A

MAJOR PROJECT REPORT

on

SERICULTURE AUTOMATION SYSTEM CLIMATE CONTROL AND PRODUCTION EFFICIENCY

Submitted in partial fulfillment of the Requirements for the award of

Degree of

BACHELOR OF TECHNOLOGY

in

Dept. of Electronics & Communication Engineering

By

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Colombonagar, Yeshwanthapur, Jangaon- 506167, Telangana

2025-2026

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CERTIFICATE

This is to certify that the project entitled "**Sericulture automation system for climate control and production efficiency"** that is being submitted by **PARIDULA VYSHNAVI (22681A0448), SANA (23685A0412), YENUGULA RAHUL KUMAR (22681A0460), NASARAPU PRANAY (23685A0410)** in partial fulfillment of the requirements for the award of degree of **Bachelor of Technology** in "**Electronics & Communication Engineering**" and submitted to **Christu Jyothi Institute of Technology and Science, Jangoan,** is a record of bonafide work carried out by them under our guidance and supervision.

Signature of Guide
(B.SANDEEP KUMAR)

Signature of HOD
(Allanki Sanyasi Rao)

Signature of External Examiner

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2025-2026

Dept. of Electronics & Communication Engg.

Institution Vision and Mission

VISION

To admit and groom students from rural background and be a truly rural technical institution, benefiting society and nation as a whole institute.

MISSION

- The mission of the institution is to create, deliver and refine knowledge. Being a rural technical institute, our mission is to.
- Enhance our position to one of the best technical institutions and to measure our performance against the highest defined standards.
- Provide highest quality learning environment to our students for their greater well- being so as to equip them with highest technical and professional ethics.
- Produce engineering graduates fully equipped to meet the ever-growing needs of industry and society.

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2025-2026

Dept. of Electronics & Communication Engg.

Department Vision & Mission

VISION

To be an established center of excellence in Electronics and Communication Engineering facilitating youth towards professional, leadership and industrial needs.

MISSION

- Impart theoretical and practical technical education of high standard with quality resources and collaborations.
- Organize trainings and activities towards Overall personality development in time with industrial need.
- Promote innovation towards sustainable solutions with multi discipline team work with ethics.

HOD

<u>DECLARATION</u>

The project entitled **“SERICULTURE AUTOMATION SYSTEM FOR CLIMATE CONTROL AND PRODUCTION EFFICIENCY**” is a record of the bonafide work undertaken by us towards partial fulfilment of the award of Degree of **Bachelor of Technology** in Electronics and Communication Engineering, to Christu Jyothi Institute of Technology and Science, Jangaon, affiliated to JNTU, Hyderabad is an authentic work and has not been submitted to any other university or institution for award of the degree.

PROJECT MEMBERS

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ABSTRACT

Sericulture denotes to the rearing of silkworm to produce silk. Parameters like Temperature, Humidity and Light intensity are the important factors in the progression of silkworms and suitable encouraging must to be done according to the requisites in every stage. Sericulture is the process of nurturing silkworm to produce silk. Many biotic and abiotic factors are responsible for growth and development of silkworm and successful crop harvest. Modernization with introduction of new technologies is the only alternative to mitigate the limitations of traditional labour intensive sericulture practices and to enhance silk production. Artificial intelligence with IoT will benefit the progress of silkworm and host plant sector by maintaining temperature, humidity and other related factors. Remote sensing technique is arising as a suitable tool for identification of favourable sites for plantation.

Environmental variations assume as the important part in the growth and development of silkworm. Sericulture is the important occupation in India and the techniques used by the agriculturists are yet outdated. Hereafter there is the need of developing modernization in sericulture cultivate. This endeavor gives a thought of providing automation in sericulture cultivate. The model goals at making use of developing technology that is IOT and smart Sericulture using automation. Observing environmental parameters of the silkworm rearing house is the most important aspect to improve vintage of the silk.

CONTENTS

LIST OF FIGURES

ACRONYMS

ADC	Analog to Digital Converter
LED	Light -Emitting Diode
DHT	Digital Humidity and Temperature
IoT	Internet of Things
COM	Component Object Model
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DRAM	Dynamic Random Access Memory
EEPROM	Electrically Erasable Programmable Read-Only Memory
GND	Ground
PWR	Power
RAM	Random Access Memory
ICSP	In-Circuit Serial Programming
IDE	Integrated Development Environment
PAN	Personal Area Network
MISO	Master In Slave Out
MOSI	Master Out Slave In

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Internet of Things (IoT) is an ideal buzzing technology to influence the Internet and communication technologies. IoT allows people and things to be connected anytime, anyplace, with anything and anyone, by using ideally in any path/network and any service. This project introduces a thought or an idea for home computerization utilizing voice acknowledgment, also the development of a prototype for controlling smart homes devices through IoT and controlling of dumb devices through IoT by the means of Wi-Fi driven chipset solution – ESP8266. This is also acknowledged by the need to give frameworks which offers help to matured and physically impaired individuals, particularly individuals who lives alone. Smart home or home automation can be said as the residential extension of building automation, it also involves the automation and controlling of lightings, ACs, ventilation and security which also includes home appliances such as dryers/washers, ovens or refrigerators/freezers which uses Wi-Fi for monitoring via remote for ease of use. Now a day's speed of the processing and communication through smart mobile devices at very affordable costs, to improve the lifestyle concept relevant to smart life, like smart T.V, Smart cities, smart phones, smart life, smart school and Internet of Things.

1.2 INTRODUCTION OF IoT TECHNOLOGY

- The Internet of Things (IoT) refers to the network of interconnected devices that communicate and share data with each other over the internet. These devices can range from everyday household items to industrial machinery.
- The term "Internet of Things" has come to describe a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical objects. The Internet of Things, also called The Internet of Objects, refers to a wireless network between objects. From any time, any place connectivity for anyone, we will now have connectivity for anything

- IoT involves embedding sensors, software, and other technologies into physical objects, allowing them to collect and exchange data. This connectivity enables devices to be monitored and controlled remotely, creating a smarter and more automated world.

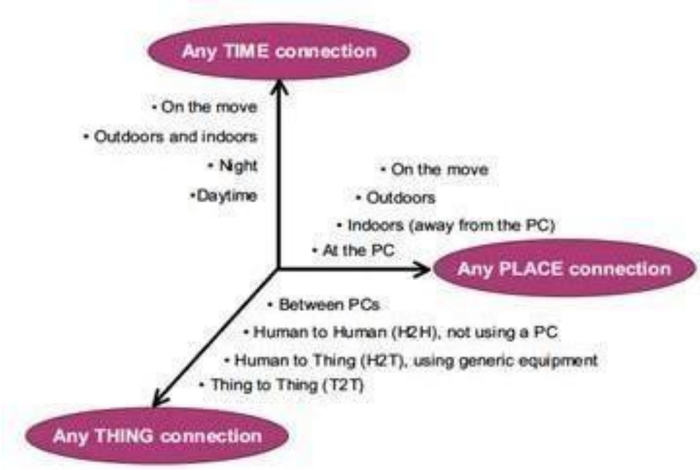


Figure 1: IoT Technology

1.3 The Vision

To improve human health and well-being is the ultimate goal of any economic, technological and social development. The rapid rising and aging of population is one of the macro powers that will transform the world dramatically, it has caused great pressure to food supply and healthcare systems all over the world, and the emerging technology breakthrough of the Internet-of-Things (IoT) is expected to offer promising solutions. Therefore, the application of IoT technologies for the food supply chain (FSC) (so-called Food-IoT) and in-home healthcare (IHH) (so called Health-IoT1) have been naturally highlighted in the strategic research roadmaps.

To develop practically usable technologies and architectures of IoT for these two applications is the final target of this work. The phrase "Internet of Things" (IoT) was coined at the beginning of the 21st century by the MIT Auto-ID Centre with special mention to Kevin Ashton and David L. Brock.

As a complex cyber-physical system, the IoT Integrates all kinds of sensing, identification, communication, networking, and informatics devices and systems, and seamlessly connects all the people and things upon interests, so that anybody, at any time and any place, through any device and media, can more efficiently access the information

Micro Electro Mechanical Systems (MEMS), mobile internet access, cloud computing, Radio Frequency Identification (RFID), Machine-to-Machine (M2M) communication, human machine interaction (HMI), middleware, Service Oriented Architecture (SOA), Enterprise Information System (EIS), data mining, etc. With various descriptions from various viewpoints, the IoT has become the new paradigm of the evolution of information and communication technology (ICT).

1.4 Definition of Internet of things (IoT)

“Today computers and, therefore, the Internet are almost wholly dependent on human beings for information. Nearly all of the roughly 50 petabytes (a petabyte is 1,024 terabytes) of data available on the Internet were first captured and created by human being by typing, pressing a record button, taking a digital picture, or scanning a bar code.

Conventional diagrams of the Internet … leave out the most numerous and important routers of all - people. The problem is, people have limited time, attention and accuracy all of which means they are not very good at capturing data about things in the real world. And that's a big deal. We're physical, and so is our environment … You can't eat bits, burn them to stay warm or put them in your gas tank. Ideas and information are important, but things matter much more. Yet today's information technology is so dependent on data originated by people that our computers know more about ideas than things. If we had computers that knew everything there was to know about things using data they gathered without any help from us we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best. The Internet of Things has the potential to change the world, just as the Internet did. Maybe even more so”.

“Things are active participants in business, information and social processes where they are enabled to interact and communicate among themselves and with the environment by exchanging data and information sensed about the environment, while reacting autonomously to the real/physical world events and influencing it by running processes that trigger actions and create services with or without direct human intervention.”

1.5Key Components of IoT

- **Devices/Sensors:** These are physical objects embedded with sensors and actuators that collect and transmit data. Examples include smart thermostats, wearable fitness trackers, and industrial sensors.
- **Connectivity:** Devices connect to the internet or other networks using various technologies such as Wi-Fi, Bluetooth, Zigbee, or cellular networks.
- **Data Processing:** The data collected by IoT devices is often processed either on the device itself or sent to a cloud-based server. This data can be analyzed to gain insights, make decisions, or trigger actions.
- **User Interface:** Users interact with IoT systems through applications or dashboards, allowing them to monitor and control devices.

1.6Applications of IoT

- **Smart Homes:** Automate and control home systems like lighting, heating, and security remotely.
- **Healthcare:** Monitor health metrics and track medication adherence with connected devices**.**
- **Industrial IoT:** Predict equipment failures, optimize manufacturing, and manage supply chains.
- **Agriculture:** Enhance farming with precision tools, automated irrigation, and livestock monitoring.
- **Transportation:** Track and manage vehicles, optimize routes, and support autonomous driving.
- **Smart Cities:** Improve public safety, waste management, and traffic flow with connected infrastructure.
- **Retail:** Manage inventory, personalize customer experiences, and monitor supply chains.
- **Energy Management:** Optimize energy use with smart grids and renewable energy integration.
- **Environmental Monitoring:** Track climate, pollution, and wildlife to better respond to natural events.
- **Education:** Enhance learning environments with smart classrooms and campus security systems.

1.7Benefits of IoT

- Improved citizen's quality of life Healthcare from anywhere
- Better safety, security and productivity
- New business opportunities
- IoT can be used in every vertical for improving the efficiency
- Creates new businesses, and new and better jobs
- Economic growth
- Billions of dollars in savings and new services
- Better environment
- Saves natural resources and trees
- Helps in creating a smart, greener and sustainable planet
- Improved Competitiveness, Competitive in providing cutting edge products/services.

1.8 Characteristics for Internet of Things:

- Event driven
- Ambient intelligence
- Flexible structure
- Semantic sharing
- Complex access technology

Anyone who says that the Internet has fundamentally changed society may be right, but at the same time, the greatest transformation actually still lies ahead of us. Several new technologies are now converging in a way that means the Internet is on the brink of a substantial expansion as objects large and small get connected and assume their own web identity.

Following on from the Internet of computers, when our servers and personal computers were connected to a global network, and the Internet of mobile telephones, when it was the turn of telephones and other mobile units, the next phase of development is the Internet of things, when more or less anything will be connected and managed in the virtual world.

Smart connectivity with existing networks and context-aware computation using network resources is an indispensable part of IoT. With the growing presence of Wi-Fi and 4G-LTE wireless Internet access, the evolution towards ubiquitous information and communication networks is already evident. However, for the Internet of Things vision to successfully emerge, the computing paradigm will need to go beyond traditional mobile computing scenarios that use smart phones and portables, and evolve into connecting everyday existing objects and embedding intelligence into our environment. For technology to disappear from the consciousness of the user, the Internet of Things demands: a shared understanding of the situation of its users and their appliances, software architectures and pervasive communication networks to process and convey the contextual information to where it is relevant, and the analytics tools in the Internet of Things that aim for autonomous and smart behavior. With these three fundamental grounds in place, smart connectivity and context-aware computation can be accomplished.

CHAPTER 2

LITERATURE SURVEY

2.1 Automation Smart Sericulture System

B Adharse et al. (2016) 'Automated Smart Sericulture System based on 6LoWPAN and Image Processing Technique**'** Sericulture is the process of growing silkworms for the purpose of producing silk. India is the world's second-largest silk producer. Sericulture is at the heart of India's social, economic, cultural, and political development. Temperature and humidity play a critical role in the growth of healthy silkworms at all stages, particularly during larval development. Disinfection is one of the most important factors to consider when raising healthy and successful silkworms.

