

Solar power is the conversion of sunlight into energy, either directly through the use of photovoltaic (PV), indirectly through the use of concentrated solar power, or through a mixture. In order to direct a wide area of sunlight through a narrow beam, focused solar power systems use lenses or mirrors and solar monitoring systems. Using the photovoltaic effect, photovoltaic cells turn light into an electric current. [17].

Initially, photovoltaics is used primarily as an energy source for small to medium-sized installations, from a single solar cell powered calculator to rural homes powered by an off-grid PV rooftop system. In the 1980s, industrial, concentrated solar power plants were first built. As the cost of solar energy has fallen, the number of solar PV systems connecting to the grid has risen to millions, and photovoltaic power stations with hundreds of megawatts are being installed on a utility scale. To harness renewable energy from the Sun, solar PV is increasingly becoming an affordable, low-carbon technology.

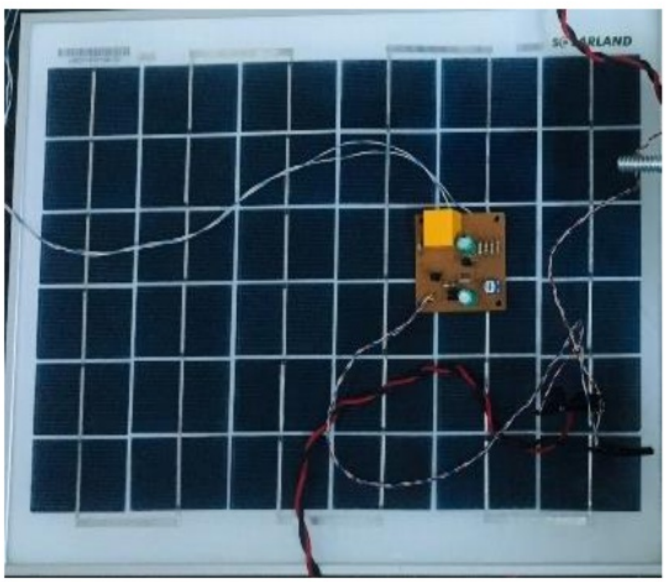


Fig.3.2: Solar power panel

3.3 Charge controller

The rate at which electric current is applied to or drawn from electric batteries is limited by a charge controller, charge regulator or battery regulator. It avoids overcharging and can guard against overvoltage, which may limit the output or lifetime of the battery and can pose a danger to safety [18]. It can also keep a battery from fully draining ("deep discharging") or conduct managed discharges to maintain battery life, based on battery technology. The words 'charging controller' or 'charge controller' can refer to either a stand-alone unit, or to a battery pack, battery-powered device, or battery charger integrated circuitry control.

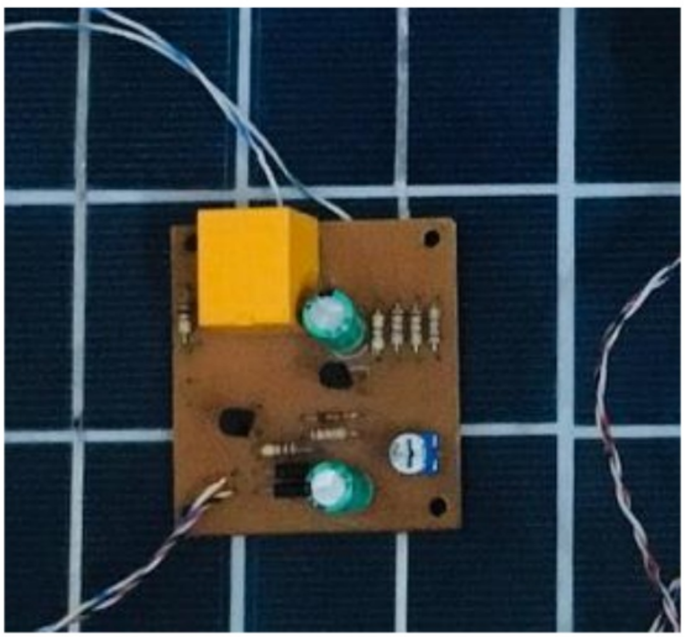


Fig.3.3 A charge controller

3.4 DC Battery

DC batteries use direct current to control small appliances, radios, computers, cell phones and other electronic devices, which flows in a single direction. A renewed interest in DC's capacity came from DC Power and Environmental Concerns at the beginning of the 21st century. In an attempt to control a possible environmental crisis, fears over global warming have led to developments [19]. In hybrid vehicles, which work to minimize carbon dioxide emissions, DC battery capacity is used, which is a significant contributor to global warming. DC generates a constant, quickly exhausted current. The lack of control is important even if it can be recovered. This is the result that can be seen over time in batteries; they lose power steadily before they cease functioning.

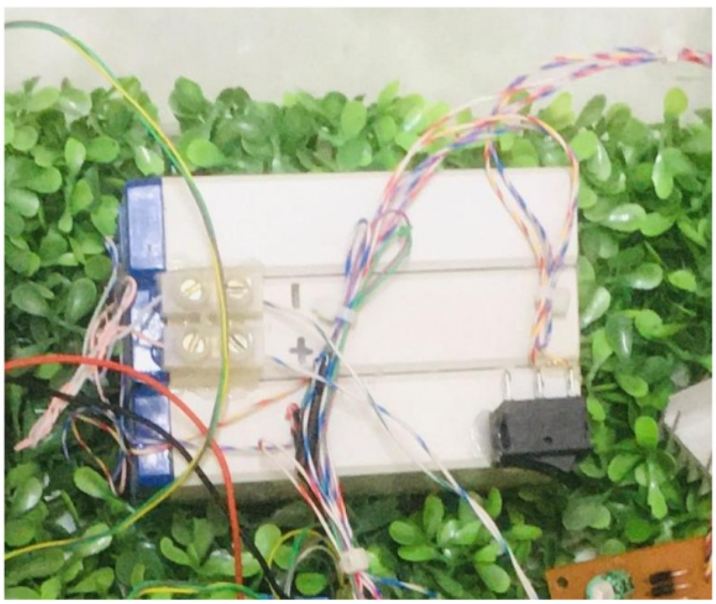


Fig.3.4: DC Battery

CHAPTER 04

LITERATURE REVIEW

4.1 Introduction

A greenhouse is a land-covering system widely used for plant growth and manufacturing. Greenhouses control environmental parameters such as temperature, humidity, water and light intensity. The cost of operations can be reduced with improved management, with limited personnel required. installing a control system with constant monitoring is very necessary for the greenhouse to achieve the highest performance and output, says Pissarides. The main factors involved in the greenhouse regulation process are temperature, humidity, CO_2, absorption, radiation, water and nutrients. The criteria for greenhouse heating depend on the optimal temperature for the plants grown. The movement of water into the greenhouse is one of the essential features of the method. The air circulation must be regulated in the winter, ensuring that the temperature in the greenhouse remains uniform. The sharing of temperature equilibrium, moisture loss, or replenishment of carbon dioxide between inside air and outside air is ventilation. In the conventional method, hand watering is the only possible way to keep the plants from getting adequate water at times. One of the most popular passive solar power applications is a greenhouse. Greenhouses provide opportunities to grow food and horticultural products close to the market in cold climates. Greenhouse technology is economically effective in building and service, including in industrial applications. Hydropower is considered to be a safer and greener source for the production of electricity.

