VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANASANGAMA, BELAGAVI, KARNATAKA–590014

A PROJECT REPORT ON

"AQUANEBULA: AIR-TO-WATER GENERATOR"

(Sponsored by Karnataka State Council for Science and Technology)

Submitted by,

HITHA S CHOWTA	**4DM20EC009**
NAEEMA THASNEEM	**4DM20EC021**
SAVI S CHOWTA	**4DM20EC029**
VEEKSHITHA	**4DM20EC039**

Under the guidance of

Mr. GANGADHARA, B.E., M.Tech.
Asst. Prof., ECE Dept.

In partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING
IN
ELECTRONICS AND COMMUNICATION ENGINEERING

YENEPOYA INSTITUTE OF TECHNOLOGY
N.H.13, Thodar, Moodbidri, Karnataka-574225

2023-2024

YENEPOYA INSTITUTE OF TECHNOLOGY

N.H.13, Thodar, Moodbidri, Karnataka-574225

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

YENEPOYA
INSTITUTE OF TECHNOLOGY

CERTIFICATE

Certified that the project work entitled **"AQUANEBULA: Air-to-Water Generator"** carried out by **Ms. Hitha S Chowta, USN: 4DM20EC009, Ms. Naeema Thasneem, USN: 4DM20EC021, Ms. Savi S Chowta, USN: 4DM20EC029, Ms. Veekshitha, USN: 4DM20EC039** bonafide students of **Yenepoya Institute of Technology** in partial fulfillment for the award of **Bachelor of Engineering** in **Electronics and Communication Engineering** of the **Visvesvaraya Technological University, Belagavi** during the year **2023-24.** It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report. The project has been approved as it satisfies the academic requirements in respect of the project work prescribed for the said degree.

…………………………	………………………… 3\5\24	…………………………
Mr. Gangadhara	**Dr. Prasanna Kumar C**	**Dr. R. G. D'Souza**
(Signature of the Guide)	**(Signature of the HOD)**	**(Signature of the Principal)**
		PRINCIPAL YENEPOYA INSTITUTE OF TECHNOLOGY N.H.13, THODAR, MIJAR – 574 225 MANGALORE TALUK, D.K

Name of the Examiners | **Signature with date**

1.____________________ | **1.** ____________________

2.____________________ | **2.** ____________________

ACKNOWLEDGEMENT

We have taken efforts in this project work to make it successful. However, it would not have been possible without the kind support of many individuals and the institution. We would like to extend our sincere thanks to all of them.

We wish to express our sincere gratitude to our project guide **Mr. Gangadhara,** Assistant Professor of the Department of Electronics and Communication Engineering for his guidance, suggestions, and support.

We are extremely grateful to **Dr. Prasanna Kumar C,** Professor and Head, Department of Electronics and Communication Engineering, YIT for permitting us to pursue our project in college and encouraging us throughout the project.

We take this opportunity to express our deep sense of gratitude to **Dr. R. G. D'Souza.,** Principal, YIT, and also Management and Trustees of the Islamic Academy of Education for their constant support.

We would like to show our greatest appreciation to all the teaching and non-teaching staff of the Department of Electronics and Communication Engineering who have been idealistic and suggestive to the successful completion of this project.

Finally, we thank all the people who have directly or indirectly helped us throughout the course of this project.

HITHA S CHOWTA **4DM20EC009**
NAEEMA THASNEEM **4DM20EC021**
SAVI S CHOWTA **4DM20EC029**
VEEKSHITHA **4DM20EC039**

ABSTRACT

This project, named AQUANEBULA, aims to revolutionize water generation from atmospheric moisture using a thermoelectric cooler (TEC) as the central component. This study delves into the intricate details of the system's setup and its performance in producing water under varying environmental conditions.

The experimental setup comprises a thermoelectric cooler (TEC) acting as the core component for water condensation, a fan for airflow regulation, and a battery for energy storage. The system's efficiency and water production capabilities were evaluated by recording temperature differentials before and after the TEC throughout the experiment.

The implications of this research are significant, highlighting the potential of such systems to mitigate water scarcity challenges globally. The AquaNebula project represents a promising step forward in sustainable water generation technologies, offering hope for a more water-secure future, particularly in regions where traditional water sources are scarce or unreliable. Continued research and development in this field hold promise for further enhancing the efficiency and accessibility of atmospheric water generation systems like AquaNebula.

The findings of this project are intended to contribute to the development of improved atmospheric water generator (AWG) technologies, particularly for use in rural areas where access to electricity may be limited. While the full results and discussion require further analysis, the initial findings suggest that the proposed system has the potential to be an effective and sustainable solution for water generation.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

PREAMBLE

1.1 INTRODUCTION

The ever-increasing strain on global freshwater resources, with water scarcity affecting two-thirds of the world's population, has ignited a fervent search for innovative water generation solutions. Traditional sources like rivers and groundwater are facing unprecedented pressure from factors like climate change, population growth, and pollution. Recognizing the urgency of this crisis, researchers are exploring alternative methods like atmospheric water generators (AWGs) that have the potential to extract water vapor directly from the air. While existing AWG technologies offer a glimmer of hope, their limitations, such as high energy consumption or dependence on reliable electricity grids, restrict their widespread use, particularly in remote areas where resources are often scarce.

This project, aptly named AQUANEBULA, aims to address these limitations by investigating the potential of a novel AWG design that utilizes a thermoelectric cooler (TEC). This approach holds immense promise for several reasons:

Sustainability: AQUANEBULA minimizes its environmental footprint, making it a sustainable solution for water generation, especially in locations with limited access to traditional energy sources.

Low-maintenance: TECs boast a simple design with minimal moving parts, translating to reduced maintenance requirements compared to conventional cooling systems, leading to lower operational costs and simplified management.

Scalability: The modular design of AQUANEBULA allows for easy adaptation and deployment in diverse settings, including remote regions with limited access to electricity. This scalability makes it a valuable tool for addressing water scarcity in geographically diverse environments.

The findings of this project have the potential to be transformative, contributing significantly to the development of sustainable and accessible AWG technologies. By offering a solution that is environmentally friendly and can be adapted to various settings, Aquanebula holds the potential to alleviate the burden of water scarcity in underprivileged communities and remote areas, paving the way for a future with improved water security for all.

1.2 OBJECTIVE

The main objective of this project is to investigate the feasibility and effectiveness of using thermoelectric coolers (TECs) in atmospheric water generators (AWGs). This project aims to determine if this innovative approach can provide a sustainable, low-maintenance, and scalable solution for water generation, particularly in areas facing water scarcity.

