CHAPTER 1
INTRODUCTION

1.1 Background

The emergence of cooling helmets arises from the urgent need to address heat stress in various industries and activities, where prolonged exposure to high temperatures poses significant health and safety risks. Traditionally, passive cooling methods like shade and hydration have been relied upon, but their efficacy may be limited, particularly in intense or prolonged heat exposure scenarios. Recognizing this challenge, researchers and engineers have turned to active cooling solutions, leading to the development of cooling helmets. These helmets integrate various cooling technologies such as fans, evaporative cooling systems, phase change materials, and thermoelectric coolers to actively dissipate heat from the head, thereby creating a more comfortable microclimate for the wearer.

The background of cooling helmets spans diverse applications across industries like construction, mining, firefighting, military operations, athletics, and outdoor recreation. The primary objective across these contexts is to enhance safety, performance, and comfort for individuals operating in hot and challenging environments. Furthermore, ongoing efforts in research and development aim to optimize the design, efficiency, and usability of cooling helmets. By seamlessly integrating with existing helmet designs and protective gear, while ensuring durability, portability, and affordability, cooling helmets are poised to become indispensable tools in safeguarding health and well-being in hot environments, thus promoting safety and performance across various sectors.

Comprising state-of-the-art components such as the STM32 microcontroller, Peltier cooling system, DS18B20 temperature sensor, LCD display, relay module, exhaust fan, and cooling spreading fan, the Intelligent Cooling Helmet embodies a fusion of innovation and practicality. This intelligent cooling system operates seamlessly, constantly monitoring the helmet's internal temperature and activating the Peltier cooling system when it surpasses a predetermined threshold. The result is an automated cooling mechanism designed to keep riders cool, focused, and comfortable throughout their journey. With its emphasis on user-centric design and technological advancement, the Intelligent Cooling Helmet sets a new standard for motorcycle gear, promising riders an unparalleled level of comfort and enjoyment regardless of the weather conditions.

1.2 Problem Statement

Motorcycle enthusiasts often face the challenge of riding in hot weather conditions, which can lead to discomfort, fatigue, and reduced concentration. While traditional helmets provide essential protection, they offer limited relief from the heat, leaving riders vulnerable to the adverse effects of elevated temperatures during extended rides. This discomfort not only detracts from the overall riding experience but also poses safety risks due to decreased focus and physical strain.

Moreover, existing cooling solutions for motorcyclists, such as makeshift vents or handheld fans, are often ineffective and impractical to use while riding. There is a clear need for an efficient and integrated cooling solution embedded directly within the helmet to address the specific challenges faced by motorcyclists riding in hot weather conditions. This solution should provide continuous and automated cooling while prioritizing comfort, safety, and ease of use for riders of all experience levels. Thus, the development of the Intelligent Cooling Helmet aims to address these pressing issues head-on and redefine the motorcycling experience by offering a comprehensive cooling solution tailored specifically for riders.

1.3 Aim of Project

The aim of cooling helmet projects is to tackle the urgent necessity for efficient temperature regulation and heat stress prevention in environments characterized by prolonged exposure to elevated temperatures. These initiatives are centered on the development of innovative solutions to ensure the comfort, safety, and well-being of individuals enduring challenging conditions. By integrating innovative cooling technologies into helmet designs, these projects aim to elevate performance, endurance, and overall health, whether for athletes striving for peak performance, military personnel engaged in demanding missions, or workers laboring in hot industrial settings.

Fig. 1.3 Prototype of Cooling Helmet

Through meticulous engineering and design, cooling helmet projects strive to achieve optimal cooling effectiveness while prioritizing comfort, portability, and durability. Energy efficiency is a paramount consideration, ensuring that cooling systems operate efficiently without imposing excessive demands on power sources. Furthermore, seamless integration with existing helmet designs and protective gear is emphasized, facilitating ease of use across diverse applications. Cost-effectiveness is also a key focus, aiming to make these life-saving technologies accessible to a broad spectrum of users, thereby significantly enhancing safety, productivity, and quality of life in hot environments.

1.4 Methodology

The cooling helmet system initializes with temperature sensors measuring both surrounding and internal temperatures. Following this, the control flow diverges based on a conditional check: if the surrounding temperature exceeds the desired threshold of 21°C, the process activates the Peltier module to initiate cooling. Subsequently, the internal helmet temperature is reassessed. Another decision point arises: if the helmet temperature meets or falls below the desired threshold, the process concludes; otherwise, it loops back to re-activate the Peltier module for further cooling until the desired temperature is achieved. This iterative process ensures effective temperature regulation within the helmet, enhancing wearer comfort and safety in environments prone to heat stress.

Fig. 1.4 Air Flow Mechanism used in Project

1.5 Significance of Project

The cooling helmet incorporates a dual ventilation system to optimize airflow and regulate internal temperature effectively. Intake vents strategically positioned within the helmet's design allow fresh air to enter, promoting the exchange of warm, stale air with cooler ambient air from the surroundings. Typically located at the front or sides of the helmet, these intake vents efficiently capture airflow during movement, ensuring a steady flow of fresh air to the wearer's head. Complementing this, exhaust ventilation systems strategically positioned at the rear or top of the helmet facilitate the expulsion of heated air and moisture, preventing heat buildup within the helmet. This continuous airflow circulation ensures a comfortable internal environment, vital for mitigating heat stress and enhancing wearer safety and comfort during prolonged use in challenging conditions.

Moreover, the cooling helmet is engineered for portability and mobility, featuring a rechargeable battery that eliminates the need for tethering to a power source. This design allows users to move freely without constraints, making it particularly valuable for outdoor sports, military operations, or emergency response scenarios where maintaining thermal comfort on the go is essential. The integration of a rechargeable battery ensures continuous operation over extended periods, enhancing user comfort and safety throughout prolonged activities or work shifts. This combination of portability, continuous operation, and efficient ventilation systems makes the cooling helmet a versatile and indispensable tool for individuals navigating hot and demanding environments.

1.6 Outline

The project document outlines the development and implementation of an innovative cooling helmet designed to mitigate heat stress and enhance wearer comfort and safety in challenging environments. It begins with an introduction detailing the critical need for effective temperature regulation in industries and activities where individuals face prolonged exposure to hot temperatures. The document then progresses to describe the methodology employed in the design and engineering of the cooling helmet, including the integration of advanced cooling technologies, dual ventilation systems, and portability features such as rechargeable batteries. Subsequent sections delve into the specific components and functionalities of the cooling helmet, emphasizing its ability to actively dissipate heat, regulate internal temperature, and promote continuous airflow circulation. Additionally, the document highlights the interdisciplinary nature of the project, drawing insights from physiology, engineering, and materials science to develop practical solutions that safeguard health and well-being in hot environments. Finally, the project document concludes with a discussion on the potential impact of the cooling helmet on safety, productivity, and quality of life for individuals working and participating in activities in hot environments.

Furthermore, the project document elucidates the implementation plan for deploying the cooling helmet across various industries and applications. It outlines strategies for optimizing design, efficiency, and usability based on user feedback and iterative testing. Additionally, the document addresses considerations regarding cost-effectiveness and scalability to ensure widespread adoption of the cooling helmet technology. Moreover, the project document discusses potential future developments and enhancements, highlighting opportunities for further innovation and refinement in cooling helmet design and functionality. Through comprehensive documentation of the project scope, methodology, and implementation plan, the document serves as a roadmap for stakeholders involved in the development, deployment, and utilization of the cooling helmet, aiming to enhance safety, performance, and well-being in hot and challenging environments.

CHAPTER 2
PRE-PROJECT ANALYSIS

2.1 Literature Survey

The literature survey for the cooling helmet project initiates with an examination of existing research in heat stress management and personal cooling systems. It delves into studies exploring the physiological effects of heat stress, recognizing its detrimental impact on health, safety, and productivity in various industries. Additionally, the survey reviews passive cooling methods' limitations and the emergence of active cooling solutions such as cooling helmets. Synthesizing insights from physiology, engineering, and materials science, the survey sets the groundwork for developing an innovative cooling helmet to revolutionize heat stress management and enhance safety and performance.