4.2 Background of the study

A summary of relevant research work was provided in this section. In agriculture and in greenhouses, some scholars have proposed using the concept of IOT. K. Rangan. and T. Vigneswaran defined an embedded device approach based on parameters such as humidity, water pH, soil wetness, temperature and light intensity for greenhouse monitoring. Ses parameters are calculated, processed, tracked and notified by the proprietor via the GSM Short Message Service technology modem using sensors [21]. A greenhouse monitoring system using GSM has been developed by Prakash.H.Patil, ChaitaliBorse, SnehalGaikwad and ShilpaPatil to track temperature, humidity, light, and CO_2 levels. Their proposed scheme incorporates technologies and sensors from the Short Message Service [22]. The unit offers a method for warning farmers about changes in the conditions of the greenhouse. However, both systems lack a real-time graphical representation of the calculated data and the greenhouse system's remote control feature. The main purpose of this paper is to clarify the method of greenhouse surveillance that will present sensed data on a web page and also provide the system with remote control and monitoring.

4.3 Importance of Greenhouse System

The obvious reason for having a greenhouse is cultivating vegetables, flowers, and herbs at a time of year when they can't be cultivated outdoors. Out-of-season tomatoes, cucumbers, onions, eggplants, spinach, basil, and other vegetables command high prices in some markets. It is important to note that, because of increased demand, the cost of growing warm-weather crops such as tomatoes in the winter is very high, but still profitable. Certain winter crops are also in high demand. If we have a market where we can sell vegetables in spring, greenhouse production, especially when combined with early field crops, can be profitable. Otherwise, a larger loss would be incurred by the system. In our nation and even outside our region, greenhouses will play an important role.

4.3.1 Solar Powered Greenhouses

Greenhouse technology has been shown to be economically effective in building and service in industrial applications. Worldwide, greenhouses are used to establish a safe and regulated ecosystem to grow a wide variety of crops in both mass production and small-scale local agriculture. There are nearly three million acres under greenhouse cover worldwide, with roughly 2.3 million of those in Asia; 490,000 in Europe; and just 30,640 in North America. Instead of glass, half of the world's land is made of plastic. Solar greenhouses are designed to store heat for use at night or at hours when it is cloudy, in addition to capturing solar energy during sunny days. They may either stand on their own or be tied to houses or barns. A solar greenhouse can be an underground pit, a shed-type building or a Quonset hut. Large-scale farmers use solar greenhouses that are free-standing, whereas home-scale farmers primarily use attached structures. Passive solar greenhouses are also excellent choices for small growers, and they are a cost-effective way for farmers to extend the growing season. In cooler climates or areas with long stretches of cloudy weather, solar heating may need to be combined with a gas or electric heating system to safeguard plants against extreme cold. Additional energy is used by active solar greenhouses to transfer hot solar air or water to other greenhouse regions from storage or collecting areas.

4.3.2 Hydro Powered Greenhouses

8

There are a wide variety of hydropower stations around the world, designed for different uses, leading to uncertainty as to the greenhouse effects of the production of hydropower. Despite this, studies around the world indicate that during their construction, large quantities of GHGs are released because both a dam and a reservoir are required for hydropower generation. Scientists in Brazil, for instance, collected reservoir data showing that these GHG hydropower emissions would exceed those of thermal capacity. In another similar analysis, researchers at Washington State University found that the construction of a reservoir increased GHG emissions and their consequences. Submerged hydropower plants often do not consume carbon dioxide and their decomposition emits the heavy greenhouse gas, methane. In the light of this and other research, it is likely that the question should emerge as to exactly how clean hydropower is and whether it can be concluded that hydropower is not as completely clean as one might suppose.

4.4 Applications of Greenhouse System with renewable energy system

IoT is designed to act as an intermediate system between the distributed devices and the applications of the data coming from these devices. its approach allows the gardener to reduce the time, cost, and complexity of implementing, managing.

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Renewable technologies are considered clean sources of energy and optimal use of these resources to minimize environmental impacts. Sun is the source of all energies. The review has been done on the scope of CO_2 mitigation through solar cooker, water heater, dryer, biofuel, improved cook stoves, and hydrogen.

13

Hydropower is the rate at which hydraulic energy is extracted from a specific amount of falling water as a result of its velocity or position or both. Water in a hydropower system is not consumed, it is thus available for other uses. Hydropower can be used to power machinery or to generate electricity or both at the same time. The mechanical application is mainly true for small-scale hydropower.

1. To provide power supply where electric grid is not available.
2. To grow plenty of crops, plants and vegetables etc.
3. To grow off-seasonal crops through this project.

4. To improve soil fertility.
5. To improve crops quality.
6. To reduce food deficiency, especially for farmers.

CHAPTER 05

METHODOLOGY

5.1 Introduction

This chapter includes the findings collected and the entire project is discussed. We have also discussed controversies regarding incentives, restrictions and execution. This will include descriptions of the key power production sources of renewable energy (hydro and solar power supplies). The three key sensors used in this project are temperature, humidity and moisture sensors that provide the exact value of temperature, humidity and humidity, respectively. Owing to the state of the plants, these sensors have the right response. These effects can be seen on the project's LCD screen and on the IOT website on the internet.

5.2 Working Principle

In this system, there are two parts, one is the module for power that we are getting from Hydro and solar power panel and other one is the module for Green house for growing Tomatoes and Strawberry. Our main supply was 12V DC battery and we have charged it through Hydro and Solar power panel. Here we are using Hydro power panel to get a renewable power that are minor and storing it on a DC battery for a long time to get the desired 12V supply. And for ensuring a better power supply we are using solar power panel too. The rating of the solar panel we are using is 0.58ampere. We have put the solar panel to get the highest sunlight intensity at 23-degree angle to the south side. After 6-8 hours we have got our desired full charge 12V for DC battery. On the other hand, the Hydro power panel was taking a much time with comparison to Solar panel to charge the battery full. In Hydro power panel we have used DC motor of highest r.p.m, a pump motor, and the water pressure with high speed but the output was much low comparison to solar power panel. After storing the desired DC power, we have run and controlled and monitored the Greenhouse through 12V rated DC battery, here we use a DC battery Humidity sensor (DHT 11) sensor connected to Arduino Nano, pin no. A1, Wi-Fi module connected to pin no. A2, Moisture sensor connected to pin no. A4, pin no.7,8,9,10,11&12 connected to the LCD display. The output is related to pin numbers 2, 3 and 4. We used Arduino Nano, and Arduino Nano acted as a full processor of the device. For linking the device to the server, the Wi-Fi module (ESP8266) is used. With the user name and password in the software, the Wi-Fi module that we connect to the router needs to be provided. Then they'll be related. We have to give it to the software, the website that will deliver the info. Then the Wi-Fi module we have will continually give us results. We primarily have two sensors, one of which is a humidity sensor and the other is a humidity sensor. We'll get the benefit of the moisture from the moisture sensor. Two measurements are in the humidity sensor, one is the temperature sensor and the other is the humidity sensor. The humidity sensor brings us temperature and humidity values at the same time. The values we get from the sensors are all ADC values. All the values will be taken by Arduino Nano and translated to string. It then displays the values as a decimal value on an LCD monitor. And the same time it will send the values into server. There are three relays that will be switching the three loads, such as cooling fan, pump motor and DC led Lights. The switching will depend on the condition of the greenhouse. We use the LCD display is like 16×2 means there are two row and 16 columns and we use a 5 volts 5 pins relay and we also use an Arduino Nano of 30 pins. We use a Wi-Fi module of ESP 8266 and humidity sensor of DHT 11 and also use a moisture sensor.

