

IOT BASED GREEN HOUSE CONTROLLING AND MONITORING SYSTEM

**Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering degree in Electronics and Communication
Engineering**

By

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ENGINEERING SCHOOL OF ELECTRICAL AND ELECTRONICS
ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work o **Yaramati Naga Venkata Nikhil** (Reg. No. 39130520) and **Sriram Tammineedu** (Reg. No. 39130464) who carried out the project entitled "**IOT Based Green House Controlling And Monitoring System**" under our supervision from October 2022to March 2023

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DECLARATION

We, **Yaramati Naga Venkata Nikhil** (Reg No. 39130520) and **SRIRAM TAMMINEEDU** (Reg No. 39130464) hereby declare that the Project Report entitled “**IOT Based Green House Controlling And Monitoring System**” done by us under the guidance of **Dr. Balamurugan V, M.E., Ph.D.** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

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ABSTRACT

The use of Internet of Things (IoT) technology in agriculture has revolutionized the way farmers monitor and manage their fields. By collecting environmental data and sending it to smartphones through online mode, farmers can now remotely oversee their fields regardless of their location. One area of focus in agriculture is the development of smart greenhouses, where the climate inside the greenhouse is controlled for optimal plant growth. This is achieved using a low-cost and efficient programmable module such as the ESP8266 Node MCU module and Arduino UNO board. The parameters that require optimization in a smart greenhouse are soil moisture, light intensity, temperature, and humidity. These parameters are monitored using soil moisture sensors, LDR sensors for light intensity, and DHT22 sensors for temperature and humidity. The collected data is then used to control various systems such as water pumps, motors, exhaust systems, and light systems to maintain the ideal conditions for crop production. The Node MCU module is connected to the wireless internet through HTTP protocol or an IoT platform, allowing farmers to access and manage the data using their smartphones or other devices. The rapid advancement of IoT technology has paved the way for optimizing and achieving maximum plant growth in agriculture. An accurate and efficient system would undoubtedly bring positive changes to the world of agriculture, facilitated by the use of Android/IOS smartphone applications.

CHAPTER-1

INTRODUCTION

1.1 General Introduction

crop growth while mitigating potential disasters.

Agriculture is the largest economic sector in India, with a majority of the population dependent on it for their livelihoods. The combination of technology and agriculture can yield better results. The traditional methods of cultivation often fall short in meeting the growing demand for food, leading to the use of chemicals in farming practices. Additionally, unpredictable weather conditions and crop diseases pose challenges to conventional agriculture. To address these issues, there is a need to adopt sustainable agriculture practices aided by technology, as seen in other countries.

With advancing technology, modern methods of agriculture, such as greenhouse farming, are becoming popular. Monitoring and controlling greenhouse environments can provide valuable insights for crop management. This can be achieved through low-cost and low-power consumption systems, utilizing technologies like Arduino, which can connect to WiFi networks and even operate on the global internet system. The objective is to optimize climatic conditions based on crop data. Sensors can collect information on parameters such as air pressure, temperature, light intensity, soil moisture, water content in the air, gases, and irrigation systems like sprinklers and drip irrigation. This data can then be viewed on a user-friendly interface for effective management of the greenhouse and maximizing.

1.1 OBJECTIVES

The greenhouse environment monitoring and controlling project, based on IoT and Arduino, utilizes four sensors to detect temperature, light, humidity, and soil moisture levels inside the greenhouse. A temperature sensor is used to measure the temperature inside the greenhouse, with the readings sent to the microcontroller. The microcontroller is connected to relays, with one relay connected to a blower. If the temperature exceeds or falls below the threshold value, the microcontroller sends signals to turn on the fan. A light sensor is used to measure the amount of sunlight inside the greenhouse, with the readings sent to the microcontroller. If the sunlight exceeds the threshold value, the microcontroller sends signals to turn on a relay, which in real-time acts as a 'shade' to reduce the amount of sunlight. For demonstration purposes, a DC motor is connected to replicate a shade.

Similarly, a humidity sensor is used to measure the humidity value, and a soil moisture sensor with two probes dug in the soil is used to measure the soil moisture. If the humidity value exceeds the threshold value or if the soil moisture reduces, the microcontroller turns on a blower to decrease humidity and opens a water outlet to increase moisture in the soil. For demonstration purposes, a DC motor is connected in place of the blower and water outlet.

1.1 Overview

REQUIREMENTS- BLOCK DIAGRAM

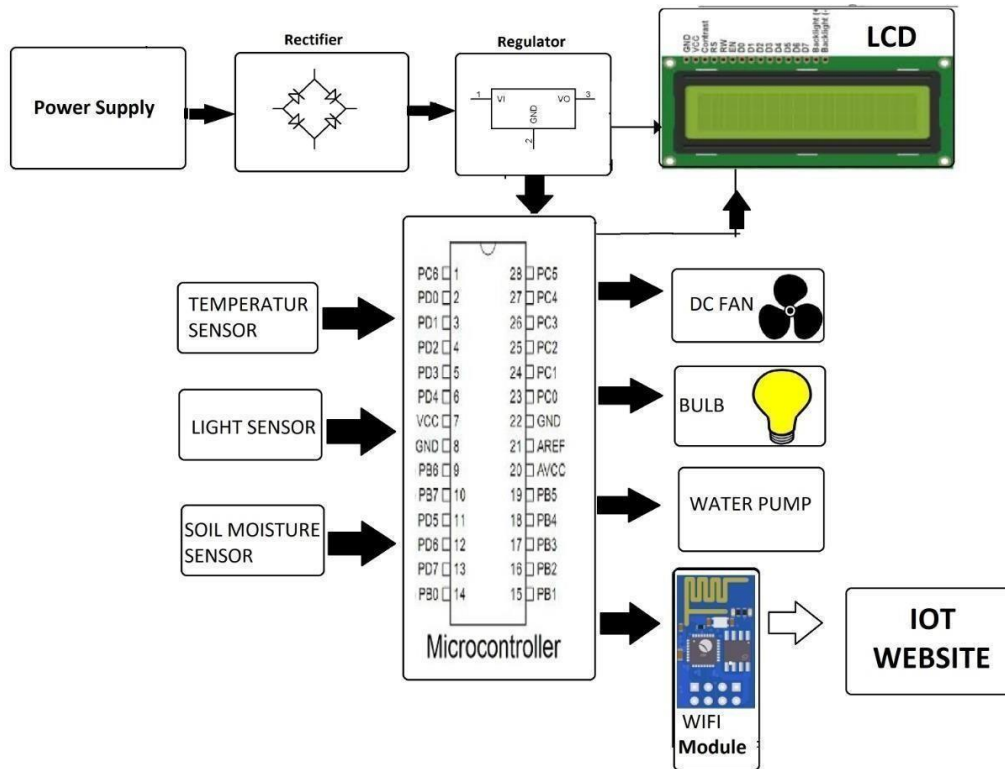


Fig- 1 Block Diagram

1.2.1 Hardware Components:

- Temperature Sensor
- Light Sensor
- Humidity Sensor
- Soil Moisture Sensor
- Microcontroller – Arduino Uno
- Relays
- DC Motor
- ESP8268

1.2.2 Software Components:

- Arduino IDE & Embedded C

1.3 HARDWARE EXPLANATION

1.3.1 Arduino UNO

Arduino is a powerful tool that enables the creation of computers capable of sensing and controlling the physical world beyond the capabilities of a typical desktop computer. It is an open-source platform for physical computing that utilizes a simple microcontroller board and a development environment for coding software for the board. With Arduino, one can develop interactive objects by integrating inputs from various switches or sensors and controlling lights, motors, and other physical outputs. Arduino projects can either be standalone or communicate with software on a computer. The boards can be assembled manually or purchased preassembled, and the open-source IDE is available for free download. The programming language used in Arduino is based on Wiring, which is a physical computing platform similar to Processing, a multimedia programming environment.

1.3.1.1 Overview of Aurdino

The Arduino microcontroller is a user-friendly yet powerful single-board computer that has gained significant popularity in both the hobbyist and professional markets. Being open-source, the hardware is affordable and the development software is free, making it accessible to a wide range of users. This guide is specifically aimed at students in ME 2011 or anyone who is new to Arduino. For more advanced users, there are ample resources available online to explore.