Cornelis P. Bogerd et al. (2014) discussed the thermal discomfort experienced by individuals wearing helmets in warm atmospheres, attributing it to the main heat transfer pathways for headgear: convection, evaporation, and radiation. They employed numerical methods, bio-physical models, and user trials to study the interaction between these mechanisms and users, emphasizing the influence of environmental conditions, helmet parameters, and user characteristics on heat transfer. The authors focused on physiological responses, comfort levels, thermal sensations, and cognitive impacts, confirming that helmet wearers often experience thermal discomfort under certain weather conditions and extended usage durations.

M. Hrari et al. (2013) elaborated on the development of cooling systems for motorcycle helmets using thermoelectric technology, leveraging the Peltier effect. Their study involved the design of efficient cooling modules using a software-based approach, incorporating aluminum pipes, electric fans, and cooling chambers. Experimental and field results indicated successful target achievement, although challenges such as the sound of electric fans inside the helmet remained to be addressed.

Linlin Cao et al. (2017) introduced a novel cooling helmet design utilizing thermoelectric refrigeration combined with air- and water-cooling mechanisms to cool both the head and neck simultaneously. Through experimentation using environmental simulation devices and thermal mankind, they evaluated the cooling effect demonstrating significant influences of environmental temperature on helmet cooling characteristics.

Yigit Sezgin and Murrat Celik (2015) explored the application of phase change materials (PCM), specifically HS 29, for motorcycle helmet cooling through forced convection. They utilized copper casing to enhance heat absorption, incorporated copper pipes inside and outside the chamber, and installed two fans at the helmet's rear for air circulation. Analysis revealed improved temperature regulation within the helmet when employing PCM, highlighting the potential for enhanced wearer comfort and extended PCM working time through material selection and interior design modifications.

2.2 Existing Methods and Drawbacks

1. Traditional Helmets:

- **Method:** Traditional helmets primarily focus on providing protection but often lack adequate ventilation mechanisms.

Fig. 2.2.1 Traditional Helmets

- **Drawbacks:** The limited airflow can result in discomfort, particularly for cyclists riding in hot weather, leading to heat-related issues like fatigue and dehydration, especially during extended rides.

2. Helmet Attachments:

- **Method:** Some cyclists resort to aftermarket attachments like handheld fans or cooling pads to alleviate heat inside the helmet.

Fig. 2.2.2 Fan Attachments to Helmets

- **Drawbacks:** These add-ons can be cumbersome, impractical to use while riding, and may not effectively address the core issue of heat buildup within the helmet, impacting overall comfort and usability.

3. Helmet Ventilation Systems:

- **Method:** Certain helmets come equipped with built-in ventilation systems, featuring air vents to enhance airflow and cooling.

Fig. 2.2.3 Ventilation System in Helmets

- **Drawbacks:** While these systems improve ventilation, they may not offer sufficient cooling, especially during strenuous activities in hot climates, limiting their effectiveness.

4. Water-Based Cooling Systems:

- **Method:** Some cyclists opt for water-based cooling systems, such as evaporative cooling vests or bandanas, to lower body temperature and combat heat.

- **Drawbacks:** While providing temporary relief, these systems are not optimized for helmet use, posing practical challenges, and potentially falling short in adequately cooling the head within the helmet.

5. Electronic Cooling Devices:

- **Method:** Helmets with integrated electronic cooling devices, such as battery-powered fans or cooling pads, aim to provide active airflow and cooling.

Fig. 2.2. 5 Electronic Cooling Helmets

- **Drawbacks:** However, these devices may introduce additional weight and bulk to the helmet, compromising comfort and aesthetics. Furthermore, their cooling capacity may not fully address the heat buildup inside the helmet during intense activities.

6. Passive Cooling Strategies:

- **Method:** Passive cooling strategies involve incorporating reflective coatings or heat-dissipating materials into helmet designs to minimize heat absorption.

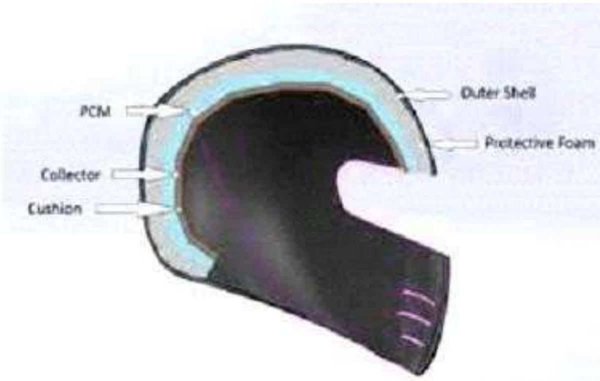


Fig. 2.2.6 Passive Strategical Helmets

- **Drawbacks:** While helpful, these strategies may not offer enough active cooling, especially in demanding weather conditions or during high intensity cycling sessions.

2.3 Significance of Survey

Conducting a comprehensive literature survey is integral to contextualizing the research endeavor focused on enhancing motorcycle helmet cooling. This survey delves into existing knowledge, methodologies, and innovations concerning helmet cooling technology. By thoroughly examining previous studies and publications, researchers can identify trends, challenges, and advancements in the field, thus laying the groundwork for informed decision-making and hypothesis formulation.

Moreover, the literature survey serves as a guidepost for identifying gaps and opportunities for further exploration within the realm of helmet cooling. Through a critical analysis of existing literature, researchers can pinpoint areas where knowledge is lacking or where existing solutions may be inadequate. This process not only informs the development of research questions and objectives but also facilitates the formulation of innovative approaches and methodologies to address these gaps effectively.

Furthermore, the literature survey is essential for establishing the credibility and validity of the research findings. By grounding the study in existing literature and established theories, researchers can demonstrate the relevance and significance of their work within the broader academic and practical contexts of helmet cooling technology. Additionally, synthesizing insights from previous studies enables researchers to interpret their findings considering existing knowledge, contributing to the advancement of the field and guiding future research endeavors.

CHAPTER 3
PROPOSED SYSTEM - THE INTELLIGENT COOLING HELMET

The proposed Intelligent Cooling Helmet stands as a groundbreaking solution poised to transform the cycling landscape through the integration of innovative cooling technology directly into the helmet. This visionary system encompasses several pivotal components, including an STM32 microcontroller, Peltier cooling system, DS18B20 temperature sensor, LCD display, relay module, exhaust fan, and cooling spreading fan. Together, these elements create an unparalleled riding experience, ensuring cyclists remain comfortable and refreshed, even amidst sweltering weather conditions.

3.1 Key Components and Functionality:

- **STM-32 Microcontroller:**
  - The heart of the Intelligent Cooling Helmet, the STM32 microcontroller orchestrates the entire cooling process, responding dynamically to temperature fluctuations within the helmet.
- **Peltier Cooling System:**
  - A sophisticated cooling mechanism activated by the microcontroller, the Peltier system rapidly cools the interior of the helmet when temperatures surpass predefined thresholds, ensuring optimal comfort for the rider.
- **DS18B20 Temperature Sensor:**
  - This sensor continuously monitors the internal temperature of the helmet, providing real-time data to the microcontroller for precise cooling control.
- **LCD Display:**
  - Integrated seamlessly into the helmet, the 16x2 LCD display offers riders instant access to temperature readings and system status updates, enhancing user experience and facilitating quick adjustments.

- **Exhaust Fan:**
  - Working in tandem with the Peltier system, the exhaust fan expels warm air from the helmet, maintaining a consistently cool environment for the cyclist.

- **Cooling Spreading Fan:**
  - Strategically placed, the cooling spreading fan ensures uniform distribution of cool air throughout the helmet, maximizing comfort and eliminating hot spots.

3.1.1 User Experience and Design Considerations:

The Intelligent Cooling Helmet is meticulously designed with user comfort and convenience in mind. Its lightweight construction and compatibility with standard helmet designs ensure a seamless fit for cyclists of all levels, prioritizing safety alongside performance. The non-intrusive nature of the system allows riders to focus on their journey without distractions, while the intuitive LCD display gives critical feedback, empowering users to monitor and optimize their cooling experience effortlessly.