2.2 Smart Sericulture System Climate Control

Srinivas B (2018) Sericulture is an important occupation in India, but outdated techniques are still used. This project aims to introduce automation in sericulture by utilizing lot and smart sericulture systems. It involves monitoring temperature, humidity, and light intensity using sensors and sending notifications to the user's mobile application.

2.3 Monitoring Using Sensor

N.A. Dawande, prof [2019] The research paper highlights the importance of sericulture in India, the need for automation in silk production, and the application of lot and data analytics for monitoring and improving sericulture. It suggests using lot sensors, an Oracle database, and Tableau for data analysis and visualization.

2.4 Temperature and Humidity Measure by DHT11 Sensor

Dixit M.A et al. (2015), 'Intelligent Control System for Sericulture'. Sericulture (the manufacture of silk) is an important rural occupation. India is the world's second largest silk producer, accounting for around 15% range, of global production after China, which accounts for a staggering 80%. An examination of Indian sericulture processes reveals a significant need for automation, particularly during the pre-cocoon stages. During this phase, the silkworms go through critical bodily changes that impact the quality and amount of the silk produced. It recommends a low cost and efficient wireless sensor network with IoT technology to monitor and control the temperature, humidity.

2.5 Including Mapping and Increasing Productivity

Shilpa Saikia1[2017], The article describes how Internet of Things (IoT) may be used in sericulture to automate maintenance and monitoring. It implies that loT may support sericulture in a number of ways, including mapping, increasing productivity, and monitoring for diseases and pests. The potential for loT and artificial intelligence (AI) to be combined for sustainable sericulture is also mentioned.The current technique and one of the oldest methods in sericulture is the labor-intensive way of checking the factors. In this technique the agriculturalists they themselves authenticate each and every factors and compute the required values. It emphases on emerging devices and tools to achieve, display and aware the operators via the benefits of a wireless sensor network scheme. It goals at building sericulture smart by applying automation and IoT technologies.

2.6 Wi-Fi Based Smart Sericulture

Poornima, G. R. [3], The introduction of sericulture the raising of silk worms-and its significance for rural subsistence are highlighted in this study. It emphasises the benefits of silk and the importance of silkworms, as well as the difficulties encountered during their metamorphosis. The suggested approach recommends use an Arduino board for automating the cultivation of sericulture and controlling weather. It emphases on emerging devices and tools to achieve, display and aware the operators via the benefits of a wireless sensor network scheme. It goals at building sericulture smart by applying automation and IoT technologies. The cloud computing devices that can make a whole computing system from sensors to tools, that observe data from sericulture field and precisely load the records into the sources. This system suggests an innovative methodology for smart farming by connecting a smart sensing devices and smart controlling system through wireless communication technology. It recommends a low cost and efficient wireless sensor network with IoT technology to monitor and control the temperature, humidity and light intensity present in silkworm rearing house.

CHAPTER 3

OVERVIEW OF THE PROJECT

3.1 INTRODUCTION

Blindness A sericulture automation system refers to the use of modern technologies—such as sensors, IoT (Internet of Things), AI (Artificial Intelligence), image processing, and automated actuation—to monitor, regulate, and optimize the process of silk-worm rearing and related activities. Traditionally, sericulture depends heavily on manual labor and human judgment to maintain environmental factors like temperature, humidity, light, air quality, feeding schedules, disease control, and mulberry plant maintenance. An automated system aims to ensure these factors are kept within ideal ranges throughout the various stages of silkworm development, thus improving yield, quality of cocoons, and reducing losses due to disease or environmental stress. Sericulture is the scientific practice of silk production through the rearing of silkworms. Silk, often referred to as the "queen of textiles," is highly valued for its natural sheen, softness, durability, and tensile strength. The process of silk production is intricate and requires careful management at every stage. Silkworms, one of the most significant domesticated insects, spin high-quality silk threads in the form of cocoons while feeding on mulberry leaves during their larval stage. Environmental factors, including temperature and humidity, play a crucial role in determining the yield and quality of silk. Variations in these conditions, both daily and seasonally.

3.2 EXISTING SYSTEM

Researchers and institutions across India have developed several prototype systems that combine IoT, image processing, and automation to improve silkworm rearing. For example, an “Image Processing-Based Smart Sericulture System using IoT” monitors temperature, humidity, and fresh air in the silkworm house and uses computer vision to detect whether worms are healthy or diseased, sending alerts to farmers.

which automates tasks like mulberry plant cutting and extraction using advanced technologies such as machine learning and image processing. This innovation aims to reduce manpower and time consumption in sericulture operations. Furthermore, the development of an AI-integrated smart sericulture system focuses on climate-resilient silkproduction.

Despite these advancements, challenges remain in scaling these technologies to benefit small-scale farmers. Issues such as high initial costs, technical expertise requirements, and infrastructure limitations can hinder widespread adoption.

3.2.1 PROBLEMS WITH EXISTING SYSTEM

- **High Implementation Costs**: The initial investment required for automation technologies, such as IoT devices, sensors, and image processing systems, is often prohibitive for small-scale farmers.

- **Limited Technical Expertise**: The complexity of automated systems necessitates skilled personnel for installation, operation, and maintenance. In rural areas, there is a shortage of trained technicians, which can lead to underutilization or malfunctioning of equipment.

- **Infrastructure Constraints:** Reliable electricity and internet connectivity are essential for the functioning of automated systems. However, many rural regions in Tamil Nadu face power outages and poor network coverage, which can disrupt operations and reduce the effectiveness of automation.

3.3 PROPOSED SYSTEM

The proposed system is a fully integrated, modular automation platform designed to optimize silkworm rearing**,** mulberry cultivation, and cocoon processing by using IoT. The goals are: increase yield, reduce disease and mortality, improve cocoon quality, lower labor inputs, and provide resilience to environmental stresses (weather, pests, etc.). A proposed system for a sericulture automation system would integrate several advanced technologies in a unified framework to overcome the limitations of existing systems and improve overall efficiency, quality, and sustainability. This proposed system would include continuous environmental monitoring (temperature, humidity, light, air quality) via IoT sensors, with automated actuators (fans, heaters, humidifiers, vents) to maintain optimal conditions. The system would also automate mulberry feeding and irrigation, including sensors to monitor leaf quality and moisture of soil, plus mechanisms for delivering leaves or managing the leaf supply chain.

Figure 2: Sericulture

3.3.1 BLOCK DIAGRAM OF PROPOSED SYSTEM

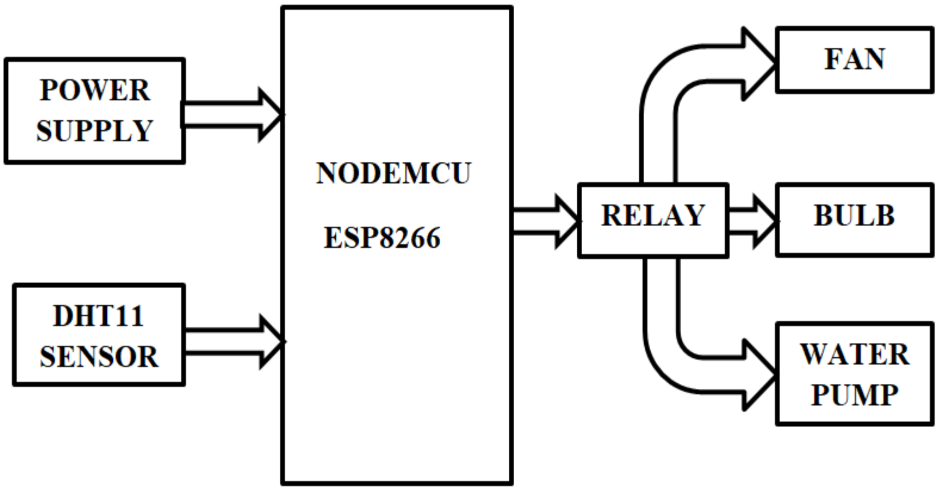


Figure 3: Block Diagram

3.3.2 Hardware components

- Power Supply
- Node MCU
- DHT11 Sensor
- Relay
- Fan

- LED
- Water Pump

3.3.3 Software tools:

Arduino IDE

3.3.4 Technology Used:

IoT(Internet of Things)

3.4 WORKING PROCESS OF PROPOSED SYSTEM

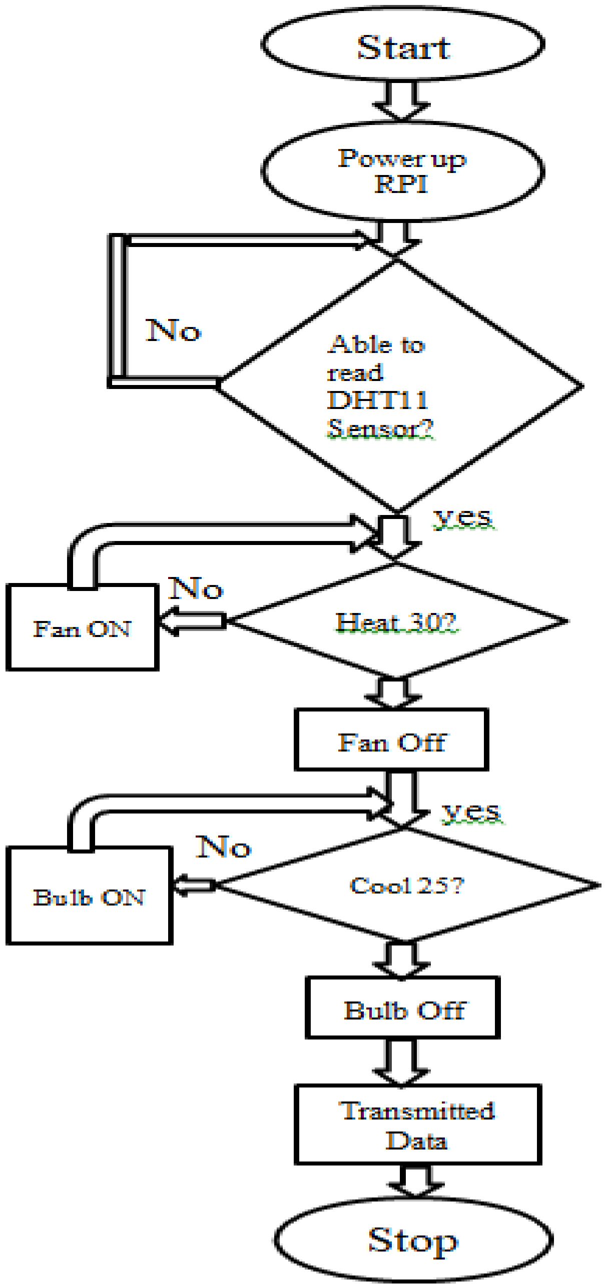


Figure 4: Flow chart

Explanation:

1. **Start**

   The system begins.

2. **Power in RPi**

   The Raspberry Pi (RPi) is powered on.

3. **Check: Able to read DHT11?**

   The system tries to read temperature (and possibly humidity) from the DHT11 sensor.

   - If **No** (i.e. reading fails), it loops back (retry).
   - If **Yes**, proceed to the next step.

4. **Decision "Heat ≥ 30?"** (in the chart "Heat 30?")

   It checks if the measured temperature is **30 °C or more** (i.e. "is it too hot?").

   - If **No** (i.e. temperature less than 30 °C), then **Fan ON** (turn the fan on).
   - If **Yes** (i.e. at least 30 °C), **Fan OFF** (turn the fan off).

5. **Decision "Cool ≥ 25?"** (in the chart "Cool 25?")

   After handling the fan, it checks if the temperature is **25 °C or more** (i.e. "is it warm enough to keep LED off?").

   - If **No** (i.e. less than 25 °C), **LED ON** (turn LED on).
   - If **Yes** (i.e. ≥ 25 °C), **LED OFF**.

6. **Transmit Data**

   After controlling fan and LED, the system sends out (or logs) the sensed data (temperature, humidity, maybe states of fan/LED).

7. **Stop**

   The loop ends (or possibly restarts, depending on how it's implemented).

CHAPTER 4

HARDWARE COMPONENTS

4.1 POWER SUPPLY

In this project we have power supplies with +5V & -5V option normally +5V is enough for total circuit. Another (-5V) supply is used in case of OP amp circuit.

Transformer primary side has 230/50HZ AC voltage whereas at the secondary winding the voltage is step downed to 12/50 Hz and this voltage is rectified using two full wave rectifiers the rectified output is given to a filter circuit to fitter the unwanted ac in the signal. After that the output is again applied to a regulator LM7805 (toprovide+5v) regulator. WhereasLM7905 is for providing –5Vregulation. Z (+12V circuit is used for stepper motors, Fanand Relay by using LM7812 regulator same process like above supplies).