1.3.1.2 Arduino Uno:

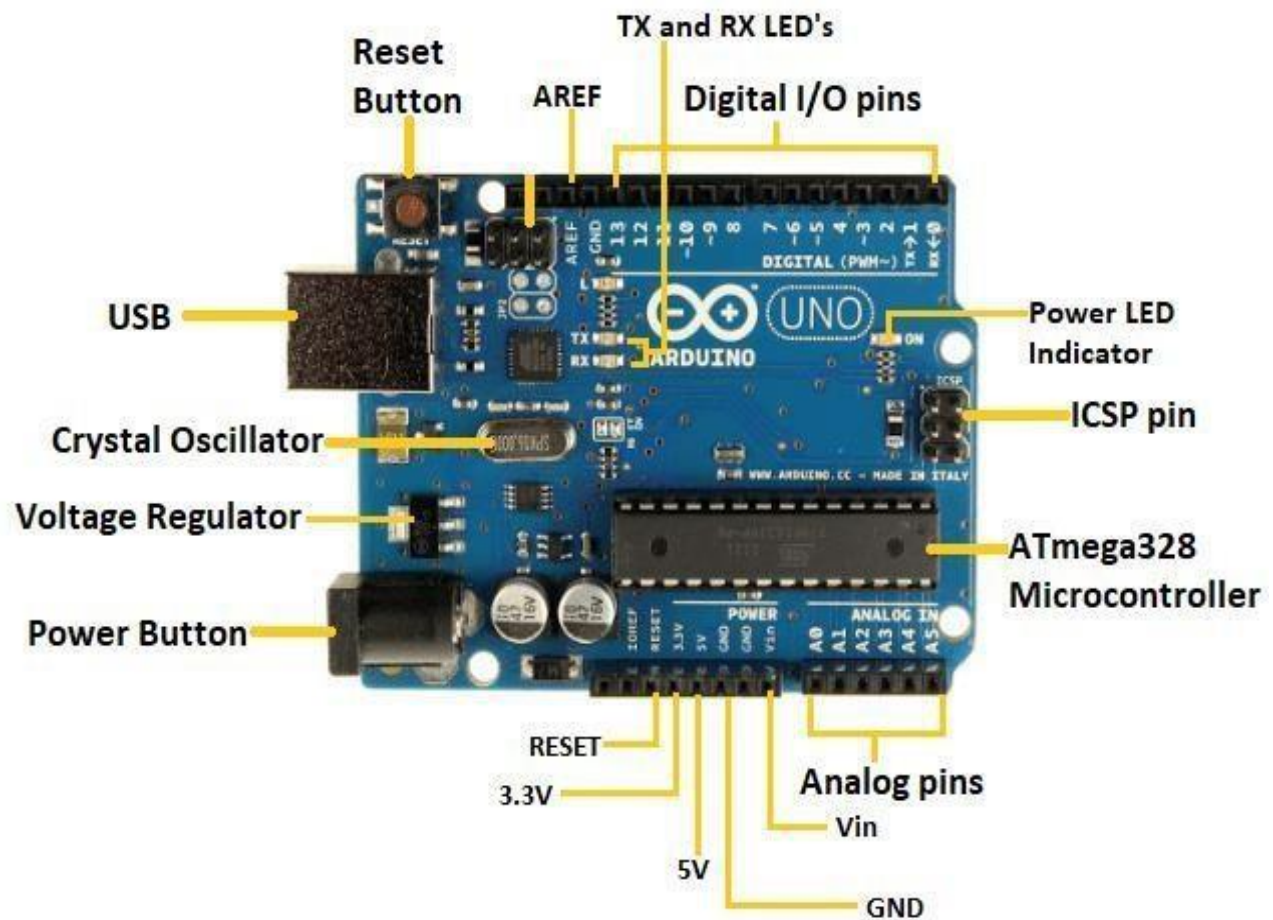


Fig- 2 ARDUINO UNO

The focus of this guide is on the Arduino Uno board (SparkFun DEV-09950, \$29.95), which is a recommended choice for students and educators. With the Arduino board, you can easily write programs and create interface circuits to read inputs from switches and sensors, as well as control motors and lights. Many of the visuals in this guide are taken from the official documentation of the Arduino Uno board, providing a clear understanding of its appearance and features.



Fig- 3 Aurdino UNO

The Duemilanove board is equipped with an Atmel ATmega328 microcontroller that operates at 5V and has 2KB of RAM, 32KB of flash memory for program storage, and 1KB of EEPROM for parameter storage. It has a clock speed of 16MHz, which allows it to execute approximately 300,000 lines of C source code per second. The board is equipped with 14 digital I/O pins and 6 analog input pins. It also includes a USB connector for communication with a host computer and a DC power jack for connecting an external 6-20V power source, such as a 9V battery, for standalone program execution. Additionally, headers are provided for easy interfacing with the I/O pins using either 22-gauge solid wire or header connectors.

The programming language used in Arduino is a simplified version of C/C++, making it familiar for those who are already familiar with C. Even if you are not familiar with C, you don't have to worry as only a few commands are needed to perform useful functions. One of the notable features of Arduino is that you can develop a control program on your host PC, download it to the Arduino, and it will automatically run. Even if you disconnect the Arduino from the PC by removing the USB cable, the program will still run from the beginning every time you push the reset button. Additionally, if you store a program in the Arduino and then disconnect the battery, you can reconnect the battery after months and the last stored program will run. This means that you only need to connect the Arduino to the host PC for development and debugging, but once that is done, you no longer need the PC to run the program.

The Arduino Uno is a microcontroller board based on the ATmega328 microcontroller. It features 14 digital input/output pins, with 6 of them capable of being used as PWM outputs, 6 analog inputs, a 16MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It comes with everything needed to support the microcontroller, and can be easily connected to a computer with a USB cable or powered with an AC-to-DC adapter or battery to get started.

What sets the Uno apart from previous Arduino boards is that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

1.3.1.3 Technical Specifications

Microcontroller:

- IC: Microchip ATmega328P^[9]
- Clock Speed: 16 MHz on Uno board, though IC is capable of 20MHz maximum at 5 Volts
- Flash Memory: 32 KB, of which 0.5 KB used by the boot loader
- SRAM: 2 KB
- EEPROM: 1 KB
- UART peripherals: 1
- I2C peripherals: 1
- SPI peripherals: 1
- Operating Voltage: 5 Volts

- Digital I/O Pins: 14
- PWM Pins: 6 (Pin # 3, 5, 6, 9, 10 and 11)^[11]
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g
- ICSP Header: Yes
- Power Sources:

1.3.2 TEMPERATURE SENSOR

Temperature is a crucial environmental parameter that is frequently measured due to its impact on various physical, electronic, chemical, mechanical, and biological systems. Many chemical reactions, biological processes, and electronic circuits perform optimally within specific temperature ranges. As a result, temperature sensing is a common practice in many fields.

There are numerous methods for temperature sensing, including both direct and remote approaches. Direct contact with the heating source is one way to measure temperature, while remote sensing involves measuring radiated energy without direct contact with the source. Today, there are a wide range of temperature sensors available in the market, such as Thermocouples, Resistance Temperature Detectors (RTDs), Thermistors, Infrared sensors, and Semiconductor Sensors.

1.3.2.1 THERMOCOUPLE

A thermocouple is a type of temperature sensor that consists of two dissimilar metals joined together at one end, known as the hot junction. The other end of the metals is called the cold end or cold junction, which is typically the last point of the thermocouple material. When there is a temperature difference between the hot junction and cold junction, a small voltage known as an electromotive force (EMF) is generated. This voltage can be measured and used to indicate the temperature.

The accompanying figure is shown below:

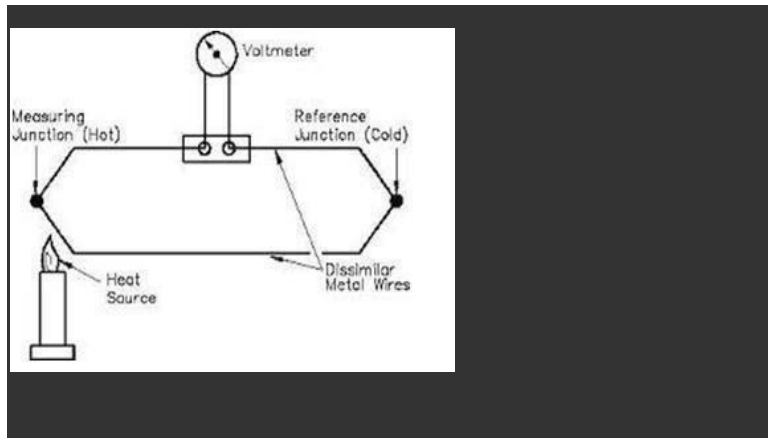


Fig- 4 Thermocouple

The RTD (Resistance Temperature Detector) is a type of temperature sensing device that changes its resistance with temperature. Typically made of platinum, although nickel or copper variants are also used, RTDs can come in various shapes such as wire wound or thin film. To measure the resistance of an RTD, a constant current is applied and the resulting voltage is measured to determine the RTD resistance. RTDs typically exhibit linear resistance-to-temperature curves within their operating range, with any nonlinearity being highly predictable and repeatable. The PT100 RTD evaluation board utilizes a surface mount RTD for temperature measurement, while an external 2, 3, or 4-wire PT100 can also be used for remote temperature sensing. The RTDs are biased using a constant current source with a low current magnitude to minimize self-heating due to power dissipation. The circuit, as shown in the figure, uses a reference voltage, an amplifier, and a PNP transistor as the constant current source. The DHT11 Temperature & Humidity Sensor is equipped with a temperature and humidity sensor complex that provides calibrated digital signal output. It utilizes an exclusive digital signal acquisition technique and temperature/humidity sensing technology, ensuring high reliability and excellent long-term stability. The sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering superior quality and fast response.

Good for 20-80% humidity readings with 5% accuracy. Good for 0-50 °C temperature readings ± 2 °C accuracy. No more than 1 Hz sampling rate (once every second) Body size 15.5mm x 12mm x 5.5mm.

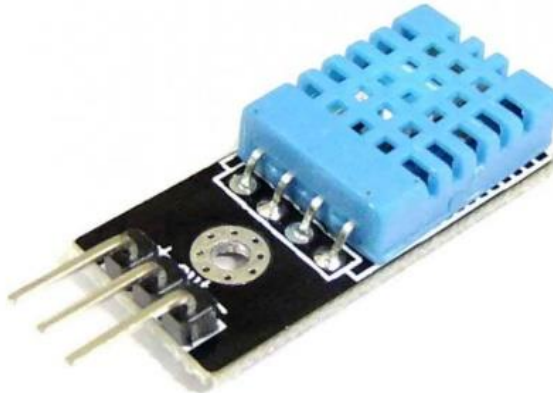


Fig- 5 DHT11 Sensor

1.3.3 Light sensor

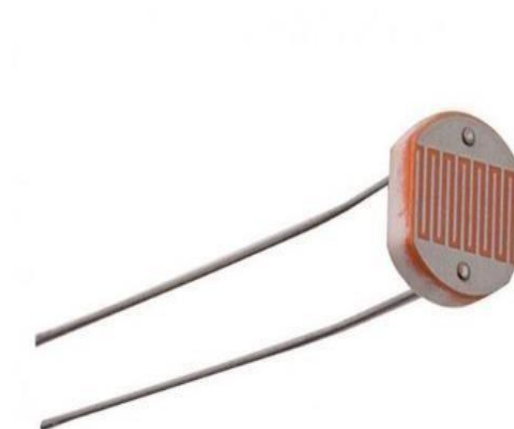


Fig- 6 Light Sensor

A light sensor is a photoelectric device that converts detected light energy (photons) into electrical energy (electrons). However, there is more to light sensors than just their definition. They come in different types and are used in various applications. In this comprehensive guide, we will explore the different types of light sensors, their applications, and provide a list of light sensors available at Seed. Additionally, we will cover how to use a light sensor with Arduino for those interested in practical implementation. Before diving into the details of light sensors, it's important to understand some commonly associated terms related to light, which are simplified for easier understanding:

Candela:

Originating from the term "candles," candela refers to luminous intensity, which indicates how strong a light appears to the naked eye.

A higher luminous intensity indicates higher sensitivity to our eyes.

Lumen:

Lumen measures the total amount of visible light emitted in all directions from a light source.

It quantifies the total amount of light emitted through the relationship between luminous intensity and the angle at which a light beam fills.

Lux:

Lux measures the total amount of light that falls on a particular surface, also known as illuminance.