Throughout the project, the team will focus on several key objectives:

- Evaluating the water generation capacity of the system under various environmental conditions: This objective will assess the effectiveness of the AWG in diverse settings and its potential to adapt to different climates.
- Assessing the energy efficiency of the TEC and its impact on the overall system performance: Understanding the energy consumption characteristics of the TEC is crucial for optimizing the system's efficiency and minimizing its environmental impact.
- Optimizing the design and operation of the AWG for improved efficiency and increased water production: This objective aims to refine the design and operational aspects of the AWG to maximize its water generation capacity while minimizing resource consumption.

By successfully achieving these objectives, this project intends to contribute significantly to the development of practical and sustainable AWG technologies. This advancement can potentially pave the way for a future where water scarcity no longer poses a significant threat to communities worldwide.

1.3 PROBLEM STATEMENT

Despite the abundance of water on Earth, two-thirds of the world's population grapples with water scarcity. This critical challenge arises from increasing reliance on traditional sources like rivers and groundwater, which are under immense pressure from factors like climate change, population growth, and pollution. While existing atmospheric water generators (AWGs) offer a promising alternative by extracting water vapor from the air, limitations such as high energy consumption or dependence on electricity grids hinder their effectiveness, particularly in remote areas lacking the necessary infrastructure.

This project seeks to address these limitations by exploring a novel AWG design that utilizes a thermoelectric cooler (TEC). This innovative approach aims to provide a sustainable, and adaptable solution for water generation, particularly in regions facing water scarcity.

The core challenge lies in evaluating the feasibility and effectiveness of TEC-based AWGs as a viable, resource-efficient, and adaptable solution for water generation, especially in locations lacking consistent access to traditional water sources and electricity grids. By successfully addressing this challenge, the project has the potential to alleviate water scarcity and contribute significantly to the development of sustainable water generation technologies for communities worldwide.

1.4 LITERATURE REVIEW

Our atmosphere contains at least some concentration of water in the air, not necessarily in the liquid but they exist as vapor or moisture in the air. Now, this concentration can exceed a lot if considering the ambient conditions on coastal areas and even very close to the shore due to the natural phenomenon of the water cycle that always persists. On the other hand, this moisture content in the air can be extracted and stored and be put to good use since in the continent of Africa especially, there is a huge problem in dealing with the availability of clean drinking water.

Since, there was a report published by U.N. in the investigation of water scarcity, it was found out to be that by the end of 2050 around 5 billion people are vulnerable to suffer from water scarcity depending on the rate of climate change nowadays. Also, a human consumes about 4600 cubic km of water every year, from that whole 70% goes to agriculture, 20% goes to the industry and the remaining 10% is consumed by households. Because of the industrial pollutions being contaminated the water, the problem has been worsening since the 1990s which is adding more stress to the demand of making sure that there is ample water available for the mankind to consume and meet their needs. But, if it keeps on going without any considerations and preventive measures, dry regions will get drier, wet regions will get wetter and the water will soon be a lost jewel that kept everyone alive and living healthy.[3]

Based on such concerns, our team, just like any other environmentalist, has come up with a plan of devising atmospheric water generator which will be working purely by the help of solar power. As water is an essential necessity for living, it is our duty as residents of this world to take of the resources and refrain from wasting them.

In regards to water projects for developing and under-developed countries such as in Africa, numerous amounts of work and projects have been done to help the African people survive and meet proper nutrition. World desperately needs alternative “water cultivation” methods and producing water from air is one of the most viable and sound solutions presented as the world’s fresh water needs increase daily. This technology has ability to meet and fill the growing demand for economical, safe, great tasting drinking water in a clean drinking water is to health and wellness for people everywhere. We have designed and developed a prototype system for removing clean (potable) drinking water from air using a traditional power grid. Use a traditional power grid to generate electricity; use electricity to cool air (or increase pressure) resulting in condensation of water; capture water vapor from air that condenses into water to obtain 99% pure and safe drinking water from the moisture in the air. Implementation of process using most efficient and cost-effective method is also an important concern in the project. [2]

Similarly, a research paper explains how the global water challenge is the motivation to find new sources of drinking water. The Earth's atmosphere holds enormous amounts of water in the form of vapor which could serve for that purpose. Various technologies already exist, and are described here, that make use of the atmospheric water vapor as freshwater source. Yet, for active cooling technologies, humidity harvesting is an energy intensive application, as water vapor is embedded in ambient air. Therefore, a method is introduced that uses water vapor selective membranes to concentrate the water vapor prior to the cooling process. The successful implementation of such membrane separation processes in other applications (flue gas dehydration) is described and the main challenges concerning their use in humidity harvesting are stated. The way these challenges will be dealt with is described in the outline of the thesis, where the content of the individual chapters is stated briefly.

Also, An Atmospheric Water Generator is an appliance that employs dehumidification/condensing technology that extracts water from the humidity in the air. The water is then filtered and purified through several filters including carbon, and reverse osmosis, and UV sterilization lights. The result is pure drinking water from the air. An Atmospheric Water Generator Works on the same principle as a refrigerators and air conditioners i.e. on the principle of cooling through evaporation. The Atmospheric water generator works by converting atmospheric air to pressurized air using a Compressor and then this air is then passed through Condenser pipes which decreases its temperature to dew point. The air condenses to liquid and is passed through a filtration system and it is then stored in a tank. The major aim or objective of our project is to provide safe and clean drinking water to those areas which are facing water shortage problems or where water transportation through regular means is expensive (especially rural areas). Our project hopes to reduce this problem by providing an atmospheric water generator that will run via bicycle-gear arrangement or stand-alone renewable source of energy i.e. either solar or wind.

The system design for determining the required dew point temperature and humidity ratio involves implementing equations derived from the Magnus formula. Here's a breakdown of the system design:

$$\gamma(T, RH) = \ln\left(\frac{RH}{100}\right) + \frac{bT}{c+T} \qquad (1)$$

$$T_{dp} = \frac{C\gamma(T,RH)}{b-\gamma(T,RH)} \qquad (2)$$

These equations are given by Magnus formula under varying temperature and relative humidity conditions. Where, b = 17.67 & c = 243.50C and T is in 0 also RH= Relative humidity T= DBT (Dry Bulb Temperature) and T_{dp}=Dew point temperature. [1]

Relative humidity is defined as the ratio of water vapor pressure to saturation vapor pressure at certain temperature. The Saturation pressure value is determined by the equations are formulated as follows:

$$RH = \frac{P_W}{P_s} x100 \qquad (3)$$

$$P_W = \frac{RH}{100} X P_s \qquad (4)$$

$$Humidity\ ratio = 0.622x \frac{P_W}{P_a - P_W} \qquad (5)$$

where P_a=constant standard atmosphere (1atm)