3.1.2 Innovation and Impact:

This project heralds a new era in cycling gear, setting a benchmark for comprehensive cooling solutions that elevate rider comfort, safety, and performance. By harnessing intelligent cooling technology, user-friendly interfaces, and innovative design principles, the Intelligent Cooling Helmet aims to redefine industry standards and enhance the global cycling experience for enthusiasts worldwide.

Fig. 3.1.2 Riding Helmet

3.2 BLOCK DIAGRAM:

The block diagram depicts a helmet cooling system that uses a microprocessor to regulate temperature. The microprocessor receives input from sensors measuring the surrounding and helmet's internal temperatures. It then controls a Peltier module and a cooling fan system to adjust the internal temperature. An LCD output displays the temperature data, allowing users to monitor the system's effectiveness. This setup ensures the helmet remains at a comfortable temperature for the wearer.

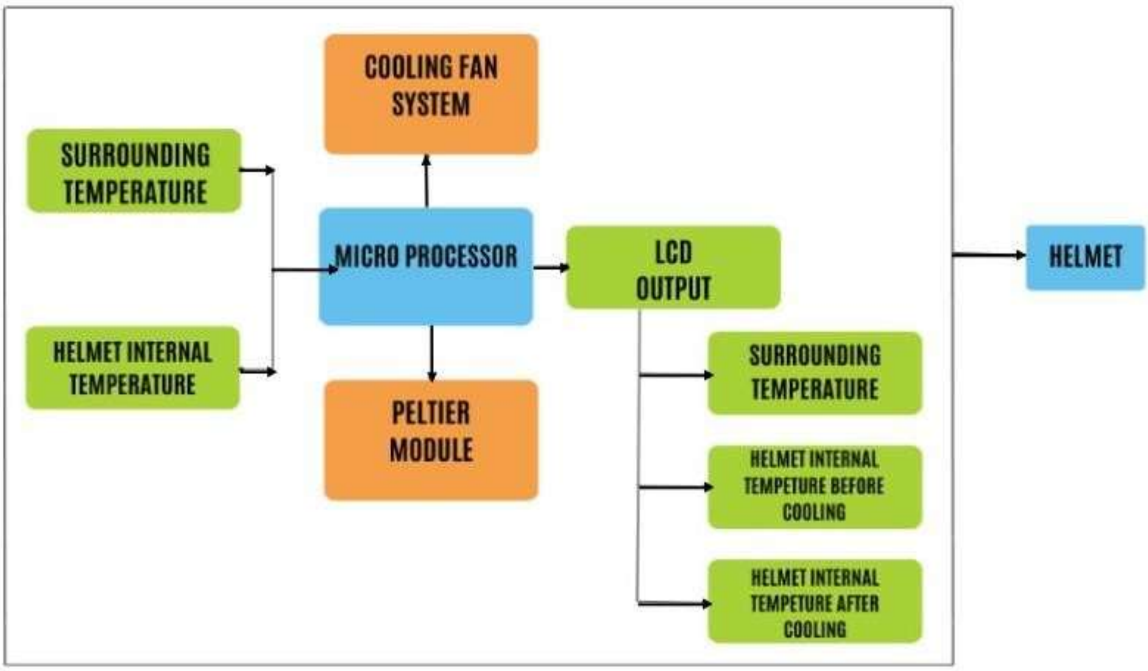


Fig. 3.2 Block Diagram of Designed Project

3.3 Implementation Steps:

- **Component Assembly:**
  - Gather all necessary components, including the helmet, STM32 microcontroller, Peltier cooling system, DS18B20 temperature sensor, LCD display, relay module, exhaust fan, and cooling spreading fan.
  - Assemble the components into the helmet, ensuring they are placed correctly and securely attached to the helmet structure.
- **Hardware Integration:**
  - Connect the DS18B20 temperature sensor to the STM32 microcontroller to enable temperature monitoring.
  - Wire the Peltier cooling system to the relay module and STM32 microcontroller to control its activation based on temperature readings.
  - Connect the exhaust fan and cooling spreading fan to the relay module and STM32 microcontroller to regulate airflow and cooling within the helmet.
- **Programming the STM32 Microcontroller:**
  - Develop firmware for the STM32 microcontroller to interface with the DS18B20 temperature sensor, LCD display, relay module, and cooling components.
  - Program the microcontroller to continuously monitor temperature readings from the sensor and activate the cooling system when temperatures exceed a preset threshold.
  - Implement logic to control the operation of the exhaust fan and cooling spreading fan to optimize airflow and cooling efficiency.
- **LCD Display Integration:**
  - Interface the 16x2 LCD display with the STM32 microcontroller to provide real-time temperature readings and system status updates to the rider.

- Develop software to display temperature data and system messages on the LCD display in a clear and user-friendly format.

➢ **Testing and Calibration:**

- Conduct thorough testing of the Intelligent Cooling Helmet to ensure all components and systems function correctly.
- Calibrate the temperature sensor and cooling system to ensure accurate temperature monitoring and effective cooling performance.
- Test the helmet under various environmental conditions and cycling scenarios to validate its performance, reliability, and user experience.

CHAPTER 4
HARDWARE DESCRIPTION

4.1 STM-32 ARM Cortex Based Microcontroller

The STM32 microcontroller series, developed by STMicroelectronics, represents a highly versatile and widely adopted family of microcontrollers based on the ARM Cortex-M processor architecture. With a range of product lines tailored to various application requirements, STM32 microcontrollers offer exceptional performance, low power consumption, and extensive peripheral integration. From the entry-level STM32F0 series to the high-performance STM32H7 series, these microcontrollers cater to diverse embedded systems applications with features such as GPIO, UART, SPI, I2C, USB, CAN, timers, ADC, and DAC. Moreover, STM32 microcontrollers provide flexibility in memory options, offering embedded Flash memory for program storage and SRAM for data storage, with varying memory sizes across product lines to accommodate different application needs.

Fig. 4.1. STM-32 ARM Cortex

Supported by a robust development ecosystem, STM32 microcontrollers streamline the software development process with integrated development environments(IDEs) like STM32CubeIDE, software development kits (SDKs), libraries, and evaluation boards. This comprehensive ecosystem facilitates rapid prototyping, debugging, and deployment of embedded systems solutions. Additionally, STM32 microcontrollers feature advanced low power modes, enabling energy-efficient operation and extending battery life in battery-powered applications. With their combination of performance, flexibility, and ease of development, STM32 microcontrollers continue to be a preferred choice for designers across industries such as automotive, industrial automation, consumer electronics, and healthcare, driving innovation and advancement in embedded systems technology.

Reference link: https://www.st.com/en/microcontrollers-microprocessors/stm32-arm-cortex-mpus.html

4.2 Sensors Used

Temperature sensors are electronic devices crucial for measuring temperature accurately across various applications. Thermistors, which alter resistance in response to temperature changes, and resistance temperature detectors (RTDs), which rely on the predictable resistance changes of certain metals, are common types. Semiconductor-based sensors offer advantages like small size and low cost, providing digital outputs for precise measurement. Additionally, infrared (IR) temperature sensors measure temperature remotely by detecting emitted infrared radiation. Each type has specific advantages depending on factors like accuracy needs, environmental conditions, and cost constraints, making temperature sensors essential components in industries ranging from manufacturing to healthcare.

4.2.1 DS18B20 Temperature Sensor:

The DS18B20 is a digital temperature sensor with a 1-Wire interface, allowing multiple sensors to be connected to a single data line. It operates over a wide temperature range from -55°C to +125°C with ±0.5°C accuracy. With its unique 64-bit serial code, each sensor can be individually addressed. Its compact design includes a built-in 12-bit ADC for temperature measurement. The sensor requires minimal external components for operation. It offers low power consumption, making it suitable for battery-powered applications. The DS18B20 provides digital temperature readings directly to the host microcontroller without the need for analog-to-digital conversion. Its versatile applications range from HVAC systems to industrial processes and weather stations. The sensor's waterproof variant (DS18B20-PAR) makes it suitable for outdoor and harsh environments. It comes in various package types including TO-92, SOIC, and waterproof versions.