It is used to measure the area where the luminous flux is spread, similar to lumen, but it takes into account the surface area.

1.3.3.1 Principle of Light Sensor

The operation principle of a light sensor is based on the internal photoelectric effect, which states that when light energy or photons strike a metal surface, it can excite and release free electrons from the metal, resulting in the flow of electric current. The amount of current generated is determined by the energy of the photons, which is correlated with the wavelength of light. The emission of electrons from the metal surface only occurs when the light reaches a specific threshold frequency that corresponds to the minimum energy required by the electrons to break the metal bonds.

The light sensor typically comprises a highly precise photoelectric tube that contains a small flat metal plate with two needle-type tubes. When light impacts the ends of the photoelectric tube and a reverse fixed pressure is applied, it results in the release of electrons or electric current. The generation of electric current or changes in electric current indicate the presence of light energy, thus allowing the light sensor to detect light.

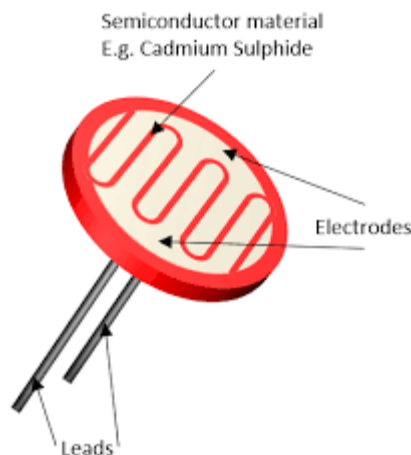


Fig – 7 Light Sensor

1.3.4 Humidity sensor

Temperature and relative humidity measurement and control are utilized in various applications across different fields. Nowadays, there are devices available that integrate temperature and humidity sensors with signal conditioning, ADC, calibration, and communication interface all built-in, making the design process simpler and more cost-effective. Previously, we discussed the use of Sensirion's SHT1x/SHT7x sensors for humidity and temperature measurements, which are highly accurate but relatively expensive for hobbyist use. In this article, we will explore the DHT11 sensor, which also provides calibrated digital outputs for temperature and humidity but at a lower cost compared to Sensirion sensors. The DHT11 sensor utilizes a proprietary 1-wire protocol, which we will implement with the PIC16F628A microcontroller to receive temperature and humidity values from the sensor.

Humidity sensors operate by detecting changes that affect electrical currents or temperature in the surrounding air. There are three main types of humidity sensors: capacitive, resistive, and thermal. All three types monitor minute changes in the atmosphere to calculate the humidity in the air.

The DHT11 Temperature & Humidity Sensor is equipped with a temperature and humidity sensor complex that provides calibrated digital signal output. It utilizes an exclusive digital signal acquisition technique and temperature and humidity sensing technology to ensure high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and can be connected to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability, and cost-effectiveness.

1.3.4.1 About DHT11 sensor

The DHT11 sensor is packaged in a single-row 4-pin package and operates on a power supply ranging from 3.5 to 5.5V. It is capable of measuring temperature in the range of 0-50 °C with an accuracy of $\pm 2^{\circ}\text{C}$, and relative humidity in the range of 20-95% with an accuracy of $\pm 5\%$. The sensor provides fully calibrated digital outputs for both temperature and humidity measurements. However, due to its proprietary 1-wire protocol, direct communication between the sensor and a microcontroller through its peripherals is not possible. The protocol needs to be implemented in the firmware of the microcontroller with precise timing requirements specified by the sensor. The data transfer protocol between the microcontroller and the DHT11 sensor is initiated by the MCU issuing a "Start" signal. To do this, the MCU pin must be configured as an output. The MCU first pulls the data line low for at least 18 ms, then pulls it high for 20-40 μs before releasing it, as depicted in the following timing diagrams.

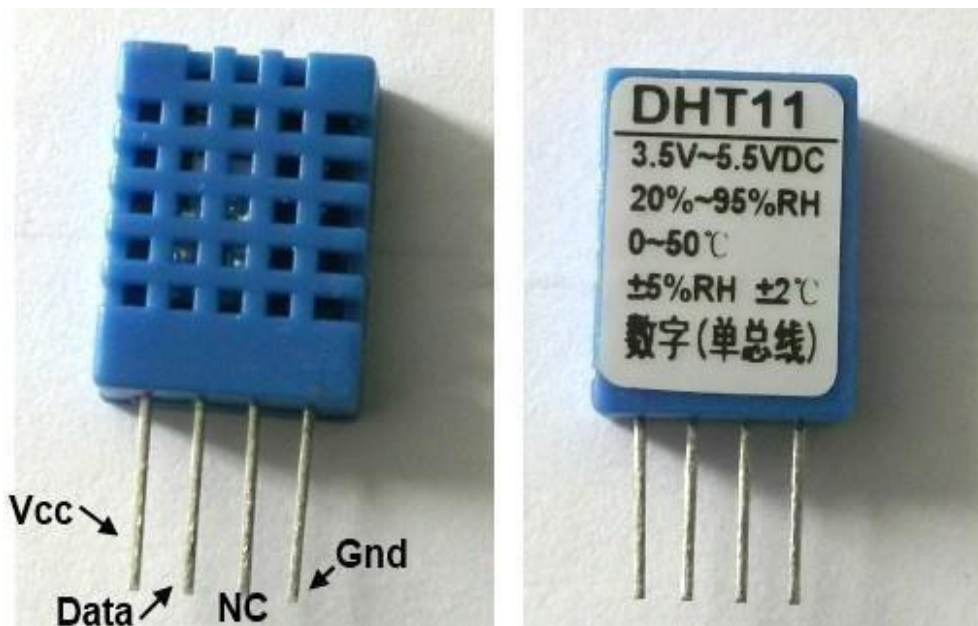


Fig 8 DHT11 Sensor

Upon receiving the "Start" signal from the MCU, the DHT11 sensor responds by pulling the data line low for a duration of 80 μ s, followed by a logic high signal that also lasts for 80 μ s. It's important to configure the MCU pin as an input after completing the "Start" signal. Once the response signal from the sensor is detected, the MCU should be prepared to receive data from the sensor. The sensor then continuously sends 40 bits (5 bytes) of data over the data line. It's worth noting that the sensor transmits the most significant bit first while sending the bytes of data.

1.3.5 Soil Moisture Sensor

Moisture in soil plays a crucial role in irrigation and plant growth in both fields and gardens. It provides essential nutrients for plant growth, and watering is necessary to regulate plant temperature through processes like transpiration. Adequate soil moisture also promotes better root development. However, excessive soil moisture can create anaerobic conditions that can benefit both plant growth and soil pathogens. This article provides an overview of soil moisture sensors, their working principles, and applications.

Soil moisture sensors are used to measure the water content in soil and estimate the amount of stored water in the soil horizon. These sensors do not directly measure water in the soil, but instead measure changes in other soil properties related to water content. Capacitance is a common method used in soil moisture sensors to gauge the water content of the soil based on its dielectric permittivity. The sensor is inserted into the soil, and the status of water content is reported as a percentage. This makes soil moisture sensors ideal for conducting experiments in various science courses such as environmental science, agricultural science, biology, soil science, botany, and horticulture.

What is a Soil Moisture Sensor?

Soil moisture sensors are a type of sensor used to measure the volumetric content of water in soil. Unlike the direct gravimetric measurement of soil moisture, which requires drying and weighing of samples, these sensors indirectly measure the volumetric water content using other properties of soil such as dielectric constant, electrical resistance, neutron interaction, or moisture replacement. The relationship between the measured property and soil moisture needs to be adjusted and can vary depending on environmental factors such as temperature, soil type, and electrical conductivity. Microwave emission and reflection, which are influenced by soil moisture, are commonly used in agriculture and remote sensing for hydrology applications.



Fig- 9 Soil-moisture-sensor-device

Soil moisture sensors are typically used to measure volumetric water content, while another type of sensors measures a related property called water potential in soils. These sensors are commonly known as soil water potential sensors and include devices such as gypsum blocks and tensiometers.

Soil Moisture Sensor Pin Configuration

The FC-28 soil moisture sensor includes 4-pins

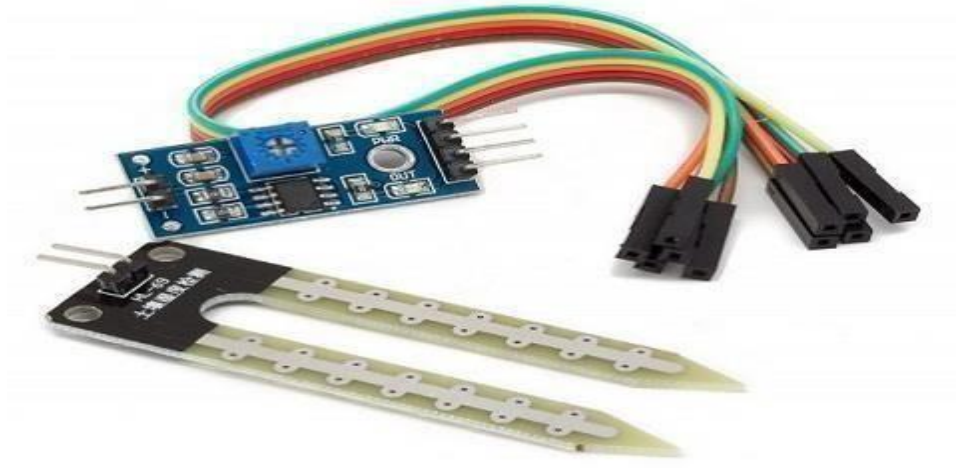


Fig- 10 Soil Moisture

soil-moisture-sensor

- VCC pin is used for power
- A0 pin is an analog output
- D0 pin is a digital output
- GND pin is a Ground

This module also includes a potentiometer that sets the threshold value, which can be evaluated by the LM393 comparator. The LED will turn on or off based on the threshold value.

- Working Principle

The soil moisture sensor primarily utilizes capacitance to measure the water content of the soil through dielectric permittivity. The sensor is inserted into the soil, and the moisture status is reported as a percentage. This makes it ideal for conducting experiments in various science courses such as environmental science, agricultural science, biology, soil science, botany, and horticulture.