CHAPTER 2

FUNCTIONAL PARTITIONING

2.1 METHODOLOGY

The flow chart of the proposed work is shown in the figure given below:

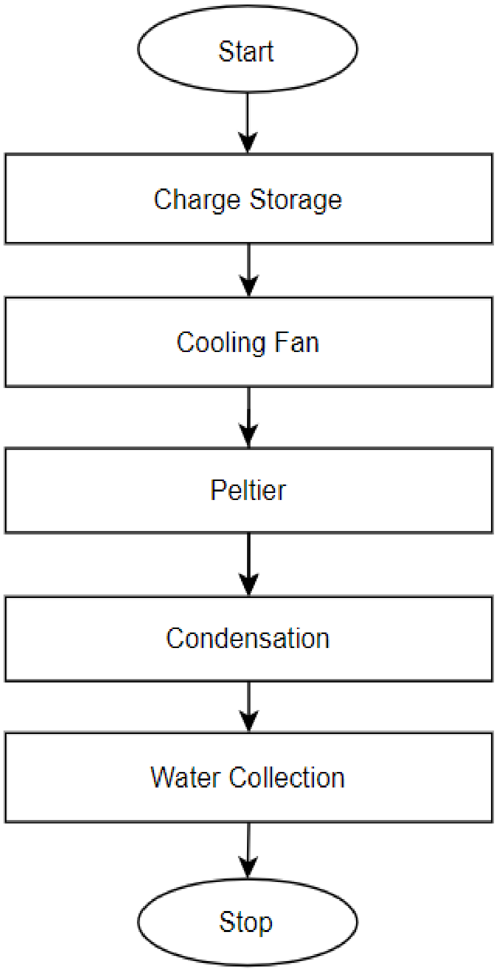

Fig No.2.1.1 Flow chart

The operational process of our system begins simply with its activation. This kickstarts a series of essential steps that are crucial for its functionality. First and foremost, energy is accumulated and stored, providing the necessary power to drive the system's operations forward.

Once energy is secured, the system moves on to regulating airflow within its setup. This is achieved through the activation of a cooling fan, which ensures that optimal operating temperatures are maintained. This step is vital for creating an environment where the system can operate efficiently.

With airflow under control, the focus shifts to the activation of the Peltier module. This component is pivotal as it creates a temperature differential, which is essential for the next stage of the process. As the Peltier module works its magic, water vapor present in the atmosphere begins to condense into liquid form.

This condensation process is a significant milestone in the operation of our system. It represents the successful transformation of water vapor into liquid water, which is the primary goal of the system. The condensed water droplets are then collected for storage or immediate use, marking the completion of the operational cycle.

Finally, as each cycle concludes, the system pauses until it is called upon once again. This moment of rest allows for reflection and optimization, ensuring that the system continues to operate effectively and efficiently in its quest to generate water from atmospheric moisture.

2.2 PROPOSED SYSTEM

The proposed system is based on a carefully constructed design aimed at extracting water from the air. This system integrates various components, each playing a vital role in using thermoelectric principles and controlling airflow to efficiently collect water vapor from the atmosphere.

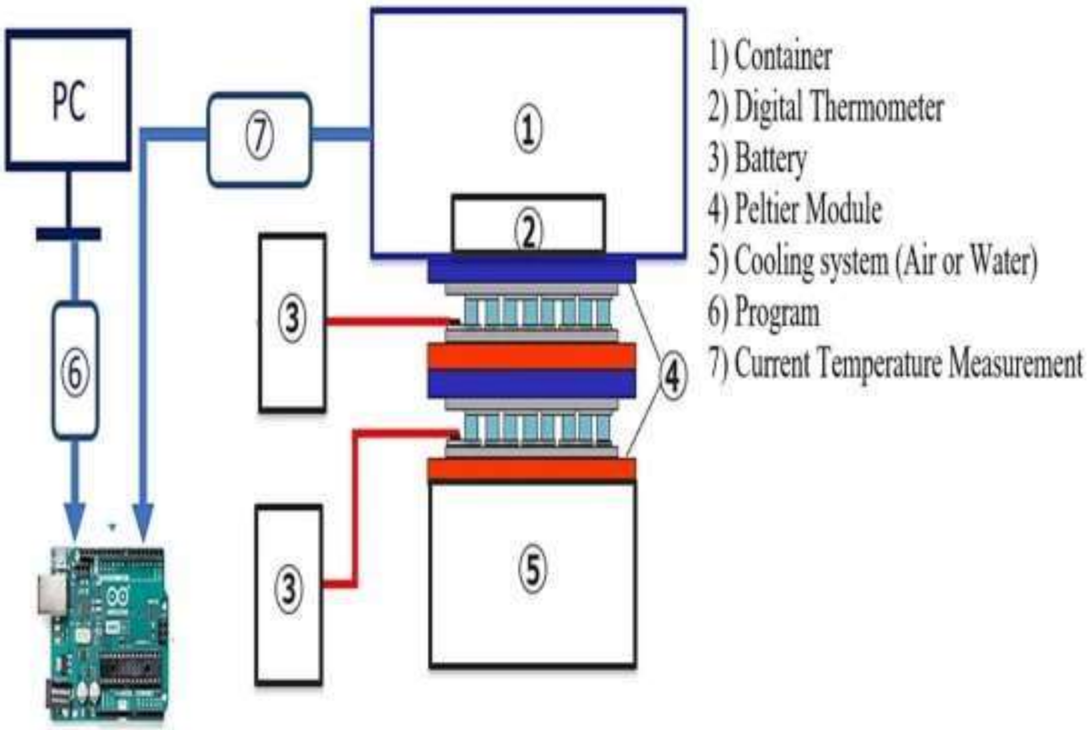

Fig No.2.2.1 Block Diagram

The depicted block diagram illustrates a system designed for generating water from atmospheric moisture. Here's an explanation of each component and its function:

The main component of the system is the Peltier module, situated at the heart of the design. This critical element serves as the driving force behind the system's core functionality, facilitating the conversion of air to water. Leveraging thermoelectric principles, the Peltier module plays a pivotal role in creating the necessary temperature differentials essential for this conversion process.

Adjacent to the Peltier module, the container provides the physical enclosure for the system's internal mechanisms. Within this container, various components work in harmony to realize the system's objectives. One such component is the digital thermometer, meticulously engineered to measure and monitor temperature levels accurately, ensuring precise control over the conversion process.

Complementing the Peltier module is the battery, positioned strategically to provide uninterrupted power supply to the system. This ensures continuous operation, regardless of exernal power sources, guaranteeing reliability and autonomy in the conversion process.