Fig. 4.2.1 DS18B20 Temperature Sensor

4.2.1.1 Pin Configuration

No.	Pin Name	Description
1	Ground	Connect to the ground of the circuit
2	Vcc	Powers the Sensor, can be 3.3V or 5V
3	Data	This pin gives output of the temperature value which can be read using 1-wire method

4.2.1.2 DS18B20 Sensor Specifications

- Programmable Digital Temperature Sensor
- Communicates using 1-Wire method
- Operating voltage: 3V to 5V
- Temperature Range: -55°C to +125°C
- Accuracy: ±0.5°C
- Output Resolution: 9-bit to 12-bit (programmable)
- Unique 64-bit address enables multiplexing
- Conversion time: 750ms (about 1 second) at 12-bit
- Programmable alarm options
- Available as To-92, SOP and even as a waterproof sensor

Note: Read further to know why these parameters are important. Also, the **DS18B20 datasheet** can be found at the bottom of the page.

4.2.1.3 Applications

- Measuring temperature at harsh environments
- Liquid temperature measurement
- Applications where temperature must be measured at multiple points

Reference link: https://www.elprocus.com/ds18b20-waterproof-temperature-sensor/

4.2.2 DHT11 Temperature Sensor

The DHT11 sensor consists of a capacitive humidity sensor and a thermistor for temperature measurement, both integrated onto a single chip. It utilizes a digital signal output, making it easy to interface with microcontrollers such as Arduino, Raspberry Pi, or ESP8266. The sensor comes in a small package with three pins for power, ground, and data.

Fig. 4.2.2 DHT-11 Sensor

4.2.2.1 Applications

- **Weather Stations:** The DHT11 is commonly used in DIY weather stations to monitor temperature and humidity levels indoors or outdoors.
- **HVAC Systems:** Heating, ventilation, and air conditioning systems benefit from the DHT11 sensor for climate control and energy efficiency.
- **Environmental Monitoring:** It is used in environmental monitoring systems to ensure optimal conditions in greenhouses, warehouses, and other controlled environments.
- **Home Automation:** In home automation projects, the DHT11 enables smart thermostats and humidity-controlled systems for enhanced comfort and energy savings.

- **Industrial Automation:** Various industrial applications rely on the DHT11 for monitoring and controlling environmental conditions in manufacturing processes, storage facilities, and more.
- **IoT Devices:** With its low power consumption and digital output, the DHT11 is ideal for IoT (Internet of Things) projects, enabling remote monitoring and data collection.

4.2.2.2 Features

- **Digital Output:** The DHT11 provides a digital signal output, simplifying integration with microcontrollers and eliminating the need for analog-to-digital conversion.
- **High Accuracy:** While not as precise as some higher-end sensors, the DHT11 offers adequate accuracy for most applications, with a temperature range of 0°C to 50°C and humidity range of 20% to 90%.
- **Low Cost:** One of the key advantages of the DHT11 is its affordability, making it accessible for hobbyists, students, and budget-conscious projects.
- **Simple Interface:** With only three pins for power, ground, and data, the DHT11 is easy to connect and use, requiring minimal external components.
- **Compact Size:** Its small form factor allows for easy integration into various projects, even where space is limited.

Reference link: https://components101.com/sensors/dht11-temperature-sensor

4.3 LCD

4.3.1 LCD 16×2 Pin Configuration and Its Working

LCDs, particularly the LCD 16×2, have become ubiquitous in modern devices like CD players, DVD players, digital watches, and computers, replacing older CRT technology. This shift is due to LCDs' advantages: they consume less power, are lighter and thinner, and are more compact than CRTs. The LCD 16×2 specifically operates by blocking light rather than emitting it, contributing to its low power consumption. This article provides an overview of the LCD 16×2, including its pin configuration and working principles, highlighting its importance in various electronic applications.

Fig. 4.3.1 16x2 LCD Display

The term LCD stands for liquid crystal display, which is a widely used electronic display module in numerous applications such as mobile phones, calculators, computers, TV sets, and more. LCDs are preferred for their versatility in displaying multi-segment light-emitting diodes (LEDs) and seven-segment displays. The key advantages of using LCD modules include their affordability, ease of programming, ability to display animations, and the absence of limitations in displaying custom characters, special symbols, and animations, making them highly adaptable for various electronic devices and visual interfaces.

4.3.2 LCD 16×2 Pin Diagram

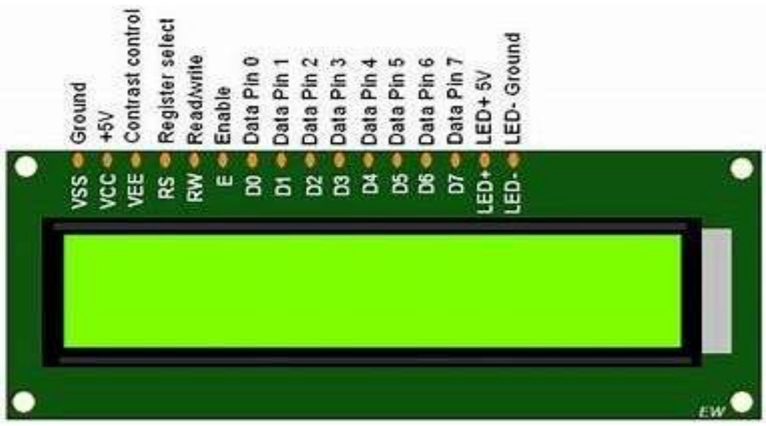


Fig. 4.3.2 Pinout Diagram of 16x2 LCD Display

The 16×2 LCD pinout is shown below.

- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.
- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).
- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.
- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V
- Pin 16 (-ve pin of the LED): This pin is connected to GND.

4.3.3 The features of the LCD 16x2

1. Operating Voltage: The LCD operates within the voltage range of 4.7V to 5.3V.

2. Display: It has two rows, with each row capable of displaying 16 characters.

3. Power Consumption: The LCD consumes approximately 1mA of current without backlight.

4. Character Representation: Each character is built within a 5x8 pixel box, allowing for clear and readable text.

5. Alphanumeric Display: It can display both alphabets and numbers, making it versatile for various applications.

6. Communication Modes: The LCD supports two communication modes, namely 4-bit and 8-bit modes, offering flexibility in data transfer.

7. Backlight Options: Available with blue and green backlight options, enhancing visibility in different lighting conditions.

8. Custom Characters: It can display custom-generated characters, enabling users to create unique visual elements as needed.

A 16×2 LCD has two registers: the data register and the command register. The RS (register select) pin is used to switch between these registers. When the RS pin is set to '0', it indicates the command register is selected, and when set to '1', it indicates the data register is selected.

Command Register: The command registers stores instructions sent to the LCD, such as clearing the display, initializing, setting the cursor position, and controlling the display's behavior. Commands are processed within this register, enabling predefined tasks to be executed.

Data Register: The data register stores the information to be displayed on the LCD screen. Information sent to the LCD, such as ASCII values representing characters, is stored in the data register. When the RS pin is set to '1', indicating the data register is selected, the LCD processes the data stored in this register to display the desired information on the screen.

Reference link: **https://www.elprocus.com/lcd-16x2-pin-configuration-and-its-working/**

4.4 Relay

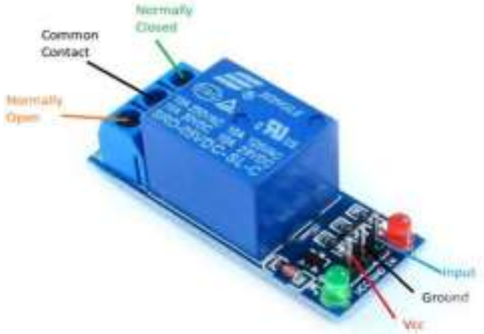


Fig. 4.4.1 5V Single-Channel Relay Module Pinout

A relay is an electromechanical device that uses an electric current to either open or close the contacts of a switch. It acts as an electrically controlled switch. A single-channel relay module is more than just a relay; it includes additional components that simplify switching and connection processes. These modules often feature indicators to show whether the module is powered and whether the relay is actively engaged or not, providing visual feedback to users about the module's status.