The specifications of this sensor are as follows:

- Operating voltage: 5V
- Operating current: <20mA
- Interface type: Analog
- Working temperature: 10°C~30°C

Applications of the soil moisture sensor include:

- Agriculture
- Landscape irrigation
- Research
- Simple sensors for gardeners

1.3.6 LCD (Liquid crystal displays)



Fig 11
LCD

Liquid crystal displays (LCDs) are composed of materials that exhibit characteristics of both liquids and crystals. They possess a temperature range in which the molecules are highly mobile like a liquid, but also form an ordered structure similar to a crystal.

An LCD typically consists of two glass panels with a layer of liquid crystal material sandwiched between them. Transparent electrodes are coated on the inner surfaces of the glass plates to define the characters, symbols, or patterns to be displayed. Polymeric layers are present between the electrodes and the liquid crystal, helping to maintain a defined orientation angle of the liquid crystal molecules.

Polarizers are applied on the outer surfaces of the glass panels, which rotate the light rays passing through them to a specific angle in a particular direction. When the LCD is in the off state, the light rays pass through the LCD without any orientation, making it appear transparent.

When a sufficient voltage is applied to the electrodes, the liquid crystal molecules align in a specific direction, causing the light rays passing through the LCD to be rotated by the polarizers and thereby activating or highlighting the desired characters.

LCDs are known for their lightweight and slim design, with thickness typically only a few millimeters. They consume less power, making them compatible with low-power electronic circuits and suitable for long-duration usage. Backlighting can be used to enable reading in the dark, as LCDs do not generate light themselves. Additionally, LCDs have a long lifespan and can operate over a wide temperature range.

LCDs are highly customer-friendly due to their ease of changing display size or layout. They are commonly used in watches, calculators, and measuring instruments as simple seven-segment displays for limited numeric data. However, advancements in technology have led to improved legibility, increased information display capability, and wider temperature range, making LCDs extensively used in telecommunications and entertainment electronics. They are even replacing CRTs for text and graphics display, as well as finding applications in small TVs.

Crystalonics dot-matrix (alphanumeric) LCD displays are available in TN and STN types, with or without backlight. These displays can be easily interfaced with 4-bit or 8-bit microprocessors/microcontrollers, utilizing C-MOS LCD controller and driver ICs that result in low power consumption. The built-in controller IC of these LCDs features a high-speed MPU interface (2MHz),

80 x 8 bit display RAM (allowing for up to 80 characters), and a character generator ROM with 9,920 bits for a total of 240 character fonts, including 208 character fonts (5 x 8 dots) and 32 character fonts (5 x 10 dots). Additionally,

there is a 64 x 8 bit character generator RAM with 8 character fonts (5 x 8 dots) and 4 character fonts (5 x 10 dots). Programmable duty cycles, such as 1/8 for one line of 5 x 8 dots with cursor or 1/11 for one line of 5 x 10 dots with cursor, are also available

.

The LCDs offer a wide range of instruction functions such as display clear, cursor home, and display on/off. cursor on/off, display character blink, cursor shift, display shift.

1.3.7 Relay

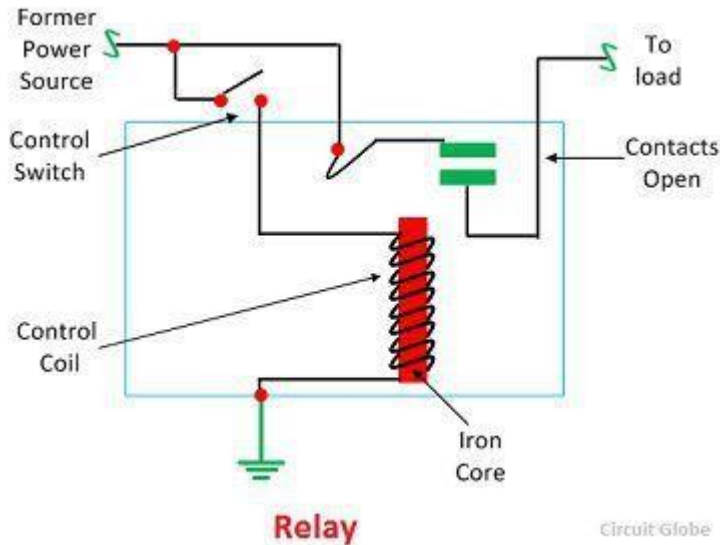


Fig- 12 Relay working

A relay is a type of switch that is operated by an electric current. It consists of a coil that, when current flows through it, generates a magnetic field that attracts a lever, causing the switch contacts to change position. Relays typically have two switch positions, making them double throw (changeover) switches. One circuit can use a relay to switch another circuit that is completely separate from the first, without any electrical connection between them.

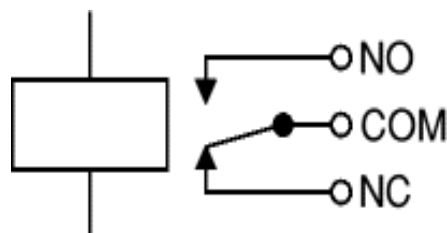
This connection is purely magnetic and mechanical in nature, relying on the principle of electromagnetic attraction. When the circuit connected to the relay detects a fault current, it activates the electromagnetic field, creating a temporary magnetic field that causes the relay to switch.

. The coil of a relay typically requires a relatively high current, such as 30mA for a 12V relay, or even up to 100mA for relays designed for lower voltages. However, many ICs (chips) are not capable of providing such high currents, and thus a transistor is often used to amplify the small current from the IC to the higher value required for driving the relay coil. For instance, the widely used 555 timer IC has a maximum output current of 200mA, which means it can directly supply relay coils without the need for additional amplification.



Fig- 13 Relay

Relays are commonly available in SPDT (Single Pole Double Throw) or DPDT (Double Pole Double Throw) configurations, but there are also relays with multiple sets of switch contacts, such as those with 4 sets of changeover contacts. Most relays are designed for mounting on printed circuit boards (PCBs), but it is also possible to solder wires directly to the pins of the relay, taking care to avoid melting the plastic case. In the animated picture, you can observe a working relay with its coil and switch contacts. The lever on the left is attracted by the magnetic field when the coil is energized, causing it to move the switch contacts. There is one set of contacts (SPDT) in the foreground, and another set behind them, making the relay capable of switching multiple circuits, DPDT.



1. **NC** = Normally Closed, COM is connected to this when the The switch connections

on a relay are typically labeled as COM (Common), NC (Normally Closed), and NO (Normally Open). The COM terminal is always connected to the moving part of the switch, and it serves as the common connection for the relay's switch contacts. relay coil is OFF.

2. **NO** = Normally Open, COM is connected to this when the relay coil is ON.

1.3.8 DC MOTORS:

A. General Information

A DC motor is employed in this laboratory experiment to drive a mechanical load, which is provided by a separately excited DC generator. The load on the motor can be adjusted by varying the field current of the DC generator. By increasing the field current, the load on the DC motor also increases. Typically, DC motors are characterized by their torque-speed curves, as depicted in Figure 9.1. However, since the lab lacks the necessary equipment for measuring shaft torque, alternative means must be employed to characterize the DC motor. One alternative approach is to plot shaft speed against armature current, as torque is directly proportional to armature current ($T = K_a * \Phi_d * I_a$) when a constant field current is supplied to the motor. Additionally, shaft speed is also influenced by the field current in a DC motor, while maintaining a constant armature voltage ($E_a = K_a * \Phi_d * \omega$), as the field current is directly proportional to the direct axis flux produced in the machine.

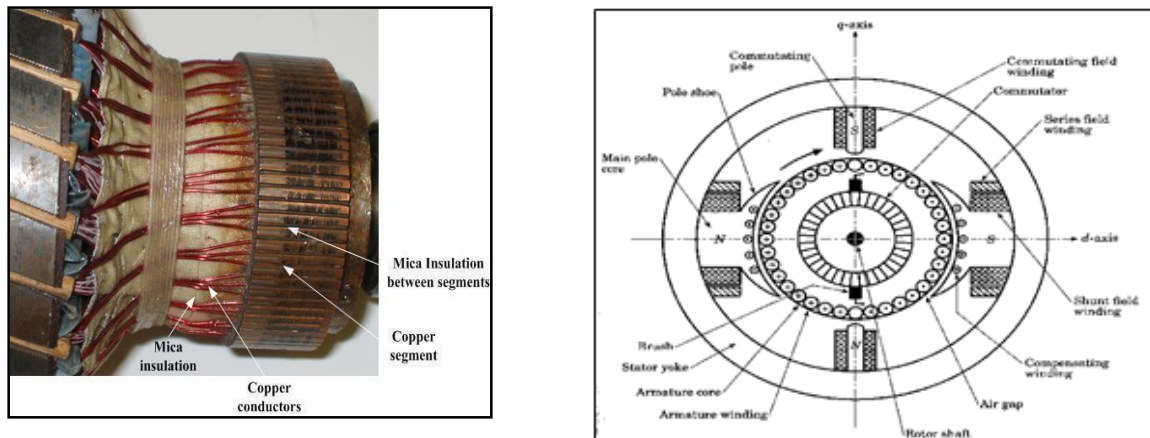


Fig- 14 DC MOTOR

The stator of a DC motor is equipped with poles that are excited by a DC current to generate magnetic fields. In order to reduce sparking of the commutator, commutating poles are positioned in the neutral zone, which lies between the main poles. These commutating poles are supplied with DC current. Compensating windings and other components are also mounted on the main poles to optimize motor performance. These

short-circuited windings damp rotor oscillations. The poles are mounted on an iron core that provides a closed magnetic circuit. The motor housing supports the iron core, the brushes and the bearings. The rotor has a ring-shaped laminated iron core with slots. Coils with several turns are placed in the slots. The distance between the two legs of the coil is about 180 electric degrees. The coils are connected in series through the commutator segments. The ends of each coil are connected to a commutator segment. The commutator consists of insulated copper segments mounted on an insulated tube. Two brushes are pressed to the commutator to permit current flow. The brushes are placed in the neutral zone, where the magnetic field is close to zero, to reduce arcing.

The rotor of a DC motor is comprised of a laminated iron core in a ring shape with slots, and the commutator consists of insulated copper segments mounted on an insulated tube. Two brushes are in contact with the commutator to allow for current flow. These brushes are positioned in the neutral zone where the magnetic field is close to zero in order to minimize arcing. The commutator is responsible for switching the current from one rotor coil to the adjacent coil, which requires interrupting the coil current. This sudden interruption of an inductive current generates high voltages, resulting in flashover and arcing between the commutator segment and the brush.