To regulate temperature and manage heat dissipation effectively, a cooling system is seamlessly integrated into the design. This cooling mechanism, indicated by blue and red arrows, may utilize air or water to maintain optimal operating conditions within the container, facilitating efficient conversion while mitigating heat buildup.

Driving the system's operation is the program component, orchestrating various functions such as temperature regulation, data processing, and communication with external devices. This software backbone ensures seamless coordination among system components, optimizing performance and efficiency throughout the conversion process.

At the forefront of monitoring and control is the current temperature measurement component, providing real-time feedback on temperature conditions within the container. This enables continuous monitoring and adjustment, ensuring precise control and optimization of the conversion process to meet desired objectives effectively.

CHAPTER 3

COMPONENTS REQUIRED

3.1 COMPONENTS USED

The following components are used to build the circuit:

- Peltier Module
- Cooling Fan
- Heat Sink
- Arduino Uno
- DHT 11
- Max775 Thermo Couple
- Max6675 Amplifier
- Lcd Display

3.1.1 Peltier Module

Peltier module (thermoelectric module) is a thermal control module that has both "warming" and "cooling" effects. By passing an electric current through the module, it is possible to change the surface temperature and keep it at the target temperature. Peltier devices, are solid-state heat pumps that utilize the Peltier effect to transfer heat from one side of the device to the other when an electric current flows through it. This technology is named after the French physicist Jean Charles Athanase Peltier, who discovered the thermoelectric effect in 1834.

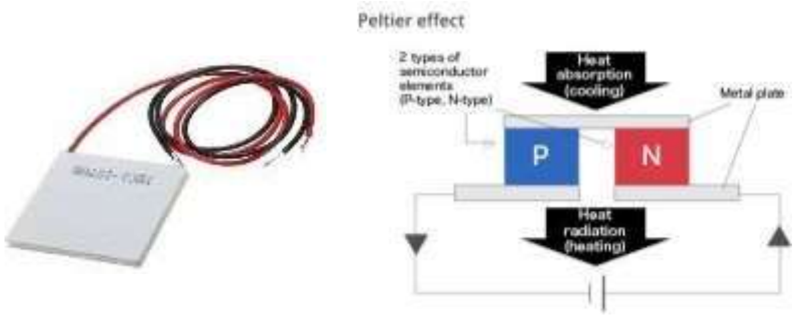

Fig No.3.1.1 Peltier

A typical Peltier device consists of an array of semiconductor pellets, usually made of materials such as bismuth telluride, which exhibit a high thermoelectric efficiency. These pellets are sandwiched between two ceramic plates, with metal conductors attached to each pellet to facilitate the flow of electric current.

When an electric current is applied to the Peltier device, one side of the device becomes cooler while the other side heats up. This cooling effect is achieved as heat is absorbed from the cold side and transferred to the hot side, where it is dissipated into the surrounding environment. This process allows Peltier devices to create a temperature differential between the two sides.

Peltier devices find applications in various fields, including electronics cooling, thermal management in spacecraft and satellites, food and beverage cooling, and temperature-controlled medical devices. They are favored for their compact size, reliability, and ability to provide precise temperature control.

3.1.2 Cooling Fan

In many Peltier device designs, a cooling fan is integrated to enhance their efficiency. The fan plays a crucial role in dissipating the heat generated on the hot side of the device, which helps maintain optimal thermal performance and prevents overheating.

Fig No.3.1.2 Cooling Fan

The cooling fan works by drawing air over the hot side of the Peltier device, facilitating the transfer of heat from the device to the surrounding environment. This airflow increases the rate of heat dissipation, allowing the device to operate at lower temperatures and improving its overall cooling capacity.

Integrating a cooling fan into Peltier device designs is essential for applications where efficient heat dissipation is critical, such as electronics cooling or temperature-controlled environments. By combining the Peltier effect with active cooling mechanisms like fans, these devices can achieve greater cooling efficiency and precise temperature control.

Overall, the cooling fan serves as a crucial component in maximizing the performance and reliability of Peltier devices, ensuring that they can effectively meet the cooling requirements of various applications.

3.1.3 Heat Sink

The cooler side of a Peltier device can effectively collect water through condensation. This occurs when the temperature of the cooler side drops below the dew point of the surrounding air. As a result, moisture in the air condenses into liquid water on the surface of the cooler.

Fig No.3.1.3 Heat Sink

This phenomenon occurs because the cooler side of the Peltier device acts as a heat sink, rapidly lowering the temperature of the surrounding air. As a result, the air loses its capacity to hold moisture, leading to the formation of water droplets on the cooler surface. To facilitate water collection, the cooler side of the Peltier device is often designed with a smooth and waterproof surface. Additionally, a collection tray or channel may be integrated to gather the condensed water and direct it to a storage reservoir or drainage system. This capability of Peltier devices to collect water through condensation can be harnessed in various applications, such as dehumidifiers, air conditioning systems, or portable cooling units. By leveraging the cooling effect of the Peltier device, moisture in the air can be efficiently condensed and collected, contributing to improved comfort and air quality.

3.1.4 Arduino Uno

The Arduino Uno is a popular microcontroller board based on the ATmega328P chip. It features digital input/output pins, analog inputs, PWM outputs, and other essential components for creating interactive electronic projects.

It can be programmed using Arduino software, which simplifies the process of writing and uploading code. The Arduino Uno is widely used in various fields, including robotics, home automation, and education.

It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again.

Fig No.3.1.4 Arduino Uno

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of

Arduino now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past outdated boards see the Arduino index of boards.

3.1.5 DHT 11

The DHT11 is a popular digital temperature and humidity sensor known for its affordability, simplicity, and reliability. It integrates a built-in capacitive humidity sensor and a thermistor for temperature measurement. One of its key features is its ease of use, as it communicates with microcontrollers via a single-wire digital interface, requiring minimal external components for operation. This makes it highly accessible to prototyping and development of various projects.

DHT11 Specifications are as follows:

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit

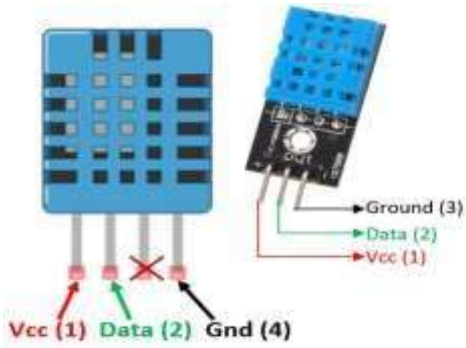

Fig No.3.1.5 DHT 11

One of the main advantages of the DHT11 is its low cost, making it an economical choice for applications where budget constraints are a concern. Despite its affordability, the sensor provides reasonably accurate readings of temperature and humidity within its specified range. This makes it suitable for a wide range of applications, including weather monitoring, indoor climate control, greenhouse management, and environmental sensing. Overall, the DHT11 sensor offers a cost-effective solution for measuring temperature and humidity in various applications. Its simplicity, reliability, and affordability make it a popular choice among hobbyists, students, and professionals seeking to incorporate environmental sensing capabilities into their projects.