4.4.1 Single-Channel Relay Module Pin Description

Pin Number	Pin Name	Description
1	Relay Trigger	Input to activate the relay
2	Ground	0V reference
3	VCC	Supply input for powering the relay coil
4	Normally Open	Normally open terminal of the relay
5	Common	Common terminal of the relay
6	Normally Closed	Normally closed contact of the relay

4.4.2 Single-Channel Relay Module Specifications

- Supply voltage – 3.75V to 6V
- Quiescent current: 2mA
- Current when the relay is active: ~70mA
- Relay maximum contact voltage – 250VAC or 30VDC
- Relay maximum current – 10A

4.4.3 Components Present on a 5V Single Channel Relay Module

The following are the major components present on a relay module; we will get into the details later in this article.

- 5V Relay
- Transistor

- Diode
- LEDs
- Resistors
- Male Header pins, 3-pin screw-type terminal connector, etc.

4.4.4 Understanding 5V Single-Channel Relay Module

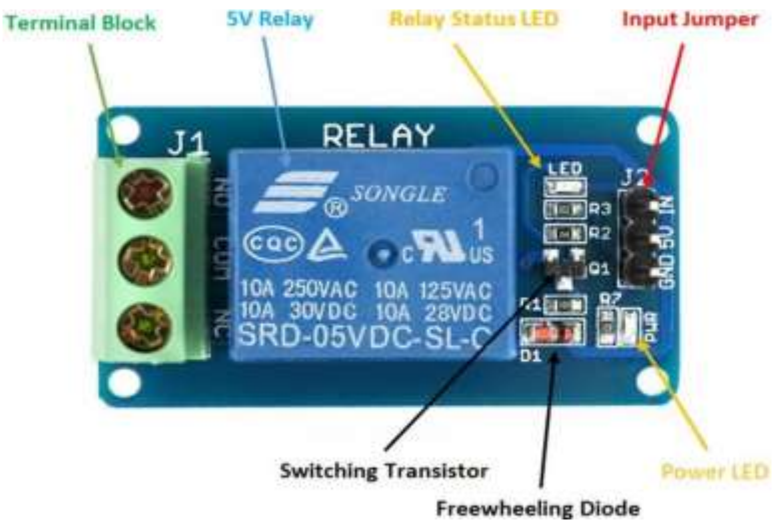


Fig. 4.4.2 Relay Board Explanation

The single-channel relay module offers more than just relay functionality, providing a comprehensive solution for switching and connection tasks. Its screw terminal block ensures reliable mains connections, accommodating thick cables that might be challenging to solder directly. This feature simplifies installation and enhances safety by securely handling mains power. The relay itself, housed in a durable blue plastic case, is equipped with informative markings like "05VDC," indicating its minimum activation voltage. Voltage and current specifications such as "10A 250VAC" and "10A 30VDC" guide users on the maximum loads the relay can handle, ensuring efficient and safe operation across various electrical systems.

In addition to its robust design, the module includes essential indicators for user convenience and monitoring. The relay status LED illuminates when the relay is active, providing a clear visual cue of its operational state. The power LED, connected to VCC, lights up to indicate that the module is powered, aiding users in quickly assessing its operational status. These indicators, along with the input jumper and switching transistor, streamline the module's functionality, making it a versatile and user-friendly component for diverse electrical applications, from home automation to industrial control systems.

The relay module is interfaced with a microcontroller using its input pins. One terminal of the main power source is connected to the common (COM) terminal of the relay module. The other terminal of the main power source is connected to either the normally open (NO) or normally closed (NC) terminal of the relay module, depending on whether the load should be connected or disconnected when the relay is active.

When the microcontroller sends a signal to the relay module through its input pins, the relay switches its contacts based on the programmed logic. If the NO terminal is used, the load is connected to the mains when the relay is activated. Conversely, if the NC terminal is used, the load is disconnected from the mains when the relay is activated. This setup allows for simple on/off control of electrical loads using a microcontroller and a relay module.

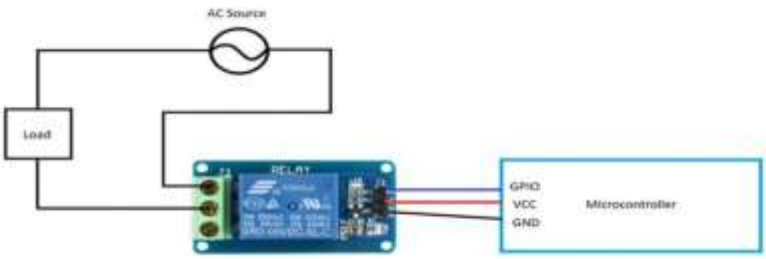


Fig. 4.4.3 Relay Connection in Circuit

The main wiring is screwed to the terminal block, and the microcontroller can be connected using jumper cables.

4.4.5 Single-Channel Relay Module Applications

- Mains switching
- High current switching
- Isolated power delivery
- Home automation

4.5 Peltier cooling System:

A Peltier cooling kit, also known as a thermoelectric cooling kit, is a form of solid-state cooling that incorporates both semiconductor technologies and electronic assembly techniques. A Peltier cooling kit typically consists of several components, each with a specific function:

Fig. 4.5 Peltier Module and Cooling Kit

1. **TEC1-12706 Thermoelectric Cooler 6A Peltier Module**: This is the core component of the kit. It is a solid-state active heat pump that transfers heat from one side of the device to the other. The module is sandwiched between two heat sinks.

2. **Heat Sinks**: These are devices that absorb and dissipate heat. The larger heat sink is for the hotter side, and the smaller one is for the cooler side. The larger the heat sink, the greater the dissipation of the heat.

3. **Cooling Fan**: This is attached to the larger heat sink. It helps in dissipating the heat from the hot side of the Peltier module.

4. **Fan Gauze**: This is a protective cover for the fan. It prevents dust and other particles from entering the fan, thus ensuring its smooth operation.

5. **Guide Cold Plate**: This component guides the cold air generated by the Peltier module to the desired location.

6. **Radiator**: This component helps in the dissipation of heat. It is usually attached to the hot side of the Peltier module.

7. **Thermal Insulation Gasket**: This component provides thermal insulation, preventing heat from escaping from the system.

8. **Screws**: These are used to assemble the various components of the kit.

Reference link: https://robocraze.com/blogs/post/peltier-cooler

CHAPTER-5

SOFTWARE DESCRIPTION

5.1 Software Used - Arduino IDE(Integrated Development Environment)

The **Arduino Integrated Development Environment (IDE)** is an open-source software designed by Arduino.cc. It is used for writing, compiling, and uploading code to Arduino boards.

The IDE is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.

Fig. 5.1 Arduino IDE Logo

The IDE environment contains two basic parts: Editor and Compiler. The former is used for writing the required code and the latter is used for compiling and uploading the code into the given Arduino Module.

This software makes code compilation so easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is available for all operating systems i.e. MAC, Windows, Linux and runs on the Java Platform. It comes with inbuilt functions and commands that play a vital role in debugging, editing, and compiling the code. You can download the Arduino IDE from the official Arduino website. It’s available for common operating systems like Linux, Windows, and MAC. Make sure you are downloading the correct software version that is easily compatible with your operating system

5.2 Software Installation Procedure

Step 1: Browser
Open any Browser (User Dependent)
Here, we have used Google Chrome (google search Engine)