In a DC motor, the stator poles are supplied with DC excitation current, which creates a DC magnetic field. The rotor, on the other hand, is supplied with DC current through the brushes, commutator, and coils. The interaction between the magnetic field and the rotor current generates a force that drives the motor. The magnetic field lines enter the rotor from the north pole (N) and exit towards the south pole (S), generating a magnetic field that is perpendicular to the current-carrying conductors. This interaction produces a Lorentz force, which is perpendicular to both the magnetic field and the conductor. This generated force causes the rotor to rotate until the coil reaches the neutral point between the poles, where the magnetic field becomes nearly zero and the force diminishes. However, due to inertia, the motor continues to rotate beyond the neutral zone, causing the direction of the magnetic field to reverse. To prevent this reversal of force direction, the commutator changes the current direction, maintaining the counterclockwise rotation. Prior to reaching the neutral zone, the current enters segment 1 and exits from segment 2, with the current entering the coil end at slot a and exiting from slot b during this stage.

After passing the neutral zone, the current enters segment 2 and exits from segment 1, and the motor continues its operation accordingly.

This Reverses the current Direction through the rotor coi, When the coil passes the neutral zone. The result of this current reversal is the maintenance of the rotation.

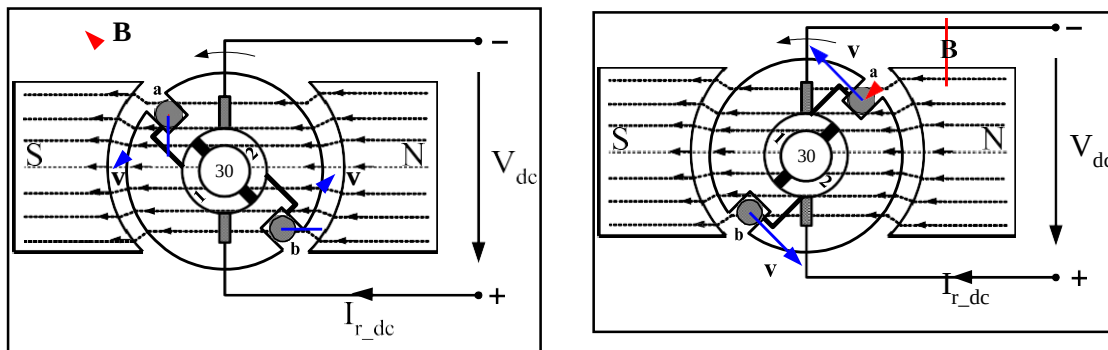


Fig 16 Working Of motor

When kept in a magnetic field, a current-carrying conductor gains torque and develops a tendency to move. In short, when electric fields and magnetic fields interact, a mechanical force arises. This is the principle on which the DC motors work.

DC motors have a wide range of applications ranging from electric shavers to automobiles. To cater to this wide range of applications, they are classified into different types based on the field winding connections to the armature as:

Self Excited DC Motor.

Separately Excited DC Motor

Current carrying conductor placed in a magnetic field experiences a force given by equation $F = B I L \sin\theta$, the direction of rotation which is given by Fleming's Left Hand rule.

1.3.9 IOT (Internet of Things)

The ultimate goal of the future internet is to establish an infrastructure that enables immediate access to information about the physical world and its objects. These physical objects can have various applications across different domains. Each individual device may have its own unique specifications that need to be considered when interacting with it. The Internet of Things (IoT) is a visionary concept that aims to seamlessly integrate the virtual world of information with the physical world of devices through a layered architecture.

The term "Internet of Things" comprises of two components: "Internet" and "Things". The Internet refers to the global network infrastructure that possesses scalable and configurable capabilities based on interoperable and standard communication protocols. "Things" refer to physical objects, devices, or virtual objects, devices, or information that possess identities, physical attributes, virtual personalities, and utilize intelligent interfaces [1]. For example, a virtual object may represent an abstract unit of sensor nodes that contains metadata to identify and discover its corresponding sensor nodes. Hence, IoT pertains to the interconnectedness of objects that provide information from the physical environment through the Internet.

Middleware serves as an interface between the hardware layer and the application layer, responsible for interacting with devices and managing information [2]. The role of middleware is to present a unified programming model for interacting with devices, while also addressing issues related to heterogeneity and distribution that arise during device interactions [3].

1.3.9.1 Motivation

IoT-based system is in charge of providing knowledge from an environment to a non-expert user. IoT-based system can be used in different environments, so it needs to be able to address many heterogeneous devices.

A significant challenge in developing an IoT-based system is how to manage the interaction with diverse devices in a user-friendly manner, particularly for non-expert users. This concern can be effectively addressed by implementing a middleware layer that acts as an interface between the devices and non-expert users.

1.3.9.2 IOT Definition:

In this section, we will provide an overview of IoT and its definitions, as well as discuss the layered architecture for IoT systems. The concept of Internet of Things (IoT) has gained significant attention in various industries due to its ability to interact with diverse types of devices. IoT has the potential to impact both private and business sectors by integrating physical devices into information networks [8]. Private users can benefit from IoT in areas such as smart homes, offices, e-health, and assisted living, while business users can experience impacts in automation, industrial manufacturing, logistics, business process management, and intelligent transportation of people and goods [9].

According to the definition provided by the International Telecommunication Union (ITU)¹, IoT is described as "a global infrastructure for the Information Society that enables advanced services by interconnecting (physical and virtual) things using existing and evolving interoperable information and communication technologies" [10].

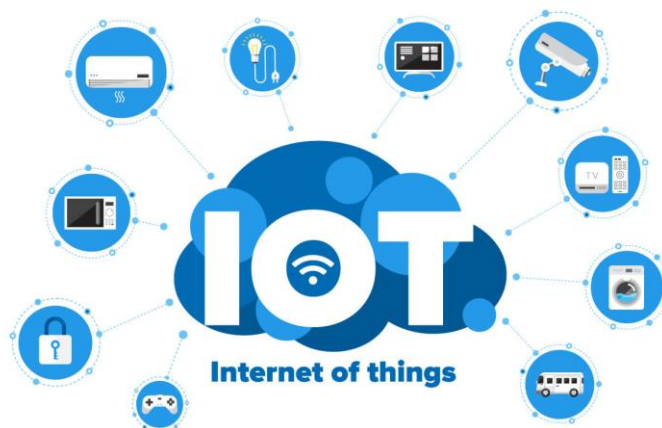


Fig-17IoT

IoT is the integration of physical objects into information networks, encompassing software, hardware, and services that support these networks. These integrated objects are capable of exchanging data about their physical properties and environment. Identification technologies such as RFID can be used to uniquely identify devices [11].

The architecture of IoT is designed with multiple layers to meet the requirements of different industries, enterprises, and society. A generic layered architecture for IoT consists of five layers, as shown in Figure 2.1, which are described below [12]:

Edge Technology Layer: This is the hardware layer that includes embedded systems, RFID tags, sensor networks, and other types of sensors. It can collect information from systems or environments, process data, and support communication.

Access Gateway Layer: This layer handles data management, including publishing and subscribing to services provided by the devices, message routing, and communication between platforms.

Middleware Layer: This layer plays a crucial role in aggregating and filtering data received from hardware devices, performing information discovery, and providing access control to devices for applications.

Application Layer

The middleware layer is tasked with delivering diverse application services in IoT-based systems. These services are provided through the middleware layer to different applications and users in various industries, such as logistics, retail, healthcare, and more. The application services offered by the middleware layer cater to the specific needs of different industries and sectors in IoT-based systems.

Figure 2-1 Layered architecture of the Internet of Things (IoT).

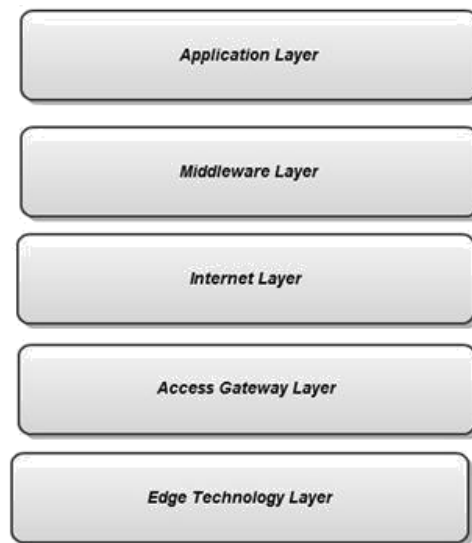


Fig - 18 Layers in IOT

1.3.10 NODE MCU

NodeMCU is a free and open-source platform that utilizes the ESP8266 chipset to facilitate seamless connectivity of objects and enable data transfer via the Wi-Fi protocol. Furthermore, NodeMCU offers crucial functionalities commonly found in microcontrollers, including GPIO (General Purpose Input/Output), PWM (Pulse Width Modulation), and ADC (Analog-to-Digital Conversion), making it a versatile and feature-rich platform for IoT applications. Rewrite this passage with same meaning.



Fig- 19 Node MCU

NodeMCU is a microcontroller platform based on the ESP8266, which is a low-cost Wi-Fi chip developed by Espressif Systems in China.

Features

The ESP8266 features a 32-bit RISC microprocessor core, running at either 80 or 160 MHz, and comes with built-in TCP/IP networking software.

It also includes ample memory options, with support for up to 16 MiB of external QSPI flash.

Additionally, the ESP8266 supports IEEE 802.11 b/g/n Wi-Fi,

Offers 17 GPIO pins for general-purpose input/output, and includes a Serial Peripheral Interface (SPI) bus for communication.

Being an open-source platform, NodeMCU allows for customization and modification of its hardware design. Rewrite this passage with the same meaning.

The ESP8266 is a low-cost Wi-Fi chip Dev Kit/board information

The ESP8266 WiFi Module, also known as NodeMCU, has a Version 2 (V2) available, specifically the NodeMCU Development Board v1.0 (Version 2), which typically comes in a black-colored PCB. There are also other NodeMCU Development Boards available in the market.

The NodeMCU Dev Kit features Arduino-like Analog (A0) and Digital (D0-D8) pins on its board, and supports various serial communication protocols such as UART, SPI, I2C, etc. This allows for connectivity with serial devices like I2C enabled LCD displays, Magnetometer HMC5883, MPU-6050 Gyro meter + Accelerometer, RTC chips, GPS modules, touch screen displays, SD cards, and more. For further information on NodeMCU boards available in the market, please refer to NodeMCU Development Boards. Rewrite this passage with the same meaning.