3.1.6 MAX775 Thermocouple Sensor

A thermocouple is a device that consists of two different electrical conductors that form an electrical junction—thermal junction. The change in temperature at the junction creates a slightly but measurable voltage at the reference junction that can be used to calculate the temperature.

A thermocouple can be made of different metals. The metals used will affect the voltage range, cost, and sensitivity. There are standardized metal combinations that result in different thermocouple types: B, E, J, N, K, R, T, and S.

Fig No.3.1.6 MAX775 Thermocouple Sensor

Our tutorial is about the k-type thermocouple. A k-type thermocouple is made out of chrome and alumel conductors and has a general temperature range of -200 to 1260ºC (-326 to 2300ºF).

3.1.7 MAX6675 Amplifier

To get the temperature from the thermocouple we need a thermocouple amplifier. The temperature output from the thermocouple amplifier depends on the voltage read on the reference junction. The voltage at the reference junction depends on the temperature difference between the reference junction and the thermal junction. So, we need to know the temperature at the reference junction.

Fig No.3.1.7 MAX6675 Amplifier

The MAX6675 thermocouple comes with a temperature sensor to measure temperature at the reference junction (cold-compensation reference) and amplifies the tiny voltage at the reference junction so that we can read it using our microcontrollers.

The MAX6675 amplifier communicates with a microcontroller using the SPI communication protocol and the data is output in a 12-bit resolution. Usually, you can get a pack with a k-type thermocouple and the MAX6675 amplifier. Here’s a list of the MAX6675 most relevant features. For a more detailed description, please consult the MAX6675 datasheet.

- Direct digital conversion of k-type thermocouple output
- Cold-junction compensaiton
- Simple SPI-compatible serial interface
- Operating voltage range: 3.0 to 5.5V
- Operating temperature range: -20 to 85ºC
- Resolves temperatures to 0.25ºC, allows readings as high as 1024ºC (1875ºF).

3.1.8 LCD Display

An LCD (Liquid Crystal Display) is a flat-panel display technology that uses liquid crystals to produce images. It consists of an array of tiny pixels, each containing liquid crystals that can change their optical properties when an electric current is applied.

LCD displays are widely used in a variety of devices, including televisions, computer monitors, smartphones, tablets, and electronic instruments. They offer several advantages, including low power consumption, lightweight design, and the ability to produce high-resolution images with vibrant colors.

One common type of LCD display is the character LCD, which is often used in embedded systems and electronic devices to provide text-based output. Character LCD displays typically consist of a grid of characters arranged in rows and columns, with each character composed of a predefined pattern of pixels.

Character LCD displays are popular due to their simplicity, affordability, and ease of use. They are commonly used in applications such as digital clocks, thermometers, weather stations, and consumer electronics.

Character LCD displays are available in various sizes, from small displays with a few characters to larger displays with multiple lines of text. They typically feature a simple interface for connecting to microcontrollers or other digital devices, making them suitable for a wide range of projects and applications.

Fig No.3.1.8 LCD Display Unit

One of the main advantages of LCD displays is their readability. They offer high contrast and sharpness, making them easy to read even in bright or dim lighting conditions. This makes them suitable for a wide range of applications, including consumer electronics, industrial control systems, instrumentation, and automotive dashboards.

CHAPTER 4

SOFTWARE USED

4.1 ARDUINO SOFTWARE IDE

It Arduino IDE is an open-source electronics platform renowned for its user-friendly hardware and software components. At its core, Arduino comprises a text editor tailored for code writing, a message area for feedback, a text console, a toolbar with essential functions, and a series of menus for seamless navigation. Its primary function is to connect to Arduino hardware, enabling program uploads and communication.

Programs written within the Arduino Software (IDE) are termed sketches, saved with the file extension .arduino. The editor boasts features like cutting/pasting and text search/replacement. The message area provides feedback during tasks like saving and exporting, as well as error displays. The console exhibits text output from the Arduino software, including detailed error messages. Additionally, the configured board and serial port are displayed in the bottom right-hand corner, while toolbar buttons facilitate program verification, upload, sketch creation, opening, saving, and serial monitor access.

Initially conceived at the Ivrea Interaction Design Institute, Arduino aimed to offer an accessible prototyping tool, particularly targeted at students devoid of electronics and programming backgrounds. As it gained traction within a broader community, Arduino evolved to cater to diverse needs, extending its offerings from simple 8-bit boards to products tailored for IoT applications, wearables, 3D printing, and embedded environments.

While Arduino stands out, several alternative microcontrollers and platforms exist for physical computing endeavors, such as Parallax Basic Stamp, Netmedia's BX-24, Phidgets, and MIT's Handyboard. These options encapsulate microcontroller programming intricacies within user-friendly interfaces, much like Arduino. Arduino's forte lies in simplifying the microcontroller programming process, rendering it accessible to a wider audience.

In essence, Arduino serves as an open-source computing framework and microcontroller, empowering users to program, erase, and reprogram basic microcontroller boards to construct electronic devices. It facilitates the utilization of free or cost-effective technologies, contributing to its widespread adoption and innovation in the realm of electronics.

Fig No.4.1.1 Arduino IDE logo

In Arduino programming, the software configuration revolves around key functions, namely:

1. setup(): This function serves as the initialization point for configurations and is invoked at least once during program execution. It is primarily used to define initial settings, initialize variables, and set up communication channels. The setup() function runs only once when the Arduino board is powered on or reset.

2. loop(): The loop() function is where the main execution of the program takes place. It is executed repeatedly, continuously looping through the code after the setup() function completes. In this function, the core logic of the program, including sensor readings, data processing, and control statements, is implemented. The loop() function continues to execute until the Arduino board is turned off or reset.

As for obtaining the Arduino IDE software, it is freely available on the official Arduino website and is compatible with various operating systems. Users can easily download the Arduino IDE from the website, ensuring accessibility and convenience for programmers across different platforms. The software provides a user-friendly interface for writing, verifying, and uploading sketches to Arduino boards, facilitating seamless development and deployment of projects.

