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DESIGN AND DEVELOPMENT OF ARDUINO BASED COLD CONTAINER

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ABSTARCT:

A cold container is a container made for maintaining a constant low temperature while holding perishable goods like food, medication, or vaccinations. They are a crucial instrument for maintaining perishable goods and guaranteeing the quality and safety of the contents kept inside. In this project, a cold container that can be used to store perishable foods is being designed. This container is made to keep the temperature consistently low, preventing spoiling and extending the shelf life of the stored goods. A temperature sensor that is attached to the Arduino microcontroller is used to keep track of the temperature**.** The microprocessor reads the temperature, compares it to a set point, or the box's preferred temperature, and modifies the container's temperature as necessary. Applications for the cold container and temperature control system include households, hospitals, and isolated places with intermittent electrical supplies. With the use of an Arduino microcontroller, it offers a practical and affordable solution for preserving perishable goods, and is simple to operate and maintain.

Keywords: Cold container, Arduino,Temperature and Humidity sensor

1. INTRODUCTION

A cold storage box is a container designed to store perishable items, such as food, medicine, or vaccines, at a consistent low temperature. It's commonly used in homes, commercial kitchens, medical facilities, and in transportation to keep goods fresh and preventspoilage.

Cold storage boxes can range in size from small portable units to large walk-in freezers. They are an essential tool for preserving perishable goods and ensuring the safety and quality of the items stored inside.

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The goal of the cold storage container is to ensure that the products are kept within a specific temperature range throughout their journey from the start to end.

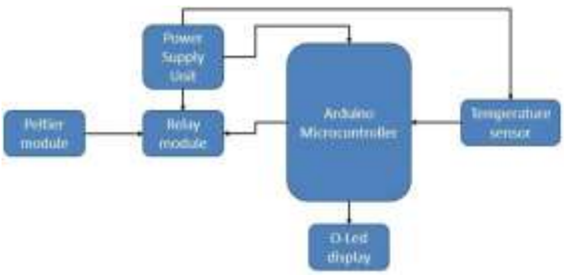
This paper comprises of 5 sections. Section two provides Design. Section three Implementation. Section four Results anddiscussion. Section five Conclusion.

2. DESIGN

2.1 Block Diagram

The temperature control and monitoring system consists of interconnected components, including a Peltier module connected to a relay module. The Peltier module utilizes thermoelectric cooling to transfer heat and achieve precise temperature adjustments. A

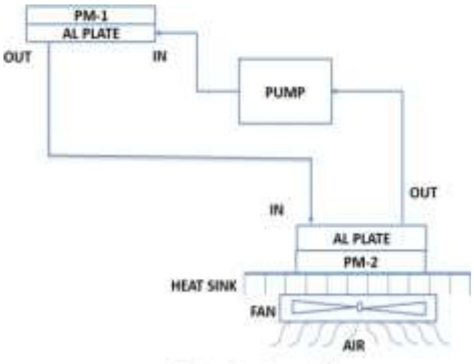
power supply unit ensures a stable and reliablepower source for the system's operation.



An Arduino microcontroller acts as the central control unit, receiving temperature inputs from a sensor placed within the container. The microcontroller uses this data to make informed decisions based on the desired temperature range and adjusts the system accordingly. It effectively controls the relay module, which functions as a switch to regulate the power supply to the Peltier module. Additionally, the Arduino microcontroller can be connected to an O-Led display, providing a visual interface for real-time temperature readings and relevant information, allowing for easy monitoring of the temperature and system performance.

2.2 Peltier Design

The design and development of an Arduino-based Peltier module involves integrating the Peltier device with an Arduino microcontroller for controlled cooling or heating. The hardware setup includes connecting the Peltier module to the Arduino, incorporating a heat sink and fan for efficient heat dissipation. Software programming enables temperature monitoring using sensors and regulates the electrical current to the Peltier module based on the desired temperature.



Design of peltier modules

Design modifications were made to enhance cooling efficiency and prevent heat damage. Two Peltier modules are used instead of one, addressing previous drawbacks. A DC pump facilitates heat transfer from Peltier Module 1 to Peltier Module 2 through water. The heat is then removed through a heat sink, resulting in simultaneous cooling of Peltier Module These modifications optimize cooling performance within the system.

The integration of hardware connections and software programming enables the Arduino-based Peltier module system to accurately maintain the desired temperature. This versatile system can be applied to various cooling or heating applications, providing precise temperature control and efficient cooling capabilities.