5.3 Block Diagram of the system

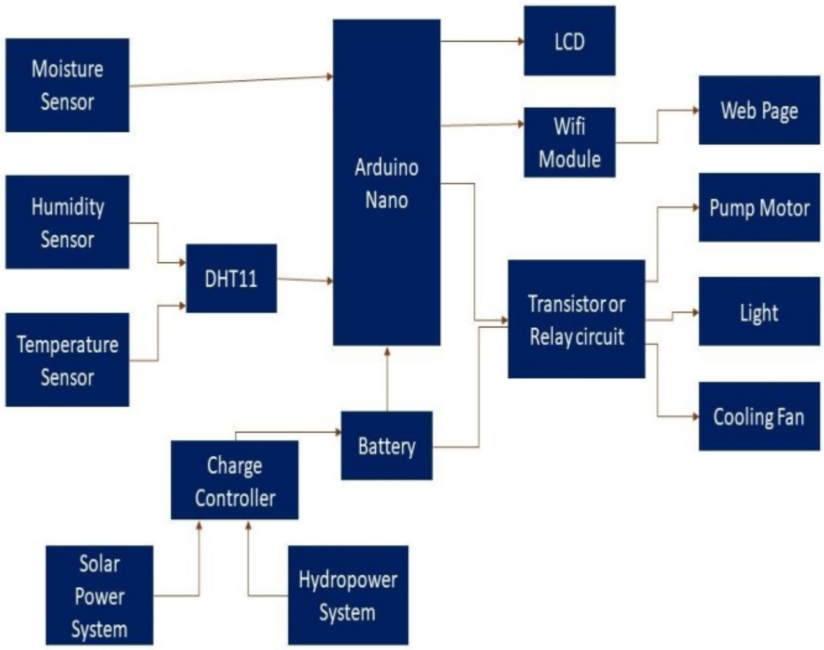


Fig.5.1: Block Diagram of the System

There are two parts of the block diagram, one is for the part of the power supplies and another is the greenhouse architecture circuit. It is a microcontroller-based circuit which tracks and records the values of various parameters, such as temperature, humidity, soil moisture, etc. And to achieve maximum yield and growth, all these values are constantly updated and optimized. And we used DHT11 sensors that would measure both humidity and temperature. It is easy to see the data and its status directly on the web page. Below are some of the essential sensors that are going to be used in this project:

1. Moisture Sensor
2. Temperature Sensor
3. Humidity Sensor

5.4 Circuit Diagram of the System

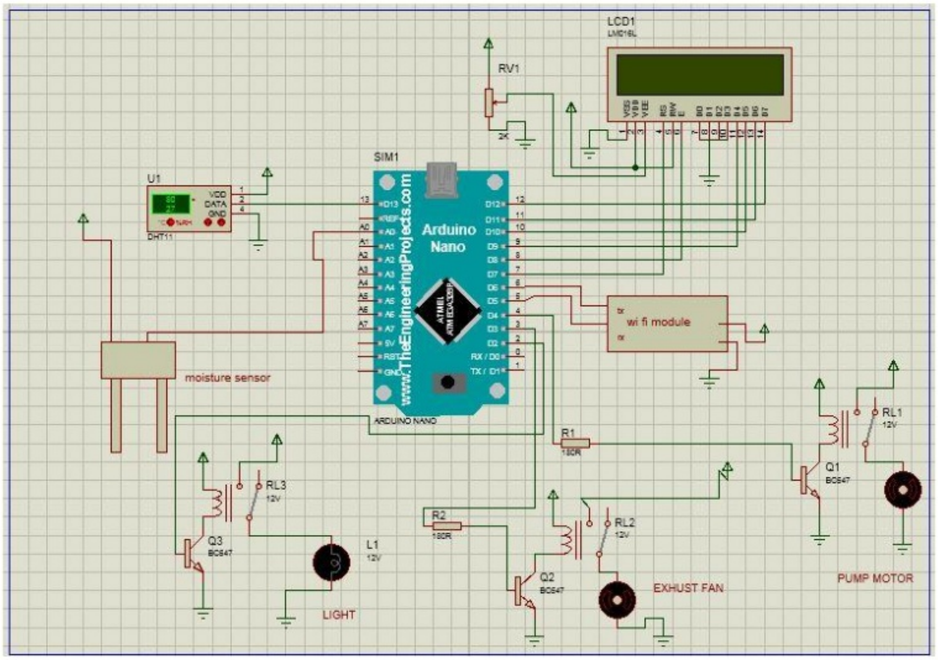


Fig.5.2: Circuit Diagram of the System.

In this system Arduino is the heart of whole system which takes control over the process. When sensors sense any change in environment or in soil Arduino comes in action and process the required operation. When soil moisture sensor does not sense moisture in soil then Arduino turns on the water pump and sends a message to the owner of status that the motor is turned on. The relation with the Arduino Nano of the key components, where data is shared. Two kinds of pins are available, such as digital and analog. Their relation is discussed below.

Arduino pin A0- connected to Moisture sensor.

Arduino pin D13- connected to DHT11(data pin).

Arduino pin D2- connected with DC light through relay 3.

Arduino pin D3- connected with Exhaust Fan through relay 2.

Arduino pin D4- connected with Pump motor through relay 1.

Arduino pin D5, D6- connected to WIFI module (pin RX, TX).

Arduino pin D (9-12)- connected to LCD monitor [pin D (4-7)].

Arduino pin D7, D8- connected to LCD monitor pin RS and EN.