CHAPTER 5

SYSTEM HARDWARE

5.1 CIRCUIT DIAGRAM

The circuit diagram reveals a detailed arrangement aimed at measuring temperature, humidity, water level, and soil moisture. Let's delve into its elements:

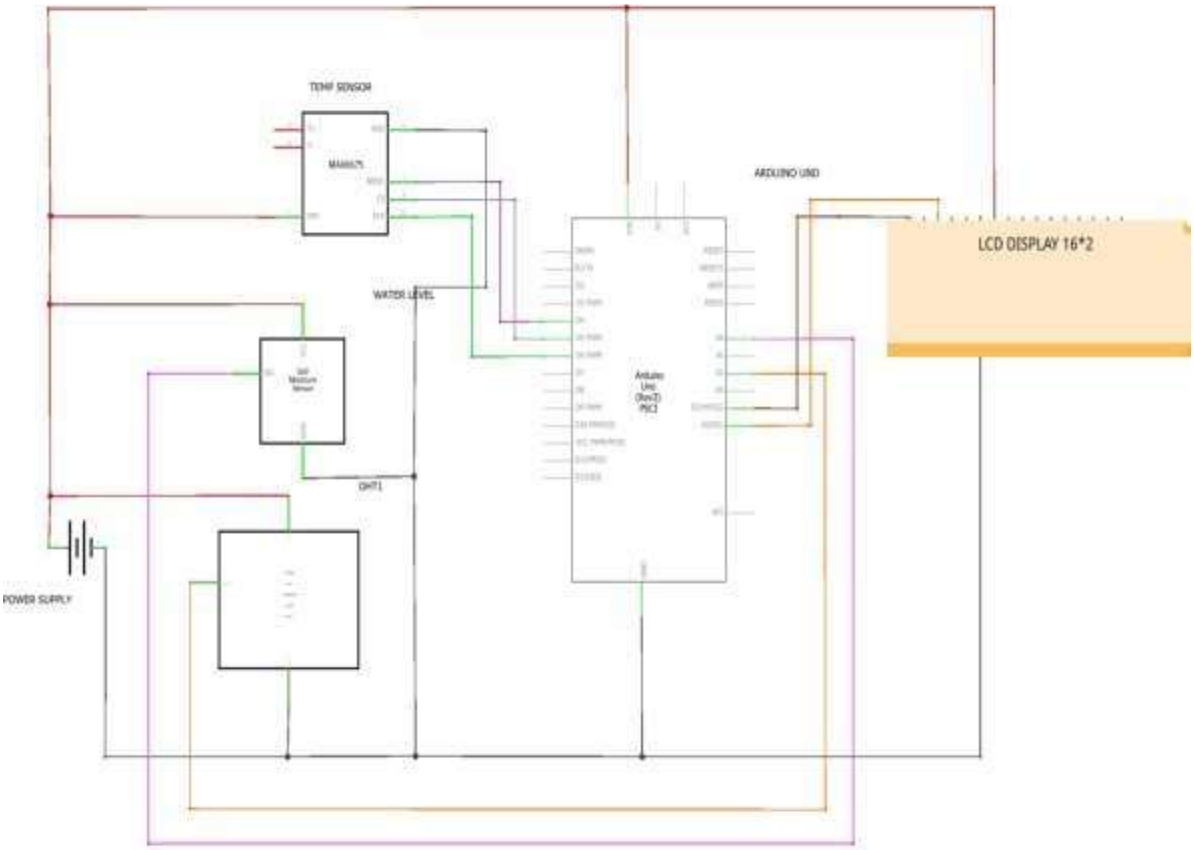

Fig No.5.1.1 Circuit Diagram

The diagram starts with a power supply section, indicating the provision of DC power to the circuit. Following this, the temperature sensor (MAX6675) is connected to the Arduino Uno (Rev3) microcontroller via SPI communication. This sensor is responsible for measuring temperature.

Next, we see the integration of a water level sensor, which communicates with the Arduino Uno through a digital signal (SIG). This sensor likely detects the water level and sends corresponding data to the microcontroller. Additionally, the circuit incorporates a soil moisture sensor, connected to the Arduino Uno. This sensor measures soil moisture levels and relays this information to the microcontroller.

Another sensor present in the circuit is the DHT11, which measures both temperature and humidity. It communicates with the Arduino Uno through a digital signal.

Central to the circuit is the Arduino Uno (Rev3) microcontroller, serving as the control unit. It receives data from the various sensors and processes it accordingly.

Finally, an LCD display (16*2) is connected to the Arduino Uno, providing a visual interface for the collected data. The microcontroller controls the display, showcasing information such as temperature, humidity, water level, and soil moisture.

In summary, this circuit configuration facilitates the measurement and monitoring of temperature, humidity, water level, and soil moisture, with the Arduino Uno acting as the central processing unit and the LCD display providing real-time data visualization.

CHAPTER 6

RESULT

6.1 OUTPUT

Our comprehensive evaluation of the AquaNebula air to water generator revealed crucial insights into its operational efficiency and water production capabilities. Powered by innovative Peltier technology, this device represents a breakthrough in sustainable water sourcing by extracting moisture from the ambient air, thereby offering a dependable solution for hydration needs.

Throughout our testing regimen, we noted a distinct pattern in water generation dynamics. In the initial hour of operation, the device experienced a temporary setback as the air required cooling to facilitate optimal water extraction. Consequently, this initial phase yielded a comparatively lower water production rate, with approximately 300ml of water generated during the first hour.

Fig No 6.1.1.: Model of AquaNebula

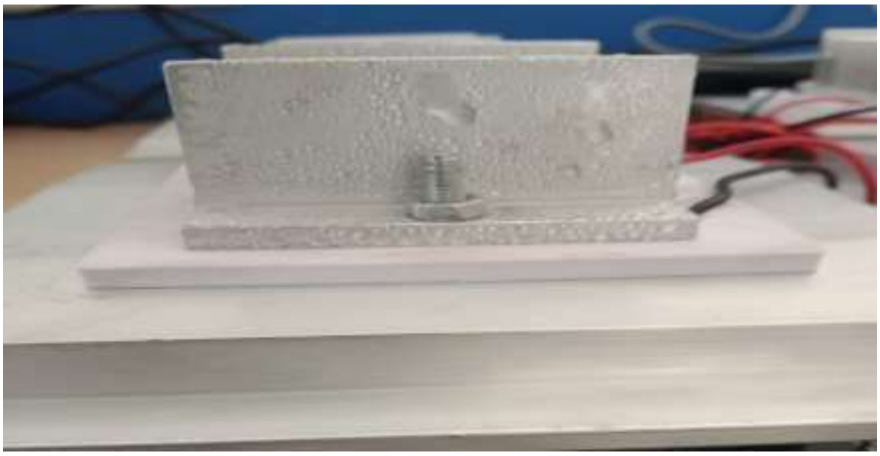

Fig No. 6.1.2: Output of AquaNebula

To project the device's performance over an extended timeframe, we embarked on a thorough analysis of its hourly water production and its cumulative impact over a 24-hour period. In the inaugural hour, as mentioned earlier, the AquaNebula air to water generator produced 300ml of water. Subsequent observations indicated an upward trajectory in water generation, albeit with variations in the rate of increase.

