IoT BASED PORTABLE HOT AND COLD SMART DECANTER USING THERMO ELECTRIC EFFECT

PROJECT REPORT

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BONAFIDE CERTIFICATE

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ABSTRACT

This project proposes the development of a portable hot and cold smart decanter based on the Internet of Things (IoT) technology and the thermoelectric effect. The proposed device aims to provide users with a convenient and efficient way to regulate the temperature of their drinks while on the go.

The decanter consists of a thermoelectric module, which can cool or heat the liquid inside the container. The module is controlled by an IoT-enabled microcontroller that receives temperature and user input data from a mobile application. The application allows users to set their desired temperature and monitor the temperature of the liquid in real-time.

The device's design also incorporates a rechargeable battery, which ensures that it remains operational while on the move. The container's ergonomic design makes it easy to carry around, and the user-friendly application interface ensures ease of use.

The project's main objective is to design a portable smart decanter that can regulate the temperature of beverages, making it ideal for individuals who enjoy hot or cold drinks while on the go. The proposed device's potential applications include outdoor activities, traveling, and commuting.

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KEYWORD: Peltier effect, Peltier module, Thermoelectric effect, Analysis of heat transfer, copper bottle, Heat sink.

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LIST OF ABBREVIATION

IoT	Internet of Things
CIoT	Consumer IoT
IIoT	Industrial Internet of Things
MIoT	Medical Internet of Things
SIoT	Smart City IoT
EIoT	Enterprise IoT
IWC	Inductive Wireless Charging System
RTDS	Thermistors and resistance temperature detectors
LCD	Liquid Crystal Display
DPDT	Double Pole Double Throw

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

The project's main objective is to design a portable smart decanter that can regulate the temperature of beverages, making it convenient for individuals who enjoy hot or cold drinks while on the move. The proposed device's potential applications include outdoor activities, traveling, and commuting. The project will involve designing the hardware and software components of the smart decanter, integrating the IoT-enabled microcontroller and mobile application, and testing the device's functionality and performance. The project's success will depend on the efficiency and accuracy of the thermoelectric module, the stability and reliability of the IoT technology, and the user-friendliness of the mobile application.

1.2 THERMOELECTRIC EFFECT

The thermoelectric effect is the phenomenon where a temperature difference between two different metals or semiconductors causes a flow of electric current. This effect is based on the Seebeck effect, discovered by Thomas Johann Seebeck in 1821. When two different materials are joined to form a circuit, and one end of the circuit is heated, a potential difference is generated across the circuit due to the temperature difference. This potential difference can be harnessed to generate electrical power or used to control the temperature of a system(shown in figure 1.1).

Thermoelectric modules are devices that utilize the thermoelectric effect to either cool or heat a system. They consist of two different materials that are sandwiched together, typically made of p-type and n-type semiconductors. When a voltage is applied across the module, a temperature gradient is created, and heat is either absorbed or expelled from one side of the module, depending on the direction of the current flow. This allows thermoelectric modules to function as both heating and cooling devices, making them useful in a wide range of applications, including portable refrigeration and temperature regulation in electronic devices.

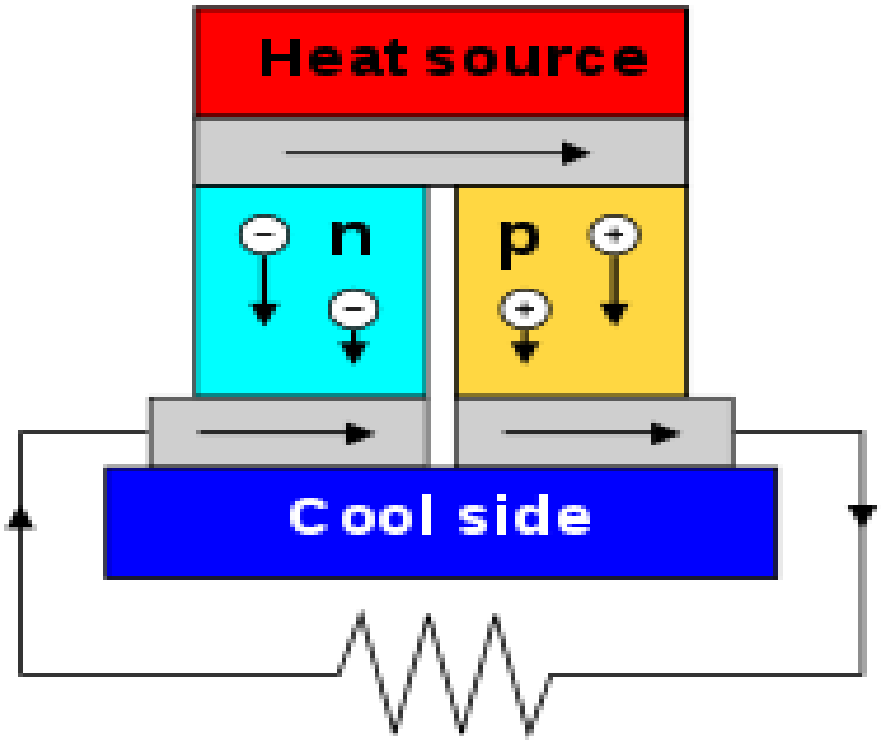


Figure 1.1 Thermoelectric effect

1.2.1 SEEBECK EFFECT

The Seebeck effect is the electromotive force (emf) that develops across two points of an electrically conducting material when there is a temperature difference between them. The emf is called the Seebeck emf (or thermo/thermal/thermoelectric emf). The ratio between the emf and temperature difference is the Seebeck coefficient. A thermocouple measures the difference in potential across a hot and cold end for two dissimilar materials. This potential difference is proportional to the temperature difference between the hot and cold ends. This was because the electron energy levels shifted differently in the different metals, creating a potential difference between the junctions which in turn created an electrical current through the wires, and therefore a magnetic field around the wires.(shown in figure 1.3)

1.2.2 PELTIER EFFECT

When an electric current is passed through a circuit of a thermocouple, heat is generated at one junction and absorbed at the other junction. This is known as the Peltier effect: the presence of heating or cooling at an electrified junction of two different conductors. The effect is named after French physicist Jean Charles Athanase Peltier, who discovered it in 1834.When a current is made to flow through a junction between two conductors, A and B, heat may be generated or removed at the junction.

1.2.3 THOMSON EFFECT

It is reverse process of peltier effect.(shown in figure 1.2).

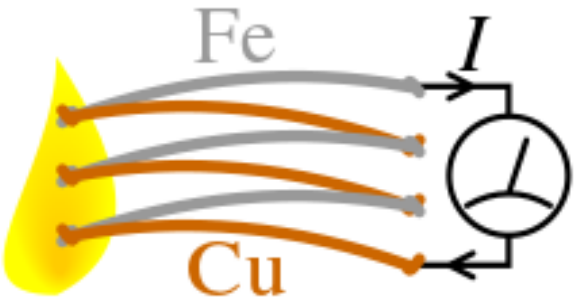
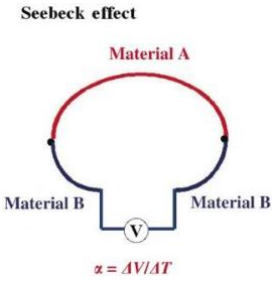


Figure 1.2 Thermoelectric effect simple diagram



. Figure 1.3 Seebeck effect

1.3 IoT

The Internet of Things (IoT) is a network of physical objects, devices, vehicles, buildings, and other items that are embedded with sensors, software, and connectivity to exchange data over the internet. The IoT has the potential to revolutionize industries and improve our daily lives by providing real-time insights, automating processes, and enabling new business models. There are several types of IoT, each with its unique features and applications.

1.3.1 Consumer IoT (CIoT)

Consumer IoT (CIoT) refers to a type of Internet of Things (IoT) devices that are designed for personal use and are typically used in

homes, offices, and other personal spaces. CIoT devices are intended to improve convenience, comfort, and quality of life.

Examples of CIoT devices include smart home devices such as smart thermostats, smart lighting, smart locks, and smart security systems. These devices can be controlled remotely using a smartphone or other internet-enabled device, allowing users to monitor and control their homes from anywhere in the world.

Wearable technology is another example of CIoT devices. Wearables include fitness trackers, smartwatches, and smart glasses. These devices can monitor activity levels, heart rate, and other health metrics, providing users with real-time feedback on their physical activity and helping them to stay healthy and active.

Personal health monitors are another type of CIoT devices. These devices include blood pressure monitors, blood glucose monitors, and other medical devices that can be used to track and manage chronic health conditions. Personal health monitors can be used to monitor health metrics remotely, allowing healthcare providers to provide timely interventions and prevent hospitalizations.

Despite the benefits of CIoT devices, there are also some challenges associated with them. One of the biggest challenges is security and privacy. CIoT devices collect and transmit large amounts of personal data, which can be used to track user behavior and habits. Therefore, it is important to implement robust security measures to protect user data.

Another challenge associated with CIoT devices is interoperability. There are many different CIoT devices available in the market, and they may not be compatible with each other, making it difficult for users to integrate them into a single ecosystem.

In conclusion, CIoT devices are an important part of the IoT ecosystem. They have the potential to improve convenience, comfort, and quality of life for users. However, it is important to address security, privacy, and interoperability challenges to ensure the safe and effective use of these devices.

1.3.2 Industrial IoT (IIoT)

Industrial Internet of Things (IIoT) refers to the use of IoT technology in industrial and manufacturing settings to optimize productivity, efficiency, and safety. IIoT devices are designed to collect and transmit data from industrial equipment and machines, providing insights into their performance and enabling predictive maintenance. Examples of IIoT devices include sensors that monitor machine performance, robotics systems that automate manufacturing processes, and equipment tracking systems that monitor the location and status of industrial assets. These devices can be connected to a central system, allowing operators to monitor and control industrial processes in real-time. .(shown in figure 1.3)

IIoT devices can provide a range of benefits to industrial and manufacturing operations. By monitoring machine performance, IIoT devices can identify inefficiencies and areas for improvement, enabling operators to optimize production processes and reduce downtime.

In addition to improving efficiency and productivity, IIoT devices can also improve safety in industrial settings. For example, sensors can monitor air quality and detect the presence of hazardous materials, alerting operators to potential dangers and enabling them to take appropriate action.

Despite the benefits of IIoT devices, there are also some challenges associated with them. One of the biggest challenges is cybersecurity. IIoT devices can be vulnerable to cyber attacks, which can compromise the safety and security of industrial processes. Therefore, it is important to implement robust security measures to protect IIoT devices and the industrial systems they are connected to.

Another challenge associated with IIoT devices is interoperability. Industrial operations typically involve a wide range of devices and systems from different manufacturers, which may not be compatible with each other. This can make it difficult to integrate IIoT devices into existing industrial systems and to share data between different devices.

In conclusion, IIoT devices are an important part of modern industrial and manufacturing operations. They have the potential to improve efficiency, productivity, and safety, but it is important to address cybersecurity and interoperability challenges to ensure the safe and effective use of these devices.

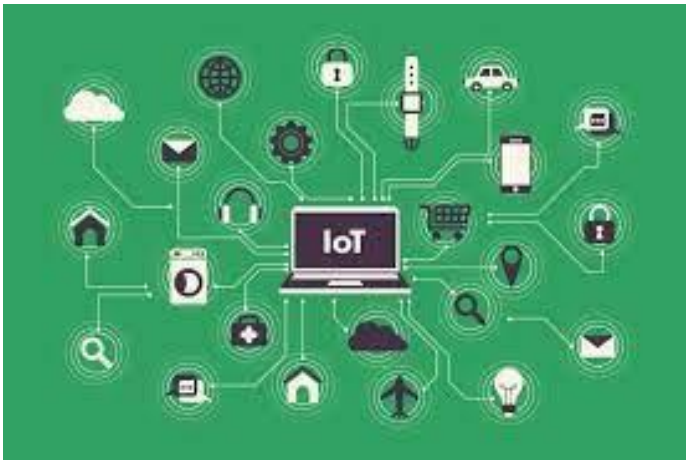


Figure 1.4 IoT

1.3.3 Medical IoT (MIoT)

Medical Internet of Things (MIoT) refers to the use of IoT technology in the healthcare industry to improve patient outcomes, increase efficiency, and reduce costs. MIoT devices can be used to collect and transmit patient data, monitor vital signs, and provide real-time alerts to healthcare providers. Examples of MIoT devices include wearable sensors that track heart rate, blood pressure, and other vital signs, as well as smart medical devices that can be remotely monitored and controlled. MIoT devices can also be used to automate healthcare processes, such as medication management and patient monitoring, improving efficiency and reducing errors**.** .(shown in figure 1.4).