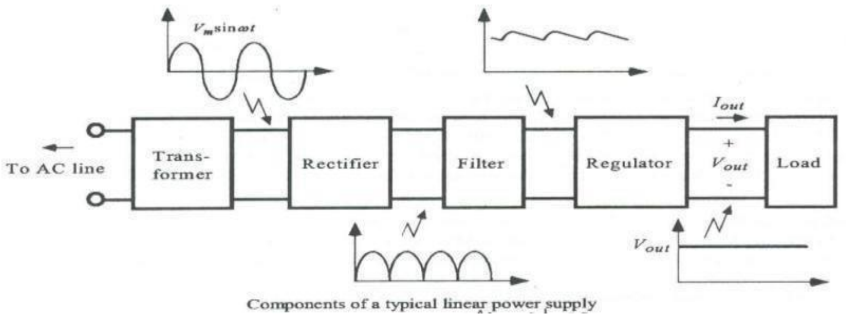


Figure 5: RPS

4.2 INTRODUCTION TO NODE MCU

Node MCU is an open-source development board and firmware based in the widely used ESP8266 12-E Wi-Fi module. It allows you to program the ESP8266 Wi-Fi module with the simple and powerful LUA programming language or Arduino IDE.

With just a few lines of code you can establish a Wi-Fi connection and define input/output pins according to your needs exactly like Arduino, turning your ESP8266 into a web server and a lot more. It is the Wi-Fi equivalent of ether net module. Now you have internet of things (IOT) real tool.With its USB-TTL, the node MCU Dev board supports directly flashing from USB port. It combines features of WIFI access point and station+ microcontroller.

These features make the Node MCU extremely powerful tool for Wi-Fi networking. It can be used as access point and/or station, host a web server or connect to internet to fetch or upload data.

Node MCU Pin out is having labels D0 to D8 and RX-TX but when programming it using Arduino IDE, we observe that its labels are not matching with IO connections. Let's see actual connections of Node-MCU with ESP8266 i.e., ESP-12.

Node MCU is an open source IoT platform. It includes firmware which runs on the **ESP8266** Wi-Fi SOC from Express if Systems, and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the dev kits.

We get two on board LEDs one is connected to GPIO2 and another is to GPIO16.

4.2.1 FEATURES OF NODE MCU

- Finally, programmable Wi-Fi module.
- Arduino-like (software defined) hardware IO.
- Can be programmed with the simple and powerful Lua programming language or Arduino IDE.
- USB-TTL included, plug & play.
- 10 GPIOs D0-D10, PWM functionality, IIC and SPI communication, 1-Wire and ADC A0 etc. all in one board.
- Wi-Fi networking (can be used as access point and/or station, host a web server), connect to internet to fetch or upload data.
- Event-driven API for network applications.
- PCB antenna.

ADVANTAGES OF NODE MCU

- Low cost
- Integrated support for WIFI network
- Reduced size of the board
- Low energy consumption

PIN DIAGRAM OF NODE MCU

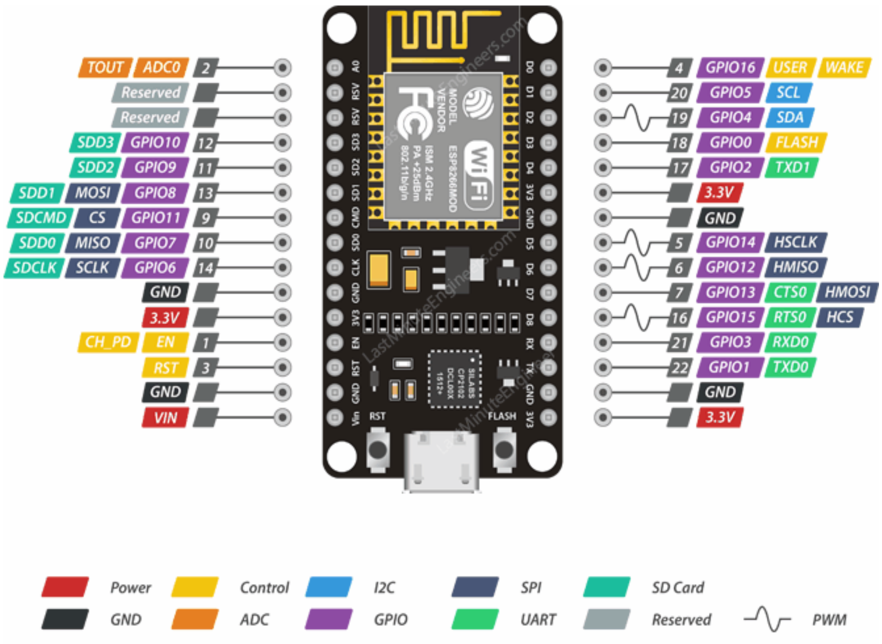


Figure 6: Node MCU

4.2.2 PIN DESCRIPTION OF NODE MCU

Power pins: There are four power pins viz. one VIN pin & three 3.3V pins. The VIN pin can be used to directly supply the ESP8266 and its peripherals, if you have a regulated 5V voltage source. The 3.3V pins are the output of an on- board voltage regulator. These pins can be used to supply power to external components…

Gnd: It is a ground pin of ESP8266 Node MCU development board.

I2c: These are used to hook up all sorts of I2C sensors and peripherals in your project. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

GPIO Pins: ESP8266 Node MCU has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance.

ADC Pins: The Node MCU is embedded with a 10-bit precision SAR ADC. The functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

UART PINS

ESP8266 Node MCU has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

SPI Pins: ESP8266 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:

- Timing modes of the SPI format transfer
- Up to 80 MHz and the divided clocks of 80 MHz
- Up to 64-Byte FIFO

PWM Pins: The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000 μs to 10000 μs, i.e., between 100 Hz and 1 kHz.

Control Pins: These are used to control ESP8266. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin. EN pin – The ESP8266 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power's pin – RST pin is used to reset the ESP8266 chip. WAKE pin – Wake pin is used to wake the chip from deep-sleep.

4.2.3 ESP8266 WIFI MODULE

ESP8266 chip having **Tensilica Xtensa® 32-bit LX106 RISC microprocessor** which operates at **80 to 160 MHz** adjustable clock frequency and supports **RTOS**. There's also 128 KB RAM and 4MB of Flash memory (for program and data storage) just enough to cope with the large strings that make up web pages, JSON/XML data, and everything we throw at IoT devices nowadays.

The ESP8266 Integrates 802.11b/g/n HT40 Wi-Fi transceiver, so it can not only connect to a Wi-Fi network and interact with the Internet, but it can also set up a network

Of its own, allowing other devices to connect directly to it. This makes the ESP8266 Node MCU even more versatile.

ESP8266 PIN DIAGRAM:

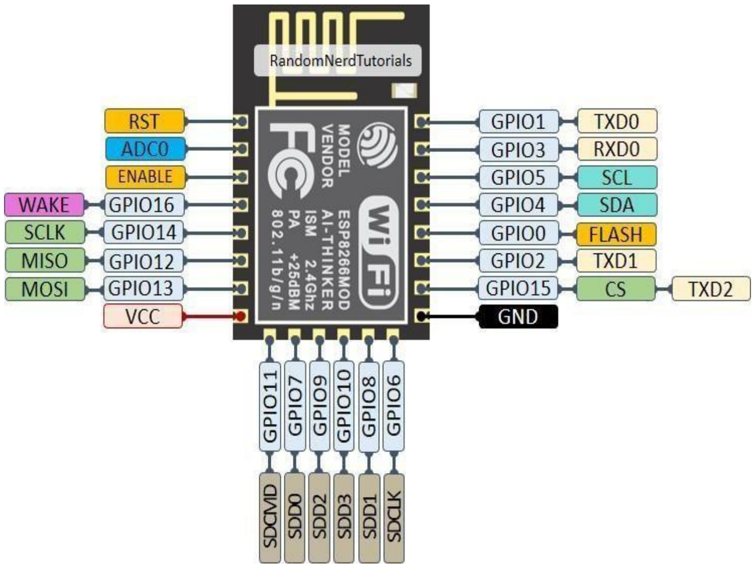


Figure 7: ESP8266

ESP8266 FEATURES:

- Low cost, compact and powerful Wi-Fi Module.
- Power Supply: +3.3V only.
- Current Consumption: 100mA.
- I/O Voltage: 3.6V (max).
- I/O source current: 12mA (max).
- Built-in low power 32-bit MCU @ 80MHz.
- 512kB Flash Memory.

ADVANTAGES OF ESP8266:

- Inexpensive& Flexible design and enhanced function
- Do different
- More compatible development environments

- Abundant learning resources
- Convenient application development

4.3 DHT11 SENSOR:

The DHT11 sensor is a low-cost digital sensor used to measure temperature and humidity. It consists of a capacitive humidity sensor and a thermistor to measure the surrounding air's temperature. The sensor converts the analog signal into a digital output, making it easy to interface with microcontrollers like the Raspberry Pi and Arduino. It operates on a voltage range of 3.3V to 5V and can measure temperatures from 0°C to 50°C with an accuracy of ±2°C, and humidity from 20% to 90% with an accuracy of ±5%. Although it has a slower sampling rate (about once every second), it is widely used in IoT projects, weather monitoring systems, and environmental control applications due to its simplicity, reliability, and low power consumption.

In terms of measurement capability, the DHT11 can sense humidity in the range of 20% to 90% RH (Relative Humidity) with an accuracy of ±5%, and temperature between 0°C and 50°C with an accuracy of ±2°C. While it is not as precise or as fast as its advanced version, the DHT22 sensor, it is still popular because of its low cost, ease of use, and stability in normal operating conditions.

Figure 8: DHT11 SENSOR

4.3.1 PIN DESCRIPTION OF DHT11 SENSOR

The DHT11 sensor's pins are arranged so that it can easily interface with microcontrollers. In its common 4-pin form, from left to right when you look at the flat face, the pins are: **VCC** (power supply, typically 3.3 V to 5.5 V), **DATA** (single-wire digital output line), **NC** (not connected, unused), and **GND** (ground). The VCC pin must be connected to a stable supply (within its allowable range), and GND must be shared with your microcontroller. The DATA pin is where the microcontroller sends a "start" signal and then reads back the 40-bit response (humidity + temperature + checksum). Because the line idles high, a pull-up resistor (e.g. ~10 kΩ) is required between DATA and VCC.

- The **VCC** pin is connected to power (3.3V–5V).
- The **GND** pin goes to ground.
- The **DATA** pin is the communication pin, and usually a pull-up resistor is already
- **Operating Voltage**: 3.3 V to 5.5 V DC
- **Current Consumption**: ~0.3 mA during measurement, very low (µA level) in idle
- **Temperature Range / Accuracy**: 0 °C to 50 °C, ±2 °C typical
- **Humidity Range / Accuracy**: 20% to 90% RH, ±5% RH typical
- **Resolution**: 1 °C (for temperature) and 1% RH (for humidity)

The **DHT11** is a low-cost, digital temperature and humidity sensor that combines a capacitive humidity sensing element and an NTC thermistor with a small microcontroller to provide calibrated digital readings. It operates over a supply voltage range of about 3.3 V to 5.5 V and communicates via a single-wire bidirectional protocol, requiring precise timing to initiate communication and read data. he sensor is typically packaged in a 4-pin format (VCC, DATA, NC, GND), though many breakout modules expose only three usable pins (VCC, DATA, GND), embedding a pull-up resistor to simplify wiring.

In terms of electrical and performance specs: it operates over a supply voltage of about 3.3 V to 5.5 V (often specified as 3.5 V to 5.5 V) and consumes very little current in standby (on the order of 60 µA) and modest current (~0.3 mA) when measuring. Its temperature measurement range is approximately 0 °C to 50 °C with a typical accuracy of ±2 °C, and its relative-humidity range is around 20% RH to 90% RH (often more conservatively 20-80%) with accuracy about ±5% RH. The sensor communicates via a proprietary single-wire (one-bus) digital protocol: the host initiates communication by pulling the data line low for a defined time, then the sensor responds, and sends a 40-bit data packet (8 bits humidity integer + 8 bits humidity decimal + 8 bits temperature integer + 8 bits temperature decimal + 8 bits checksum). Because of this protocol and internal processing, you should typically wait at least ~1-2 seconds between successive reads to allow the sensor to update and transmit new data reliably.

On the practical side, the DHT11 is praised for its simplicity and low cost: one only needs three connections (VCC, GND, and DATA) in most breakout modules (the pull-up resistor is either built in or should be added externally according to the datasheet) and there are many ready-made libraries for popular microcontrollers like Arduino and Raspberry Pi. However, there are several limitations worth noting: its sampling rate is low (at most ~0.5 to 1 Hz, i.e., measurements let-up every 1-2 seconds), its resolution is relatively coarse (often 1 °C increments and 1% RH increments) and its measurement range is modest (not suitable for very low or high temperatures/humidities). Also, external conditions such as long wiring, strong heat sources nearby, chemical vapors, or exposure to direct sunlight/UV can degrade readings or shorten the sensor's lifetime.

The DHT11 combines a capacitive humidity sensing element (to measure relative humidity) and a thermistor (NTC type, to measure temperature) into a compact unit. A small microcontroller is embedded alongside the sensor elements: it handles the calibration data (which is stored in OTP memory) and outputs a digital signal on a single-wire data line. For humidity, the sensor detects a change in conductivity/resistance (via the moisture absorbing substrate and electrodes) as the ambient moisture changes. For temperature, the thermistor changes resistance with temperature changes. The microcontroller reads both, applies calibration, and then sends the result via the single-bus protocol.