While the second hour showed signs of enhanced water production, further data acquisition is necessary to precisely quantify this progression. However, we anticipate a consistent improvement in water output beyond the initial hour. As such, over the course of the 3rd to 24th hour, we envisage a notable augmentation in total water generation.

In conclusion, the AquaNebula emerges as a promising solution for addressing water scarcity challenges, thanks to its sustainable and efficient water extraction mechanism. Despite the transient dip in water production during the initial hour, the device's ability to enhance its efficiency over prolonged operation underscores its reliability as a source of clean water.

CHAPTER 7

FEATURES

7.1 ADVANTAGES

This project, the Aquanebula: Atmospheric Water Generator (AWG), offers several advantages:

- Energy Efficiency: The use of Peltier technology in the Aquanebula AWG ensures energy efficiency compared to traditional methods like desalination. Peltier devices require minimal energy input to drive the water generation process, reducing overall energy consumption and operating costs.
- Sustainability: By extracting water from atmospheric moisture, the Aquanebula project offers a sustainable solution to water scarcity. It taps into a virtually limitless resource without depleting finite water reserves, contributing to environmental sustainability and long-term water security.
- Compact Design: Leveraging Peltier devices enables a compact design for the AWG system. This compactness enhances versatility and makes the system suitable for deployment in various settings, including remote or space-constrained areas where traditional water generation infrastructure may not be feasible.
- Reduced Environmental Impact: Unlike traditional water generation methods that may involve chemical discharge or habitat disruption, the Aquanebula AWG operates quietly and without emissions. Its solid-state thermoelectric cooling minimizes environmental impact, making it an environmentally friendly water generation solution.
- Flexibility and Versatility: The AWG's ability to extract water from ambient air makes it adaptable to different environments and climatic conditions. It can be deployed in a wide range of settings, including arid regions, coastal areas, or disaster-stricken areas.
- Reliability: Through meticulous design and integration of components, the Aquanebula AWG has proven its capability to produce clean, potable water consistently. This reliability is crucial, especially in emergency situations or areas with unreliable access to traditional water sources, ensuring a dependable water supply.

7.2 DISADVANTAGES

While the Aquanebula, Atmospheric Water Generator (AWG) presents several advantages, there are also some potential disadvantages to consider:

- Initial Cost: The setup cost for implementing an AWG system can be relatively high, including the purchase of components such as Peltier devices and digital thermometers. This initial investment may be prohibitive for some individuals or communities.
- Maintenance Requirements: AWG systems require regular maintenance to ensure optimal performance. Components like Peltier modules and cooling systems may need periodic calibration or cleaning, adding to operational costs and potential downtime.
- Dependence on Environmental Factors: The efficiency of AWG systems can be affected by environmental factors such as temperature and humidity levels. In areas with low humidity, the water generation rate may decrease, impacting overall performance.
- Limited Water Production Capacity: AWG systems typically have a limited water production capacity compared to large-scale water treatment facilities. This limitation may restrict their suitability for meeting the water demands of larger communities or industries.
- Energy Consumption: While Peltier devices are energy-efficient, AWG systems still require electricity to operate. Energy consumption may be a concern in regions with limited access to reliable electricity or where electricity costs are high.

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

8.1 CONCLUSION

In conclusion, the Aquanebula project represents a significant advancement in sustainable water generation technology. By leveraging innovative methods, the project has demonstrated the feasibility of extracting clean, potable water from atmospheric moisture efficiently and reliably. The results of this project offer promise for addressing water scarcity challenges in various contexts, including remote communities and disaster-stricken areas.

In summary, the Aquanebula project represents a significant breakthrough in the quest for sustainable water solutions. By successfully demonstrating the feasibility of extracting water from atmospheric moisture, this initiative offers a ray of hope amidst the persistent challenge of water scarcity. The adaptability and versatility of the AWG system make it a potential game-changer for communities worldwide, particularly those facing water stress or lacking access to traditional water sources.

8.2 FUTURE SCOPE

The Aquanebula project opens up promising avenues for future research and development in sustainable water generation technology. Here are some potential future scopes:

Scalability: Efforts can be directed towards exploring modular designs or integrating multiple units to create larger-scale water generation facilities, thus meeting the water demands of larger communities or industrial applications.

Cost Reduction: Research can concentrate on cost-effective manufacturing processes, material selection, and component optimization to make AWG technology more accessible to diverse populations.

Integration with Renewable Energy: Further integration of AWG systems with renewable energy sources, such as solar power or wind energy, can enhance sustainability and reduce reliance on grid electricity.

Water Quality Improvement: Future scopes may include the development of filtration methods to ensure that water generated by the systems meets stringent quality standards.

REFERENCES

[1] Anbarasu T., Pavithra S. “Vapour Compression Refrigeration System Generating Fresh Water from Humidity in the Air”, 2011.

[2] Ekad, A, Pawar, T., Yeole, N., Taksale, A., & Gajjar,A. (2016). Peltier-seebeck thermoelectric element thermoelectric cooler. Energies, 4, 1-17.

[3] Joshi, V.P., Joshi, V.S., Kothari, H.A., Mahajan, M.D., Chaudhari, M.B. and Sant, K.D., 2017. Experimental investigations on a portable fresh water generator using a thermoelectric cooler. Energy Procedia, 109, pp.161-166 Thermal Science Engineering Progress, 6, 14-26.

[4] Liu, S., He, W., Hu, D., Lv, S., Chen, D., Wu, X., Xu, F. and Li, S., 2017. Experimental analysis of a portable atmospheric water generator by thermoelectric cooling method. Energy Procedia, 142, pp.1609-1614.

[5] Lawrence, M. G. (2005). The relationship between relative humidity and the dewpoint temperature in moist air: a simple conversion and applications. Bulletin of the American Meteorological Society, 86(2), 225-233.

[6] Nandy, A., Saha, S., Ganguly, S., & Chattopadhyay, S. (2014). A project on atmospheric water generator with the concept of peltier effect. International Journal Advanced Computing Research, 4(15),481-486.

[7] Lucia Cattani, Anna Magrini, Paolo in the year 2021 about Water Extraction from Air: A Proposal for a New Indicator to Compare Air Water Generators Efficiency.