MIoT devices can provide a range of benefits to the healthcare industry. By collecting and analyzing patient data in real-time, MIoT devices can provide healthcare providers with valuable insights into patient health, enabling early detection and intervention of potential health issues. MIoT devices can also improve patient outcomes by enabling remote monitoring of chronic conditions and reducing the

need for hospital visits.

In addition to improving patient outcomes, MIoT devices can also reduce healthcare costs by improving efficiency and reducing waste. For example, MIoT devices can enable more efficient use of hospital resources by automating processes and reducing the need for manual intervention.

Despite the benefits of MIoT devices, there are also some challenges associated with them. One of the biggest challenges is data security. MIoT devices collect sensitive patient data, which must be protected from cyber attacks and data breaches. Therefore, it is important to implement robust security measures to protect MIoT devices and the patient data they collect.

Another challenge associated with MIoT devices is interoperability. Healthcare operations typically involve a wide range of devices and systems from different manufacturers, which may not be compatible with each other. This can make it difficult to integrate MIoT devices into existing healthcare systems and to share data between different devices.

In conclusion, MIoT devices are an important part of modern healthcare operations. They have the potential to improve patient outcomes, increase efficiency, and reduce costs, but it is important to address data security and interoperability challenges to ensure the safe and effective use of these devices.

Figure 1.5 Medical IoT

1.3.4 Smart City IoT (SCIoT)

Smart City IoT (SCIoT) is a term used to describe the use of Internet of Things (IoT) technology to improve the efficiency and quality of life in urban areas. SCIoT devices can be used to collect and transmit data about various aspects of city life, such as traffic patterns, air quality, and energy consumption, and use that data to make informed decisions about how to manage city resources and improve the urban environment.

Figure 1.6 Smart city IoT

Examples of SCIoT devices include sensors that monitor air quality, traffic cameras that provide real-time data on traffic flow, and smart streetlights that adjust their brightness based on the amount of ambient light and pedestrian activity. SCIoT devices can also be used to automate city services, such as waste management and public transportation, making them more efficient and cost-effective.

SCIoT has the potential to improve the lives of city residents in several ways. For example, it can help reduce traffic congestion by providing real-time information about traffic patterns, enabling drivers to choose alternative routes and reducing travel times. SCIoT can also help improve air quality by monitoring pollution levels and identifying areas where air quality is poor. .(shown in figure 1.5).

In addition to improving the quality of life for residents, SCIoT can also help cities become more sustainable and environmentally friendly. By monitoring energy consumption and identifying areas where energy is being wasted, cities can make targeted improvements to their infrastructure to reduce energy use and carbon emissions.

Despite the benefits of SCIoT, there are also some challenges associated with implementing it in cities. One of the biggest challenges is data management. SCIoT devices generate vast amounts of data, which must be collected, analyzed, and stored securely. This requires the development of sophisticated data management systems and the implementation of robust cybersecurity measures to protect sensitive data.

Another challenge associated with SCIoT is interoperability. City operations typically involve a wide range of devices and systems from different manufacturers, which may not be compatible with each other. This can make it difficult to integrate SCIoT devices into existing city systems and to share data between different devices.

1.3.5 Enterprise IoT (EIoT)

Enterprise IoT (EIoT) is a term used to describe the use of Internet of Things (IoT) technology in the context of business and industry. EIoT devices can be used to collect and transmit data about various aspects of business operations, such as supply chain management, inventory control, and equipment maintenance, and use that data to make informed decisions about how to optimize business processes and improve productivity.

Examples of EIoT devices include sensors that monitor equipment performance and detect potential failures before they occur, as well as smart logistics systems that track shipments in real-time and optimize delivery routes to reduce costs and improve efficiency. EIoT devices can also be used to automate routine tasks, such as data entry and inventory management, freeing up employees to focus on more strategic activities.

EIoT has the potential to transform the way businesses operate in several ways. For example, it can help companies reduce downtime and improve equipment reliability by providing real-time data about equipment performance and identifying potential issues before they lead to failures. EIoT can also help companies reduce costs by optimizing supply chain management and

improving inventory control, leading to more efficient use of resources and reduced waste.

In addition to improving productivity and reducing costs, EIoT can also help companies stay competitive by providing them with real-time insights into market trends and customer preferences. By collecting and analyzing data from EIoT devices, companies can make more informed decisions about product development, marketing, and sales, leading to improved customer satisfaction and increased revenue. .(shown in figure 1.6).

This requires the development of sophisticated data management systems and the implementation of robust cybersecurity measures to protect sensitive data.

Figure 1.7 Enterprise Iot

1.3.6 IOT AND ITS APPLICATIONS

The Internet of Things (IoT) refers to the interconnected network of physical devices, vehicles, home appliances, and other objects that are embedded with sensors, software, and connectivity capabilities that enable them to collect and exchange data with other devices and systems over the internet. The application of IoT has revolutionized various industries, including healthcare, transportation, agriculture, manufacturing, and energy, among others. This paper explores some of the most significant applications of IoT and their potential benefits.

1. IoT in Healthcare:

IoT has the potential to transform healthcare by enabling remote monitoring, predictive analytics, and personalized care. Wearable devices such as smartwatches, fitness trackers, and health monitors can track a patient's vital signs, activity level, and medication adherence, providing real-time data to healthcare providers. This information can be used to detect early warning signs of chronic diseases, monitor patients with chronic conditions, and improve the overall quality of care. IoT can also be used to track medical equipment, manage inventory, and improve patient safety by reducing errors and improving communication among healthcare providers.

2. IoT in Transportation:

IoT is transforming the transportation industry by enabling real-time tracking of vehicles, optimizing routes, and improving safety.

Connected cars, buses, and trucks can communicate with each other and with infrastructure, such as traffic lights and road sensors, to reduce congestion, improve fuel efficiency, and prevent accidents. IoT can also be used to monitor driver behavior, such as speed, braking, and acceleration, to improve safety and reduce insurance costs. In addition, IoT can be used to track the location and condition of goods in transit, improving supply chain efficiency and reducing losses.

3. IoT in Agriculture:

IoT has the potential to revolutionize the agriculture industry by enabling precision farming, smart irrigation, and crop monitoring. Connected sensors can monitor soil moisture, temperature, and nutrient levels, allowing farmers to optimize irrigation and fertilizer use. Drones and satellites can be used to monitor crop health, detect pests and diseases, and improve yield. IoT can also be used to monitor livestock health, improve feed efficiency, and reduce waste.

4. IoT in Manufacturing:

IoT is transforming the manufacturing industry by enabling predictive maintenance, quality control, and supply chain optimization. Connected sensors can monitor equipment performance, detect faults, and predict maintenance needs, reducing downtime and improving efficiency. IoT can also be used to monitor product quality, detect defects, and improve production processes. In addition, IoT can be used to optimize supply chain management by tracking inventory, improving logistics, and reducing costs.

5. IoT in Energy:

IoT has the potential to transform the energy industry by enabling smart grid management, energy efficiency, and renewable energy integration. Connected sensors can monitor energy usage, predict demand, and optimize grid performance, reducing energy waste and improving reliability. IoT can also be used to monitor energy consumption in buildings, optimize HVAC systems, and reduce energy costs.

1.4 PROJECT INTRODUCTION

The Internet of Things (IoT) has revolutionized the way we interact with the world around us, by connecting everyday devices to the internet and enabling them to communicate with each other. IoT has led to the development of smart homes, cities, and industries, with the potential to enhance the quality of life and improve efficiency in various domains. In this project, we propose an IoT-based solution for a portable hot and cold smart decanter that leverages the thermoelectric effect to regulate the temperature of liquids.

A decanter is a device used to transfer liquids from one container to another while separating any sediment or impurities. Decanters are commonly used for wine, whiskey, and other beverages, and the temperature of the liquid can significantly impact the taste and aroma. The traditional approach to temperature control in decanters relies on external heating or cooling devices, which can be inconvenient and limit portability. In contrast, our proposed solution leverages the thermoelectric effect, which involves the conversion of temperature differences into electrical voltage, to maintain the desired temperature of the liquid.

The device consists of a thermoelectric module, which is connected to an IoT-enabled microcontroller and a mobile application. The thermoelectric module utilizes the Peltier effect, which is a thermoelectric effect that occurs when a current is passed through a junction between two different materials, causing one side of the module to heat up and the other side to cool down. By controlling the direction and magnitude of the current, we can maintain a desired temperature range for the liquid.

The microcontroller is responsible for processing data from the temperature sensor and controlling the thermoelectric module. The device is connected to the internet via Wi-Fi or Bluetooth, enabling users to control the temperature of the liquid remotely through a mobile application. The application provides real-time data on the temperature and allows users to set the desired temperature range, adjust the temperature, and receive alerts when the temperature is outside the desired range.

The proposed solution has several potential applications, including in the hospitality industry, where it can be used to maintain the temperature of beverages in hotels and restaurants, or in households, where it can be used to keep beverages at the desired temperature during outdoor activities or picnics. The device is portable, lightweight, and easy to use, making it an ideal solution for temperature control on the go.

In summary, our proposed IoT-based solution for a portable hot and cold smart decanter using the thermoelectric effect has the potential to revolutionize temperature control in the beverage industry. The device

is not only efficient and easy to use but also provides users with real-time data and remote control capabilities, enabling a more convenient and enjoyable experience.

1.4.1 OBJECTIVE OF THE PROJECT:

- To design and develop an IoT-based solution for a portable hot and cold smart decanter that utilizes the thermoelectric effect for temperature control.
- To integrate a thermoelectric module, temperature sensor, microcontroller, and Bluetooth module to create a smart decanter that can maintain the desired temperature range.
- To develop a mobile application that enables users to control the temperature of the liquid remotely, set the desired temperature range, and receive alerts when the temperature is outside the desired range.
- To evaluate the performance of the smart decanter and compare it with traditional decanters in terms of temperature control, portability, and user experience.
- To explore potential applications of the smart decanter in the hospitality industry, households, and outdoor activities.
- To identify potential areas of improvement for the smart decanter and suggest future research directions.

Overall, the main objective of this project is to leverage the power of IoT and the thermoelectric effect to create a more efficient, portable, and user-friendly solution for temperature control in decanters. By achieving these objectives, we hope to contribute to the growing field

of IoT and provide a practical solution that enhances the quality .

1.4.2 ORGANISATION OF THE REPORT

The organization of the report is given in the following way:

CHAPTER 1 gives the overview about the wireless charging vehicle and Antitheft electric vehicle. It also gives a brief explanation about the working and features of Blockchain Technology and Android. It also adds the objective of the project.

CHAPTER 2 provides an elaborate explanation of Existing work. It also deals with survey of literature of existing system for wireless charging and antitheft vehicle.

CHAPTER 3 gives the overall view of the proposed work which contains the hardware and software components used for the development of prototype to obtain the result.

CHAPTER 4 deals with the detailed explanation and working of proposed system.

CHAPTER 5 gives the conclusion and future enhancement of the proposed work.

CHAPTER 2

EXISTING SYSTEM

2.1 GENERAL

The traditional decanter is a household item that is used to serve drinks at a specific temperature. However, the traditional decanter has certain limitations, such as limited portability, inconvenience in temperature control, lack of smart features, inaccurate temperature control, and energy inefficiency. These limitations have led to the development of more advanced solutions that leverage modern technology to provide a better user experience.

In recent years, IoT-based devices have become increasingly popular due to their ability to provide remote control and real-time monitoring of various aspects of a device's performance. In the context of decanters, an IoT-based smart decanter can provide a more efficient, convenient, and sustainable solution for temperature control.