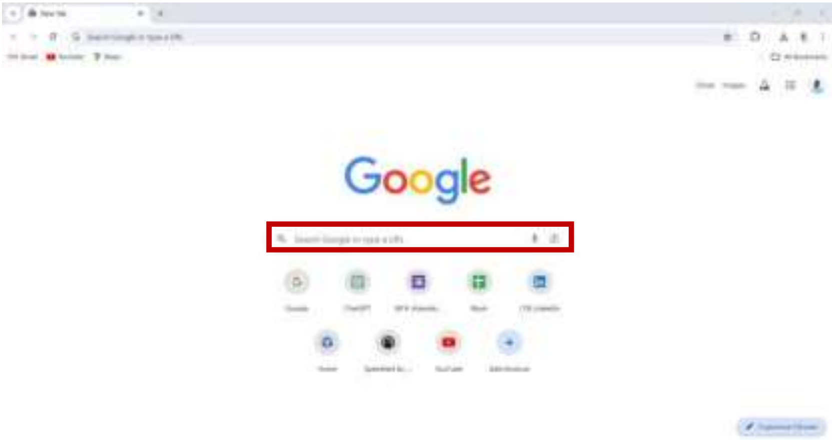


Fig. 5.2.1 Browser Home Page

- **Step 2: Search for Arduino Website**

  In Google Search Engine Search for Arduino and click on the First link

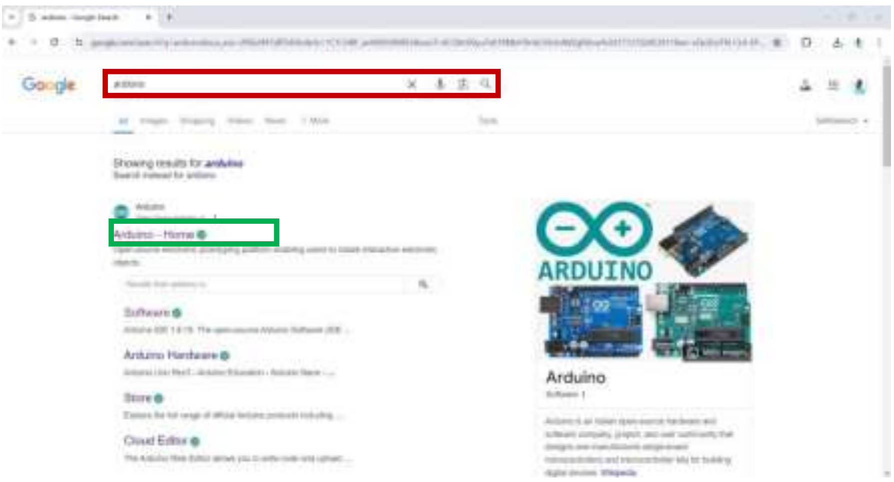


Fig. 5.2.2Arduino website Links

Note: User can directly go to Arduino Website using this provided Link (Optional)
https://www.arduino.cc/

- **Step 3: Arduino Home Page**

  Follow Step- 1,2,3 or Click on the given link below and directly go to the Arduino Home Page and the Page Appears as given below and then click on **"Software"**

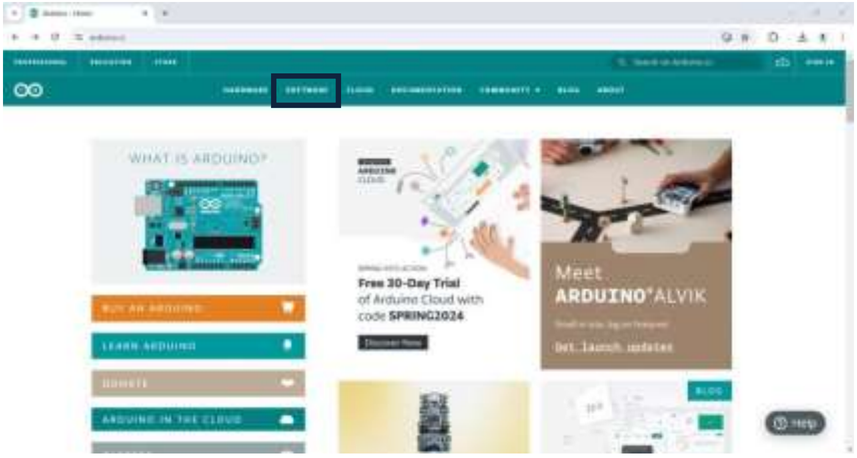


Fig. 5.2.3 Arduino IDE Home Page

- **Step 4: Click on the Download Link.**

  In **"Download Options"** choose the option Depending on User Operation System Compatibility.

  In this Project we have used Windows OS. So, we have tested "**Windows win 10 and newer, 64 bits"**

Fig. 5.2.4 Latest Version of Arduino (2.3.2)

- **Step 5: Start Download**

  After clicking on the download link it will be redirected to the donation page, here you can donate or skip it if you like by clicking on the 'Just download' link.

And Check whether the Download has started or not, If the below popup is found then it means download has started and then you can also close the browser.

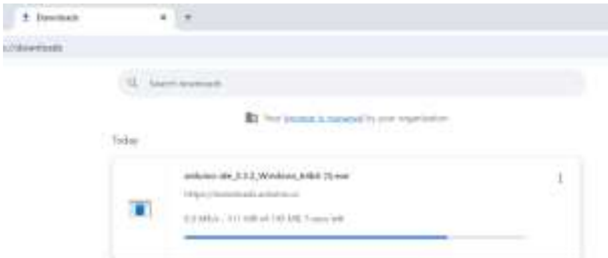


Fig. 5.2.5.2 Arduino File Download Pop-up

- **Step 6: Start Installation**

Open the downloaded file. A new window popup will regarding Installation policies User Licenses and ask user to agree to the license agreement. Click on **'I agree'** to continue.

Fig. 5.2.6 User License and Policies Check Box

➢ **Step 7: Installation Options**

Choose the type of Installation Option required, depending on permissions of PC User and click on 'Next' to continue.

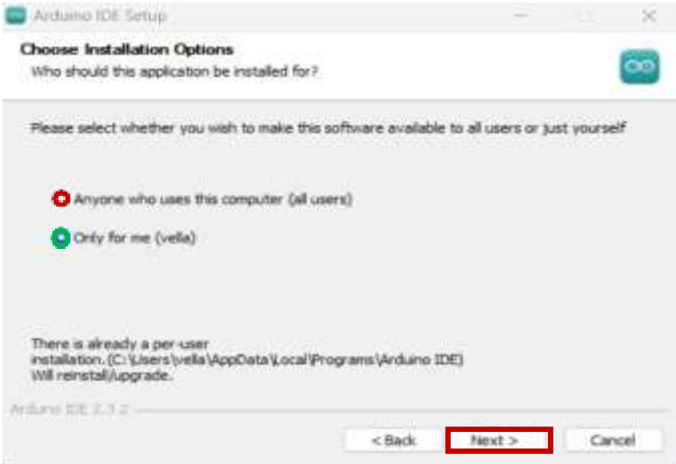


Fig. 5.2.7 User Installation Options

➢ **Step 8: Choose the Installation Path.**

Now User should have to choose the path the where the files required to run software are Installed.

Or User can Choose path (Optional).

Then click on 'Install' to begin the installation.

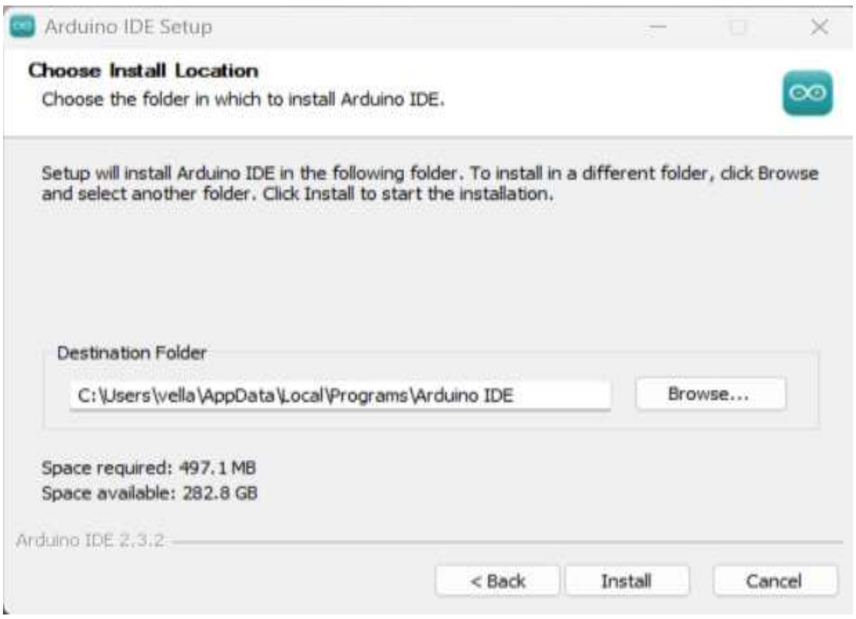


Fig. 5.2.8 Software Path Configuration

- **Step 9: Finish the Installation.**

Wait until the installation is finished, it should not take exceptionally long.

When the installation is finished you may click on 'close' to end the setup wizard.