3. IMPLEMENTATI

ONHardware Setup:

• The Peltier-based freezer consists of a Peltier module, heat sink, and fan for temperature regulation. The microcontroller (e.g., Arduino) is used to control the freezer's operations.

• Temperature sensors (e.g., DTH11 temperature and humidity sensor) are placed inside the freezer to measure the temperature and humidity.

• A relay module is connected to the microcontroller, and the Peltier module is connected to the relay.

Initialization:

• The microcontroller initializes the necessary libraries, pins, and communication interfaces. The temperature sensors are configured to readthe temperature data.

Temperature Monitoring:

• The microcontroller continuously reads the temperature from the sensors. The temperature readings are used to determine the freezer'soperation.

Control Logic:

• If the temperature exceeds the upper threshold (e.g., 8°C), indicating it's too warm. The microcontroller triggers the relay to turn onthe Peltier module.

• The Peltier module starts cooling the freezer by absorbing heat from the inside and releasing it to the heat sink. The fan may also be activated to enhance heat dissipation from the heat sink.

• If the temperature drops below the lower threshold (e.g., 0°C), indicating it's too cold: The microcontroller triggers the relay to turn off the Peltier module.

• The Peltier module stops cooling, allowing the freezer to warm up naturally.

Feedback and Monitoring:

• The microcontroller can provide real-time feedback on the freezer's status, such as the current temperature and operational state.

• The status can be displayed on an LCD screen or transmitted through a communication interface (e.g., serial communication, IoTprotocols).

Iteration:

• The temperature monitoring and control process is repeated in a loop, ensuring continuous regulation of the freezer's temperature.

4. RESULTS AND DISCUSSION

The Arduino-based cold container effectively maintains a temperature using an Arduino microcontroller, DTH11 temperature sensor, and Peltier module. Insulation materials like expanded polystyrene and aluminium foil are utilized for prolonged temperature maintenance.

Front view

Back view

Internal view

It has been tested successfully to maintain temperatures within the range of 0 degrees to 8 degrees. The portable design and reduced power consumption address previous limitations, while the Arduino-based system offers control flexibility and customization options for different applications and the addition of extra sensors or components as required. Also the cold container reaches in between 6 to 8 degrees in 1min and takes 1hr approx. to reach 0 degrees Celsius.

Cold container reaching 0 degrees in 1hr

Cold container reaching 6-8 degrees in 2mins

Specifications:

Capacity	1 and a half litres
Inner dimensions	14.5cm X 11.5cm X 26.5cm
Outer dimensions	25.5cm X 18.5cm X 55cm
Body	Polystyrene
Carrier weight	950grams
Temperature	Between 0 to 8 degrees C
Time taken	i. 2mins to reach 6-8 degrees C ii. 1hr to reach 1 degrees C
Battery	3hours to 5 hours
Sensors	DTH11 Temperature and Humidity sensor

5. CONCLUSION

In Conclusion, the cold container system offers an automated and effective solution for temperature regulation with the integration of a microcontroller, temperature sensors, a relay module, and a Peltier module. The system enables continuous monitoring and control of the container's temperature. It ensures the temperature remains within the desired range of 0 to 8 degrees Celsius. It enters the range of 6 to 8 degrees within 2minutes and takes 1hour to reach 0 degrees. Previous limitations have been addressed by optimizing the heat dissipation of the Peltier modules, managing power consumption, and enhancing portability with a battery backup of 3 to 5 hours. The lightweight and customizable design makes it suitable for various applications.

Hence, this project protocol and control logic create a reliable and efficient system for temperature regulation in the cold container, maintaining optimal conditions for the storage of perishable items.

6. PERMITTED APPLICATIONS

- **Pharmaceuticals Industry:** The pharmaceuticals industry also requires the storage and transportation of temperature- sensitive items, such as vaccines and medicines between 0 to 8°C, etc.
- **Agriculture:** To avoid spoiling and preserve quality crops must be maintained at low temperatures like Vegetable below 4°C and flowers between 0 to 1°C, etc.
- **Food Industry:** To maintain quality and safety, temperature-sensitive foods must be stored and transported at precise temperatures including fresh fruits and vegetables below 4°C, and dairy goods at 1 to 3°C, etc.
- **Research and Development**: In research and development labs, cold containers can be utilized to transport and preserve delicate goods, including biological samples or chemical reagents, in the best possible condition.

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