The proposed project aims to develop an IoT-based portable hot and cold smart decanter that uses the thermoelectric effect for temperature control. By leveraging the capabilities of modern technology, this smart decanter will overcome the limitations of traditional decanters and provide a more advanced and user-friendly experience. The project will involve designing and

prototyping the smart decanter, integrating various components such as the thermoelectric module, temperature sensor, microcontroller, Bluetooth module, and LCD display, and testing its performance in different settings. .(shown in figure 2.1).

Overall, the project represents an important step forward in the development of smart and sustainable solutions for temperature control in decanters, and has the potential to revolutionize the way people enjoy their drinks.

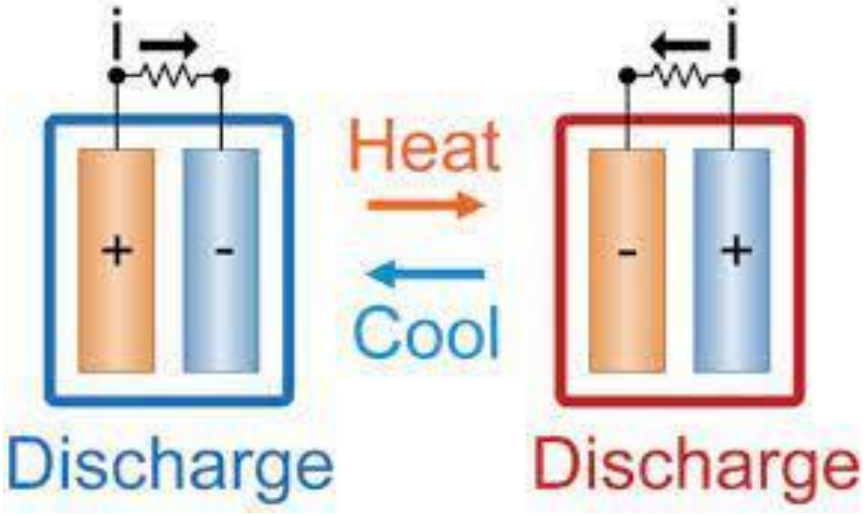


Figure 2.1 Schematic of generating temperature

2.2 METHODS OF GENERATING TEMPERATURE

2.2.1. INTRODUCTION

Temperature is a physical quantity that is widely used in various applications, ranging from scientific research to industrial processes. Generating temperature refers to the process of creating a temperature

difference between two objects, which can be used to measure the temperature or transfer heat. In this article, we will explore different methods of generating temperature, including thermal expansion, thermoelectric effect, optical pyrometry, radiation thermometry, thermocouples, resistance temperature detectors, thermistors, and liquid-in-glass thermometers.

2.2.2. METHODS

- **Thermal Expansion**
- **Thermoelectric Effect**
- **Optical Pyrometry**
- **Radiation Thermometry**
- **Thermocouples**
- **Resistance Temperature Detectors**
- **Thermistors**
- **Liquid-in-Glass Thermometers**

1.Thernal Expansion:

Thermal expansion is a phenomenon in which the volume of a material changes with temperature. When a material is heated, its atoms or molecules vibrate more, causing the material to expand. This expansion can be used to generate temperature, as shown in devices such as bimetallic strips and thermal actuators. Bimetallic strips consist of two different metals bonded together, with each metal having a different coefficient of thermal expansion. As the temperature changes, the strip bends due to the different expansion rates of the two metals. Thermal actuators are similar to bimetallic

strips, but they use a single metal that expands or contracts when heated or cooled. These devices are used in various applications, such as thermostats, switches, and valves. .(shown in figure 2.2).

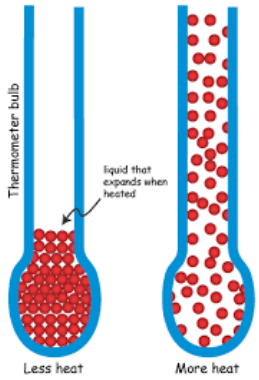


Figure 2.2 Thermal Expansion

2.Thermoelectric Effect:

The thermoelectric effect is a phenomenon in which a temperature difference between two materials generates an electric voltage. This effect is used in thermocouples, which consist of two different metals joined together at a junction. When the junction is heated, an electric voltage is generated, which can be used to measure the temperature. Thermocouples are widely used in temperature sensing applications, such as in furnaces, ovens, and engines.

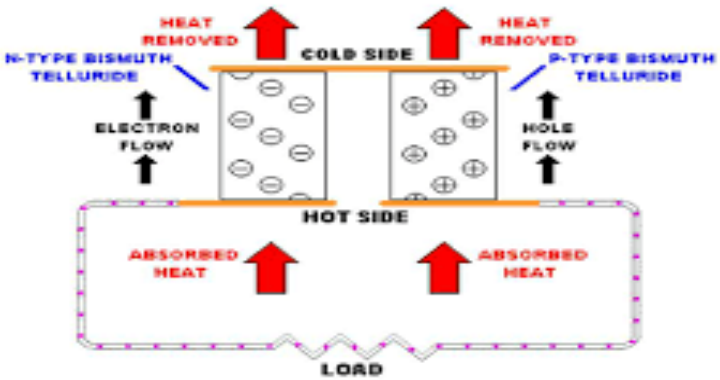


Figure 2.3 Thermoelectric Effect

Thermoelectric modules are devices that utilize the thermoelectric effect to either cool or heat a system. They consist of two different materials that are sandwiched together, typically made of p-type and n-type semiconductors. .(shown in figure 2.3).

3. Optical Pyrometry and Radiation Thermometry

Optical pyrometry and radiation thermometry are two methods of generating temperature that are based on the principles of electromagnetic radiation. Optical pyrometry involves measuring the temperature of an object by analyzing the color of the light it emits. This method is used for measuring high temperatures, such as in furnaces and combustion engines. Radiation thermometry, on the other hand, involves measuring the temperature of an object by analyzing the radiation it emits. This method is used for measuring both high and low temperatures, such as in food processing, medical applications, and materials testing. (shown in figure 2.4 & 2.5).

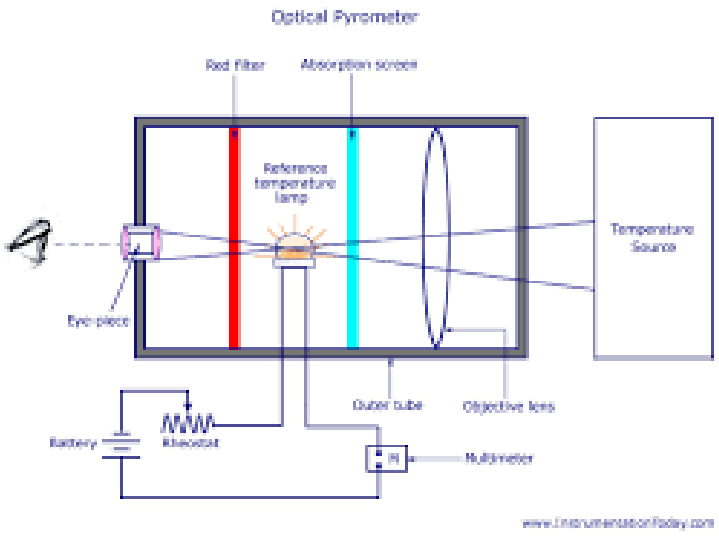


Figure 2.4 Optical Pyrometer

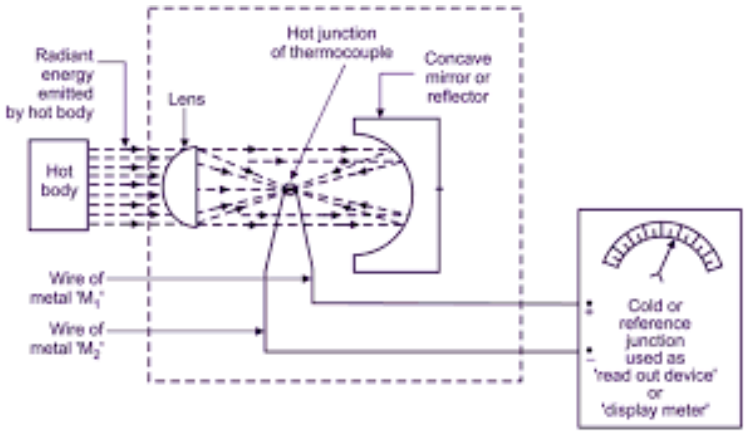


Figure 2.5 Radiation Pyrometer

4. Thermistors and Resistance Temperature Detectors

Thermistors and resistance temperature detectors (RTDs) are two types of temperature sensors that are based on the principle of electrical resistance. A thermistor is a device that has a resistance that changes with temperature. This change in resistance can be used to generate temperature. RTDs are similar to thermistors, but they use a material that has a more predictable resistance-temperature relationship, such as platinum or nickel. These sensors are widely used in temperature measurement applications, such as in HVAC systems, laboratory equipment, and automotive applications.
(shown in figure 2.6).

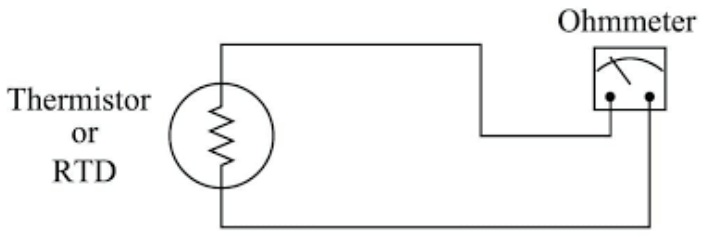


Figure 2.6 Thermistors and resistance temperature detector

5. Liquid-in-Glass Thermometers:

Liquid-in-glass thermometers are a type of temperature sensor that consists of a glass tube filled with a liquid, such as mercury or alcohol. The liquid expands or contracts with temperature, causing it to rise or fall in the tube. The temperature can be read by calibrating the thermometer with known reference temperatures. These thermometers are widely used in everyday applications, such as in weather monitoring, cooking, and medical applications. .(shown in figure 2.7).

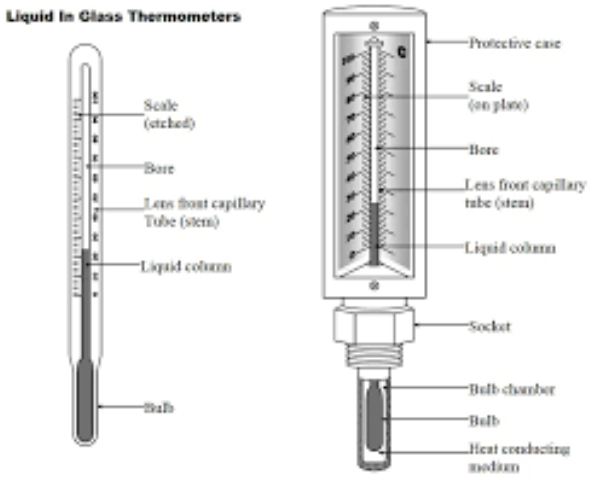


Figure 2.7 Liquid-in-glass thermometers

2.3 CONCLUSION

In conclusion, generating temperature is a critical process in various industries and applications. There are several methods available for generating temperature, each with its own advantages and disadvantages. Thermal expansion and the thermoelectric effect are two of the most common methods used in industrial applications. Optical pyrometry and radiation thermometry are

useful for measuring high and low temperatures, respectively. Thermocouples and resistance temperature detectors are widely used in industrial and scientific applications, while thermistors are commonly used in electronic applications. Liquid-in-glass thermometers, while less commonly used today, remain an important historical method for generating temperature. Regardless of the method used, accurate temperature measurement is essential for ensuring the quality and safety of products and processes. Advances in technology continue to improve temperature generation and measurement, and future prospects are promising.

2.4 LITERATURE SURVEY

The following are the reviews from previous works which were designed and implemented before.

[1] Najmie, M. S., and M. K. Fadzly. "Thermoelectric portable water cooler using Arduino Uno." In *AIP Conference Proceedings*, vol. 2129, no. 1, p. 020147. AIP Publishing LLC, 2019.

Drawbacks:

- It occupies large area.
- Cost efficient is high.

Solution:

- To overcome this drawback, providing a design which requires small in size and it can be afford at low cost.

[2] Alsaif, Hussain F., and Mohammed A. Almaghrabi. "Smart Travel Mug for Hot and Cold Beverages." In *ASME International Mechanical Engineering Congress and Exposition*, vol. 58493, p. V014T07A015. American Society of Mechanical Engineers, 2017.