5.5 Flow Chart of the system

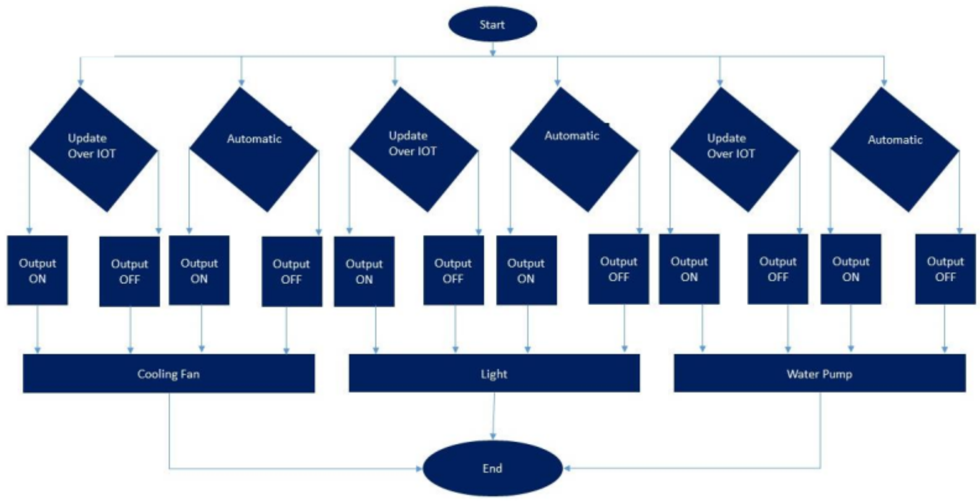


Fig.5.3: Flow Chart

Here the system will work for two modes. These are Automatically or Manually (Updat IOT). When it will work on Automatic mode the response of Cooling Fan, Pump Motor and Fan will work Automatically with respect to control Temperature, Moisture and Humidity for a desired environment.

In other mode (Update over IOT) the system response is based on controlling through server. In this mode one can control Moisture, Temperature, Humidity just by switching relay as well as controlling pump motor, fan and lights from distant places.

5.6 Solar and Hydropower System

Solar power is the conversion of energy from sunlight into electricity, either directly through the use of photovoltaics (PV), indirectly through the use of concentrated solar power, or combined. In order to direct a wide area of sunlight through a narrow beam, focused solar power systems use lenses or mirrors and solar monitoring systems. Using the photovoltaic effect, photovoltaic cells turn light into an electric current.

Here as a supply source we are using a 10W 0.58a rated solar panel from where we will find The power that will charge the DC battery to 12V. Basically, constructing a dam on a large river that has a large drop in elevation is the idea. The dam collects a lot of water in the reservoir behind it. The water source is at the bottom of the dam wall. Gravity allows the penstock inside the dam to drop into it. There is a turbine propeller at the end of the penstock, which is tipped over by the flowing water. The shaft goes up into the generator from the rotor, which generates the electricity. Power lines which carry electricity are linked to the generator. Basically, we generate a small voltage that only requires a DC motor, turbine and water flow. We only use it to produce the power needed to charge a 12V DC battery that is very small (million times) than the functional Hydro Power Plant as a procedure.

CHAPTER 6

IMPLEMENTATION AND RESULTS

6.1 INTRODUCTION

The system is designed to get 12V supply from the renewable energy sources. For Hydro and solar system, we have charged DC battery to an optimum level. Then from the charged battery we run the greenhouse system and monitored and controlled temperature, Humidity and soil moisture. We have used IoT to control and monitor the greenhouse system from anywhere in the world.

In this system all the sensors, humidity and temperature(DHT11), moisture sensor, DC battery, relay, wifi module, DC pump motor, Exhaust Fan, DC light, Arduino, voltage regulator etc. here first the supply will charge the battery. Then from battery 12v charge will go to Exhaust Fan and DC pump 3.3v to wifi module. The rest will get 5v from supply through voltage regulator.

Arduino and relay are used to give information and signal to the desired channel. Here, Exhaust Fan is used for cooling the plant, pump motor for watering the plant when the soil moisture become low and DC light for increasing temperature when required. Here we are creating an atmosphere to grow tomatoes and strawberries together whose required temperature for growing is 20-24^{o}C, soil moisture 65-80% and humidity 60-75% for growing together.

So the Exhaust Fan will respond and start rotating when temperature will be more then 24^{0}C, the light will be on when temperature less than 20^{0}C. The pump motor will be on when the soil moisture will be lower than 65%. The pump motor will work also for humidity when it will be less than 60%.

For Hydro power we need system rpm 4000 to get 12v on DC battery. But we are getting enough rpm from Hydropower system. We are getting just 1.5-2.2v at max pressure created by us. The battery will need a long time to charge. But we can increase the rpm of the turbine of the motor by any means rather than Hydro. Then we will get 12v charge battery.

Table 6.1 System component response in different temperature. Moisture and humidity

Temperature	Response	Humidity	Response	Moisture	Response
<20^0 C	DC Light on	>85%	Motor Off	<65%	Motor On
>24^0 C	Exhaust Fan on	>60%	Motor On	>65%	Motor Off

6.2 Result of Controlling and monitoring from IoT server:

Now we are controlling it through IoT Server will give us controlling or temperature, humidity and moisture of greenhouse plant. We have turned server on mood to control the Temperature, humidity, moisture from IOT. Here by Arduino and relay we are giving information and signal for relay 1, relay 2 and relay 3. If relay 1 is on then pump motor will be on when we will see there is less water and moisture as well as humidity we will turn relay 1. If relay 2 is on than Exhaust Fan is on and we will turn it on when temperature will more than 25^0 C. We will turn on relay 3 when there will be low temperature. Than our expected temperature.

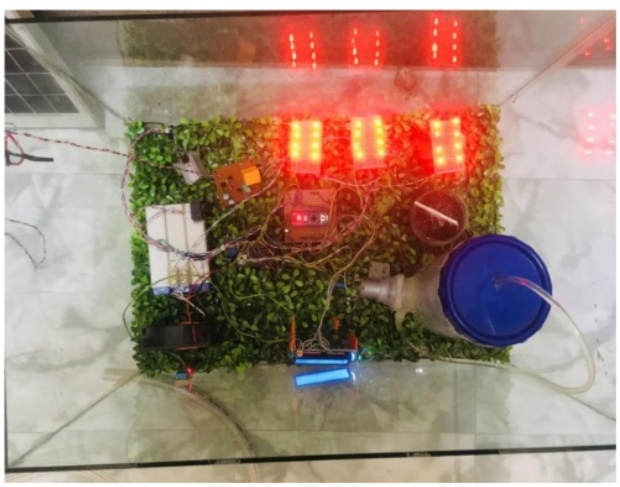


Fig.6.1: Greenhouse

When relay 1,2,3 on Pump motor, exhaust fan and lights will be on.