The DHT11 is a low-cost digital sensor designed to measure both relative humidity and ambient temperature. It uses a capacitive humidity sensing element combined with a thermistor for temperature measurement, and the signals from these are processed by an internal 8-bit microcontroller which outputs a calibrated digital value via a single-wire serial protocol. In terms of specifications, the DHT11 typically operates at a supply voltage of 3.3 V to 5.5 V and supports relative humidity measurements in the range of approximately 20 %–90 % RH with an accuracy of about ±5 % RH, and temperature measurements from around 0 °C to 50 °C with an accuracy of about ±2 °C. From a usage perspective, the DHT11 is quite easy to interface: it has a small number of pins (commonly 3 or 4 including VCC, GND, data output, and sometimes a “not connected” pin) and uses a proprietary one-wire-style digital communication protocol. You typically initiate communication by pulling the data line low for a specified period, then the sensor responds and sends 40 bits of data (humidity integral, humidity decimal, temperature integral, temperature decimal, and a checksum) in sequence. The DHT11 has a slow sampling rate (commonly once every 1–2 seconds), and its measurement range and accuracy are modest compared to higher-end sensors (for example it cannot reliably measure very low temperatures or high humidity extremes). One guide notes you can get new data only every ~2 seconds.

Because of these characteristics, the DHT11 is well suited for hobbyist, educational, or basic environmental monitoring applications (such as simple weather stations, home automation for HVAC control, or greenhouse monitoring), but may not be ideal where very high accuracy, fast response, or wide environmental ranges are required. There are some caveats and practical considerations. Because the DHT11 is a low-cost sensor, its range and precision are modest. For example, if you need very low temperatures (below 0 °C), very high humidity (>90 % RH), or fast updates, other sensors may be better suited. Also, its accuracy can be affected by environmental conditions: for instance, extended exposure to chemicals, strong sunlight/UV, or mounting near heat sources can degrade performance or calibration.

In practical use, it is very popular in hobbyist, educational, home automation, and basic environmental monitoring setups (e.g., simple weather stations, greenhouse monitoring, HVAC trigger systems). Its ease of use (digital output, minimal wiring) makes it accessible for microcontrollers like Arduino, Raspberry Pi, or ESP-based boards. If you decide to use it, remember to allow for the recommended intervals between readings, avoid placing it near heat or strong airflow sources, and consider calibration or using a higher-grade sensor for more demanding applications.

4.4 RELAY

A **relay** is an electrically operated switch used to control a high-power or high-voltage circuit with a much smaller, low-power signal. Internally, it uses an electromagnetic coil: when you energize the coil (by applying voltage to it), the magnetic field moves an internal armature (mechanical contact), causing the common terminal to switch between normally closed (NC) and normally open (NO) contacts.

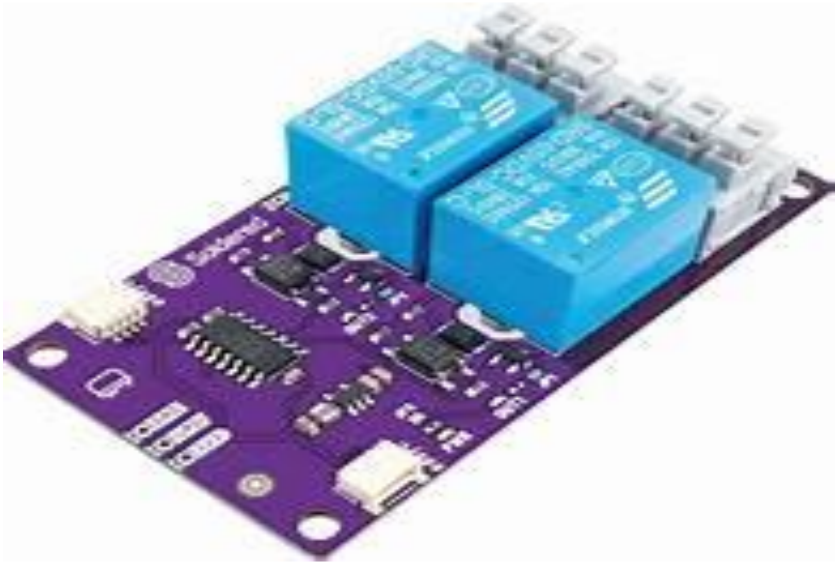
0 

Figure 9: RELAY

Relays are widely used because they provide **circuit isolation**, **control of high-power loads using low-power signals**, and **flexibility** in switching multiple circuits or complex switching patterns. One limitation of electromechanical relays is **contact wear**. Each time the relay switches under load (especially inductive loads), an electrical arc may form between the contacts, gradually degrading them and shortening relay life—typical lifespans under load are tens to hundreds of thousands of switching cycles. Relays come in many types — for example, single-pole single-throw (SPST), single-pole double-throw (SPDT), double-pole double-throw (DPDT), latching relays (which retain their state without continuous power), reed relays, and solid-state relays (using semiconductor switching rather than mechanical contacts).

Their applications span across automation, protection systems, automotive electronics, power switching, and more. Because mechanical contacts wear over time (especially under inductive loads that cause arcing during switching), relay life is finite, and designers may include snubber circuits, diodes (for DC coils), or contact suppression measures to extend reliability. Also, because of the moving parts, switching speed is limited compared to semiconductor alternatives, and bounce or contact chatter can occur.

APPLICATIONS :

- Control of high-voltage or high-current loads using low-power control circuits
- Automotive systems (e.g. switching headlights, horns, fuel pumps, starter motors)
- Industrial automation (switching motors, pumps, solenoids, conveyor systems)
- Home appliances (e.g. controlling compressors, heater elements, fans)
- Power systems & protection (e.g. overcurrent protection, circuit isolation, load shedding) Lighting control systems (especially in buildings or smart systems) Renewable energy / grid integration (controlling connection/disconnection of solar panels, wind turbines)
- Signal routing and telecommunication (switching signals, line protection) Use in HVAC systems (for switching fans, compressors, heating)
- Latching relays in applications needing memory of state without continuous power Solid-state relays in applications requiring silent, high-speed, and wear-free switching.

ADVANTAGES:

- Provides electrical isolation between control and load circuits
- Enables a low-power signal to switch high voltage/current loads
- Can switch AC or DC loads depending on design
- Available in various contact configurations (NO, NC, SPDT, etc.)
- Simple, reliable, and cost-effective
- Durable and long lifespan (especially solid-state types)
- Supports remote or automated control of devices
- Acts as a form of signal amplification (small input → large output)

Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example, a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC. Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available.

For further information about switch contacts and the terms used to describe them please see the page on switches. Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay. The supplier's catalogue should show you the relay's connections. The coil will be obvious and it may be connected either way round. Relay coils produce brief high voltage 'spikes' when they are switched off and this can destroy transistors and ICs in the circuit. To prevent damage you must connect a protection diode across the relay coil.

The animated picture shows a working relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on.This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

The relay's switch connections are usually labelled COM, NC and NO:

- COM = Common, always connect to this, it is the moving part of the switch.
- NC = Normally Closed, COM is connected to this when the relay coil is off.
- NO = Normally Open, COM is connected to this when the relay coil is on.
- Connect to COM and NO if you want the switched circuit to be on when the relay coil is on.
- Connect to COM and NC if you want the switched circuit to be on when the relay coil is off.

Coil voltage: The voltage you apply to the relay’s coil must match the relay’s rated coil voltage (e.g., 5 V, 12 V, 24 V). If you under-drive the coil, the contacts may not reliably switch; if you over-drive, you risk overheating or damaging the coil.

Contact current & voltage rating: The relay's contacts are rated for a certain maximum

current and voltage (for the load side). Make sure your load (e.g., motor, lamp, heater) does not exceed those ratings; otherwise, the contacts may weld shut or fail prematurely.

Isolation voltage: Good relays provide safe isolation between the coil circuit (control side) and the contact circuit (load side). Especially important if switching high-voltages or for safety reasons.

Contact configuration: Understand how many poles and throws (SPST, SPDT, DPDT etc) you need. For example, if you want to switch two independent lines you might need a DPDT relay.

Operating environment & lifetime: The life of the relay depends on how many switching cycles it can handle, how heavy the load is, whether arcs occur during switching, and whether the environment has dust, moisture or corrosive gases. For instance, exposure to sulphuric or nitric aerosols can degrade contact reliability.

Switching speed & bounce: When contacts open or close, there's often "bounce" (contacts making and breaking rapidly for short times) which can affect circuits (especially digital or inductive loads). Good relay design accounts for this to reduce arcing and wear.

AC vs DC loads: Switching AC and DC loads have different challenges. For example, DC circuits don't have the zero-crossing point that AC does, making it harder to extinguish arcs in the relay contacts. Some relays are designed with special mechanisms (like shaded pole coils) for AC operation.

Relays are classified by pole (how many separate circuits they switch) and throw (how many possible paths each pole can connect to). For example, the commonly used types include: SPST relay (Single Pole Single Throw), SPDT relay (Single Pole Double Throw), DPST relay (Double Pole Single Throw), and DPDT relay (Double Pole Double Throw). For high-speed switching or many cycles, you might consider solid state relays (which have no moving parts) though they come with their own trade-offs (such as leakage current, heat dissipation). If your application involves motor direction control or switching between two loads, a DPDT relay is especially useful (because it can route two independent circuits simultaneously).

In the context of sericulture (silk-worm rearing and mulberry cultivation), a **relay** plays a vital role in automating environmental control and equipment actuation. A relay is an electrically-operated switch that allows a small, low-voltage signal (from sensors or a microcontroller) to control larger loads such as heaters, fans, water pumps, lighting fixtures or disinfection systems—thus enabling automation without the control circuit being directly exposed to high power.

Specifically in sericulture systems, relays are used to enable automatic activation of equipment when sensor readings exceed or drop below set thresholds. For example, within an IoT-based automated silkworm-rearing house, sensors (temperature, humidity, light) send data to a controller (e.g., Arduino, NodeMCU or Raspberry Pi). When conditions deviate (e.g., humidity too high, temperature too low, lighting inadequate), the control unit triggers a relay module that turns on or off the relevant device (like a heater via the relay, cooler via another relay) to restore optimal conditions.

Typical relay modules used in these systems are rated for low-coil voltage (5 V or 12 V DC) on the control side and able to switch higher power loads (e.g., 10 A at 250 V AC or similar) on the load side. They often have “COM” (common), “NC” (normally closed) and “NO” (normally open) contacts, allowing flexible wiring: when the relay is de-energised the COM is connected to NC, and when energized it connects to NO.

In modern automated sericulture setups (for example those managing Bombyx mori silkworm rearing houses or mulberry-leaf feed environments), relays serve as the crucial interface between a microcontroller/sensor subsystem and the higher-power devices (like fans, heaters, pumps, lights) that actually adjust the environment. For instance, in one automated sericulture farm project, when sensors detected humidity or temperature outside ideal thresholds, the system used a relay to switch on a fan or heater accordingly.

Acting as an electrically-isolated switch: The low-voltage control signal from a microcontroller (e.g., 5 V or 12 V) drives the relay coil, which then switches a higher-voltage device (e.g., a 230 V AC fan or water pump) safely.

Enabling automatic actuation: When a temperature sensor outputs a value above a set point, the system triggers the relay, thereby turning on a cooling fan. When the value falls back into range, the relay switches off. This ensures consistent environmental control without continual human intervention.

Supporting multiple devices: In many setups, multiple relays are used (or a relay-module with multiple channels) so that fans, heaters, pumps, lights, etc., can each be independently controlled by different sensors and thresholds.

Integrating with remote/IoT systems: Some more advanced systems combine relays with GSM or WiFi modules so the farmer can receive alerts and actuate devices remotely. For example, when a sensor reading crosses a threshold, the system triggers a relay and simultaneously sends a mobile alert.

The relay must be sized appropriately for the load: for instance, if the device being switched is a fan motor drawing several amps at AC mains, the relay contacts must support that current safely and have sufficient voltage rating. Solid-state relays (SSR) may be used instead of electromechanical relays in some installations to provide silent operation, longer lifetime, and faster switching—though SSRs may cost more. (In general relay behaviour is well covered in electronics references.).

In the wiring scheme, typical relay modules include “COM” (common), “NO” (normally open) and “NC” (normally closed) terminals — this allows flexibility (e.g., when coil is inactive, COM-NC is connected, when active, COM-NO is connected). Many microcontroller boards trigger the coil to activate NO circuits when needed. Safety and isolation: Since the microcontroller side is low-voltage and the device side may be mains or high-power, the relay provides galvanic isolation and reduces risk of back-feeding or damage to the controller. Use relays only after thorough sensor calibration and threshold setting: If thresholds are too loose or sensors drift, the relay may be triggered too often or too late, causing stress to silkworms (which are sensitive to temperature/humidity swings).

Provide manual override or fail-safe mode: In many automated systems, manual control or a “safe state” is needed in case of controller failure. For example, if relay fails off, the fan/heater might stay off and cause temperature rise. Systems often include an alert via GSM or display.

4.5 FAN

A fan is an electrical device used to create airflow for cooling, ventilation, and air circulation. It works by converting electrical energy into mechanical energy through an electric motor, which rotates the blades to move air. Fans are widely used in homes, offices, and industries to provide comfort and maintain proper ventilation. The main parts of a fan include the motor, blades, shaft, frame, and speed regulator. Fans come in different types such as ceiling fans, table fans, pedestal fans, and exhaust fans, each designed for specific purposes.