Drawbacks:

- Mug like structure which can hold paper cups.
- We cant use large containers.

Solution:

- To overcome this drawback, a container which can change the temperature using this TEC container.

[3] Patil, Rajendra P., Pradhyumna Suryawanshi, Akshay Pawar, and Avdhoot Pawar. "INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY THERMOELECTRIC REFRIGERATION USING PELTIER EFFECT."

Drawbacks:

- A box which can store specimens for preservation.

Solution:

- This technology can be used for heating and cooling water or beverages.

[4] Attavane, Pavan, G. B. Arjun, Rajath Radhakrishna, and Santhosh Rao Jadav. "Solar powered portable food warmer and cooler based on peltier effect." In *2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, pp. 1975-1978. IEEE, 2017.

Drawbacks:

- Power consumption is high.

Solution:

- It requires low power

CHAPTER 3

PROPOSED SYSTEM

3.1 OVERVIEW

The proposed solution for the project is an IoT-based smart decanter that uses the thermoelectric effect for temperature control. The smart decanter consists of several key components, including a thermoelectric module, a temperature sensor, a microcontroller, a Bluetooth module, and an LCD display.

3.2 PROPOSED SYSTEM

The proposed solution is an IoT-based smart decanter that leverages the thermoelectric effect to control the temperature of the liquid inside. The smart decanter is designed to be portable, making it ideal for use in a variety of settings, including homes, offices, and outdoor events.

The smart decanter consists of several key components, including a thermoelectric module, a temperature sensor, a microcontroller, a Bluetooth module, and an LCD display. The thermoelectric module is used to generate a temperature difference between the two sides of the module, which can be used to either heat or cool the liquid in the decanter.

The temperature sensor is used to measure the temperature of the liquid inside the decanter. The sensor sends this information to the microcontroller, which uses a PID control algorithm to maintain the

desired temperature of the liquid.

The microcontroller is responsible for controlling the operation of the thermoelectric module, LCD display, and Bluetooth module. It receives temperature data from the temperature sensor and adjusts the thermoelectric module's operation to maintain the desired temperature.

The Bluetooth module enables remote monitoring and control of the temperature of the liquid inside the decanter. Users can connect to the system using a smartphone app and adjust the desired temperature. The LCD display provides real-time feedback on the temperature of the liquid inside the decanter.

Overall, the proposed solution combines several key technologies to create an advanced and sustainable solution for temperature control in decanters. By leveraging IoT technology, the proposed solution provides users with greater control and flexibility over the temperature of their liquids.

3.2.1 ADVANTAGES

- **Portability:** The smart decanter is designed to be portable, which makes it convenient for users to take it with them wherever they go. This means that users can enjoy hot or cold drinks on-the-go, whether at work, at home, or while traveling.
- **Temperature control:** The use of the thermoelectric effect allows for precise temperature control of the decanter. This means that users can set the desired temperature for their drink and the decanter will maintain it.

- **Energy efficiency:** The thermoelectric module used in the smart decanter is energy-efficient, which means that it consumes less power than traditional heating and cooling systems. This makes it an eco-friendly option for users who want to reduce their carbon footprint.
- **IoT connectivity:** The smart decanter is IoT-enabled, which means that it can be connected to the internet and controlled remotely using a smartphone app. This allows users to monitor and control the temperature of their drink from anywhere, at any time.
- **User-friendly interface:** The smart decanter is equipped with an LCD display and a user-friendly interface, which makes it easy to set the desired temperature and monitor the temperature of the drink.
- **Health benefits:** The ability to control the temperature of the drink has health benefits, such as preventing burns from hot drinks and reducing the risk of tooth sensitivity from cold drinks.

Overall, the IoT-based portable hot and cold smart decanter using thermoelectric effect is a convenient, energy-efficient, and user-friendly solution for temperature-controlled drinks, with added health benefits and IoT connectivity.

3.3 COMPONENTS USED

The charging mechanism is made up of different components used in the layout. These are the essential elements:

(i) HARDWARE COMPONENTS

i) Peltier 12706
ii) DPDT switch
iii) DS18B20RFID temperature sensor
iv) JHD LCD
v) Bluetooth HC05
vi) ESP8266
vii) 12V 10 A Input Supply Module
viii) Relay

ix) Buzzer
x) LCD

(ii) SOFTWARE USED

(i) Arduino IDE
(ii) Ubidots software

3.3.1. HARDWARE COMPONENTS

1. PELTIER 12706:

The Peltier 12706 module is a thermoelectric cooling device that is widely used in many industries and applications. It works based on the Peltier effect, which is a phenomenon where a temperature difference is created when a DC current flows through two different materials that are connected electrically in a series and thermally in parallel.

The Peltier 12706 module is a small device that is only a few millimeters thick and has a surface area of about 40mm². Despite its small size, it can generate a temperature difference of up to 70°C, making it a powerful and versatile device for many cooling and heating applications.

One of the advantages of the Peltier 12706 module is its ease of use. It requires only a DC power supply to operate, making it a simple and cost-effective solution for many temperature control applications. It can be easily integrated into various systems and devices, such as refrigerators, air conditioners, and temperature-controlled water bottles.

Another advantage of the Peltier 12706 module is its low noise level. Unlike compressor-based refrigeration systems, the Peltier module does not have any moving parts, which makes it a quiet and reliable option for many applications. Additionally, the module's low power consumption makes it an energy-efficient choice for many cooling and heating applications.

The Peltier 12706 module can also be used for precise temperature control. It can maintain a constant temperature within a range of ±0.1°C, which makes it a popular choice for laboratory and scientific applications. It can also be used in electronic components and circuits to prevent overheating and improve performance.

However, the Peltier 12706 module has some limitations. One of the main limitations is its low efficiency compared to other cooling and heating techniques, such as compressor-based refrigeration systems. The module's efficiency is affected by factors such as the temperature difference, current flow, and thermal resistance, which can limit its cooling and heating capabilities.

Another limitation of the Peltier 12706 module is its temperature range. It can only cool or heat within a temperature range of -40°C to 100°C, which may not be sufficient for some applications. Additionally, the module's cooling and heating capabilities may be affected by external factors, such as ambient temperature and humidity.

Despite its limitations, the Peltier 12706 module remains a popular choice for many designers and engineers due to its ease of use, low

noise level, and precise temperature control capabilities. It is commonly used in portable cooling and heating devices, electronic components, and laboratory and scientific applications.

To improve the efficiency and performance of the Peltier 12706 module, many researchers are working on developing new materials and techniques. For example, some researchers are using nanotechnology to improve the thermal conductivity and reduce the thermal resistance of the module. Others are experimenting with new semiconductor materials to enhance the module's cooling and heating capabilities. **.**(shown in figure 3.1).

Figure 3.1 Peltier 12706

In summary, the Peltier 12706 module is a powerful and versatile thermoelectric cooling device that has many advantages and limitations. Its ease of use, low noise level, and precise temperature control capabilities make it a popular choice for many applications. However, its low efficiency and limited temperature range may limit its use in some applications. Nevertheless, ongoing research and

development are expected to improve the efficiency and performance of the Peltier 12706 module in the future.

2. DPDT SWITCH:

A Double Pole Double Throw (DPDT) switch is a type of electrical switch that is commonly used in a variety of electrical applications. It is a switch that has two poles and can switch between two different circuits, allowing it to control multiple functions.

The DPDT switch is often used in applications where multiple circuits need to be controlled simultaneously, or where the user needs to switch between different modes of operation. For example, it is commonly used in audio equipment to switch between different input sources, or in lighting systems to control different levels of illumination. **.**(shown in figure 3.2).

The switch consists of two sets of contacts, each of which can be connected to a different circuit. When the switch is in one position, one set of contacts is connected to the circuit, and when it is in the other position, the other set of contacts is connected to the circuit.

DPDT switches come in a variety of sizes and configurations to meet the needs of different applications. They are often available in toggle, rocker, or slide configurations, and can be purchased with different ratings to accommodate various voltages and currents.

One of the advantages of using a DPDT switch is that it allows for more flexibility in the control of electrical circuits. By switching

between different circuits, users can adjust the operation of a system to suit their needs, without having to install additional switches or other components.

Figure 3.2 DPDT Switches

DPDT switches are also relatively easy to install, and can be used in a variety of applications with minimal modification. They are commonly used in electrical equipment, lighting systems, and automotive applications, among other uses.

Overall, the DPDT switch is a versatile and reliable component that is widely used in a variety of electrical applications. Its ability to switch between multiple circuits and its ease of use make it a popular choice for engineers, hobbyists, and DIY enthusiasts alike.

3. DS18B20 TEMPERATURE SENSOR:

The DS18B20 is a digital temperature sensor that is widely used in a variety of applications. It is a low-cost, high-precision device that can be easily integrated into a wide range of electronic systems.

One of the advantages of the DS18B20 is its simplicity. It is a

digital sensor that communicates over a 1-Wire interface, which means that it requires only a single data pin to operate. This makes it easy to connect to a microcontroller or other digital device.

Another advantage of the DS18B20 is its high level of accuracy. It can measure temperatures with a resolution of up to 0.0625°C, making it suitable for use in precision applications. It also has a temperature range of -55°C to +125°C, which makes it suitable for use in a wide range of environments. **.**(shown in figure 3.3).

The DS18B20 is also versatile, and can be used in a variety of applications. It is commonly used in environmental monitoring systems, home automation systems, and industrial control systems, among other uses.

Figure 3.3 DS18B20 Temperature sensor

One of the key features of the DS18B20 is its ability to operate in a "parasitic" mode. This means that it can be powered solely from the

data line, which eliminates the need for an external power supply. This makes it particularly useful in low-power applications.

The DS18B20 is also designed to be rugged and reliable. It is housed in a waterproof and stainless-steel package that can withstand harsh environments and exposure to water and chemicals.

Overall, the DS18B20 is a versatile and reliable temperature sensor that is widely used in a variety of applications. Its simplicity, accuracy, and ruggedness make it an excellent choice for a wide range of electronic systems.

4. **JHD LCD:**

The JHD LCD is a popular type of liquid crystal display (LCD) that is commonly used in a variety of electronic systems. It is known for its reliability, ease of use, and high level of compatibility with a wide range of microcontrollers.

One of the main advantages of the JHD LCD is its simplicity. It is easy to connect to a microcontroller and does not require a lot of additional circuitry or programming. This makes it a popular choice for hobbyists and professionals alike.

Another advantage of the JHD LCD is its versatility. It comes in a range of sizes and configurations, from small character displays to larger graphical displays. This makes it suitable for a wide range of applications, including industrial control systems, home automation

systems, and consumer electronics.

The JHD LCD also features a high level of compatibility with popular microcontrollers, such as the Arduino and Raspberry Pi. This makes it easy to integrate into existing projects and to find resources and support online.

In addition, the JHD LCD is known for its low power consumption, which makes it suitable for battery-powered applications. It is also designed to be rugged and reliable, with a long lifespan and resistance to shock and vibration.

Figure 3.4 LCD

Another advantage of the JHD LCD is its ease of use. It features a simple interface that allows users to display text, graphics, and other information on the screen. It also supports a wide range of fonts and character sets, which makes it suitable for use in multilingual applications.

Overall, the JHD LCD is a reliable and versatile display that is widely used in a variety of electronic systems. Its simplicity,

versatility, and compatibility with popular microcontrollers make it an excellent choice for a wide range of applications.

5. **BLUETOOTH HC – 05**:

The HC05 Bluetooth module is a popular and versatile wireless communication module that allows devices to communicate with each other over short distances. It is commonly used in hobbyist and professional projects to enable wireless control and data transfer between devices. **.**(shown in figure 3.5).

One of the main advantages of the HC05 module is its ease of use. It features a simple interface that allows users to easily pair and connect devices, making it a popular choice for beginners and experienced users alike.

Another advantage of the HC05 module is its versatility. It supports a wide range of data transfer rates and can be used for a variety of applications, such as wireless serial communication, remote control, and data logging.

The HC05 module also features a small form factor, making it easy to integrate into existing projects. It is designed to be low power, which makes it suitable for battery-powered applications.

One of the unique features of the HC05 module is its support for both master and slave modes. This allows the module to act as both a central device that controls other devices and as a peripheral device that is controlled by other devices.