1.3.10.1 How to start with NodeMCU?

The NodeMCU Development board is equipped with built-in Wi-Fi capability, analog pins, digital pins, and supports various serial communication protocols. To begin using NodeMCU for IoT applications, it is important to understand how to write or download NodeMCU firmware onto NodeMCU Development Boards. Prior to that, it is necessary to obtain the appropriate NodeMCU firmware based on our specific requirements. Fortunately, there are online resources available that offer custom NodeMCU builds, making it convenient to obtain a tailored firmware that meets our specific needs.



Fig- 20 Node MCU

1.3.10.2 Invention of NodeMCU

The NodeMCU project was initiated by Hong on October 13, 2014, just a few months after Espressif Systems began producing the ESP8266 on December 30, 2013. Hong committed the first file of nodemcu-firmware to GitHub, and shortly after, developer Huang R contributed the gerber file of an ESP8266 board called devkit v0.9, which expanded the project to include an open-hardware platform.

In the following months, the NodeMCU project saw significant updates. Tuan PM ported the MQTT client library from Contiki to the ESP8266 SoC platform, enabling NodeMCU to support the MQTT IoT protocol and access MQTT brokers using Lua. Another important update was made on January 30, 2015, when Devsaurus ported the u8glib to the NodeMCU project, allowing NodeMCU to easily drive various displays such as LCDs, screens, OLEDs, and even VGA displays. In the summer of 2015, the original creators of NodeMCU abandoned the firmware project, but a group of independent contributors took over. By the summer of 2016, the NodeMCU project had grown to include more than 40 different modules, further enhancing its capabilities as a popular development platform for the ESP8266.

1.3.10.3 NodeMCU Specifications

The NodeMCU is available in various package styles, all of which are based on the ESP8266 core. These designs typically adhere to the standard 30-pin layout, but may differ in their footprint width. Some NodeMCU designs use the more common narrow (0.9") footprint, while others utilize a wider (1.1") footprint, which is an important consideration when selecting a NodeMCU board.

The Amica and LoLin are among the most common models of NodeMCU boards. The Amica follows the standard narrow pin-spacing, while the LoLin has a wider pin spacing and a larger board size. Additionally, due to the open-source nature of the ESP8266, the market constantly sees the emergence of new variants of the NodeMCU as designers continue to innovate and create new designs based on the ESP8266 architecture.

Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106

- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects

13.10.4 NodeMCU Pin out And Functions

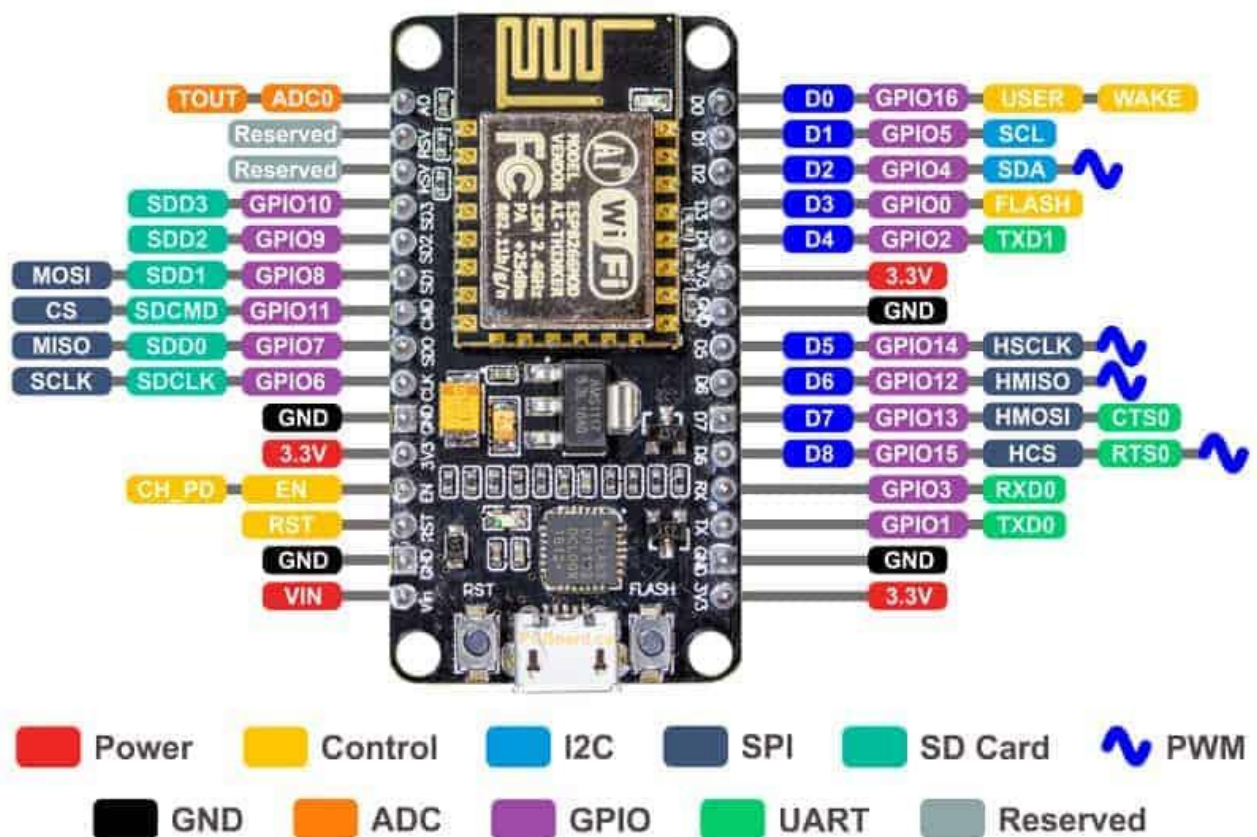


Fig- 21 MCU Specifications

The NodeMCU/ESP8266 has various pins with different functionalities:

- 1) Power pins: There are four power pins, including the VIN pin and three 3.3V pins. The VIN pin can be used to directly supply power to the NodeMCU/ESP8266 and its peripherals. Power delivered to the VIN pin is regulated through the onboard regulator on the NodeMCU module, and it can also accept 5V regulated input. The three 3.3V pins are the output of the onboard voltage regulator and can be used to supply power to external components.
- 2) GND pins: These are the ground pins of the NodeMCU/ESP8266, which provide the common reference point for electrical signals.
- 3) I2C pins: The I2C pins are used to connect I2C sensors and peripherals. Both I2C Master and I2C Slave modes are supported. The I2C interface functionality can be programmed, and the maximum clock frequency is 100 kHz. It's important to note that the I2C clock frequency should be higher than the slowest clock frequency of the slave device.
- 4) GPIO pins: The NodeMCU/ESP8266 has 17 GPIO pins that can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light, and Button programmatically. Each digital enabled GPIO pin can be configured as an input or output, and can also be configured with internal pull-up or pull-down resistors, or set to high impedance. Additionally, input pins can be configured as edge-trigger or level-trigger to generate CPU interrupts.
- 5) ADC Channel: The NodeMCU/ESP8266 has a 10-bit precision SAR ADC (Analog-to-Digital Converter). The ADC can be used for two functions: testing the power supply voltage of the VDD3P3 pin and testing the input voltage of the TOUT pin. However, it's important to note that these functions cannot be implemented simultaneously.
- 6) UART Pins: The NodeMCU/ESP8266 has two UART interfaces (UART0 and UART1) that provide asynchronous communication (RS232 and RS485) at

speeds of up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0, and CTS0 pins) can be used for communication, while UART1 (TXD1 pin) only features data transmit signal and is typically used for printing logs.

- 7) SPI Pins: The NodeMCU/ESP8266 features two SPI interfaces (SPI and HSPI) that can be used in slave and master modes for communication with SPI devices.
- 8) The NodeMCU/ESP8266 has several pins with specific functionalities:

- 9) SDIO Pins - These pins are used to interface SD cards through the Secure Digital Input/Output Interface (SDIO). The NodeMCU/ESP8266 supports 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0.

- 10) PWM Pins - These pins are also used for Secure Digital Input/Output Interface (SDIO) to interface SD cards. The NodeMCU/ESP8266 supports 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0.

- 11) Control Pins - These pins are used to control the NodeMCU/ESP8266 and include the Chip Enable pin (EN), Reset pin (RST), and Wake pin.

EN: When the EN pin is pulled HIGH, it enables the ESP8266 chip. When pulled LOW, the chip works at minimum power.

RST: The RST pin is used to reset the ESP8266 chip.

WAKE: The Wake pin is used to wake the chip from deep-sleep.

The Control Pins on the NodeMCU/ESP8266, including the Chip Enable (EN), Reset (RST), and Wake (WAKE) pins, are used to control the operation of the chip.

EN: When the EN pin is pulled HIGH, it enables the ESP8266 chip, and when pulled LOW, it puts the chip into minimum power mode.

RST: The RST pin is utilized to reset the ESP8266 chip, allowing for a fresh start.

WAKE: The Wake pin is used to wake the chip from deep-sleep mode, allowing it to resume normal operation.

Chapter 2

Literature Survey

Title: Green House Environment Monitor Technology Implementation Based on Android Mobile Platform

Author: Wei Ai, Cifa Chen The advancements in greenhouse environment monitoring technology have resulted in improved crop quality, shortened growth cycles, and increased production, making it a topic of significant theoretical significance and value for research. In this paper, we propose the use of a mobile phone as a monitoring terminal for greenhouse environment monitoring. By leveraging the capabilities of a mobile phone, we aim to monitor and analyze the greenhouse environment in real-time, enabling efficient management and optimization of greenhouse conditions for enhanced crop growth and productivity.