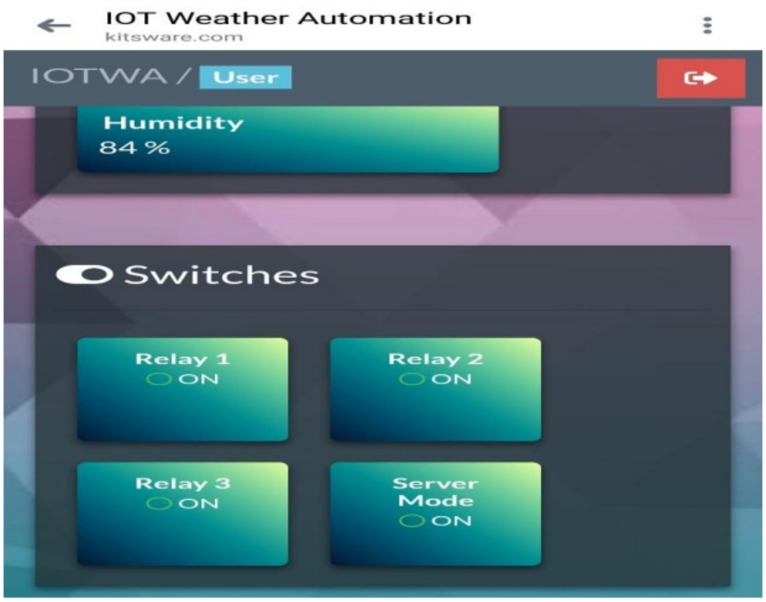


Fig.6.2: Controlling of green house

When only relay 2 is on the exhaust fan will remain on and the others will be off.

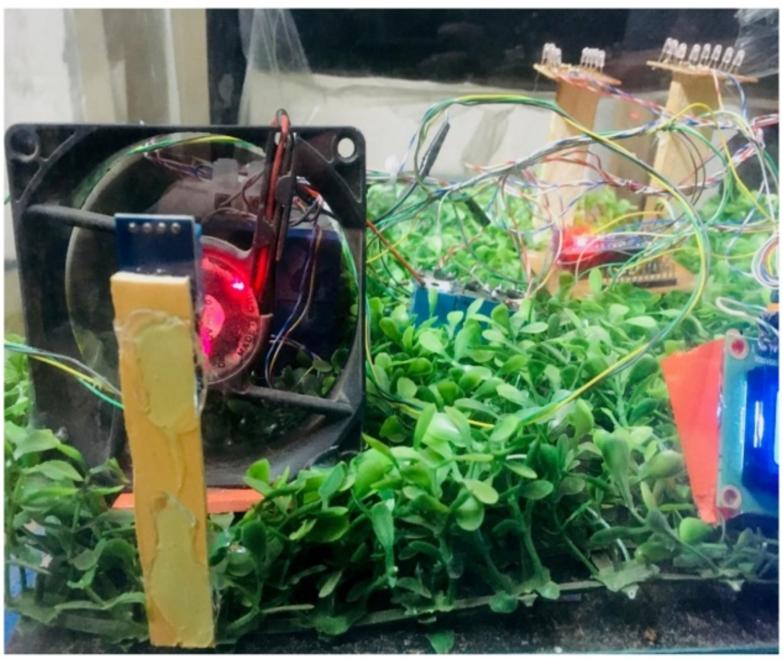


Fig.6.3: Controlling of green house

When relay 1 and 3 is on but 2 is off the light and pump motor will be on and the exhaust fan remain stop working.

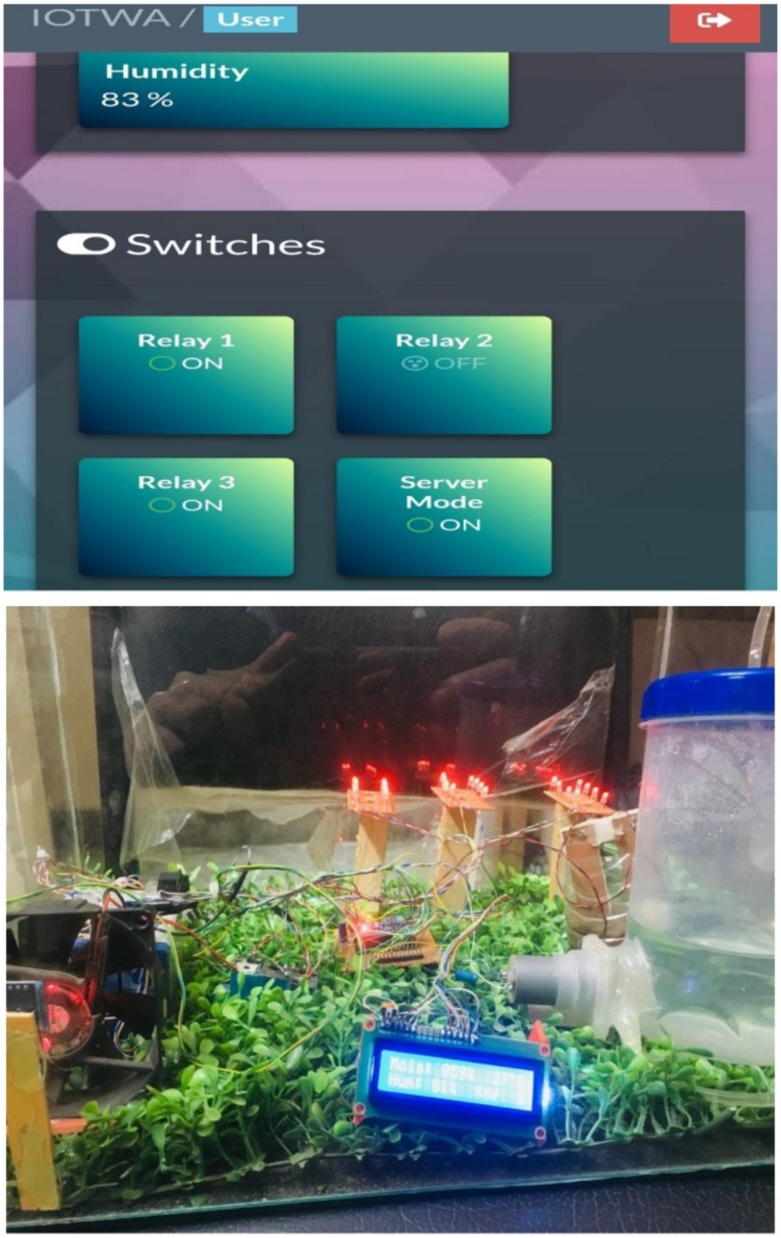


Fig.6.4: Controlling of green house

6.3 Result and data of renewable energy system:

For hydropower system there will need a water height for creating water pressure. But it is shown from our result that we are not getting the full pressure to rotate the DC motor with rpm 4000 to get 12v.

But we are not getting enough voltage for different height, the voltage is

Table 6.2 Voltage gained from hydro supply for different height

Height	Voltage
25cm	1.3v
30cm	1.32v
35cm	1.37v

For overcoming this problem, we are used blower pressure instead of water pressure to increase rpm. And then when we used blower we have seen that the pressure was so high that we got full 4000 rpm to get the full 12v supply from motor.