Figure 3.5 Bluetooth HC-05

In addition, the HC05 module is highly configurable. Users can modify the settings of the module to adjust the baud rate, data format, and other parameters to suit their specific application requirements.

The HC05 module is also highly compatible with a wide range of microcontrollers, such as the Arduino and Raspberry Pi, which makes it easy to integrate into existing projects.

Another advantage of the HC05 module is its low cost. It is one of the most affordable Bluetooth modules on the market, making it an attractive choice for budget-conscious projects.

Overall, the HC05 Bluetooth module is a reliable and versatile wireless communication module that is widely used in a variety of electronic systems. Its ease of use, versatility, and low cost make it an excellent choice for a wide range of applications.

6. ESP8266:

The ESP8266 is a highly popular and versatile Wi-fi-enabled microcontroller that is widely used in a variety of Internet of Things (IoT) projects. Developed by Espressif Systems, the ESP8266 is designed to be low-cost, low-power, and easy to use.

One of the key advantages of the ESP8266 is its built-in Wi-fi connectivity. It features an onboard 802.11b/g/n Wi-fi transceiver, which makes it easy to connect to wireless networks and communicate with other devices over the internet. **.**(shown in figure 3.6).

The ESP8266 is also highly flexible and configurable. It supports a variety of operating modes, including station mode, access point mode, and both station and access point mode. This makes it easy to integrate the module into a wide range of applications, such as smart home devices, environmental sensors, and data loggers.

Another advantage of the ESP8266 is its low cost. It is one of the most affordable Wi-fi-enabled microcontrollers on the market, making it an attractive choice for budget-conscious projects.

The ESP8266 also features a powerful processor with plenty of memory and processing power. It is based on a Tensilica L106 32-bit microcontroller with clock speeds up to 80 MHz, and it includes up to 4 MB of flash memory for program storage.

In addition, the ESP8266 is highly compatible with a variety of programming languages and development tools. It can be

programmed using the Arduino IDE, Micro Python, Lua, and other popular programming languages and frameworks.

The ESP8266 is also highly versatile and can be used in a variety of applications beyond IoT. For example, it can be used in robotics, home automation, and other embedded systems projects.

One of the unique features of the ESP8266 is its support for Over-The-Air (OTA) updates. This allows users to update the firmware of the module wirelessly, without the need for physical access to the device.

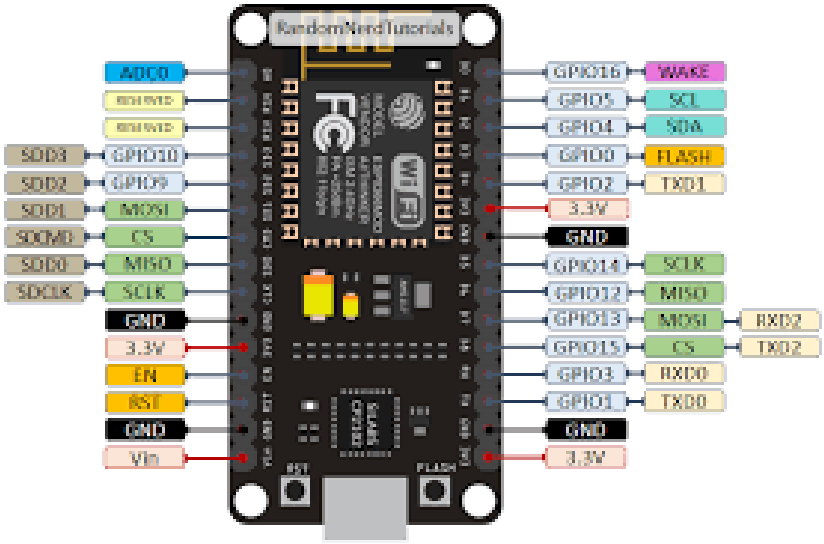


Figure 3.6 ESP8266

Overall, the ESP8266 is a powerful and versatile Wi-fi-enabled microcontroller that is widely used in a variety of IoT and embedded systems applications. Its low cost, ease of use, and flexibility make it an attractive choice for hobbyists, students, and professional developers alike.

7. 12 V 10 A INPUT SUPPLY MODULE:

The DC 12V 10A module is an electronic component that can be used to regulate and convert DC voltage. It is commonly used in a wide range of electronic devices and applications, including automotive, industrial, and home automation systems. **.**(shown in figure 3.7).

Here are some more details about this component:

Input voltage: The DC 12V 10A module accepts a DC input voltage range of 10V to 36V.

Output voltage: The module is capable of outputting a regulated DC voltage of 12V.

Output current: The maximum output current of the module is 10A, which makes it suitable for powering high-current devices and components.

Efficiency: The module has high efficiency, which means that it can convert DC voltage with minimal energy loss.

Protections: The DC 12V 10A module also has several built-in protections, including overvoltage protection, overcurrent protection, and short-circuit protection. These protections ensure that the module and the devices connected to it are not damaged in case of any voltage or current fluctuations.

Cooling: The module also has a built-in cooling system that helps dissipate the heat generated during voltage conversion and regulation, which ensures stable operation.

Overall, the DC 12V 10A module is a versatile and reliable component that can be used in a variety of electronic applications to regulate and convert DC voltage with high efficiency and built-in protections.

Figure 3.7 12 v 10 a input supply module

8. RELAY

A relay is an electronic component that allows electrical signals to control larger electrical circuits or devices. It acts as a switch, which can be operated manually or automatically to turn devices on or off.

.(shown in figure 3.8).

Here are some more details about relays:

Types of relays: There are different types of relays available, including electromagnetic relays, solid-state relays, thermal relays, and reed relays.

Working principle: The working principle of a relay is based on the electromagnetic effect. When a current flows through the coil of the relay, it creates a magnetic field that attracts or repels the contact switch. This contact switch then opens or closes the circuit.

Applications: Relays are widely used in various electronic applications, including home automation, industrial control systems, automotive electronics, and telecommunications.

Contacts: The contacts of the relay are the parts that actually connect and disconnect the electrical circuit. These contacts are made of materials that are highly conductive and can withstand high temperatures and currents.

Ratings: The ratings of a relay determine its maximum voltage, current, and power handling capacity. It is important to select a relay with appropriate ratings for a particular application to ensure safe and reliable operation.

Advantages: Some advantages of using relays include their ability to control high-power devices, their low power consumption, and their durability.

Figure 3.8 Relay module

Overall, relays are important components in many electronic systems, and their versatility and reliability make them ideal for a wide range of applications.

9. BUZZER

A buzzer is an electronic component that produces sound when an electrical signal is applied to it. It is typically used as an audible indicator to alert the user or provide a warning in a wide range of electronic applications. Here are some more details about buzzers:

Types of buzzers: There are different types of buzzers available, including magnetic buzzers, piezoelectric buzzers, and electrodynamic buzzers. **.**(shown in figure 3.9).

Working principle: The working principle of a buzzer depends on its type. For example, a magnetic buzzer works by using a magnet and a coil to produce sound, while a piezoelectric buzzer uses a piezoelectric crystal to create vibrations that produce sound.

Applications: Buzzers are used in various electronic devices and applications, including alarm systems, timers, appliances, and automotive electronics.

Sound output: The sound output of a buzzer can be characterized by its frequency, loudness, and tone. Different types of buzzers produce different types of sounds, such as a continuous tone or a pulsed tone.

Power consumption: The power consumption of a buzzer is an important consideration when selecting a buzzer for a particular application. Low-power buzzers are available for battery-powered devices or applications that require low power consumption.

Advantages: Some advantages of using buzzers include their low cost, simplicity, and versatility. They are easy to integrate into electronic circuits and can be used for a wide range of applications.

Figure 3.9 Buzzer

Overall, buzzers are important components in many electronic

systems, and their ability to provide audible feedback or warnings makes them essential in many applications.

10.LED

LED stands for Light Emitting Diode, which is a type of semiconductor component that emits light when a current flows through it. LEDs have several advantages over traditional light sources such as incandescent bulbs and fluorescent tubes, including lower power consumption, longer lifespan, and greater durability. Here are some more details about LEDs:

Types of LEDs: There are different types of LEDs available, including through-hole LEDs, surface-mount LEDs, and high-power LEDs. Each type has its own advantages and disadvantages. **.**(shown in figure 3.10).

Color: LEDs are available in different colors, including red, green, blue, yellow, and white. The color of an LED depends on the materials used to construct it and the amount of current that is passed through it.

Brightness: The brightness of an LED is measured in lumens and depends on the amount of current that is passed through it. High-power LEDs can produce up to several thousand lumens.

Applications: LEDs are used in a wide range of applications, including lighting, displays, automotive lighting, and backlighting for LCD screens.

Power consumption: LEDs consume much less power than traditional

light sources, making them ideal for battery-powered devices and applications where power consumption is a concern.

Lifespan: LEDs have a much longer lifespan than traditional light sources, with some LEDs lasting up to 50,000 hours or more.

Advantages: Some advantages of using LEDs include their energy efficiency, long lifespan, low heat output, and durability.

Figure 3.10 LED

Overall, LEDs are an important component in many electronic systems, and their energy efficiency, long lifespan, and low heat output make them ideal for a wide range of applications.

3.3.2. SOFTWARE COMPONENTS

1. UBIDOTS SOFTWARE:

Ubidots is a cloud-based IoT platform that offers a range of tools and services for collecting, storing, and visualizing data from connected devices. It is designed to help businesses and developers easily connect, manage, and analyze IoT data, and supports a wide range of devices and protocols.

One of the key advantages of Ubidots is its ease of use. It provides a user-friendly interface that enables users to quickly and easily set up and manage their IoT deployments. Additionally, Ubidots offers a range of tutorials, documentation, and sample code to help users get started with IoT development and quickly build and test their applications.

Another advantage of Ubidots is its flexibility and scalability. Users can start with a small deployment and easily expand their IoT deployments as needed. Ubidots provides a range of pricing plans to fit different business needs, and offers a pay-as-you-go model that allows users to only pay for the services they use.

Ubidots also provides robust security features to ensure the privacy and security of user data. It uses SSL encryption to protect data in transit, and provides two-factor authentication to prevent unauthorized access. Additionally, Ubidots provides a range of data privacy options to ensure that user data is only shared with authorized parties.

Overall, Ubidots is a powerful and comprehensive IoT platform that provides businesses and developers with the tools and services they need to easily connect, manage, and analyze their IoT data. With its ease of use, flexibility, scalability, and security features, Ubidots is a great choice for businesses looking to build and deploy IoT solutions.

Advantages of Ubidots for IoT Development and Deployment:

Ubidots is a cloud-based IoT platform that offers a range of advantages for businesses and developers looking to build and deploy IoT solutions. Here are some of the key advantages of Ubidots:

Ease of Use: Ubidots provides a user-friendly interface that makes it easy for users to set up and manage their IoT deployments. It also provides a range of tutorials, documentation, and sample code to help users get started with IoT development. **.**(shown in figure 3.11).

Flexibility and Scalability: Ubidots is designed to be flexible and scalable, allowing users to start with a small deployment and easily expand as needed. Ubidots provides a range of pricing plans to fit different business needs, and offers a pay-as-you-go model that

allows users to only pay for the services they.

Figure 3.11 Ubidots

Security: Ubidots provides robust security features to ensure the privacy and security of user data. It uses SSL encryption to protect data in transit, and provides two-factor authentication to prevent unauthorized access. Additionally, Ubidots provides a range of data privacy options to ensure that user data is only shared with authorized parties.

Integration: Ubidots supports a wide range of devices and protocols, making it easy to integrate with other software and applications. Ubidots also provides a RESTful API, making it easy for developers to integrate Ubidots with their own applications.

Customization: Ubidots enables users to easily create custom dashboards and visualizations for their IoT data. This makes it easy for users to monitor and analyze their data in real-time, and to quickly identify and respond to issues.

Overall, Ubidots is a powerful and comprehensive IoT platform that provides businesses and developers with the tools and services they need to easily connect, manage, and analyze their IoT data. With its ease of use, flexibility, scalability, security, integration,

and customization features, Ubidots is a great choice for businesses looking to build and deploy IoT solutions.