While a fan does not actually reduce the temperature of a room, it helps in circulating air and enhancing the evaporation of sweat, making the surroundings feel cooler. Fans are essential appliances in daily life, providing an efficient and economical way to maintain airflow and comfort. In **sericulture** (silkworm rearing), fans (or ventilation systems) are used to manage the micro-environment of the rearing house. They help in circulating air, removing excess heat, dispersing harmful gases (like ammonia and CO_2), and preventing stagnation of humid air.

Figure 10: FAN

In **sericulture** (silkworm rearing), fans (or ventilation systems) are used to manage the micro-environment of the rearing house. They help in circulating air, removing excess heat, dispersing harmful gases (like ammonia and CO_2), and preventing stagnation of humid air. Proper air movement via fans supports stable temperature and humidity, which are crucial for healthy silkworm development. Remove excess heat generated by larvae metabolism, preventing local overheating. Prevent accumulation of harmful gases such as ammonia and carbon dioxide produced by respiration and decomposition Distribute humidity evenly, avoiding damp pockets or sharp humidity gradients. Reduce microbial growth (fungi, bacteria) by ensuring air is not stagnant.

To maintain air quality: Fans help remove CO_2, ammonia, and other gases produced by silkworm respiration and waste. Without airflow, these gases accumulate and can harm silkworms, reducing growth or causing mortality.

To regulate temperature: The metabolic heat of many worms plus external heat can raise temperature inside the house. Proper airflow helps dissipate excess heat, keeping temperature in the optimum range (about 26-28 °C for many stages) so that silkworms develop well.

To control humidity: Ventilation helps distribute moisture, avoid pockets of excessively damp or dry air, and prevent high humidity that can promote fungal or bacterial disease. It also helps when humidity is too high: moving air helps dry slightly. For example, ideal RH is around 60-70% in many stages.

To prevent stagnant air & drafts: It’s important airflow be gentle. Strong direct drafts can stress the silkworms, disrupt feeding, molting, cocooning, and cause uneven growth. So fans or ventilation must be positioned so air circulates smoothly, not blowing directly on worms.

To assist before feeding in later in stars: Some guidelines suggest creating an air current ~1.0 m/s for some minutes (e.g. 30 minutes) before feeding in late-age rearing to improve ingestion, digestion, worm weight, and reduce mortality.

Cooling fans used in electronics are typically **DC powered** (commonly 5 V, 12 V, 24 V) and often employ a brushless DC motor design. Inside the fan you’ll find a rotor with permanent magnets, a stator with coils and electronic commutation control (often using Hall-effect sensors), and the impeller (fan blades) that move air. When current flows through the stator coils, a magnetic field interacts with the rotor magnets to produce torque, spinning the blades. The blades draw air from one side and expel it out the other, creating airflow that helps carry away heat from components, boards or enclosures. Because airflow removes hot air and brings cooler ambient air in (or simply moves air across a heated surface), this convection helps keep temperatures down. Small DC fans (often rated at **5 V**) are brushless axial or centrifugal fans used to move air in enclosures, dissipate heat from modules, or provide cooling/ventilation in projects. Dust, humidity, and high ambient temperature reduce fan efficiency and lifespan. Clean fan blades and vents periodically; avoid very dusty/humid conditions without protection.

In the field of Sericulture (silk-worm rearing and silk production), using a **fan** (ventilation or air-circulation device) plays a key role in maintaining optimal environmental conditions. For successful silkworm rearing and cocoon drying, the temperature and humidity must be carefully controlled — for example, shed-cooling systems specify an ideal range of around 24 °C to 28 °C and relative humidity of 80 % to 85 % for incubation and rearing of larvae.

A fan helps by circulating air within the rearing room or drying chamber to avoid hot spots, reduce excess moisture, improve uniformity of conditions, and thereby support silkworm health and silk-yield quality. For cocoon drying especially, manuals note that a drying chamber “comprises a fan to maintain constant and uniform air current throughout the layers along with a heater for heating the air driven by the fan.”

Practically, the fan used in sericulture must be robust (since the environment may include higher humidity, possible dust/mulberry-leaf particles, and frequent operation), well mounted so as to distribute airflow evenly, and often integrated with control systems (thermostats, humidity sensors) so that when temperature or humidity drifts beyond thresholds, the fan activates (or deactivates) to restore the set-point.

Overall, proper ventilation via a correctly specified fan is a crucial enabling technology in sericulture—both for the rearing of silkworms and for the post-cocoon processing (drying, stifling) phases—and contributes significantly to quality and yield of the final silk product. Good ventilation is vital because during rearing, larvae and their waste release gases such as carbon dioxide and ammonia, and moisture builds up in the room. Without proper airflow, these accumulate, creating poor air quality and promoting disease and sub-standard growth. A fan (or a system of forced ventilation) helps evacuate stale air, refresh the room with new air, reduce humidity build up, and maintain uniform temperature and humidity throughout the rearing house.

In more advanced setups, automatic systems integrate fans with sensors (temperature, humidity) so that when conditions deviate (e.g., temperature rises, humidity spikes), the fan kicks in (or is adjusted) to restore optimal conditions. For example, one project described uses an exhaust fan triggered by temperature sensor readings.

From a specification perspective: during late-age rearing (4th & 5th instars) and spinning, the environment should be well-aerated to keep humidity at recommended levels (for instance around 60-70% RH) and avoid strong draughts, which can disturb larvae. Using a fan helps by generating a gentle airflow, aiding evaporation of excess moisture, and distributing heat (if heating is used) evenly. Some patents describe combined heating+fan units specifically designed for silkworm rooms, where a fan circulates air over heating elements or through ducts to regulate ambient conditions.

A fan in sericulture is a key component of the micro-climate control system — used for air circulation, ventilation, removal of excess moisture/gases, and maintaining uniform temperature/humidity. For best results, the fan must be sized and positioned appropriately, the room must still be designed with good passive ventilation (so windows/vents + fan work together), and the airflow should be gentle (to avoid stressing larvae) yet sufficient to prevent air stagnation. If you'd like, I can pull together typical fan specifications (airflow rate, placement, power, control logic) for a silkworm-rearing house.

4.6 LED

Light plays an important role in silkworm rearing: it affects larval behavior, feeding, growth, cocoon formation, and even the next generation. Silkworms (Bombyx mori) are **photosensitive**, tending to prefer **dim light** (approximately 15-30 lux) rather than strong light or total darkness. This level helps reduce stress, ensures better feeding, and promotes a calm environment.

Too much light (bright or prolonged) or light at night can disrupt natural cycles: it may inhibit embryonic diapause (which is a kind of dormancy) in the next generation, or affect survival rates. Thus, many modern sericulture operations use controlled or programmable lighting (sometimes using LED lights) to maintain consistent, dim, and correctly timed light conditions to optimize silk yield and quality.

A light-emitting diode, or LED, is a semiconductor device that emits light when an electric current passes through it. The light is produced via **electroluminescence**, a process in which electrons recombine with “holes” across a p–n junction in the semiconductor, releasing energy in the form of photons.

In silkworm rearing, light is an important environmental factor alongside temperature, humidity and ventilation. Research shows that larvae of Bombyx mori prefer **dim light conditions**, typically around 15–30 lux, and a photoperiod of about 16 hours light followed by 8 hours darkness.

LED lighting offers advantages in this context: because LEDs generate less heat, their intensity and spectrum can be more precisely controlled, and they consume less energy. For instance, a patent describes the use of a yellow-LED lamp in silkworm houses (intensity range ~10–150 lux) in combination with natural light, to accelerate growth, shorten lifecycle, increase larval weight and improve cocoon yield.

In practice therefore, LED lights can be installed in a rearing room so that after natural light subsides (or in windowless houses) they provide a **gentle, uniform dim illumination** suited to silkworm behaviour. The goals include avoiding hot-spots or shadows, maintaining the light level in the optimal range and ensuring the light does not stress or disturb the larvae. LED usage should thus be coordinated with other environmental parameters: if the room is too bright, too hot, or has strong air-currents from lighting fixtures, it can upset the larvae.

In a modern automated sericulture setup, LEDs (Light-Emitting Diodes) serve as a vital component of the lighting and photoperiod control subsystem, helping to simulate or supplement natural light with precise intensity, colour spectrum and timing to support optimal growth of Bombyx mori larvae. For example, some IoT-based sericulture systems incorporate a light sensor (LDR) to detect ambient illumination; if the natural light falls below a threshold, the LED lamps are automatically triggered via a controller and relay to maintain the minimum required lux level.

The benefits of using LED lighting include low heat emission (important because silkworms are sensitive to temperature/humidity fluctuations), long lifespan, energy efficiency, and the ability to fine-tune light intensity (e.g., around 10-150 lux as reported in one patent for yellow LED use in silkworm rearing).

Furthermore, LED systems can be integrated into the broader automated control ecosystem—interfaced with sensors (temperature, humidity, light), microcontrollers (Arduino, NodeMCU), and actuators (relays, fans) so that lighting is coordinated with other environmental controls (ventilation, heating, humidification) to maintain the ideal micro-climate in the rearing house.

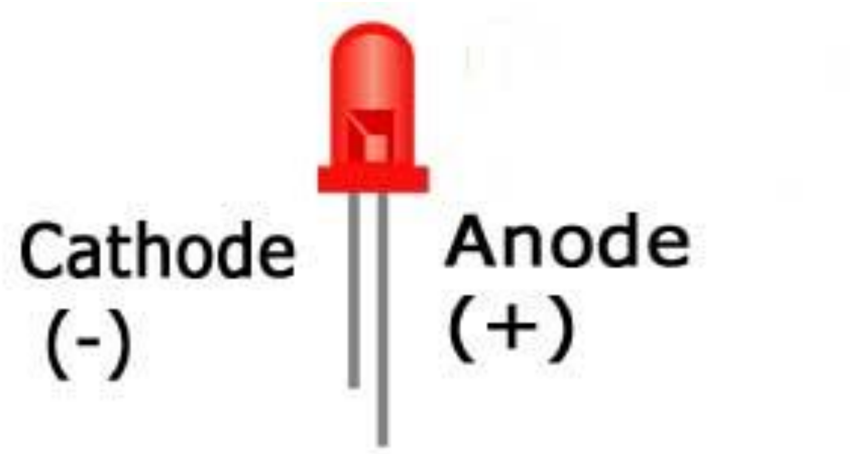


Figure 11: LED

Photoperiod (the duration of light vs darkness in a 24-hour cycle) is also critical: an arrangement like **16 hours light / 8 hours dark** has been found favorable especially for late instar larvae. Light intensity and color (wavelength) have measurable effects: different colored lights influence silk filament length, cocoon weight, shell ratio, and even biochemical markers (proteins, enzymes) in the silkworms. For example, exposure to green light or red light under certain schedules has improved silk filament length or cocoon shell characteristics compared to control (natural light) in some studies.

Depending on the semiconductor materials and their band gaps, LEDs can emit light in different colors (visible or infrared); for white light, combinations of colored LEDs or phosphor coatings are often used.

Compared to traditional incandescent or fluorescent lighting, LEDs are far more energy efficient, converting a much larger fraction of electrical energy into light, and they have very long lifetimes — often tens of thousands of hours before their brightness degrades appreciably. An LED (Light-Emitting Diode) is a special kind of semiconductor device which emits light when a current flows through it in the forward direction.

Internally, it’s built as a p-n junction: the n-type semiconductor has extra electrons, the p-type has “holes”, and when the diode is forward biased electrons cross into the holes and drop into a lower energy level, releasing energy in the form of photons (light). The colour of the light depends on the band-gap of the semiconductor material used — different materials/dopings produce red, green, blue, etc.

If you’re integrating into a board or enclosure, ensure you choose the appropriate resistor (or driver) for your supply voltage, ensure the LED has space, consider brightness vs power trade-off, and make sure the LED isn’t placed where heat or physical stress may reduce its life.

Even though LEDs are efficient, they still generate heat. High power LEDs especially need good heat-sinking or ventilation to maintain performance and longevity. LEDs don’t “burn out” in the filament-way of incandescent lamps; instead they slowly lose brightness (lumen depreciation). A good quality LED can last tens of thousands of hours. An LED doesn't behave like a simple bulb.

Once forward biased, it has a more or less constant voltage drop (depending on colour) but the current rises steeply with voltage. Without proper current-limiting (typically via a resistor or dedicated driver) you risk burning out the LED. Being a diode, it only lights when connected the correct way (anode to positive, cathode to negative). Reversing it typically means no light (though in some cases you can permanently damage it).

ADVANTAGES:

EnergyEfficiency:

LEDs use far less electricity than traditional incandescent or fluorescent lights for the same amount of light. They convert a much larger portion of input energy into visible light, rather than wasting it as heat.

LongLifespan:

LED bulbs typically last many times longer than incandescent bulbs. Depending on quality and usage, lifespans of 25,000-50,000 hours (or more) are common. This reduces how often you need to replace bulbs.

LowerHeatEmission:

LEDs generate very little heat compared to incandescent lamps, which waste most of their energy as heat. Less heat means less risk of burns, safer light fixtures, and reduced need for cooling in indoor spaces.

DurabilityandReliability:

Because LEDs are solid-state devices (no filament to break, no fragile glass parts), they are more robust. They resist shock, vibration, and temperature fluctuations better than many traditional bulbs.