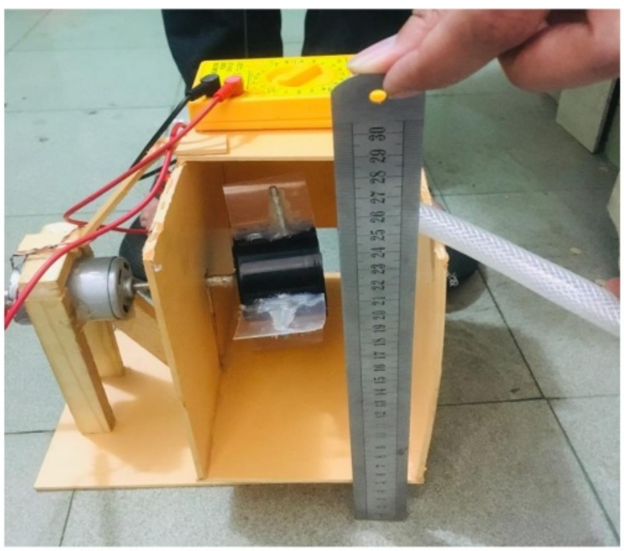
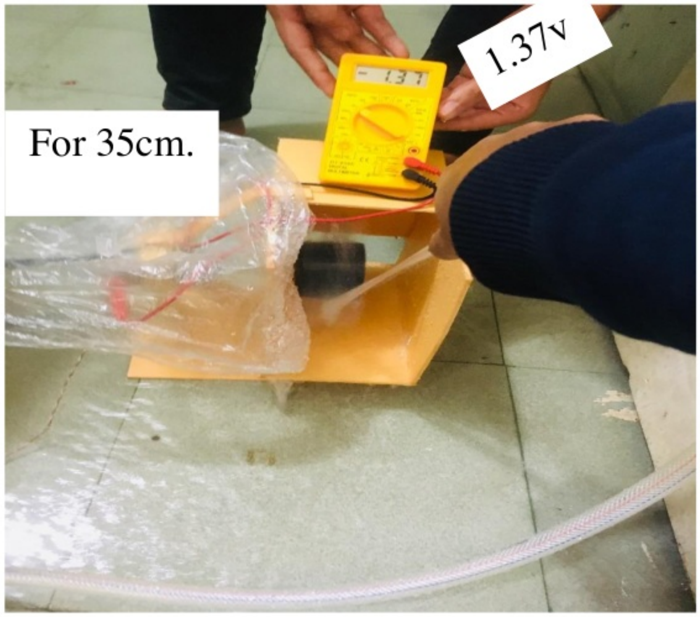
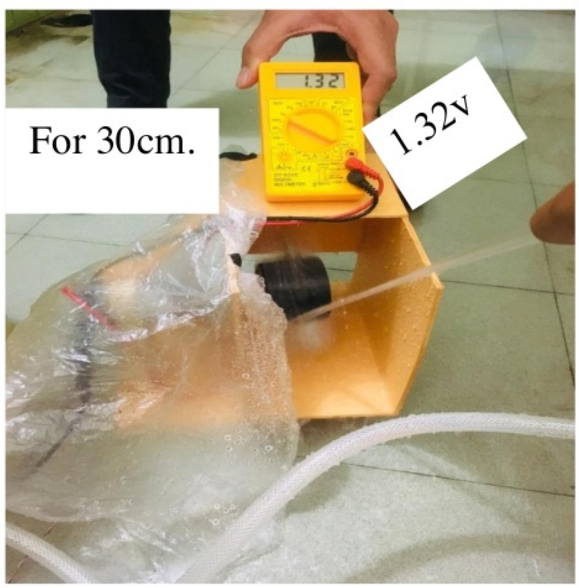


Fig.6.5: Height of waterfall measuring

For 35cm.



For 30cm



For25cm

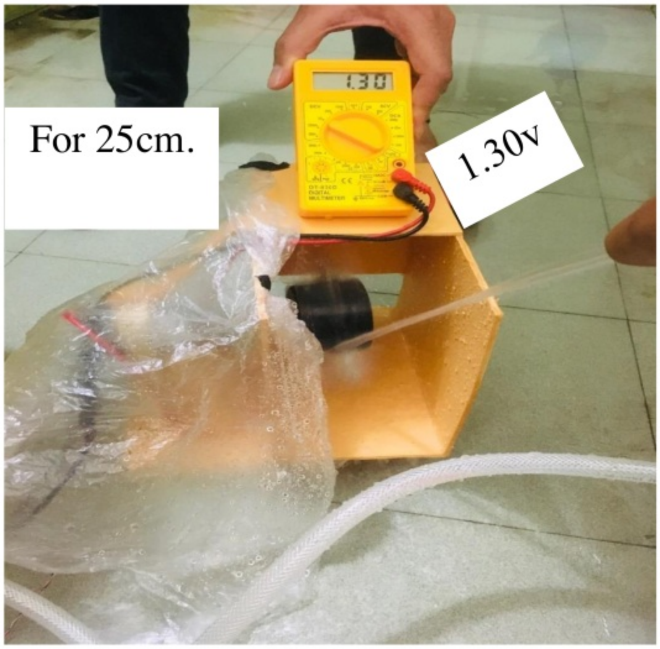


Fig.6.6: Power measuring for different height(35cm,30cm,25cm)

The other renewable system was solar power panel system. Here as a supply source we are using a low 0.58 A rated solar panel from when we have find full 12v for charging DC battery through charge controller. To get best sun radiation we have kept the solar panel 23^0 angle to the south side.

There almost needed 8 hours to get the full 12v output from the solar panel through charge controller to charge the DC battery. From hydro and solar power panel the charge will store on 12v DC battery from where we will get enough power supply to control and monitor greenhouse system.

Now here the solar power system and hydropower system are connected together with charge controller. The charge controller will charge whenever it will get supply from Solar supply or Hydro supply.