2. ARDUINO IDE:

The Arduino Integrated Development Environment (IDE) is a software application used to write and upload code to Arduino microcontrollers. It provides a simple and user-friendly interface for writing code in a programming language that is similar to C++. In this article, we will explore the Arduino IDE in detail and discuss its various features and capabilities.

Overview

The Arduino IDE is an open-source application that can be downloaded and installed on a variety of platforms, including Windows, macOS, and Linux. It includes a code editor, a compiler, and a bootloader that allows the code to be uploaded to the microcontroller via a USB cable. The IDE also provides a serial monitor that allows the microcontroller to communicate with the computer.

Code Editor

The code editor in the Arduino IDE is a simple and easy-to-use tool for writing and editing code. It includes features such as syntax highlighting, auto-indentation, and auto-completion, which make writing code faster and more efficient. The editor also includes a toolbar with buttons for common actions, such as compiling and

uploading code.

Compiler

The compiler in the Arduino IDE is responsible for converting the code written in the editor into machine code that can be executed by the microcontroller. The compiler checks the syntax of the code and generates error messages if there are any issues. The IDE also includes a feature called "Verify" that checks the code for errors without uploading it to the microcontroller.

Uploader

The uploader in the Arduino IDE is used to upload the compiled code to the microcontroller. The IDE includes a feature called "Upload" that automatically compiles and uploads the code to the microcontroller via a USB cable. The uploader also includes features such as "Burn Bootloader," which is used to install a new bootloader on the microcontroller.

Libraries

The Arduino IDE includes a library manager that allows developers to easily download and install libraries. Libraries are pre-written code that can be used to interact with sensors, actuators, and other components. The IDE includes a set of standard libraries, but additional libraries can be downloaded from the internet.

Serial Monitor

The serial monitor in the Arduino IDE is used to communicate with the microcontroller. It allows developers to send and receive data from the microcontroller, which is useful for debugging and testing. The serial monitor also includes features such as line ending options and baud rate settings.

Debugging

The Arduino IDE does not include a traditional debugger, but it does include a feature called "Serial print," which can be used for debugging. This feature allows developers to print debug information to the serial monitor, which can help identify issues in the code.

Advantages

The Arduino IDE is an easy-to-use tool that allows developers to quickly write and upload code to Arduino microcontrollers. Its simplicity and user-friendly interface make it an ideal platform for hobbyists and professionals alike to create innovative projects and solutions. Additionally, the IDE includes a large community of users and developers, which provides access to a wealth of resources and support**.(**shown in figure 3.12).

Figure 3.12 Arduino IDE

In conclusion, the Arduino IDE is a powerful and flexible tool that makes it easy to develop applications for Arduino microcontrollers. It’s simple and user-friendly interface, combined with a wide range of features and capabilities, make it an ideal platform for a wide range of applications. Whether you're a hobbyist or a professional developer, the Arduino IDE provides a great starting point for your next project.

CHAPTER 4

RESULT AND IMPLEMENTATION

4.1 WORKING OF SUBSYSTEMS

This chapter gives a brief discussion about the result obtained from the developed system. The IoT-based portable hot and cold smart decanter using the thermoelectric effect is a complex system that consists of several subsystems working together to achieve the desired functionality.

Some of the major subsystems of the smart decanter include:

1. Thermoelectric module subsystem:

This subsystem includes the thermoelectric module, a heatsink, and a fan. The thermoelectric module is responsible for cooling or heating the liquid in the decanter based on the temperature readings from the temperature sensor. The heatsink dissipates the heat generated by the thermoelectric module, while the fan ensures that there is adequate air flow for efficient cooling and heating.

2. **Microcontroller subsystem**:

The microcontroller subsystem consists of an Arduino microcontroller board, which receives temperature readings from the DS18B20 temperature sensor and sends control signals

to the thermoelectric module through the relay module. The microcontroller also controls the LCD display and the Bluetooth module, which enables remote control of the smart decanter through a mobile application.

3. Power supply subsystem:

The power supply subsystem provides the necessary power for the various components of the smart decanter to function. It consists of a DC 12V 10A power supply unit that powers the thermoelectric module, the fan, and the microcontroller.

4. User interface subsystem:

The user interface subsystem includes an LCD display and a buzzer. The LCD display shows the current temperature of the liquid in the decanter, while the buzzer provides an audible alert when the desired temperature has been reached.

5. Bluetooth module subsystem:

This subsystem includes the HC-05 Bluetooth module, which enables remote control of the smart decanter through a mobile application. The Bluetooth module receives commands from the mobile application and sends control signals to the microcontroller board.

In summary, the IoT-based portable hot and cold smart decanter using the thermoelectric effect consists of several subsystems working together to provide efficient and accurate temperature control of the liquid in the decanter. The integration of advanced technology and IoT connectivity enables users to remotely control and monitor the smart decanter, making it a versatile and valuable addition to any setting where temperature-controlled beverage dispensing is required.

4.2 BLOCK DIAGRAM

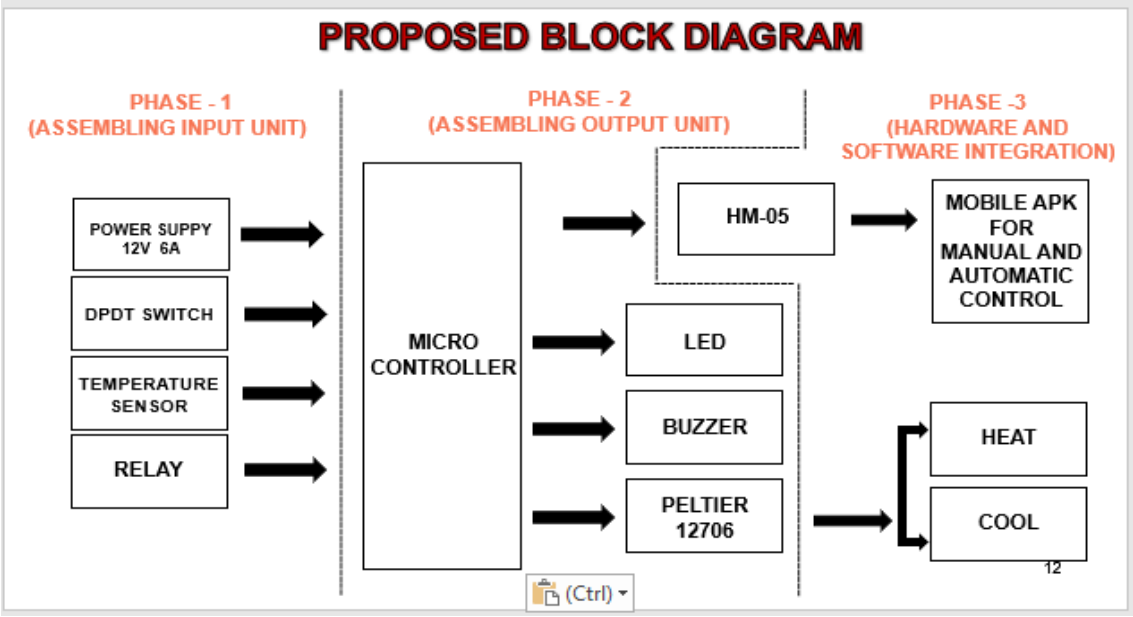


Figure 4.1 Proposed block diagram

4.3 HARDWARE WORKING

The hardware of the IoT-based portable hot and cold smart decanter consists of several key components that work together to achieve the

desired functionality.

Firstly, the power supply unit provides a 12V DC input to the system, which is used to power the various components. The 12V DC input is regulated using a voltage regulator to ensure stable power supply to the entire system.

The thermoelectric module is used to generate hot and cold temperatures as required. The module consists of two sides, one that gets hot and the other that gets cold when a voltage is applied. The hot side is connected to the decanter's heating element, and the cold side is connected to the cooling element. The temperature generated by the thermoelectric module is regulated using a temperature sensor.

The microcontroller receives temperature readings from the temperature sensor and then decides whether to activate the thermoelectric module to heat or cool the decanter. The microcontroller also controls the LCD display, Bluetooth module, and other components of the system.

The LCD display is used to show the current temperature of the decanter and the temperature setpoints. The display also shows the status of the system and any error messages.

The Bluetooth module enables communication between the decanter and a smartphone app. The smartphone app can be used to control the temperature of the decanter remotely and also monitor its status.

The relay and the DPDT switch are used to switch between heating and cooling modes. When the switch is turned on, the relay is activated, and the system starts heating the decanter. When the switch is turned off, the system switches to cooling mode, and the relay is deactivated.

The buzzer and LED are used to provide audio and visual alerts when the decanter's temperature is beyond the setpoint or when there is a system error. The buzzer beeps, and the LED blinks to notify the user of the error.

Overall, the hardware subsystems work together to create a functional IoT-based portable hot and cold smart decanter that can be controlled remotely using a smartphone app.

4.4 SOFTWARE WORKING

The software for the IoT based smart decanter can be divided into two main components: the code for the microcontroller and the code for the mobile application.

The microcontroller code is written using the Arduino Integrated Development Environment (IDE) and is responsible for reading the temperature sensor data, controlling the thermoelectric module, and communicating with the mobile application using the Bluetooth module. The code initializes the pins for the temperature sensor, thermoelectric module, and Bluetooth module, and sets the initial temperature and mode values.

The main loop of the code constantly reads the temperature sensor data and compares it to the target temperature for either the hot or cold mode. If the current temperature is lower than the target temperature for the hot mode, the thermoelectric module is turned on to heat up the liquid. If the current temperature is higher than the target temperature for the cold mode, the thermoelectric module is turned on to cool down the liquid. The LCD display is updated with the current temperature and mode information.

The mobile application is developed using the Ubidots platform and is responsible for displaying the temperature data and allowing the user to control the temperature mode remotely. The application is connected to the microcontroller through the Bluetooth module and receives temperature data and mode information. The application also sends commands to the microcontroller to change the temperature mode.

The application interface is designed to display the current temperature in a graphical format and allows the user to select the desired temperature mode. The user can switch between the hot and cold modes by clicking the respective buttons on the application. When the mode is changed, the application sends a command to the microcontroller to update the mode value and adjust the thermoelectric module operation.

In summary, the software components of the IoT based smart decanter work together to provide real-time temperature monitoring and control, allowing the user to enjoy their hot or cold beverage at

the desired temperature.

4.5 ARDUINO CODE

```
const int LM35_PIN = A0;
#include <LiquidCrystal.h>
// initialize one wire bus and temperature sensor objects
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
// define relay pins
#define RELAY_PIN_1 9
#define RELAY_PIN_2 10
// define buzzer and LED pins
#define BUZZER_PIN 6
#define LED_PIN 7
#define LED1_PIN 8
void setup() {
  // initialize serial communication
  lcd.begin(16, 2);
  // initialize relay pins as outputs
  pinMode(RELAY_PIN_1, OUTPUT);
  pinMode(RELAY_PIN_2, OUTPUT);
  // initialize buzzer and LED pins as outputs
  pinMode(BUZZER_PIN, OUTPUT);
  pinMode(LED_PIN, OUTPUT);
  pinMode(LED1_PIN, OUTPUT);
```

```
}
  void loop() {
  int reading = analogRead(LM35_PIN); // Read analog value from
LM35 sensor
  float temperature = (reading * 5.0 / 1024.0) * 100.0; // Convert
analog value to    temperature in Celsius
  // print temperature to serial monitor
  lcd.setCursor(0, 0);
  lcd.print("Temp: ");
  lcd.print(temperature);
  lcd.print(" C");
   digitalWrite(RELAY_PIN_1, HIGH);
   digitalWrite(RELAY_PIN_2, HIGH);
   digitalWrite(LED_PIN, HIGH);
  // check temperature threshold and control relays, buzzer, and LED
accordingly
  if (temperature >= 50) {
    // turn off relay 1 and turn on buzzer and LED
    digitalWrite(RELAY_PIN_1, LOW);
    digitalWrite(LED_PIN,LOW);
    digitalWrite(LED1_PIN,HIGH);
     // Turn off the relay
    tone(BUZZER_PIN,HIGH);
    delay(3000);
    noTone(BUZZER_PIN);
```

```
  delay(2000);
  digitalWrite(LED1_PIN,LOW);
  // exit loop
  while (true) {
    delay(1000);
  }
} else if (temperature <= 20) {
  // turn off relay 2 and turn on buzzer and LED
  digitalWrite(RELAY_PIN_2, LOW);
  digitalWrite(LED_PIN, LOW);
  digitalWrite(LED1_PIN, HIGH);
// Turn off the relay
  tone(BUZZER_PIN,HIGH);
  delay(3000);
  noTone(BUZZER_PIN);
  delay(2000);
  digitalWrite(LED1_PIN,LOW);
  // exit loop
  while (true) {
    delay(1000);
  }
} else {
  // turn off buzzer and LED
  digitalWrite(BUZZER_PIN, LOW);
```

```
    digitalWrite(LED1_PIN, LOW);
  }
  // delay before next temperature reading
  delay(5000);
}
```