[8] Anurag Tripathi, Samir Tushar, Saurabh Pal, Shoumik Lodh, Shashank Tiwari, Prof. R. S. Desai April 2015. Atmospheric Water Generator that employs dehumidification/condensing technology.

YENEPOYA INSTITUTE OF TECHNOLOGY

YENEPOYA
INSTITUTE OF TECHNOLOGY

(Approved by AICTE, New Delhi, Recognized by Govt. of Karnataka and Affiliated to VTU, Belagavi)
Thodar, Moodbidri - 574 225, D.K., Karnataka. Phone: 08258-262733 Fax: 08258-262723
E-mail: info@yit.edu.in, Website: www.yit.edu.in

3rd International Conference on Frontiers in Engineering Science and Technology

IBM Innovation Centre for Education

ICFEST 2024

18th & 19th April, 2024

idp INTERNATIONAL EDUCATION SPECIALISTS

CERTIFICATE

This is to certify that **Mr. Gangadhara** of **Yenepoya Institute of Technology, Moodabidri.** has participated in the **International Conference on Frontiers in Engineering Science and Technology (ICFEST-2024)** during **18th & 19th April 2024** organized by **Yenepoya Institute of Technology, Moodabidri.**

Title of the Paper : ***"AQUA NEBULA: Air to Water Converter"***

Authors : Mr. Gangadhara, Ms. Savi S Chowta, Ms. Hitha S Chowta, Ms. Naeema Thasneem, Ms. Veekshitha

Convenor
ICFEST 2024

Chief Convenor
ICFEST 2024

YENEPOYA

YENEPOYA INSTITUTE OF TECHNOLOGY

(Approved by AICTE, New Delhi, Recognized by Govt. of Karnataka and Affiliated to VTU, Belagavi)
Thodar, Moodbidri - 574 225, D.K., Karnataka. Phone: 08258-262733 Fax: 08258-262723
E-mail: info@yit.edu.in, Website: www.yit.edu.in

3rd International Conference on Frontiers in Engineering Science and Technology

IBM Innovation Centre for Education

ICFEST 2024

18th & 19th April, 2024

idp INTERNATIONAL EDUCATION SPECIALISTS

CERTIFICATE

This is to certify that **Ms. Hitha S Chowta** of **Yenepoya Institute of Technology, Moodabidri.** has participated in the **International Conference on Frontiers in Engineering Science and Technology (ICFEST-2024)** during **18th & 19th April 2024** organized by **Yenepoya Institute of Technology, Moodabidri.**

Title of the Paper : *"AQUA NEBULA: Air to Water Converter"*

Authors : Mr. Gangadhara, Ms. Savi S Chowta, Ms. Hitha S Chowta, Ms. Naeema Thasneem, Ms. Veekshitha

Convenor
ICFEST 2024

Chief Convenor
ICFEST 2024

YENEPOYA INSTITUTE OF TECHNOLOGY

YENEPOYA

(Approved by AICTE, New Delhi, Recognized by Govt. of Karnataka and Affiliated to VTU, Belagavi)
Thodar, Moodbidri - 574 225, D.K., Karnataka. Phone: 08258-262733 Fax: 08258-262723
E-mail: info@yit.edu.in, Website: www.yit.edu.in

3rd International Conference on Frontiers in Engineering Science and Technology

IBM Innovation Centre for Education

ICFEST 2024

18th & 19th April, 2024

idp INTERNATIONAL EDUCATION SPECIALISTS

CERTIFICATE

This is to certify that **Ms. Naeema Thasneem** of **Yenepoya Institute of Technology, Moodabidri.** has participated in the **International Conference on Frontiers in Engineering Science and Technology (ICFEST-2024)** during **18th & 19th April 2024** organized by **Yenepoya Institute of Technology, Moodabidri.**

Title of the Paper : ***"AQUA NEBULA: Air to Water Converter"***

Authors : Mr. Gangadhara, Ms. Savi S Chowta, Ms. Hitha S Chowta, Ms. Naeema Thasneem, Ms. Veekshitha

Convenor
ICFEST 2024

Chief Convenor
ICFEST 2024

YENEPOYA INSTITUTE OF TECHNOLOGY

YENEPOYA
INSTITUTE OF TECHNOLOGY

(Approved by AICTE, New Delhi, Recognized by Govt. of Karnataka and Affiliated to VTU, Belagavi)
Thodar, Moodbidri - 574 225, D.K., Karnataka. Phone: 08258-262733 Fax: 08258-262723
E-mail: info@yit.edu.in, Website: www.yit.edu.in

3rd International Conference on Frontiers in Engineering Science and Technology

IBM Innovation Centre for Education

ICFEST 2024

18th & 19th April, 2024

idp INTERNATIONAL EDUCATION SPECIALISTS

CERTIFICATE

This is to certify that **Ms. Savi S Chowta** of **Yenepoya Institute of Technology, Moodabidri.** has participated in the **International Conference on Frontiers in Engineering Science and Technology (ICFEST-2024)** during **18th & 19th April 2024** organized by **Yenepoya Institute of Technology, Moodabidri.**

Title of the Paper : ***"AQUA NEBULA: Air to Water Converter"***

Authors : Mr. Gangadhara, Ms. Savi S Chowta, Ms. Hitha S Chowta, Ms. Naeema Thasneem, Ms. Veekshitha

Convenor
ICFEST 2024

Chief Convenor
ICFEST 2024

YENEPOYA

YENEPOYA INSTITUTE OF TECHNOLOGY

(Approved by AICTE, New Delhi, Recognized by Govt. of Karnataka and Affiliated to VTU, Belagavi)
Thodar, Moodbidri - 574 225, D.K., Karnataka. Phone: 08258-262733 Fax: 08258-262723
E-mail: info@yit.edu.in, Website: www.yit.edu.in

3rd International Conference on Frontiers in Engineering Science and Technology

IBM Innovation Centre for Education

ICFEST 2024

18th & 19th April, 2024

idp INTERNATIONAL EDUCATION SPECIALISTS

CERTIFICATE

This is to certify that **Ms. Veekshitha** of **Yenepoya Institute of Technology, Moodabidri.** has participated in the **International Conference on Frontiers in Engineering Science and Technology (ICFEST-2024)** during **18th & 19th April 2024** organized by **Yenepoya Institute of Technology, Moodabidri.**

Title of the Paper : ***"AQUA NEBULA: Air to Water Converter"***

Authors : Mr. Gangadhara, Ms. Savi S Chowta, Ms. Hitha S Chowta, Ms. Naeema Thasneem, Ms. Veekshitha

Convenor
ICFEST 2024

Chief Convenor
ICFEST 2024