DirectionalLighting:

LEDs emit light in specific directions, which makes them more efficient for applications where you want focused or task lighting (e.g. downlights, spotlights). Less light is wasted.

APPLICATION:

Indicator and signalling lights – LEDs are extensively used as status indicators in electronics (power-on, error flags, charging indicators) and in devices like traffic signals, dashboards, alarms.

General illumination & lighting – Modern LED bulbs and fixtures are used in homes, offices, outdoor lighting (street lights, landscape), and industrial spaces. Their energy efficiency and long lifetime make them preferred

Displays, signage & screens – LEDs are used in back-lighting for TVs, monitors, mobile displays, and in large-scale signage or video walls.

Automotive & transportation lighting – In vehicles, LEDs are used for headlights, brake lights, interior lighting, instrument panels because of fast response time, compact size and durability.

Medical & phototherapy uses – In medical equipment, LEDs are used for surgical lights, phototherapy (skin treatments), and dental curing lights, thanks to their reliability and controllable wavelengths.

Agriculture, horticulture & post-harvest – Specialized LEDs provide light spectra tailored for plant growth (indoor farms, vertical farming) and for post-harvest food processing (to improve storage or nutritional value).

Communication & sensing – LEDs (especially infrared or UV types) are used in optical communications, remote controls, sensors, machine-vision systems and other non-lighting roles because they can switch fast and be modulated.

An LED is a semiconductor device that emits visible (or sometimes infrared/ultraviolet) light when an electric current flows through it in the forward direction. In essence, it is a specially constructed p-n junction diode where, under forward bias, electrons from the n-type region recombine with holes from the p-type region at the junction and release energy in the form of photons.

The colour (wavelength) of the light emitted depends on the band-gap energy of the semiconductor material used; materials with larger band-gaps emit photons of higher energy (shorter wavelength) and vice versa.

Structurally, an LED often consists of a substrate, the semiconductor die with the p-n junction, and a transparent or semi-transparent lens or dome that both protects the die and helps focus or diffuse the light. Compared to older light sources, LEDs have major benefits: far higher energy-efficiency (because much less energy is wasted as heat), compact size, long operational lifetime, instant turn-on, and availability in many colours and package types.

Because of these sensitivities, using LED lighting in a silkworm-rearing house gives several advantages: LEDs generate less heat (which helps avoid local overheated spots), allow more uniform and controllable light intensity, are energy-efficient, and can be tuned for timing (photoperiod) and placement. For example, one patent describes use of a yellow LED lamp in combination with natural light, set at about 10-150 lux at the silkworm body surface, with lighting for 12-14 hours during the night, and shows that this helps accelerate growth, shorten life-cycle, increase body-weight and improved cocoon layer rate.

4.7 WATER PUMP

A water pump is a mechanical device used to move water from one place to another through pipes or hoses. It works by converting mechanical energy into hydraulic energy, allowing water to flow efficiently for various purposes. Water pumps are commonly used in homes, agriculture, industries, and construction to supply water, drain excess water, or irrigate fields. The main components of a water pump include the motor, impeller, casing, and inlet and outlet pipes. When the motor operates, it drives the impeller, which creates suction to draw water in and then pushes it out with force. There are different types of water pumps such as centrifugal pumps, submersible pumps, and jet pumps, each suited for specific applications. Water pumps play an essential role in providing a continuous water supply, managing wastewater, and supporting irrigation and industrial processes efficiently.

A water pump is a mechanical device that uses energy, often from an electric motor or engine, to move water from one location to another by creating a pressure difference within the system. By converting mechanical energy into the kinetic energy of water, the pump increases its pressure, enabling it to be transferred for various uses, such as providing water for homes, irrigation, or removing water from flooded areas.

In the context of sericulture (the cultivation of silkworms and their food plants), a water pump plays a valuable supporting role by helping to maintain optimal growing conditions for the food crop—typically Morus alba (mulberry)—and by facilitating related infrastructure needs. For the mulberry plantation that feeds the silkworms, reliable irrigation is essential: plants require steady moisture and good soil health to produce the tender leaves preferred by larvae. A water pump ensures that water from wells, boreholes, or collection systems can be delivered uniformly across the plantation, especially during periods of low rainfall or erratic power supply. For example, solar-powered water pumps are increasingly being used in Indian sericulture to overcome electricity reliability issues and ensure timely irrigation of mulberry fields.

Beyond irrigation, water pumps also support secondary sericulture operations. Some integrated systems include soil-moisture sensors that trigger the pump when the soil becomes too dry, thereby maintaining the ideal leaf moisture content for rearing. One research project outlines a pump motor being activated based on soil-moisture sensor readings in a smart sericulture setup.

However, it is important to select and position the water pump carefully: the flow rate must match the size of the mulberry field and the delivery system (pipes, hoses, sprinklers), and the water quality must be suitable (e.g., free from high salinity or chemicals) so as not to harm the plants, which in turn would affect silkworm health. Additionally, managing water distribution properly helps avoid overly wet or damp soil conditions around the rearing houses or leaf storage areas, which could promote mould, disease or adverse micro-climates for the larvae. In this way, the humble water pump becomes a crucial element in a wider chain of sericulture environmental control—connecting plant irrigation, leaf quality and ultimately silkworm growth and cocoon output.

The cultivation of Morus alba (mulberry) is fundamental to sericulture because its leaves are the primary food for the silkworm species Bombyx mori. Maintaining an adequate and reliable water supply for mulberry gardens is therefore critical, particularly in dry or rain-fed zones where rainfall is erratic. A water pump plays a central role by lifting or conveying water from sources such as wells, tanks or ponds to irrigation systems that serve the mulberry plantation. For example, a paper on a solar-drip irrigation kit for rain-fed mulberry cultivation describes how a 0.25 HP solar-pump was used to lift water into an overhead tank which then supplied the drip network.

In practical terms, the pump must be sized and specified correctly: the head (vertical lift) and flow rate must match the irrigation layout and the water source characteristics. In mulberry cultivation, drip irrigation is increasingly recommended because of its water-saving benefits; the irrigation system documentation for mulberry states that the "control head" of the system includes a pump or overhead tank to provide sufficient pressure.

Further, the use of efficient delivery systems means that the pump's role is not just to move water, but to enable precise water application to the root zone, minimise wastage (evaporation, runoff), and thereby support good leaf growth which in turn supports silkworm health and cocoon yield. One study found a 37 % improvement in leaf yield and 24 % water saving when a solar-pump-driven drip irrigation kit was compared with surface irrigation.

Ensuring water quality is suitable (e.g., avoid high salts or pollutants) so the mulberry plants don’t get stressed, which would indirectly impact the silkworms. Implementing storage (ponds, tanks) in conjunction with the pump so that water can be lifted during favorable times and stored for later use—especially important in rain-fed or power-inconsistent regions. Using solar-powered or energy-efficient pump systems when conventional electricity supply is unreliable—reporting from India indicates that solar pumps have helped sericulture farmers in water-scarce zones.

Within sericulture, the water pump is more than just a mechanical appliance: it is a key link in the chain of environment management—from ensuring good mulberry leaf growth, to supporting appropriate feed for silkworms, and thus supporting cocoon production. Choosing the right pump (type, size, power source), integrating it with irrigation design (drip or other efficient method), and aligning it with water-management strategies (storage, quality control) all contribute significantly to successful sericulture operations.

In many sericulture setups, especially those growing Morus alba (mulberry) as feed for silkworms, the irrigation system is divided into two major components: the **control head**, which includes the pump (or sometimes an overhead tank) plus filters and valves, and the **distribution network**, such as drip laterals or sprinklers. When a pump is used, typically a **centrifugal pump** is recommended for drip or low-pressure systems, to ensure sufficient pressure for uniform water supply. In practical field research on mulberry cultivation under sericulture, it has been observed that efficient irrigation systems driven by pumps (or solar pumps) not only maintain plant health but also reduce water consumption significantly. For example, a study using a solar pump-based drip irrigation kit (with a 0.25 HP pump and 80 Wp solar panel) in rain-fed mulberry gardens reported a **37% improvement** in leaf yield and **24% water saving** compared to surface irrigation. Another important practical figure: During dry periods, the peak water demand for mulberry under recommended spacings (e.g., 60×60 cm) is around **1.2 litres per plant per day**, and for 90×90 cm spacing about **2.0 litres per plant per day** using micro-tube drip systems.

The pump must produce sufficient head (vertical lift) plus friction losses in piping and filters. The design guides mention that sometimes an overhead tank replacing a pump may be viable, but where pump is used it must supply required pressure.

Water-quality matters: if the water source has sediments, algae or organic matter, then filters must protect the drip system to avoid clogging. This means the pump may need to handle a reliable source of filtered water.

In an automated sericulture system (especially for mulberry plantation and silkworm-rearing facility irrigation), the **water pump** becomes a central actuation device governed by sensors, controllers, and automation logic. The setup typically includes soil-moisture sensors (or leaf/plant moisture sensors), water-level sensors, and environmental sensors linked to a controller (such as an Arduino, ESP32, or PLC).

When the sensor readings (for example, soil moisture below a preset threshold) indicate the plants need water, the controller triggers a relay or motor-starter to power the pump, which then delivers water to the distribution network (drip lines, sprinklers, overhead pipes) for the mulberry plantation or for maintaining the rearing house micro-climate. This approach helps ensure precise water delivery, avoids manual switching, reduces the risk of over- or under-watering, and conserves water and energy.

Further, the automation of the pump often includes protective features such as **dry-run protection** (to shut off if no water is detected or water level is below safe limit), **over-current/over-load protection**, and remote monitoring capabilities so the farmer can receive alerts or control the pump from a mobile app or dashboard. These features are vital in sericulture setups where water supply, power reliability, and consistent leaf quality matter.

In practice, the pump's integration into the automation framework also links it to other systems: for example, the rearing house lighting or ventilation might trigger irrigation indirectly by affecting plant growth or leaf moisture, or the pump may be scheduled/controlled via mobile app or cloud interface to match the photoperiod, leaf harvesting cycles and silkworm feeding schedule. This kind of automation helps maintain the ideal leaf quality for silkworm feeding, which in turn supports better larval growth and cocoon yield.

Remote monitoring & control: Some systems allow the pump to be started/stopped remotely via mobile phone, GSM or IoT modules. For instance, the Nano Ganesh system in India enables remote control of the pump set for irrigation.

Integration with drip/micro-irrigation systems: Automated pump control is often paired with drip lines or micro-irrigation networks, delivering water precisely and reducing wastage. For example, smart micro-irrigation systems include a pumping station that lifts water and distributes via pipelines, using sensors and valves to regulate flow.

Water and energy savings: Automation enables better timing and quantity of irrigation, which can reduce water use and energy consumption. For example, smart irrigation systems in India show 20-48% water savings and 30% energy savings.

Sensor-based triggers and safety features: Pump control systems typically incorporate features such as low-water-level cut-off (to avoid dry-run), flow or pressure sensors (to detect blockages or leaks), and scheduling logic (to avoid watering at inappropriate times). For example, one irrigation automation service mentions pump control including moisture sensors and tank-level monitoring.

Matching pump size and system design: The pump must be sized to match the elevation (head), flow rate required by the drip or irrigation layout, and the local water source. Undersized pumps may fail to deliver adequate water; oversized ones may waste energy. The design of the irrigation head (‘control head’) and distribution network is fundamental.

Water quality and system maintenance: Since mulberry leaves feed silkworms, water quality (free from high salinity, pollutants) is important for plant health. Also pump and irrigation lines must resist sediment, bio-fouling, or leaf dust.