4.5.1 WORKING PROCESS OF ARDUINO CODE :

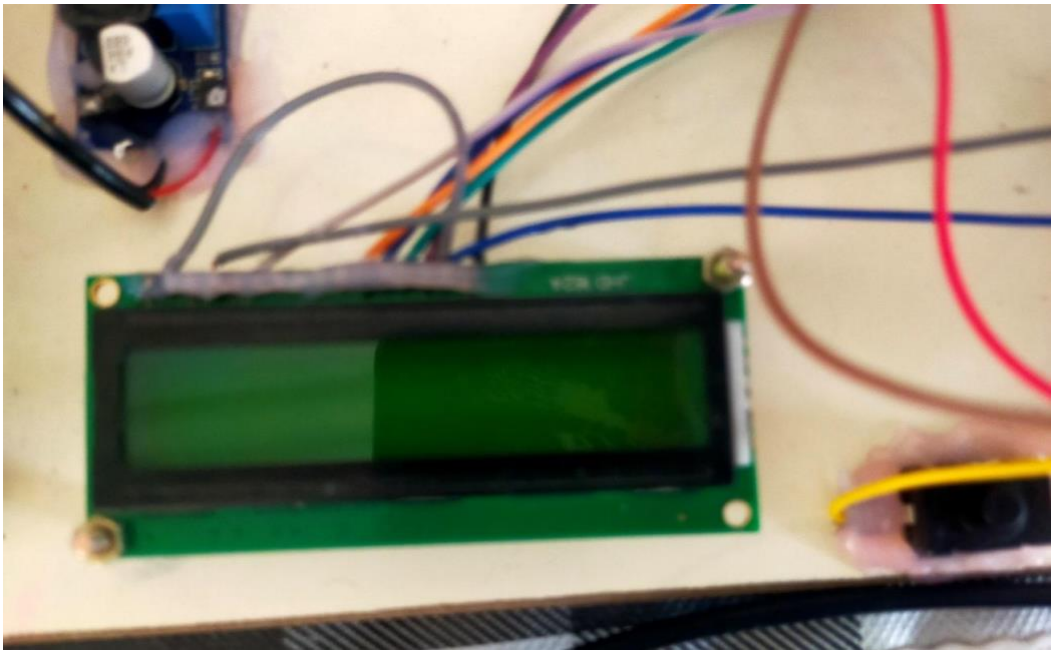
This Arduino code is designed to read the temperature from an LM35 temperature sensor and control a relay, buzzer, and LED based on temperature thresholds.

The setup function initializes the communication with the LCD and sets the relay, buzzer, and LED pins as outputs. The loop function reads the temperature value from the LM35 sensor and converts it into Celsius. The temperature value is then displayed on the LCD.

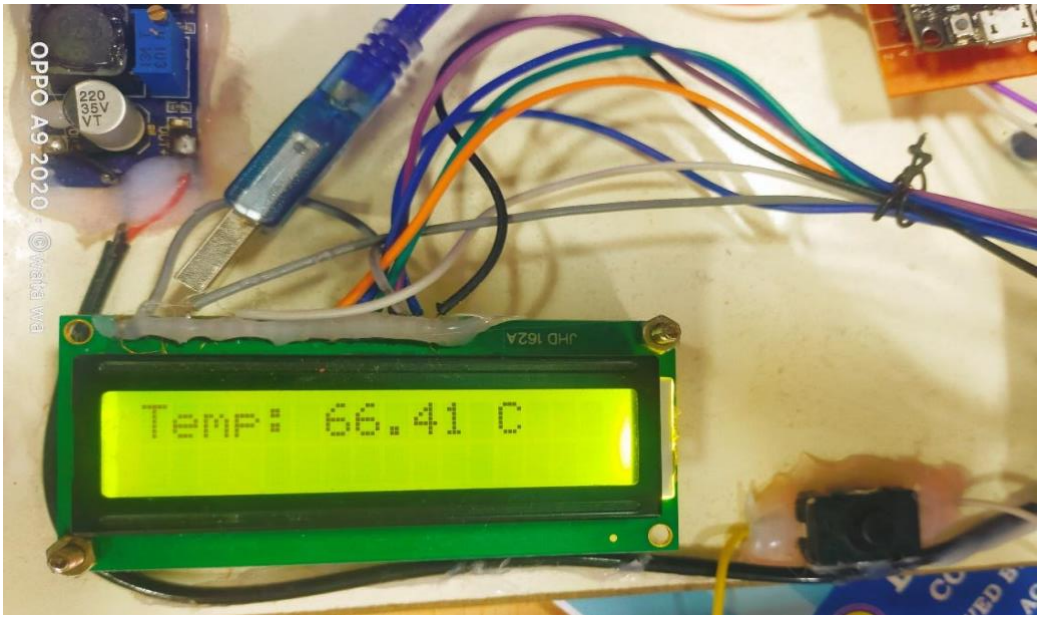
The code checks for temperature thresholds and controls the relays, buzzer, and LED accordingly. If the temperature is greater than or equal to 50 degrees Celsius, it turns off relay 1 and turns on the LED and buzzer. It also plays a tone on the buzzer for three seconds, waits for two seconds, and then turns off the LED. The loop is then exited. Similarly, if the temperature is less than or equal to 20 degrees Celsius, it turns off relay 2 and turns on the LED and buzzer. It also plays a tone on the buzzer for three seconds, waits for two seconds, and then turns off the LED. The loop is then exited. If the temperature is between 20 and 50 degrees Celsius, it turns off the buzzer and LED.

Finally, the delay function is used to wait for five seconds before taking the next temperature reading.