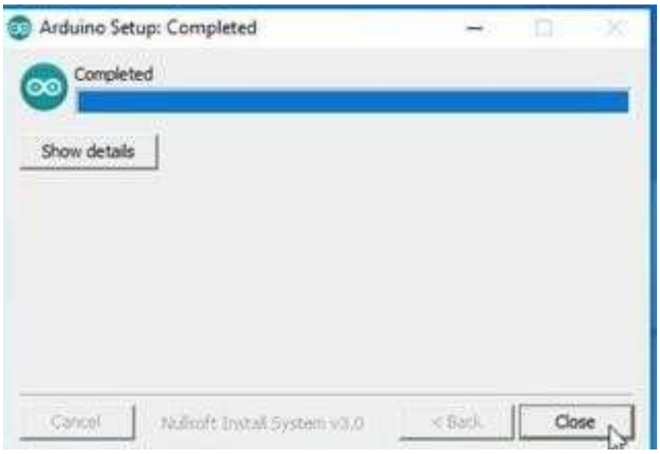


Fig. 5.2.9 Confirmation for Software Installation

- **Step 10: Launch the Arduino IDE.**

After Successful Installation of Arduino IDE,

Launch the Software by clicking on the Desktop icon from Chosen Path or From Start Menu.

Fig. 5.2.10Arduino IDE Developing Environment

- **Step 11: Download Required libraries.**

  Goto Tools ->Manage Library and search for required Libraries

  Select the version and download the libraries.

  For this Project Libraries Required are:

  - LiquidCrystal
  - DFRobot_DHT11
  - OneWire
  - DallasTemperature

- **Step 10: Board Selection**

  For this Project we have used **Generic STM-32F1 Board** and Install it Follow the given below link for Board Installation Procedure **https://youtu.be/jF6R5D08dk8?si=cdjCMbY8E25VISVB**

Note: All the mentioned steps should be followed for Efficient Results

5.3 Boards Used

The STM32F103C8T6, also known as the Blue Pill development board, is a compact board that integrates the STM32F103C8T6 microcontroller from STMicroelectronics12. It is a popular choice for both beginners and experienced developers due to its powerful features and compatibility with the Arduino IDE32.

Here are some key features of the STM32F103C8T6 board:

- It contains a 32-bit Cortex-M3 RISC ARM core with an internal oscillator of 4 -16 MHz1.
- The chip is based on CMOS flash technology1.
- It has 37 GPIO pins and 10 Analog pins1.
- It includes modern communication interfaces like a CAN and a USB port1.
- The board also houses two crystal oscillators, one is an 8MHz crystal, and the

other is a 32 KHz crystal, which can be used to drive the internal RTC (Real Time Clock)2.

- It operates at 3.3V, but most of its GPIO pins are 5V tolerant2.
- There are also two on-board LEDs, one (red color) is used for power indication, and the other (green color) is connected to the GPIO pin PC132.

You can program the STM32F103C8T6 board using the Arduino IDE4. This involves installing the STM32 support in the Arduino IDE, selecting the STM32 microcontroller, and then uploading the code4. This makes it easy to interface with a wide range of expansion boards, modules, and shields5.

5.4 Libraries Used

- **LiquidCrystal**

LiquidCrystal is a library in the Arduino programming environment used for controlling liquid crystal displays (LCDs). It provides functions to easily interface with various LCDs, allowing you to display text, numbers, and other characters. This library simplifies the process of sending commands and data to LCDs, making it easier for hobbyists and developers to incorporate them into their project

- **DFRobot_DHT11**

The `DFRobot_DHT11` library for Arduino is a library specifically designed for the DHT11 temperature and humidity sensor manufactured by DFRobot. This sensor is commonly used in Arduino projects to measure temperature and humidity levels in the surrounding environment. The library provides functions to easily interface with the DHT11 sensor, read temperature and humidity values, and perform error checking to ensure accurate data retrieval. It simplifies the process of integrating the DHT11 sensor into Arduino projects, making it accessible to beginners and advanced users alike.

- **OneWire**

The OneWire library in Arduino is a library that allows communication with devices using the OneWire protocol, a simple serial protocol that can be used to connect multiple devices to a single data line.

The most common use of the OneWire library is with the DS18B20 temperature sensor, which is a digital temperature sensor that communicates over the OneWire protocol. This library simplifies the process of interfacing with the DS18B20 sensor, allowing you to easily read temperature values from it.

In addition to the DS18B20 sensor, the OneWire protocol can be used to communicate with other types of devices, such as EEPROMs, digital potentiometers, and more, making the OneWire library versatile for various Arduino projects.

- **DallasTemperature**

The `DallasTemperature` library in Arduino is an extension of the OneWire library and is specifically designed to work with Dallas Semiconductor (now Maxim Integrated) temperature sensors, particularly the DS18B20 family of digital temperature sensors.

This library simplifies the process of interfacing with DS18B20 sensors and provides functions to easily read temperature values from them. It also includes features for advanced temperature control, such as setting resolution and alarms.

Overall, the DallasTemperature library is widely used in Arduino projects that involve temperature sensing, offering a convenient way to integrate DS18B20 sensors into your projects.

5.5 Code Installation:

To install the latest version of the Arduino IDE, simply adhere to the "5.2 Software Installation Procedure" provided above. Once the Arduino IDE's latest version is successfully installed, proceed with the following steps to design your code:

- **Step 1: Design/Write/Import Code**

  Goto File > New Sketch > Design/ Write or Import Code and then Click on Tick mark to compile the code and to verify errors in program

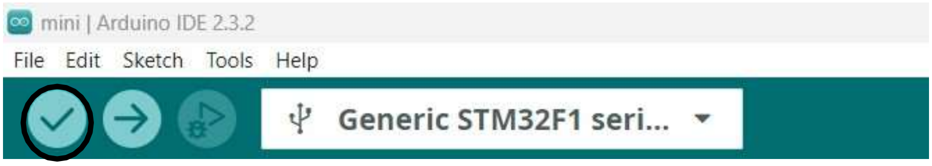


Fig. 5.5.1 Compilation Procedure

- **Step 2: Wait for Successful Message**

  Wait till the compilation gets completed and if there are Zero Errors in designed code this message appears

Fig. 5.5.2 Compilation Successful Message

- **Step 3: To Import code to Hardware**

  Once the compilation Successful message is obtained connect the STM-32 Board to PC/ Laptop using USB Type –B or User Interface Cable and Once the STM-32 Board is connected Choose Port Number and Click on **Import.**

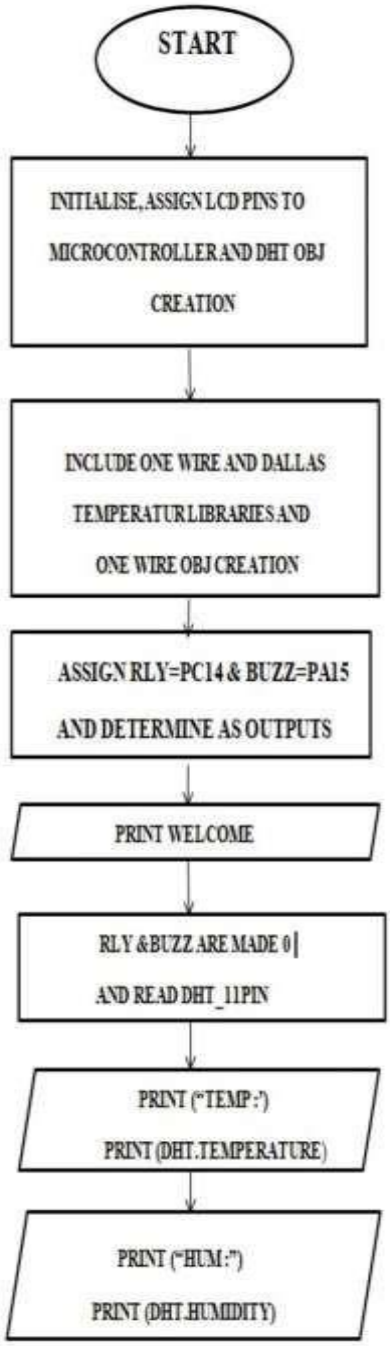
Fig. 5.5.3 Import of Code into STM-32 Board