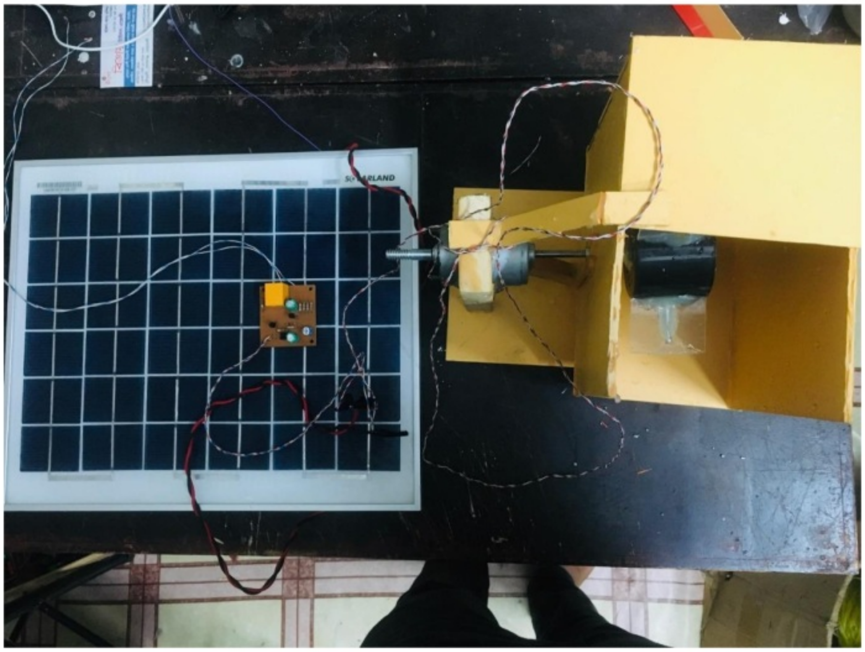


Fig.6.7: Charge controller with solar and hydro power panel

6.4 Hydro power Modelling

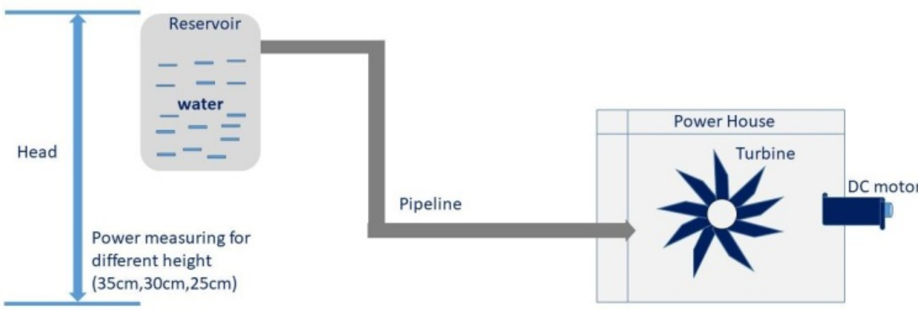


Fig.6.8: Hydro power Modelling

Here at three heights we have built a hydro model with the speed of water. Where we have used different components like Reservoir, Penstock Pipeline, Turbine and DC Motor.

Here we are working on a 12-volt DC battery. But it is impossible to get 12-volt electricity due to low speed of water. However, it is possible to get 12-volt with this turbine and DC motor. That's why we showed in the video with the speed of water as well as the blower.

6.5 Calculation

Solar power calculation:

For our projected system the total load is 12 watts.

Now we have to calculate Watt-Hour of the battery to get the solar panel Watt-hour. And for these we have to calculate the battery ampere per hour calculation, Current required for Battery Charging Calculation.

The battery ampere per hour calculation:

Battery AH = [(time of consumption * power consumption in watts) / (Voltage of battery * battery efficiency)]

Now for 12W load for battery backup time 7 hours the Battery capacity AH will be

Battery AH = [(7*12) / (12*1)

= 7AH [When efficiency is 100%]

Battery backup time calculation:

Battery backup time= [(battery AH*12v*Efficiency) / (Power consumption in units)]

So for 7AH battery AH, 12V battery, 85% efficiency and 12 Watts power consumption the battery backup time will be;

Battery backup time = [(7*12*0.8) / (12hours)]

= Almost 6 hours

Where the battery efficiency is 85%

If the battery efficiency is 100% we will get 7 hours' battery backup time

Current required for Battery Charging Calculation:

Battery charging current = [(Battery Ah) / (Total time of sunlight available)]

SO, Battery charging current = [(7AH) / (10hours)]

=0.7A

So output current from solar plate will be required is 0.7A.

The 10W solar panel will give us 0.68 short circuits current and its operating current is 0.58A

The Watt-hour Calculation of the battery as well as the solar panel:

The Watt-Hour of the battery = Voltage of the battery × Battery Ampere-Hour capacity

= 12V × 7AH

=84 Watt-Hour

For 10 hours' sunlight radiation,

We will get the solar panel Watt-hour = [(Watt of solar panel × Time of sun radiation × Battery efficiency)]

$$= 10\times10\times0.85$$

$$=85 \text{ Watt-Hour.}$$

So we will get the full charge for charging 12V DC battery with Solar panel system.

Hydro Power Calculation:

For Hydropower system we know that the potential energy of Hydropower system converted into kinetic energy and generate power.

For Hydropower system the work done by potential energy is

$$W=PT$$

$$\text{Or, } P=\frac{W}{T}$$

Here, W=mgh

Where W = work done of the system

P= power gained from potential energy

h= Height of the water

m= mass of water =30kg/m^3

g= Gravitational constant=9.8 ms^{-2},

t= time of water flow per minute

Now for 0.25m water head

W=mgh

=30×9.8×0.25

=73.5 joule

So power gained from potential energy is

$$P = \frac{W}{t} = \frac{73.5}{60} \text{ watt } = 1.225 \text{ Watt}$$

By applying same method, for 0.30m water head we will get 1.47 Watt

And for 0.35m water head we will get 1.71 Watt

Here from Hydro power panel we are getting lowest output charging DC battery because the water flow per minute is very much lower than our required pressure.

If we can increase the water pressure per minute to 294 kg/m^3 for 0.25m water head, we will get our 12W desired output power for charging DC battery.

Now for 294 kg/m^3 water head

W= mgh

$= 294 \times 9.8 \times 0.25 \quad = 720.3$ joule

So power gained from potential energy is

$$P = \frac{W}{t} = \frac{720.3}{60} \text{ watt} = 12 \text{ Watt}$$

6.6 Advantages

1. This method of robotic control was used to remove manpower.
2. The IoT architecture has been developed to be easy to monitor and save time.
3. In such a favorable scenario, further plants will be grown under this system.
4. Simple to run, install, and troubleshoot.
5. Useful on a small scale for producers and greenhouse managers. Low Setup Cost.
6. Can be found at home
7. Simple to manage, easy to sustain, and rapier.
8. Low power consumption.

6.7 Limitation

1. Internet connection is needed for always.
2. If the network is gone, there will still be a gap of the grid.
3. It's a dynamic system.
4. A lot of water and sunlight required

6.8 Application

1. Without a human, this machine operates automatically.
2. Always send the data to the web side.

6.9 COST ANALYSIS

Estimated Cost

Sl. No	**Particulars**	**Quantity**	**Unit price (In BDT)**	**Total Price (In BDT)**
01	Arduino NANO (ATmega328P)	1	300	300
02	LCD Display	1	140	140
03	Humidity Sensor(DHT 11)	1	110	110
04	Soil Moisture Sensor	1	80	80
05	Cooling fan	1	60	60
06	Pump Motor	1	300	300
07	Artificial DC Light stand	3	30	90
08	Hydro supply panel	1	500	500
09	Transformer	1	70	70
11	Relay	3	60	180
12	Wi-Fi Module	1	280	280
13	Transistor	3	15	45
14	Glass	……	3000	3000
15	Solar supply panel and battery	1	1000	1000
16	Power supply	1	200	200
17	Miscellaneous	…….	500	500
Total = BDT Six Thousand and Eight Hundred and Fifty Five Taka Only				**6,855/=**