.Title: Smart Green House for Controlling & Monitoring Temperature, Soil& Humidity Using IOT

Author: Akash Saha,Prinyaka Sarkar Das, Bipasha Chakrabarti Banik

Agricultural economics plays a pivotal role in the overall economic development of a country, as a significant portion of the population depends on the agriculture sector for their livelihood. Higher agricultural productivity not only boosts rural incomes but also stimulates demand for industrial goods and services. In countries like India, where nearly 70 percent of the population relies on agriculture, agricultural development is crucial for overall economic growth. Agricultural development has a significant impact on farmers' incomes, leading to increased demand for farm inputs, services, and non-farm goods. Additionally, increased agricultural production creates a higher demand for processing facilities. Despite various challenges that may hinder agricultural development, smart farming has emerged as a management concept that utilizes modern technology to enhance the quantity and quality of agricultural products. Today, agriculture is increasingly leveraging sophisticated technologies such as robots, temperature and moisture sensors, aerial images, and GPS technology. These advanced devices, along with precision agriculture and

robotic systems, enable businesses to operate more profitably and efficiently in the agriculture sector. Smart farming practices have the potential to revolutionize traditional farming methods, optimize resource utilization, minimize environmental impact, and improve overall agricultural productivity, leading to sustainable agricultural development and economic growth. The advancement in greenhouse environment monitoring technology has brought about safer and more environmentally friendly agricultural practices. The main objective of this paper is to design a smartphone-controlled greenhouse with an advanced monitoring system that can effectively control various parameters such as temperature, soil moisture, and humidity in agricultural processes. The prototype presented in this paper utilizes sensors, IoT (Internet of Things), and ISP (Internet Service Provider) to monitor and control temperature, soil moisture, and humidity levels. This innovative approach to greenhouse management enables farmers to have real-time access to critical environmental data and make informed decisions to optimize agricultural processes for improved productivity, resource utilization, and environmental sustainability.

Title: Green House Monitoring and Controlling Using Android Mobile Application

Author: Aji Hanggoro, Mahesa Adhitya Putra, Rizki Reynaldo, Riri Fitri Sari

The current system has the capability to monitor but lacks the ability to control indoor humidity levels in a greenhouse. To address this limitation, a comprehensive Greenhouse Monitoring and Controlling system has been designed to effectively monitor and control humidity levels inside a greenhouse. This system utilizes an Android mobile phone connected via WiFi to a central server, which in turn communicates with a microcontroller and humidity sensor through serial communication. The results obtained from testing show that the system performs according to the specifications provided in the sensor's datasheet, demonstrating its appropriateness in real-world conditions. The successful test results confirm the proper functioning of the system, indicating its effectiveness in monitoring and controlling greenhouse humidity levels.

Title: Wireless sensing and control for precision Green housemanagement

Author: Akshay C.1 ,Nitin Karnwal2 , Abhfeeth K.A.3 , Rohan Khandelwal4 ,Tapas Govindraju5 , Ezhilarasi D.6 , Sujan Y.7

Precision greenhouse management in agriculture involves integrating information and production-based farming systems to optimize farm production in specific environments. This approach relies on intensive sensing of ground-level climate conditions and rapid communication of data to a central repository. Wireless sensor networks have emerged as a promising technology for monitoring and controlling agricultural parameters, enabling intelligent and automated systems inside greenhouses. The proposed system in this paper consists of a CPU for data monitoring using the LABVIEW platform, along with a Zigbee module and PIC microcontroller for establishing wireless communication between remote locations. The main objective of this work is to sense, monitor, and control temperature, humidity, and irrigation in a greenhouse from a remote location using Zigbee technology at a low cost. The wireless transceiver is configured using TMFT 2.6 software from Melange Systems, and the PIC microcontroller is programmed using Microchip's IDE version 8.2. This technology is intended to be simpler and more cost-effective compared to other WPANs (Wireless Personal Area Networks) such as Bluetooth or wireless internet nodes. In the current work, the data from the sensing node is amplified and fed to an ADC, which is then connected to the microcontroller. The microcontroller communicates with the Zigbee module to transmit the data to the receiving Zigbee module at the other end. The data is then displayed on the host computer through LABVIEW, and control sequences are generated to wirelessly control the greenhouse parameters from a control room.

Title: Low Cost and IoT Based Greenhouse with Climate Monitoring and Controlling System for Tropical Countries

Author: YP Jayasuriya, CS Elvitigala, K Wamakulasooriya and BH Sudantha

Greenhouses in tropical countries often face challenges in controlling temperature and humidity, despite being equipped with state-of-the-art control systems. This

research aimed to identify solutions for effectively controlling these parameters in tropical greenhouses. Weather parameters were measured using an IoT-enabled weather station, and the data was stored in a remote server. The control algorithms were developed based on the real-time and historical data available in the server, allowing for more precise and effective control of temperature and humidity inside the greenhouse.

Title: IOT Based environment change monitoring & controlling in greenhouse using WSN

Author: D Shinde and N Siddiqui

Monitoring and controlling greenhouse parameters are crucial for ensuring high-quality crop production. The objective of this system is to design a simple circuit based on Raspberry Pi 3 to continuously monitor and read values of soil moisture, humidity, temperature, and light in the environment, which are critical for optimal plant growth. In this paper, we propose a system that utilizes wireless sensor nodes to monitor soil quality. Data from each sensor is acquired and analyzed in real-time. In the past, farmers had to rely solely on human efforts to protect their fields from various disasters caused by nature or human factors, which often required significant manpower and expenses. However, in this system, we utilize sensors such as temperature, humidity, soil moisture, and light intensity sensors to monitor the field conditions. This system helps to maintain optimal soil quality for specific crop growth. The system is validated using two crops, tomatoes, and brinjals, in a greenhouse environment. Furthermore, the total power consumption and expenditures incurred for controlling devices are estimated on a yearly basis. This enables farmers to predict the total cost of controlling actions for the next year, which can lead to increased product quality and quantity compared to crops grown without proper monitoring and controlling.

Title: IOT Based Green house monitoring system**Author: S Rupali, G Hemant, K Shoaib, I Aaditya and Deep D**

A smart greenhouse-controlled environment area for optimized plant growth is being designed using an affordable and efficient programmable module, the ESP8266 NodeMCU module. The module will detect and control various climatic parameters inside the greenhouse, including soil moisture, light intensity, temperature, and humidity, based on the specific crop production requirements. The system will utilize sensors such as soil moisture sensor, LDR sensor, and DHT22 sensor for temperature and humidity data collection. The NodeMCU module will process the collected data and control parameters such as water pump, motors, exhaust system, and light system accordingly. The module will also be connected to wireless internet or IoT platforms such as telegram bot using HTTP protocol for remote monitoring and control.

Title: An IoT-based greenhouse monitoring system with Micaz motes.**Author: MA Akkas and R Sokullu**

Wireless sensor networks (WSN) have emerged as a pivotal technology in the 21st century, offering an ideal solution for distributed data collection and monitoring in challenging environments such as greenhouses. Another rapidly evolving technology of the 21st century is the Internet of Things (IoT), which has found widespread applications in diverse fields including civil, health, military, and agriculture. In modern greenhouse operations, multiple measurement points are necessary to monitor local climate parameters across various areas of a large-scale greenhouse, ensuring effective automation system operation. Traditional cabling methods can be costly, vulnerable, and challenging to relocate once installed. This paper introduces a prototype WSN system utilizing MicaZ nodes to measure temperature, light, pressure, and humidity within greenhouses. The measurement data is then shared using IoT technologies. This innovative system enables farmers to remotely control their greenhouses from their mobile phones or computers with internet connectivity, providing convenient and efficient

greenhouse management capabilities.

Title: entranceway style of Agricultural Greenhouse IoT entranceway Sensors and Sensors

Author: Li Guohong, Zhang Wenjing and Zhang Yi

Smart agriculture, also known as precision agriculture, is a modern management concept in industrial agriculture that utilizes advanced technologies such as big data, cloud computing, and the Internet of Things (IoT) to monitor, automate, and evaluate agricultural operations. Software and sensors play a crucial role in smart agriculture, enabling precise management of agricultural processes. This paper suggests the development of an affordable device for monitoring environmental parameters and electrical quantities. Through IoT devices, this system can digitize relevant data, providing farmers with valuable information to make informed decisions and optimize their agricultural practices.

Title: Greenhouse Protection Against Frost Conditions in Smart Farming using IoT Enabled Artificial Neural Networks.

Author: Chen, Joy long-Zong and Lu-Tsou Yeh.

In this innovative work, a frost forecasting system is proposed that integrates Artificial Intelligence (AI) and the Internet of Things (IoT). Within a greenhouse, objects such as actuators, sensors, and assisting aids are interconnected through IoT devices. A smart system, utilizing Fuzzy Associative Memory and Artificial Neural Networks (ANN), is designed, developed, and implemented to effectively manage potential irrigation issues arising from frost conditions. Continuous monitoring of the temperature inside the greenhouse is carried out to ensure timely and efficient frost forecasting and mitigation measures.

TITLE: IOT based greenhouse environment monitoring and controlling system using Arduino platform

Author: P. V. Vimal and K. S. Shivaprakasha

The optimal growth of plants in a greenhouse requires continuous monitoring and control of environmental parameters such as temperature, humidity, soil moisture, light intensity, and soil pH. The goal of this project is to develop a simple and cost-effective system using Arduino to monitor and update these parameters in order to achieve optimal plant growth and yield. The main sensors used in this project are DHT11 sensor, Soil Moisture sensor, LDR sensor, and pH sensor, which provide accurate values for temperature, humidity, water content, light intensity, and soil pH, respectively. The system sends the environmental parameter data to an Android mobile phone both offline and online. A GSM modem is used to send SMS alerts to the user when the sensor values exceed a predefined threshold. This allows farmers to remotely monitor the status of their greenhouse parameters and control actuators such as cooling fans, exhaust fans, water pumps, artificial lights, and motor pumps by sending SMS commands. Alternatively, Ethernet is used to send the data parameters to the mobile phone, eliminating SMS charges. The data is also sent to a server through Ethernet and stored in a database, allowing users to monitor and control the parameters through an Android mobile application. This system provides farmers with convenient and efficient control over their greenhouse environment, enabling optimal plant growth and yield.

Title: Intelligent agriculture greenhouse environment monitoring system based on IOT technology.

Author: L. Dan, C. Xin, H. Chongwei and J. Liangliang.

In recent years, the field of greenhouse technology in agriculture has been rapidly evolving towards automation and information technology, particularly with the widespread application of Internet of Things (IoT) technology. In this paper, the design and implementation of an agriculture greenhouse environment monitoring system based on ZigBee technology is presented, with the CC2530 chip serving as the core component. The wireless sensor and control nodes utilize the CC2530F256 chip to control the collection of environmental data.