Note: All the mentioned steps should be followed for Efficient Results

CHAPTER-6

CODE

```
#include <LiquidCrystal.h>
const int rs = PB12, en = PB13, d4 = PB14, d5 =
PB15, d6 = PA8, d7 = PA11;
LiquidCrystal lcd (rs, en, d4, d5, d6, d7);
#include <DFRobot_DHT11.h>
DFRobot_DHT11 DHT;
#include <OneWire.h>
#include <DallasTemperature.h>
#define ONE_WIRE_BUS PB9
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);
#define DHT11_PIN PB7
int rly=PC14;
int buz=PA15;
void setup () {
pinMode(rly,OUTPUT);
pinMode(buz,OUTPUT);
lcd.begin(16, 2);
lcd.print(" WELCOME");
Serial.begin(9600);
delay (1000);
sensors.begin();
digitalWrite(rly,0);
digitalWrite(buz,0);
}
void loop () {
DHT.read(DHT11_PIN);
Serial.print("temp:");
```



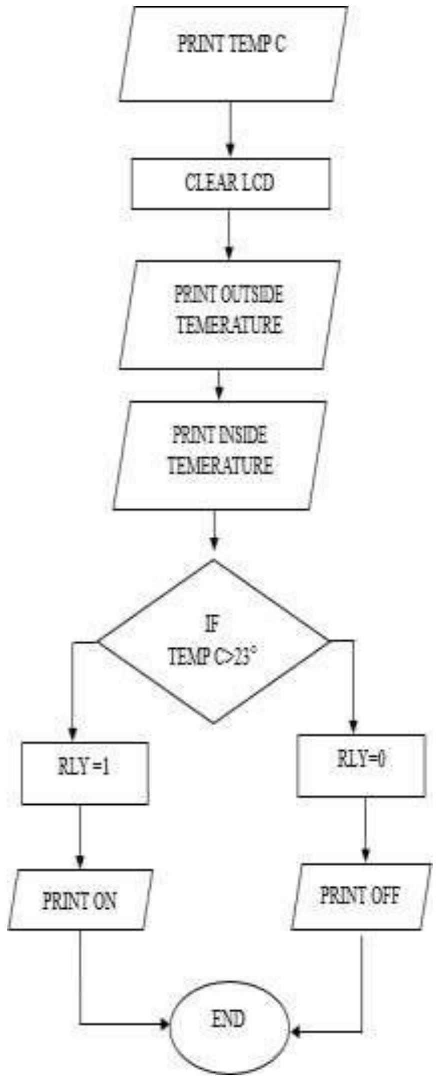
```
Serial.print(DHT.temperature);
Serial.print(" humi:");
Serial.println(DHT.humidity);
sensors.requestTemperatures();
float tempC = sensors.getTempCByIndex(0);
Serial.println(tempC);

lcd.clear();
lcd.print("OUTTM:"+String
(DHT.temperature));
lcd.setCursor(0,1);
lcd.print("IN TM:"+String(tempC));

if(tempC>23) {

   digitalWrite(rly,1);
   lcd.setCursor(12,1);
   lcd.print(" ON");

 }
 else if(tempC<21) {
   digitalWrite(rly,0);
   lcd.setCursor(12,1);
   lcd.print("OFF");
  }
delay (1000);
}
```



CHAPTER-7

RESULT

7.1 Output- 1

Dated: 27/02/2024

(12:35 PM to 1:05 PM)

S. No.	Time	External Temperature (° C)	Internal Temperature (° C)	Fan Status
1	12:35 PM	30 ° C	28.12 ° C	ON
2	12:40 PM	29 ° C	24.69° C	ON
3	12:45 PM	31 ° C	21.56 ° C	ON
4	12:50 PM	31° C	21.44° C	ON
5	12:55 PM	30° C	20.87° C	OFF
6	1:00 PM	30° C	21° C	OFF
7	1:05 PM	30° C	23.62° C	ON

7.1.1 Photographs Supporting Result-1

Fig. Obtained Output at 12:35 PM

Fig. Obtained Output at 12:40 PM

7.1.2 Graphical Representation of Test Result- 1

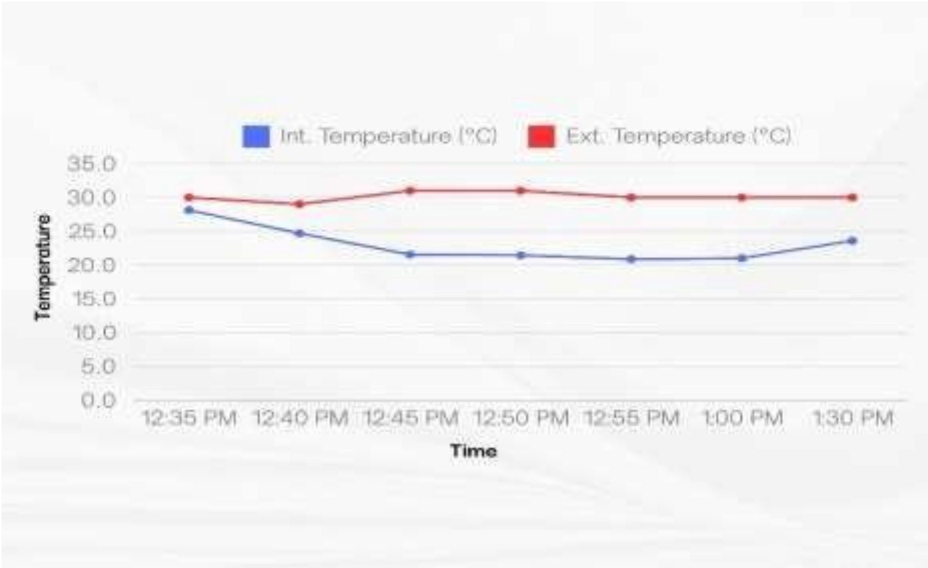


Fig. Graphical Representation of Test Result- 1

7.2 Output-2

7.2.1 Dated: 06/03/2024

(6:00 PM to 6:25 PM)

S. No.	Time	External Temperature (° C)	Internal Temperature (° C)	Fan Status
1	6:00 PM	31 ° C	32.06 ° C	ON
2	6:05 PM	32 ° C	23.75 ° C	ON
3	6:10 PM	32° C	23.62° C	ON
4	6:15 PM	32° C	22.93° C	ON
5	6:20 PM	34° C	22.56° C	ON
6	6:25 PM	33° C	21.98° C	ON
7	6:30 PM	33° C	21.00° C	OFF
8	6:35 PM	33° C	23.02° C	ON

Fig. Obtained Output at 6:00 PM

Fig. Obtained Output at 6:05 PM

7.2.2 Graphical Representation of Test Result- 2

Fig. Graphical Representation of Test Result- 2

CHAPTER-8

CONCLUSION

The introduction of the Intelligent Cooling Helmet represents a groundbreaking innovation in the realm of cycling gear, addressing a fundamental challenge faced by riders worldwide: combating discomfort in hot weather conditions. Through the integration of innovative cooling technology directly into the helmet, this system revolutionizes the cycling experience by prioritizing rider comfort, safety, and performance. By effectively managing heat and humidity, cyclists can now maintain focus and stamina even during the most demanding rides, fostering a newfound sense of confidence and enjoyment.

Moreover, the Intelligent Cooling Helmet distinguishes itself through its adaptability, catering to a diverse spectrum of cyclists ranging from daily commuters to competitive athletes. This versatility ensures that riders of all backgrounds and skill levels can benefit from its advanced features, whether navigating urban streets, exploring scenic trails, or pushing boundaries in competitive events. By offering customizable cooling options and real-time temperature monitoring, the helmet empowers cyclists to tailor their comfort levels according to individual preferences and environmental conditions, further enhancing the overall riding experience.

In summary, the Intelligent Cooling Helmet represents a change in basic assumptions in cycling equipment, setting new benchmarks for comfort, safety, and performance. Its innovative design, user-friendly interface, and broad applicability position it as an indispensable asset for riders seeking to elevate their cycling journey. By redefining the standards for cycling gear, this revolutionary helmet not only enhances the individual experience but also contributes to the collective advancement of the cycling community worldwide.

Fig. Designed Prototype

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