Table 6.3: Estimated Cost

CHAPTER 08

CONCLUSION

The increased population needs vast amounts of crop production in today's world. We may grow greenhouse crops that require certain unique environmental conditions. The two crops in our country are tomatoes and strawberries. But these crops are not viable all year round due to climatic changes. A greenhouse is a ground covering structure widely used for plant growth and development. Protecting crops from harsh environments and supplying them with a better environment for productive production are the main goals of using greenhouses. The proposed greenhouse monitoring system based on the IoT is a full system with a renewable energy system intended to track and regulate the environmental parameters of small plants such as tomatoes and strawberries within a greenhouse in rural areas where there is inadequate electricity supply. Renewable energy sources, which are independent of the national power grid and conventional gas heating systems, can provide ample supplies for this system. The conventional method is labor-intensive and time consuming for greenhouse surveillance and management. In the microcontroller, temperature, humidity, and soil moisture levels are designed and regulated and tracked by IoT to create a perfect environment for the growth of tomatoes and strawberries. Time, money, and human effort are saved by the proposed method. Greenhouses minimize the risk and use of shipping-related fossil fuels. This planned project would assist individuals from certain regions that lack cultivation due to sufficient grid supply and who wish to cultivate their preferred crops all year round. It can be regulated and tracked from anywhere in the world, based on internet connectivity. It provides plants with a regulated atmosphere to avoid harm and thus facilitates the analytical analysis of plants and flowers in the biotechnology field. The smart greenhouse monitors the different parameters necessary for the plants automatically or manually with modern technology and sends the sensory data to a personalized web page for continuous and efficient greenhouse monitoring. In construction and operation, greenhouse technology is economically efficient, even in industrial applications. In cold climates, greenhouses offer opportunities to produce food and horticultural goods close to the consumer, reducing the cost and usage of fossil fuels connected to transportation. A greenhouse could be as simple as plastic films backed by cables, and yet it might help lift the internal temperature.

Future Works

We will interact with more sensors and process controls. There are three sensors we have. It can also be used exclusively as a tracking device to make it really simple. We will have updates by SMS. The green energy grid can also be interlocked as all the outlets are available simultaneously.

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APPENDIX

Embedded C Code

```
#include <Adafruit_Sensor.h>
#include <DHT.h>
#include <DHT_U.h>
#include <LiquidCrystal.h>
#include <SoftwareSerial.h>
#define rly1 2
#define rly2 3
#define rly3 4
#define modeBtn A2

#define DHTPIN 13
#define DHTTYPE DHT11

LiquidCrystallcd(7, 8, 9, 10, 11, 12);
SoftwareSerialwifi(5, 6);
DHT_Unifieddht(DHTPIN, DHTTYPE);

String wifiSSID = "test01";
String wifiPASS = "1234";
String HOST = "kitsware.com/projects/iotweather.000webhostapp.com";

byte temp, humidity;
int soil;

byte cross[] = {
  B00000,
  B10001,
  B01010,
  B00100,
```

```
  B01010,
  B10001,
  B00000,
  B00000
};

byte tick[] = {
  B00000,
  B00001,
  B00010,
  B10101,
  B01010,
  B10100,
  B01000,
  B00000
};

void setup() {
Serial.begin(9600);
wifi.begin(9600);
lcd.begin(16, 2);
lcd.createChar(0, cross);
lcd.createChar(1, tick);

pinMode(rly1, OUTPUT);
pinMode(rly2, OUTPUT);
pinMode(rly3, OUTPUT);
pinMode(modeBtn, INPUT_PULLUP);

wifi.println((String)"AT+CWJAP=\"" + wifiSSID + "\",\"" + wifiPASS + "\"");
checkResponse();
}

void loop() {
```

```
readDHT();
soil = analogRead(A0);
soil = map(soil, 0, 1023, 0, 100);
Serial.println((String)"Soil: " + soil + "\tTemp: " + temp + "\tHumidity: " + humidity);

lcd.setCursor(0, 0);
lcd.print((String)"Soil: " + int2Str(soil) + "%  " + temp + (char)223 + "C  ");
lcd.setCursor(0, 1);
lcd.print((String)"Hum: " + humidity + "%  ");

if(digitalRead(modeBtn) == 1){
lcd.setCursor(15, 1);
lcd.print("A");
if(soil < 60) digitalWrite(rly1, 0);
elsedigitalWrite(rly1, 1);

if(temp < 24) digitalWrite(rly2, 0);
elsedigitalWrite(rly2, 1);

if(humidity < 60) digitalWrite(rly3, 1);
elsedigitalWrite(rly3, 0);
  }
else {
lcd.setCursor(15, 1);
lcd.print("S");
checkServer();
  }

lcd.setCursor(10, 1);
if(digitalRead(rly1)) lcd.write(byte(0));
elselcd.write(byte(1));
lcd.setCursor(11, 1);
if(digitalRead(rly2)) lcd.write(byte(0));
elselcd.write(byte(1));
```

```
lcd.setCursor(12, 1);
if(digitalRead(rly3)) lcd.write(byte(1));
elselcd.write(byte(0));

send2Server();
  //delay(1000);
}

void send2Server(){
  String post = (String)"GET /connect.php?s_value=" + soil + "&t_value=" + temp +
"&h_value=" + humidity + " HTTP/1.1";
int index = post.length() + 69;

wifi.println("AT+CIPMUX=0");
checkResponse();
wifi.println("AT+CIPSTART=\"TCP\",\"" + HOST + "\",80");
checkResponse();
wifi.println((String)"AT+CIPSEND=" + index);
checkResponse();
wifi.println(post);
wifi.println("HOST: " + HOST);
wifi.println("Connection: Close\r\n");
checkResponse();
}

voidcheckServer(){
wifi.println("AT+CIPMUX=0");
checkResponse();
wifi.println("AT+CIPSTART=\"TCP\",\"" + HOST + "\",80");
checkResponse();
wifi.println("AT+CIPSEND=93");
checkResponse();
wifi.println("GET /update.php HTTP/1.1");
wifi.println("HOST: " + HOST);
```

```
wifi.println("Connection: Close\r\n");
  String raw = checkResponse();
inti = raw.indexOf("RELAY=");
if(i != -1){
raw.remove(0, i + 6);
raw.remove(3, raw.length());

if(raw[0] == '1') digitalWrite(rly1, 0);
elsedigitalWrite(rly1, 1);

if(raw[1] == '1') digitalWrite(rly2, 0);
elsedigitalWrite(rly2, 1);

if(raw[2] == '1') digitalWrite(rly3, 1);
elsedigitalWrite(rly3, 0);
  }
}

String checkResponse(){
  String r;
while(!wifi.available());
while(wifi.available()){
    r = wifi.readString();
    //Serial.println(r);
  }
return r;
}

String int2Str(intval){
if(val< 10) return (String)"00" + val;
else if(val< 100) return (String)"0" + val;
else return (String)val;
}
```

```
voidreadDHT(){
sensors_event_t event;
dht.temperature().getEvent(&event);
if (!isnan(event.temperature)) temp = event.temperature + 17; // adjust temp
dht.humidity().getEvent(&event);
if (!isnan(event.relative_humidity)) humidity = event.relative_humidity - 100; // adjust
humidity
}
```

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