Figure 12: WATER PUMP

CHAPTER 5

SOFTWARE COMPONENTS

5. ARDUINO SOFTWARE:

PROGRAMMING

Step 1: Installing the Firmware

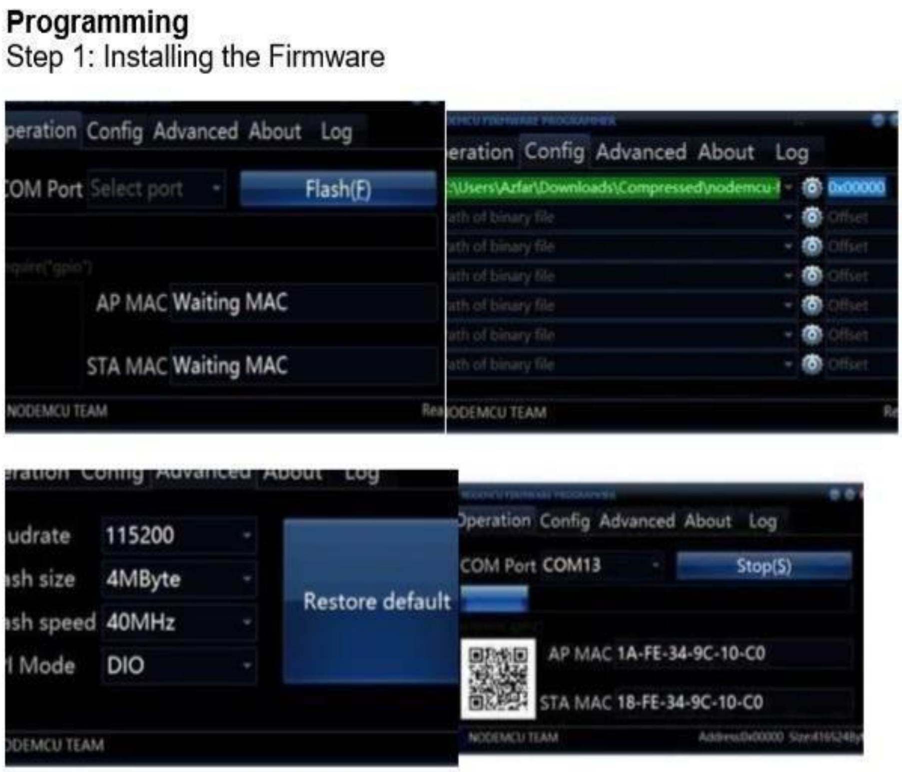


Figure 13: Installing Firmware

In Node MCU Boards the first thing you need is to install the Firmware to the board the following method works for all Node MCU Boards

1. Open the Node MCU flasher master folder than open the win32/win64 folder as your computer. Now open the folder Release than double click ESP8266Flasher.
2. Select the COM Port.
3. Go to configure tab.
4. Click on the small gear and open up the firmware which you have downloaded.
5. Go to the advanced tab and select the desired Baud rate.
6. Go to the Operation tab and click on Flash Button. Add Tip Ask Question Comment Download

Step 2: Preparing the Arduino IDE

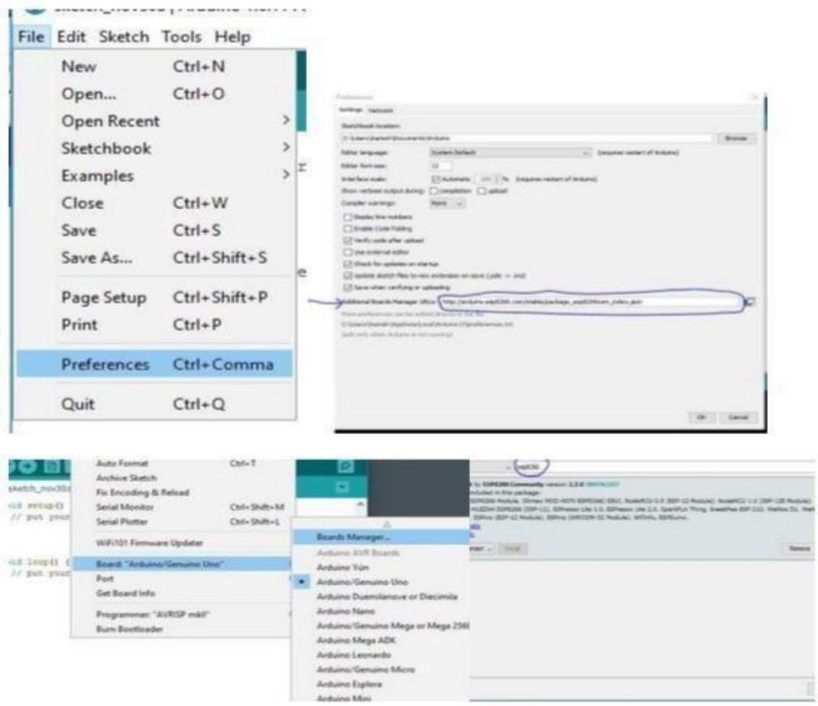


Figure 14: Arduino IDE

After installing the firmware, you are ready to do the programming with the ESP8266

a. Install the Arduino IDE

b. Open the Arduino IDE from the desktop icon

c. Click on File tab and then open preferences

d. In the additional Boards Manager URLs add the following link

e. (http://arduino.esp8266.com/stable/package_esp8266com_index.json)

f. Go to Tools>Borads>Boards Manager

g. In the search field type esp8266 click the esp8266 by ESP8266

h. Community option and click Install

Step 3: Power up your board.

The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either,the USB connection to the computer or an external power supply. If you are using an Arduino Diecimila, you have to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks.

- Connect the LED's positive leg on D9 pin of board and negative to the ground of the code.

- Power up the board and open the serial monitor from Arduino IDE
- After connecting to the Wi-Fi, it will show you the IP address. Type that IP address on the web browser (Edge, Chrome, Firefox etc.,)

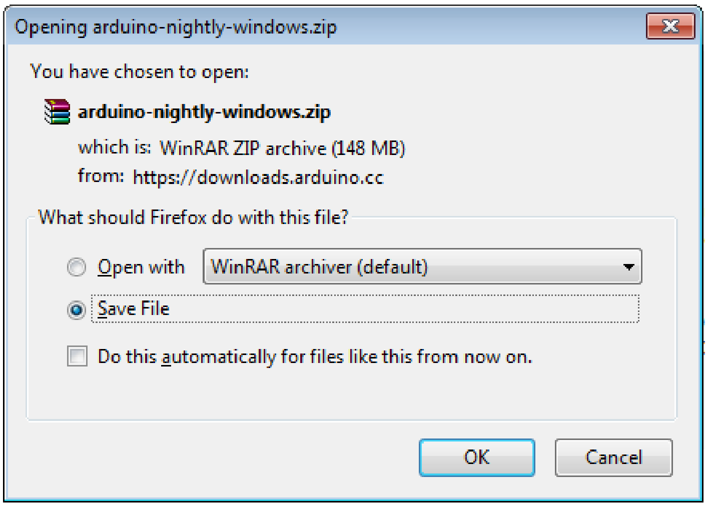


Figure 15: Arduino ide for node mcu

A webpage will open you can change the status of LED by turning it ON or OFF.

Step 4: Launch Arduino IDE.

SMART OFFICE AUTOMATION USING ESP

After your Arduino IDE software is downloaded, you need to unzip the folder.

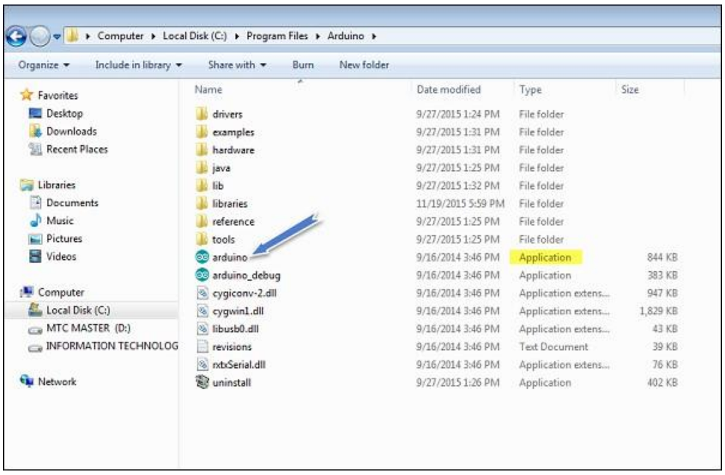


Figure 16: Install arduino

Step 5: Open your first project.

Once the software starts, you have two

options:

Open an existing project example.

To create a new project, select File-→ New, To open

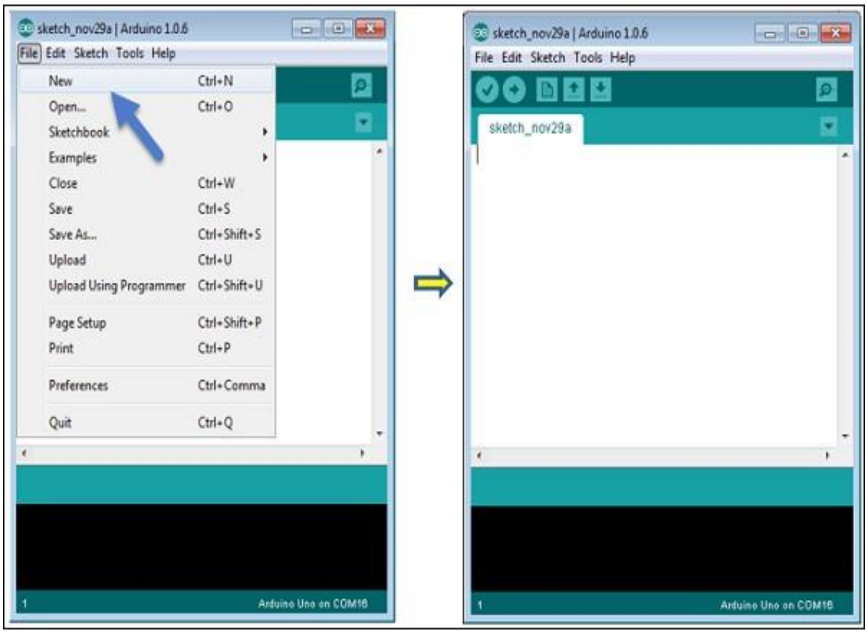


Figure 17: Creating new project

To open an existing project example, select File Example Basics -> Blink.

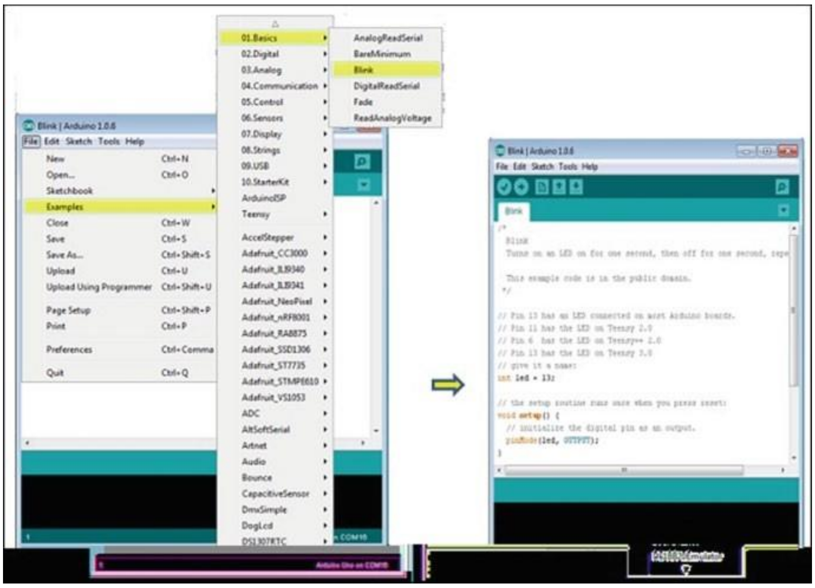


Figure 18: Installed boards under tools

Here, we are selecting just one of the examples with the name Blink. It turns the LED on and off with

Sometimes delay. You can select any other example from the list.

Step 6: Select your Arduino board to avoid any error while uploading your program to the board, you must select the correct Arduino board name, which matches with the board connected to your computer.

Here, we have selected Arduino Uno board according to our tutorial, but you must select the name matching the board that you are using

Step 7: Select your serial port.

Select the serial device of the Arduino board. Go to Tools Serial Port menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports), To find out, you can disconnect your Arduino board and re-open the menu, the entry that disappears should be of the Arduino board. Reconnect the board and select that serial port.

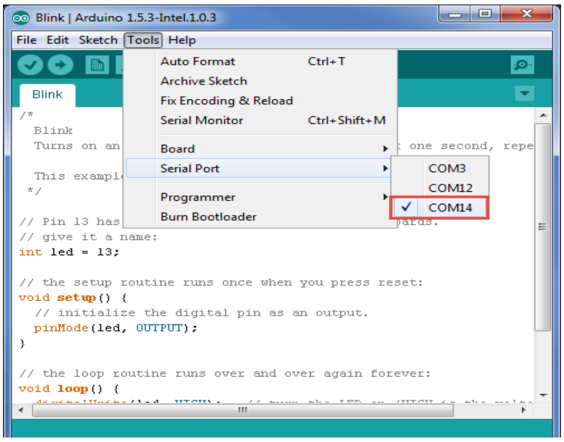


Figure 19: Selecting serial port

Step 8: Upload the program to your board. Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar.

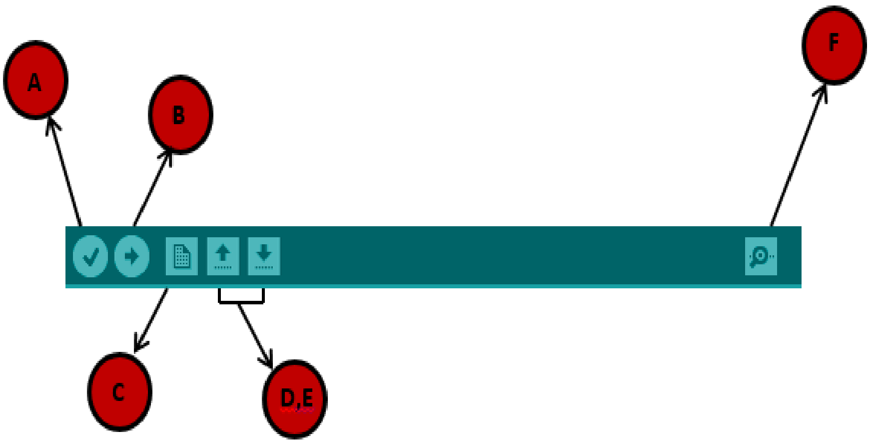


Figure 20: upload the program

A- Used to check if there is any compilation error.

B- Used to upload a program to the Arduino board.

C- Shortcut used to create a new sketch.

D- Used to directly open one of the example sketch.

E- Used to save your sketch.