4.6 OUTPUT FROM LCD DISPLAY

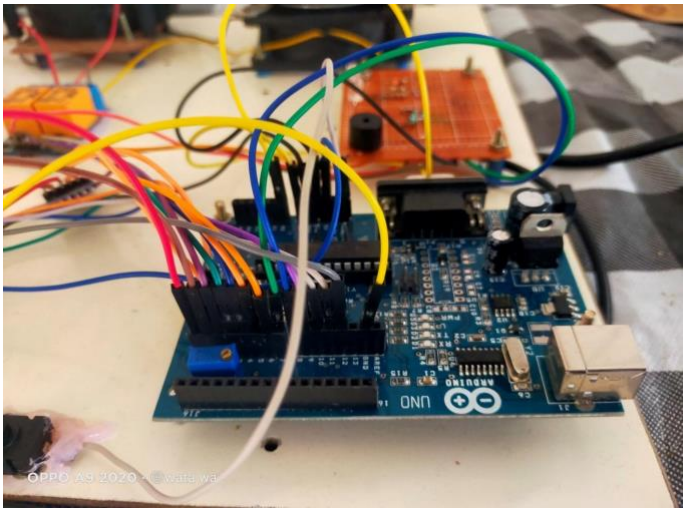


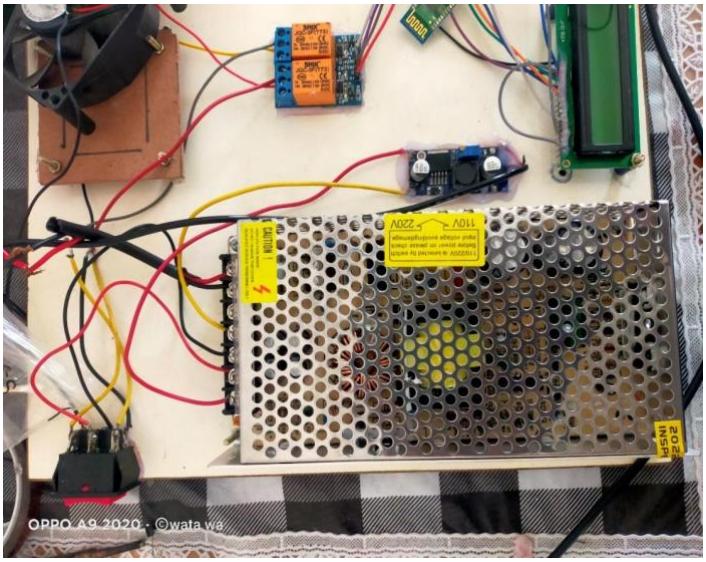
BEFORE



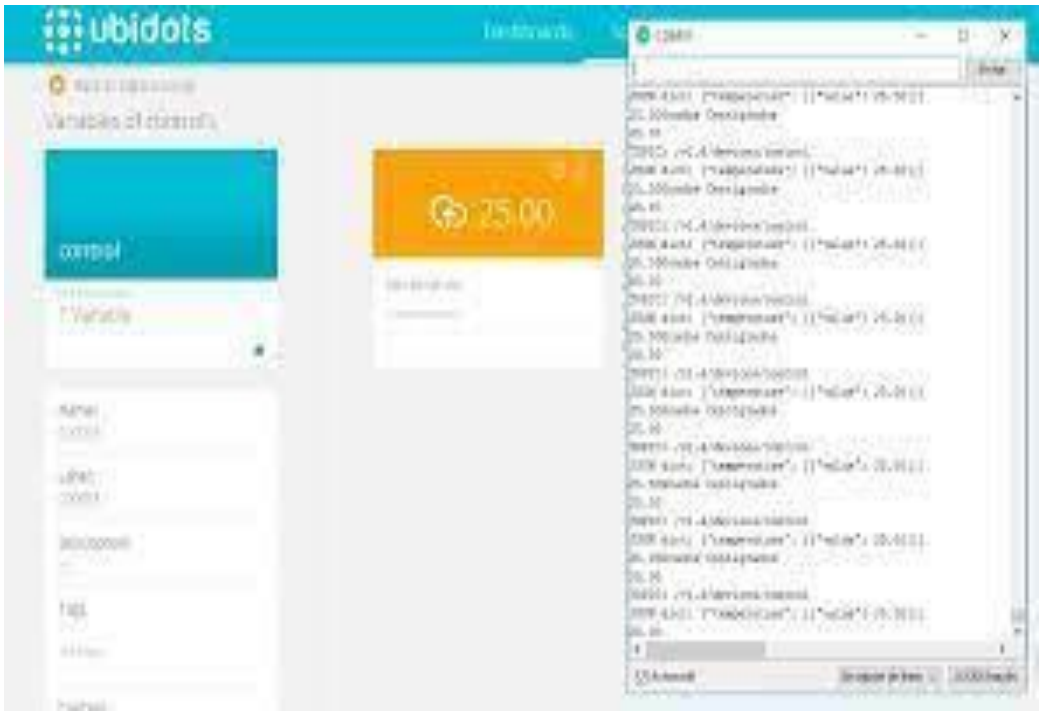
AFTER

4.7 IMAGE OF ALL COMPONENTS

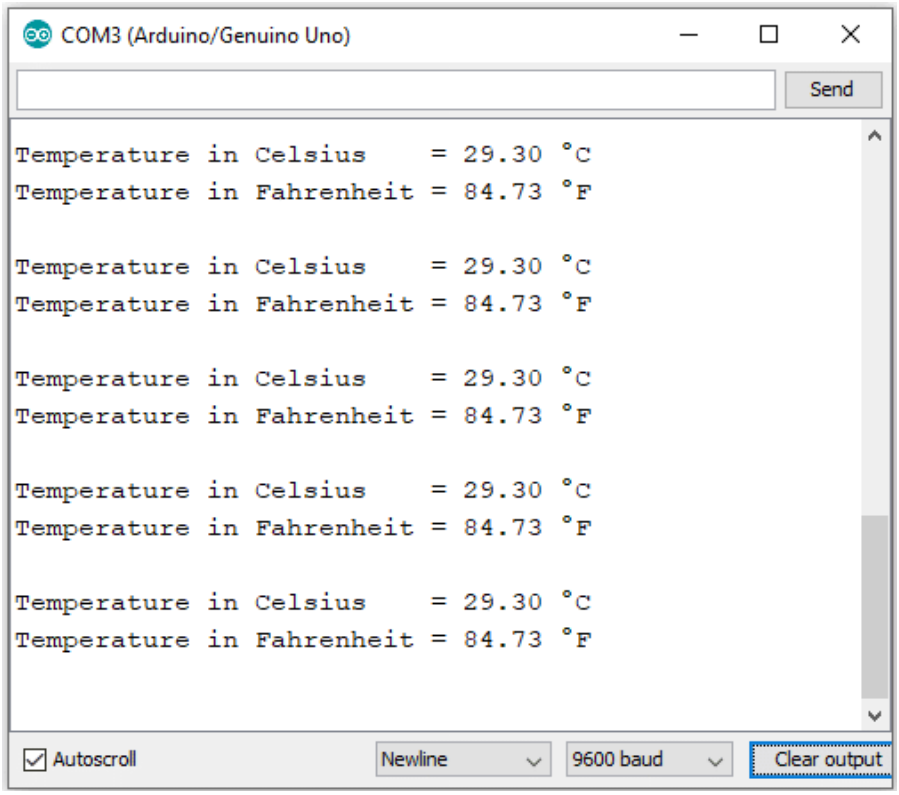




4.8 OUTPUT FROM ARDUNIO AND UBIDOTS

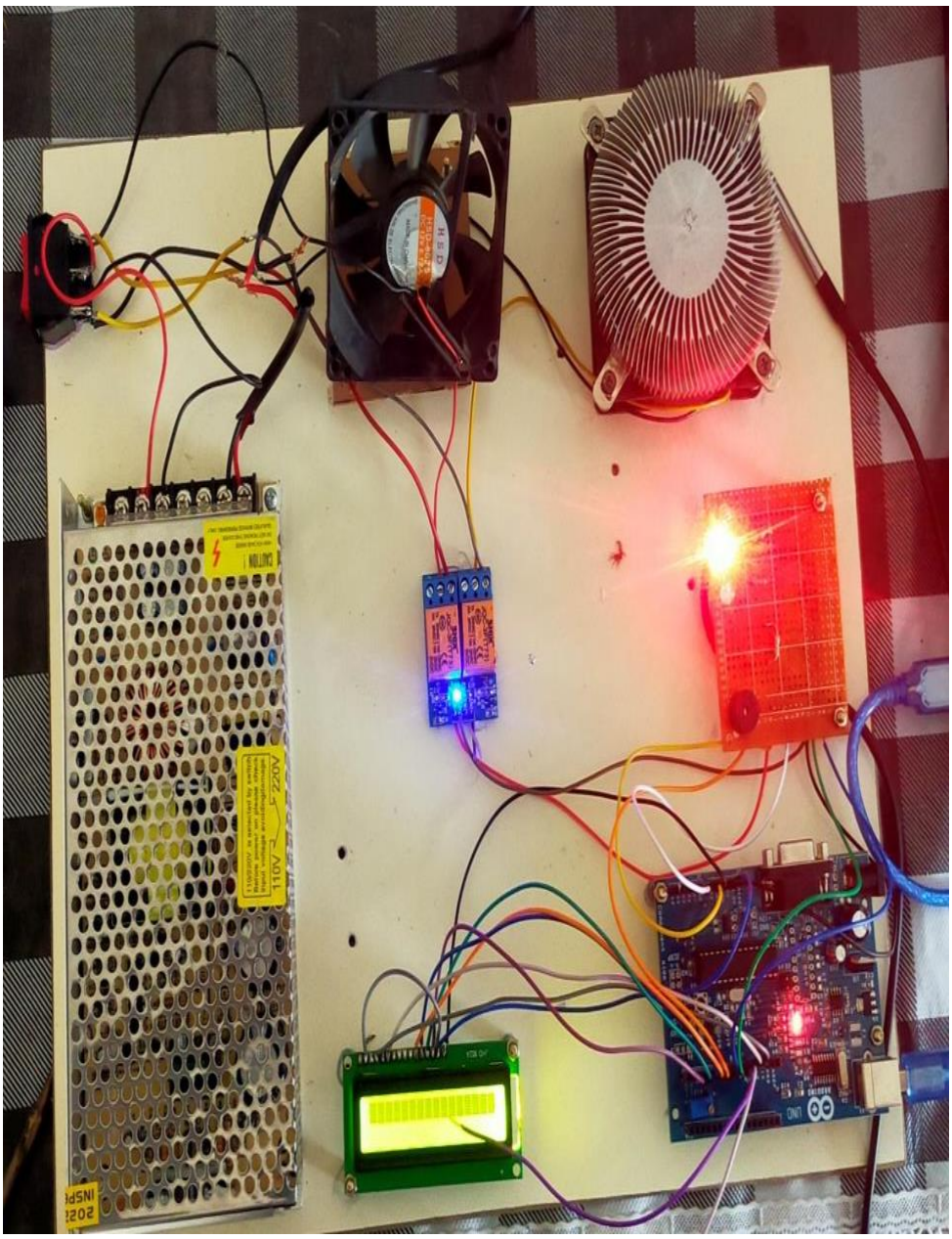


UBIDOTS



ARDUNIO IDE

4.9 OVERALL PERFORMANCE



OVERALL PROTOTYPE

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1 CONCLUSION

In conclusion, the IoT-based portable hot and cold smart decanter using the thermoelectric effect is a practical and efficient solution for temperature-controlled beverage dispensing. By utilizing the thermoelectric effect and IoT technology, the smart decanter provides accurate temperature control and easy access to temperature data, allowing users to adjust the temperature of their beverage to their liking.

The proposed system uses a thermoelectric module for temperature control and a microcontroller to interface with the various components of the system. The system also includes a temperature sensor, Bluetooth module, LCD display, and other components such as a relay, LED, and buzzer to provide additional functionality.

One of the key advantages of the proposed system is its portability. The decanter can be easily moved from one location to another, making it ideal for use in a variety of settings such as offices, homes, and events. Additionally, the use of IoT technology enables remote monitoring and control of the decanter, making it even more convenient for users.

Overall, the IoT-based portable hot and cold smart decanter using the thermoelectric effect is a promising solution for

temperature-controlled beverage dispensing. With its advanced technology, portability, and ease of use, it has the potential to become a popular choice for beverage lovers everywhere.

5.2 FUTURE SCOPE

The IoT-based portable hot and cold smart decanter using the thermoelectric effect is a project with immense potential for future development and improvement. Some of the potential future scope for this project include:

Integration with voice assistants: The smart decanter can be integrated with voice assistants such as Amazon Alexa or Google Assistant, allowing users to control the temperature of their beverage through voice commands.

Enhanced user interface: The LCD display on the smart decanter can be replaced with a touch screen display, providing users with a more interactive and intuitive interface.

Integration with mobile applications: A mobile application can be developed to control and monitor the smart decanter, making it even more convenient for users.

Use of machine learning algorithms: Machine learning algorithms can be integrated into the smart decanter to predict user preferences and adjust the temperature accordingly.

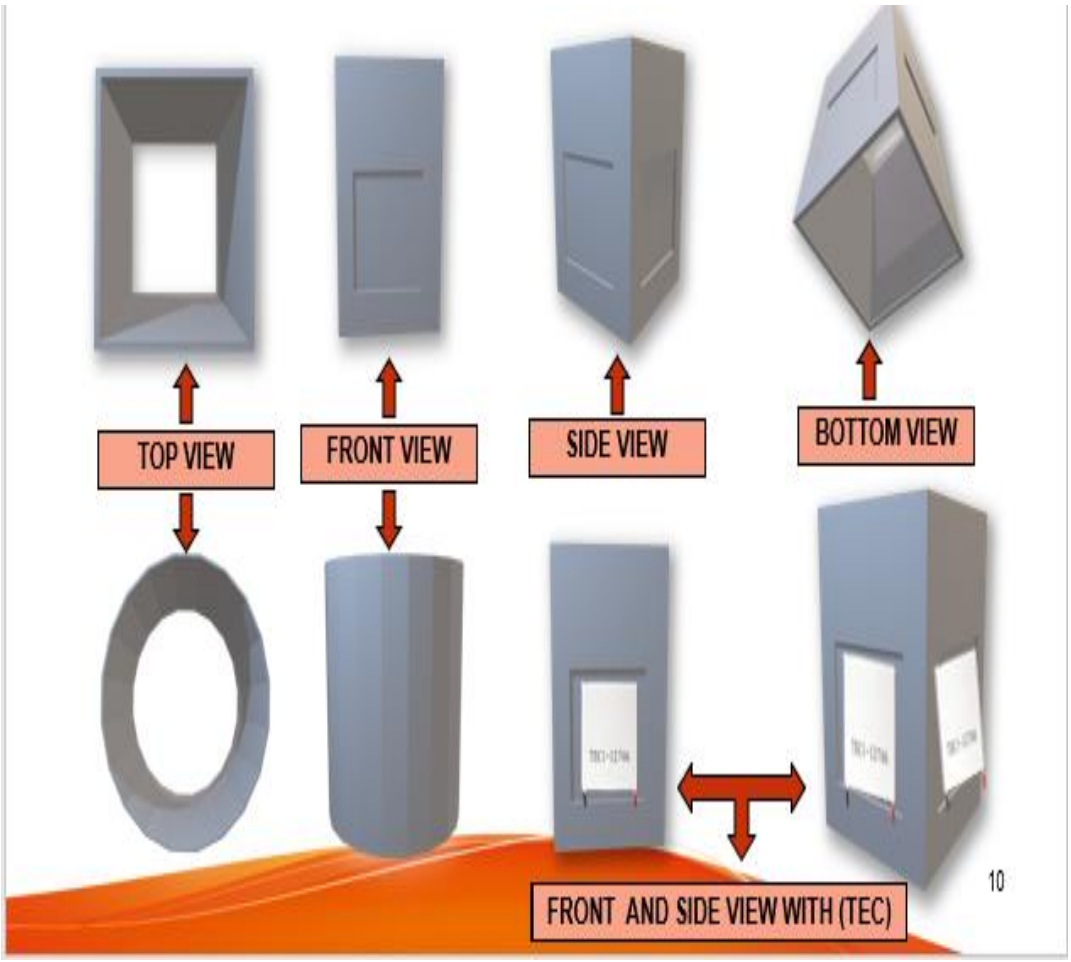
Incorporation of additional sensors: Other sensors such as pH

sensors, pressure sensors, and flow sensors can be integrated into the smart decanter to provide additional functionality and data.

Use of solar power: The smart decanter can be designed to operate using solar power, making it eco-friendlier and more cost-effective.

In summary, the IoT-based portable hot and cold smart decanter using the thermoelectric effect is a project with a wide range of potential future applications and developments. The use of advanced technology and IoT connectivity offers numerous possibilities for enhancing the functionality and usability of the smart decanter, making it a versatile and valuable addition to any setting where temperature-controlled beverage dispensing is required.

5.2.1 FUTURE PRODUCT DESIGN



REFERENCE

[1] Najmie, M. S., and M. K. Fadzly. "Thermoelectric portable water cooler using Arduino Uno." In *AIP Conference Proceedings*, vol. 2129, no. 1, p. 020147. AIP Publishing LLC, 2019.

[2] Alsaif, Hussain F., and Mohammed A. Almaghrabi. "Smart Travel Mug for Hot and Cold Beverages." In *ASME International Mechanical Engineering Congress and Exposition*, vol. 58493, p. V014T07A015. American Society of Mechanical Engineers, 2017.

[3] Patil, Rajendra P., Pradhyumna Suryawanshi, Akshay Pawar, and Avdhoot Pawar. "INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY THERMOELECTRIC REFRIGERATION USING PELTIER EFFECT.“

[4] Attavane, Pavan, G. B. Arjun, Rajath Radhakrishna, and Santhosh Rao Jadav. "Solar powered portable food warmer and cooler based on peltier effect." In *2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, pp. 1975-1978. IEEE, 2017.