The system is composed of front-end data acquisition, data processing, data transmission, and data reception modules. The data terminal node's temperature sensor continuously captures and processes ambient temperature data in real-time. The processed data is then wirelessly transmitted to an intermediate node, which aggregates all the data and sends it to a PC through a serial port. The PC allows staff to view, analyze, and store the data, providing real-time information for temperature control equipment such as fans in the agricultural greenhouse. This enables automatic temperature control based on the received data, ensuring optimal environmental conditions for plant growth.

Title: IOT Based environment change monitoring & controlling in greenhouse using WSN

Author: Dattatraya Shinde and Naseem Siddiqui

As we are aware, monitoring and controlling greenhouse parameters are crucial for ensuring high-quality crop production. The objective of this system is to design a simple circuit based on Raspberry Pi 3 that can continuously monitor and read values of soil moisture, humidity, temperature, and light in the environment, and make necessary adjustments to optimize plant growth. In this paper, we propose a system that utilizes wireless sensor nodes to monitor soil quality. Data is collected from each sensor used in this system to assess the environmental conditions. In the past, farmers had to rely on manual efforts to protect their fields from various disasters caused by human or natural factors, which often required significant manpower and resources. In this system, we employ temperature, humidity, soil moisture, and light sensors to continuously monitor the field conditions. This allows for effective maintenance of soil quality, which is essential for proper crop growth. The system is designed to predict and analyze greenhouse parameters, specifically for tomatoes and brinjals as the selected crops. Two sets of crop samples were taken and the system was verified in a greenhouse environment. Additionally, the total power consumption and expenditures associated with controlling devices were estimated for one year. This information enables farmers to predict the total costs of controlling crop growth for the next year. Through the

use of this system, it was observed that controlled action resulted in increased product quality and quantity compared to crops grown without such action, thus demonstrating the positive impact of monitoring and controlling greenhouse parameters on crop growth.

Title: Greenhouse Monitoring and Control System Based on Zigbee Wireless Sensor Network

Author: Jian Song

To overcome the limitations of wired systems, such as complex wiring and low anti-interference capacity, a wireless measurement and control system for greenhouse is developed using Zigbee technology. The system consists of an upper monitor control PC, wireless gateway CC2430, sensor node CC2430, and sensor modules. Based on the characteristics of greenhouse control systems, a star network topology is adopted. The wireless sensor network is structured in a tree topology, comprising of a center controller and six wireless sensor nodes. The hardware circuit for the sensor nodes is designed to include temperature sensors, humidity sensors, and illuminance sensors. The software for the wireless modules is programmed in C language using IAR Embedded Workbench for MCS-51 Evaluation. Additionally, a user interface software is developed using Visual C++ 6.0 for Windows. The system is tested in a 70m x 10m greenhouse with six wireless sensor nodes evenly distributed. The results show that the measurement error for temperature, humidity, and illuminance is within 3%, indicating the accuracy and reliability of the system.

CHAPTER 3

METHODOLOGY

3.1 EXISTING SYSTEM

The existing system for greenhouse automation comprises of three main components: the HSM 20G humidity sensor module with signal conditioning circuit, the PIC18F452 microcontroller, and the ZigBee transceiver present at both the transmitting and receiving ends. At the receiving end, the ZigBee module is connected to a host computer for continuous monitoring and database maintenance. Wireless communication with simple hardware and user-friendly software, such as Labview, has been demonstrated as an efficient solution for automated greenhouse management in agriculture. The approach allows for monitoring and control of climate and irrigation systems, making it a valuable tool in high-tech agriculture. Although the experimental results have been shown for two parameters, the system is scalable and can be extended to monitor and control additional parameters. The proposed approach has the potential for remote crop monitoring and control using Wireless Sensor Network (WSN) technology for large-scale greenhouses. The system is user-friendly, low-cost, and easily implementable, making it a promising solution for modern greenhouse automation.

Disadvantages

- Can be expensive to build.
- Can be expensive to heat.
- Requires constant monitoring, maintenance and care.
- Could increase electrical and water bills.
- May detract from aesthetic appeal of a garden.

3.2 Proposed System

This project is designed to monitor and control the greenhouse environment using IoT and Arduino. Four sensors are used to detect the temperature, light, humidity, and soil moisture inside the greenhouse. The temperature sensor detects the temperature, and if it goes above or below the threshold value, a signal is sent to the microcontroller. The microcontroller is connected to relays, and one of them is connected to a blower to turn on the fan if necessary. The light sensor detects the amount of sunlight, and if it is above the threshold value, a signal is sent to the microcontroller to turn on the relay that would reduce the amount of sunlight. Similarly, the humidity sensor and soil moisture sensor are used to detect the humidity level and soil moisture, respectively. If the humidity value or soil moisture decreases, the microcontroller would turn on a DC motor in place of a blower and water outlet to decrease the humidity or increase the soil moisture.

Data from these sensors are sent to the IoT module (ESP8266) at regular intervals, and the ESP8266 chip is used to connect the microcontroller to the Wi-Fi network and send data. It also allows TCP/IP connections to be made. The project requires a Wi-Fi module to be connected to a Wi-Fi zone or hotspot. In the absence of the IoT module, a GSM module can be used to trigger an SMS. This project is user-friendly, low-cost, and can be easily implemented, making it ideal for greenhouse monitoring and control using IoT and Arduino technology.

Advantages

- This system helps in monitoring and controlling the climatic conditions that are favorable for the cultivation of a particular plant.
- By using this system, crop growth can be improved along with maximized yield, irrespective of the weather conditions.
- This project can be further enhanced to monitor and control the pesticide level

CHAPTER- 4

RESULT AND DISCUSSION

Greenhouse monitoring and controlling system is about knowing the climatic conditions of environment in a greenhouse. Greenhouse monitoring and controlling system- the project works through NodeMCU using IOT. The sensors in the unit are connected and processed through NodeMCU using Blynk IoT application.

According to the recommended conditions of plants, the following temperature and water flow is set by the programming of the system. The particular climate conditions make plant to grow in its perfect growth and with protection.

With the green house system, Temperature is measured, Amount of sunlight is measured, Humidity is measured and soil moisture is measured. By the use “Blynk IoT” Application, the following readings of temperature, sunlight, soil moisture, humidity is specified and controlled.

While process of the system is begin, the first reading is specified about temperature. When temperature increases the above programmed temperature in Green house, then automatically DC motor get starts to control the temperature of green house. The sunlight measurements also displayed in Blynk application in according to light sensor. Another main measurement – Soil Moisture is displayed in application and LCD.

When the moisture of the soil decreases the DC motor starts automatically and pumps the water to soil up to its essential. And the soil moisture works in according to Soil sensor. DC motor turns off when the soil moisture in soil gets up to the limit. The Soil moisture system can be allocated according to timing system too.

So according to specified climatic conditions- Temperature, Humidity, Soil moisture, Sunlight the plant maintained perfect to obtain good production.

The Following result diagram

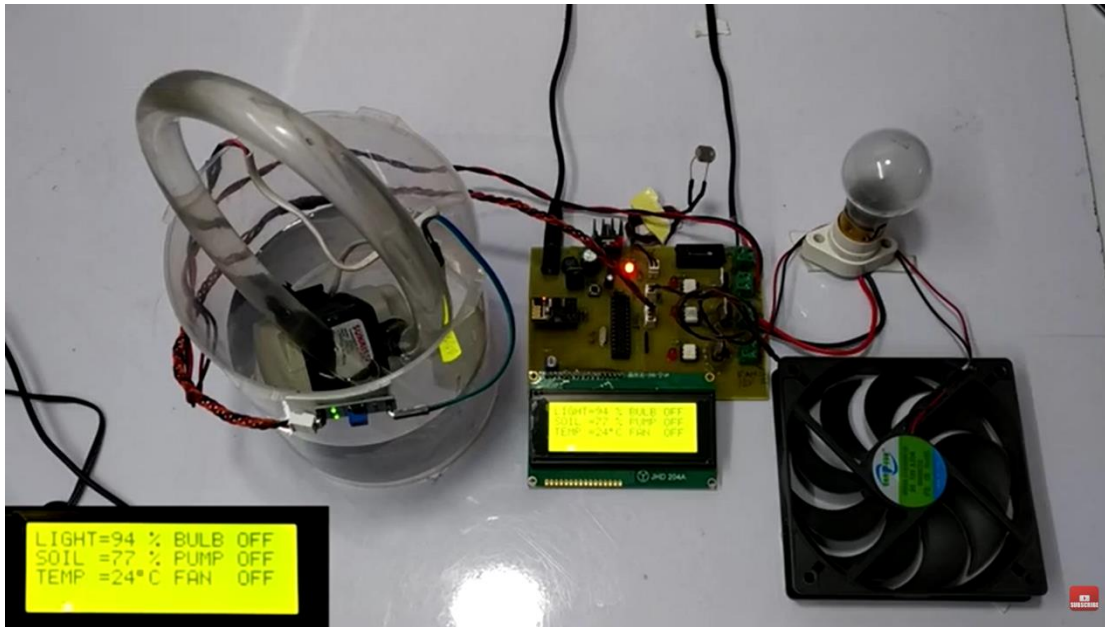


Fig 22 Whole unit



Fig 23 Measuring Parameters.

CHAPTER- 5

CONCLUSION

The implementation of an IoT-based smart greenhouse monitoring system has proved to be a game-changer for the agriculture sector, which previously relied on labor-intensive and time-consuming traditional monitoring methods. The proposed system has not only saved time, money, and human effort but has also provided a controlled environment for the plants, resulting in an overall increase in yield. The smart greenhouse automatically optimizes various parameters for plant growth and sends real-time data to a customized webpage for continuous and effective monitoring. This project can be used not only in greenhouses, botanical gardens, and agriculture farms but also in mechanical companies and mills to measure various parameters of operating machines such as temperature and others with minimal modifications.

FUTURE SCOPE

In the future, we can expand the capabilities of plant monitoring systems by incorporating image processing techniques to assess the health condition of plants. This would allow us to identify any areas with dead cells or unhealthy plant parts. Additionally, we could use various technologies to detect the amount of chemicals required for optimal plant growth. By monitoring the specified climatic conditions, such as temperature, humidity, soil moisture, and sunlight, we can ensure that plants are maintained in a perfect environment, resulting in good production and healthier plants and surroundings. By deploying wireless sensors throughout a greenhouse, we can measure temperature, humidity, CO₂, and light levels, and adjust the environment in real-time with a grow room controller. The sensors send crop-level data to an operating system, which controls motors that open or close based on specific triggers.

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