PROJECTS AND APPLICATIONS:

Node MCU V3 is mainly used in the Wi-Fi Applications which most of the other embedded modules fail to process unless incorporated with some external Wi-Fi protocol. Following are some major applications used for Node MCU V3.

Node MCU ESP-12E Arduino IDE Digital Input Tutorial

Application Example:

- Internet Smoked Alarm
- VR Tracker
- Octopod
- Serial Port Monitor
- ESP Lamp
- Incubator Controller
- IoT home automation

CHAPTER 6

RESULTS AND DISCUSSIONS

The sericulture automation system for climate control and production efficiency was successfully developed and operated as intended. In the proposed system, there is an analyzing of the execution parameters of Silkworm rearing house such as temperature, humidity and light intensity using IoT. The variation in the parameters such as temperature and humidity of silk worm rearing house is sensed by the sensor. In case if the temperature increases then the fan will be turned on and if it decreases the heater will be turned on, if light intensity is low then light will on. Recent advancements in sericulture automation have demonstrated significant improvements in productivity, efficiency, and sustainability. For instance, a multi-sensor system employing image processing and support vector machines achieved a cocoon classification rate of approximately 5.5 cocoons per minute, equating to about 2,640 cocoons in an 8-hour shift. The system attained an accuracy ranging from 86.48% to 93.54%, depending on the silkworm breed, showcasing its potential to enhance grainage center operations by reducing human error and labor costs.

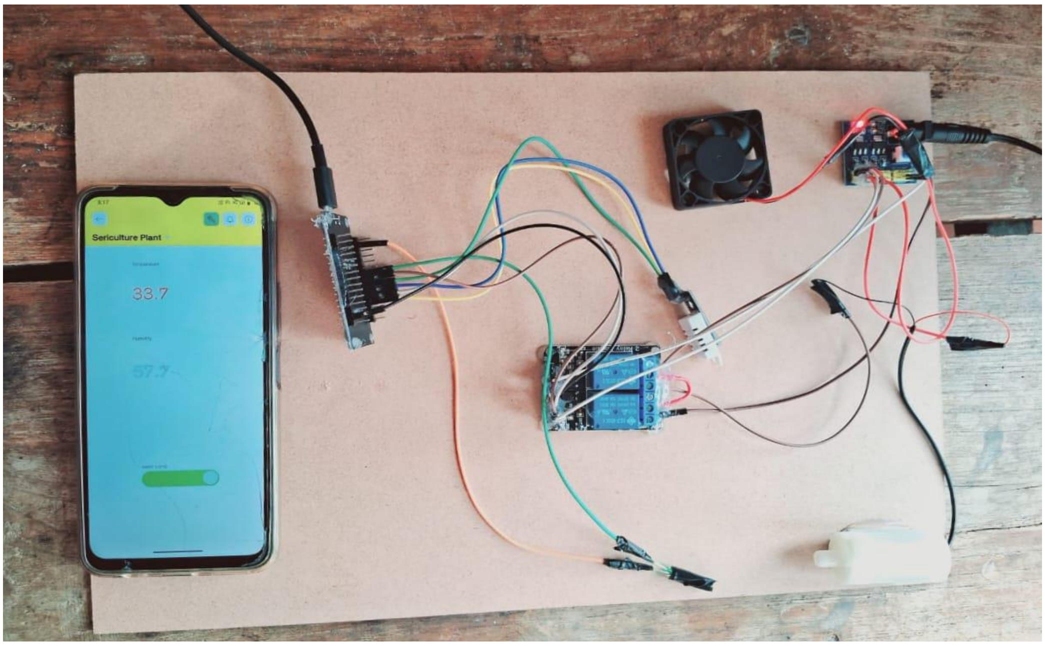


Figure 21: Experimental Setup

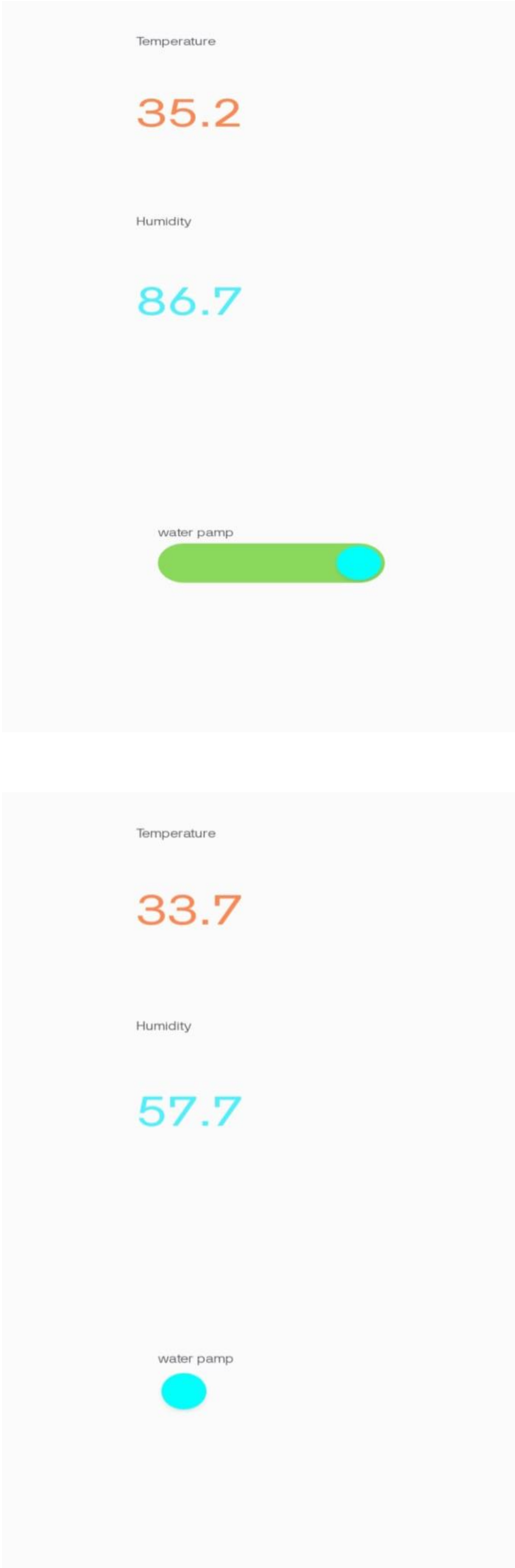


Figure 22: The Temperature and Humidity is Displayed on the Mobile

CHAPTER 7

ADVANTAGES AND APPLICATIONS

7.1 ADVANTAGES:

- **Better Climate Control :** Automation helps regulate temperature, humidity, and light inside the rearing house. This creates the ideal environment for silkworm growth and cocoon production.
- **Reduced Human Effort**: Manual monitoring and control are minimized. Automated systems save time and reduce labor costs.
- **Increased Production Efficiency**: Controlled climate reduces worm mortality and improves silk yield, leading to higher-quality cocoons and more profits.
- **Real-time Monitoring**: Sensors and controllers can provide real-time data, enabling early detection of unfavorable conditions like excess heat or humidity.
- **User-Friendly Interface**: Simple to operate even for users without technical experience.
- **Remote Operation**: The system can be connected to mobile or computer applications, allowing farmers to Consumes minimal power and uses efficient control the environment from anywhere.

7.2 APPLICATIONS:

- **Temperature and humidity control**: It automatically keeps the rearing house at the right temperature and humidity for silkworms to grow healthy.
- **Automatic feeding**: The system can feed silkworms at regular times without much manual work.
- **Monitoring**: Sensors check the room conditions and send alerts if temperature or humidity go too high or low.
- **Lighiting Control**: I for learning and demonstrating robotics, embedded systems, and human-machine interaction.
- **Data recording:** The system records all information like temperature, humidity, and growth stages for future use.

  .

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

8.1 CONCLUSION:

The IoT-based sericulture automation system, modern technology such as artificial intelligence and internet of things could stimulate the development of sericulture and expected to reduce the challenges of the rearers, reelers and those who are involved in the venture. Successful installation of the technologies will surely prevent losses due to fluctuation of environmental factors. Operations related to field activities such as choice of soil for plantation and weather forecasting, diseases, pests will also be made easy.

Automation systems in sericulture—using tools like sensors (for temperature, humidity, gases), actuators, monitoring modules (IoT), image processing, AI/ML for disease/damage detection, robotics for feeding, and environmental control—are presenting a transformative opportunity for the silk-industry. These systems increase **precision** and **consistency** in critical parameters (temperature, humidity, feeding schedules), which are essential for healthy silkworm growth and high-quality cocoon production.

8.2 FUTURE SCOPE:

The future scope of sericulture automation systems is bright and expanding rapidly. With the integration of Internet of Things (IoT), Artificial Intelligence (AI), robotics, and smart sensors, traditional sericulture practices are being transformed for higher efficiency, yield, and sustainability. Researchers are developing real-time environmental monitoring systems that maintain optimal temperature, humidity and light automatically, along with AI models for early disease detection and predictive maintenance. There is also growing interest in using biotechnology and nanotechnology—such as nano-fertilisers, transgenic silkworms, and improved mulberry varieties—to increase disease resistance, accelerate growth, and improve silk quality.

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6. Farooq Nasir, “Effect of Rearing Temperature and Humidity on Fecundity and Fertility of Silkworm, Bombyx Mori L. (Lepidoptera: Bombycidae)”

APPENDIX

```
#define
BLYNK_TEMPLATE_ID
"TMPL3P_r_YepO"

#define
BLYNK_TEMPLATE_NA
ME "Smart Sericulture"

#define
BLYNK_AUTH_TOKEN
"u1xk0V4jGlmdJukgZf2Sd
C7PL-TFaZTf"

#include
<ESP8266WiFi.h>#include
<BlynkSimpleEsp8266.h>

#include "DHT.h"

// WiFi credentialschar
ssid[] = "rpi15";

char pass[] = "raspberry";

// DHT configuration

#define DHTPIN D3

#define DHTTYPE DHT22

DHT dht(DHTPIN,
DHTTYPE);
```

```
// LED, FAN & BULB
configuration

#define LED_PIN D4     //
LED pin

#define FAN_PIN D5     //
FAN pin

#define BULB_PIN D6    //
BULB pin

BlynkTimer timer;//
Function to read DHT22
and send data to Blynk,
control FAN & BULB

void sendSensorData() {

  float h =
dht.readHumidity();

  float t =
dht.readTemperature();

  if (isnan(h) || isnan(t)) {

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

    return;}

float hic =
dht.computeHeatIndex(t, h,
false);
Serial.print("Humidity: ");
```

```
  Serial.print(h);

  Serial.print("%
Temperature: ");

  Serial.print(t);

  Serial.print("°C  Heat
Index: ");

  Serial.print(hic);

  Serial.println("°C");  //
Send sensor data to Blynk
app

  Blynk.virtualWrite(V0, t);
// Temperature

  Blynk.virtualWrite(V1, h);
// Humidity  // Fan control
logic: turn ON fan if temp >
30°C

  if (t > 30.0) {

    digitalWrite(FAN_PIN,
LOW); // Turn ON fan
(active LOW relay)

    Serial.println("Fan: ON
(Temp > 30°C)");

    Blynk.virtualWrite(V3,
1); // Optionally update a
Blynk widget for fan status
```

```
  } else {

    digitalWrite(FAN_PIN,
HIGH);  // Turn OFF fan

    Serial.println("Fan: OFF
(Temp <= 30°C)");

    Blynk.virtualWrite(V3,
0); // Optionally update a
Blynk widget for fan status

  }// Bulb control logic: turn
ON bulb if temp < 27°C

  if (t < 29.5) {

    digitalWrite(BULB_PIN,
LOW); // Turn ON bulb
(active LOW relay)

    Serial.println("Bulb: ON
(Temp < 27°C)");

    Blynk.virtualWrite(V4,
1); // Optionally update a
Blynk widget for bulb status

  } else {

    digitalWrite(BULB_PIN,
HIGH); // Turn OFF bulb

    Serial.println("Bulb: OFF
(Temp >= 27°C)");
```

```
  Blynk.virtualWrite(V4,
0); // Optionally update a
Blynk widget for bulb status

  }

}

// Function to handle LED
control from Blynk app

BLYNK_WRITE(V2) {  //
V2 is the virtual pin for
LED control

  int ledState =
param.asInt(); // 1 = ON, 0
= OFF

  digitalWrite(LED_PIN,
ledState);  Serial.print("LED
State: ");
Serial.println(ledState ?
"ON" : "OFF");}void
setup() {
Serial.begin(9600);
Serial.println("Connecting
to Blynk...");
pinMode(LED_PIN,
OUTPUT);
digitalWrite(LED_PIN,
HIGH); // Turn off LED
initially
pinMode(FAN_PIN,
OUTPUT);
```

```
  digitalWrite(FAN_PIN,
HIGH); // Turn off FAN
initially (Active LOW relay)
pinMode(BULB_PIN,
OUTPUT);

  digitalWrite(BULB_PIN,
HIGH); // Turn off BULB
initially (Active LOW relay)
Blynk.begin(BLYNK_AUT
H_TOKEN, ssid, pass);

  dht.begin();
timer.setInterval(2000L,
sendSensorData); // Send
DHT22 data every 2
seconds

}

void loop() {

  Blynk.run();

  timer.run();

}
```