Mini Portable Refrigerator for Vaccines and Medicines

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Abstract: **The present cooling refrigerators in the markets do fulfill one need for keeping their vaccines and insulins at the preferred temperature but one of the major disadvantages of a mini refrigerator is that it needs to be plugged in every time it needs to be used. This problem can be overcome by making a portable mini refrigerator. We can accomplish this with the help of the Peltier effect, Thermoelectric cooling. A portable mini refrigerator that anyone can carry anywhere without thinking about electricity. This mini fridge refrigerator is specifically designed for storing vaccines and medicines at the recommended temperature range of 2-8°C. With a compact size and portable design, it is ideal for use in clinics, pharmacies, and other healthcare facilities with limited space. The fridge features advanced temperature control technology and a digital display for easy monitoring and adjustment. It also has a reliable power supply system, with both AC and DC power options, to ensure continuous operation even during power outages. Overall, this mini fridge refrigerator provides a convenient and effective solution for the safe and reliable storage of vaccines and medicines.**

Keywords: **Arduino coding, DHT 11 temperature sensor, L293D motor driver, Peltier effect, Seebeck effect.**

INTRODUCTION

Refrigeration is the process of removing heat from a space, substance, or system to lower and maintain its temperature below the surrounding environment. Our project, 'Mini Portable Refrigerator for Vaccines and Medicines' aims to provide cooling by using the Peltier plate based on the Peltier effect.

Peltier devices function as cooling components in microprocessors, blood analyzers, and portable coolers.

In this project, we aim to develop a Mini Fridge Refrigerator for Vaccines and Medicines. The importance of maintaining the proper storage conditions of vaccines and medicines cannot be overstated. Vaccines and medicines are highly sensitive to temperature and humidity changes, which can render them ineffective and unusable. Hence, there is a pressing need to ensure that vaccines and medicines are stored in an appropriate environment to maintain their efficacy and safety.

This project proposes a solution that can provide reliable and effective storage for vaccines and medicines. The Mini Fridge Refrigerator will be designed to maintain the required temperature and humidity levels to prevent spoilage and degradation of the vaccines and medicines. This device can be an effective tool for healthcare professionals in remote areas or low-resource settings, where access to conventional refrigerators may be limited.

The Mini Fridge Refrigerator will be designed to be portable, lightweight, and user-friendly. The device will be equipped with advanced features, including temperature and humidity sensors, an adjustable thermostat, and a digital display for easy monitoring. This project aims to develop a cost-effective and sustainable solution that can benefit healthcare professionals and patients globally.

Overall, the Mini Fridge Refrigerator for Vaccines and Medicines project is a crucial step towards ensuring the safe and effective storage of vaccines and medicines, especially in areas where access to modern healthcare facilities is limited.

1.1 The Peltier Effect: The Peltier effect is a thermoelectric principle that occurs when electrons flow through the collection of two dissimilar conductive substances, resulting in the transfer of heat across the junction. The transfer of heat is caused by the flow of electrons from one material to the other, which leads to the absorption or release of heat depending on the flow of electric current. The Peltier effect is a reversible process, meaning that if the direction of the current is changed, the heat flow will also be reversed. This effect has important applications in refrigeration and cooling systems, as well as in thermoelectric power generation.

METHODOLOGY/EXPERIMENTAL

Method

1. Make a box using cardboard and a polystyrene sheet. Here we took four combos of 15*15 cm and 2 of 20*15 cm.
2. The door is attached for easy and better movement.
3. Put a Peltier plate between both heat sinks.
4. Connect the Peltier plate with the battery.
5. Here we used a temperature sensor for measuring the temperature of the internals of the fridge.
6. Make a room for the battery and Arduino and circuit.
7. Turn on the Peltier plate and fan for the first 20 minutes.
8. Put the vaccines in the fridge and now it is ready to use.

COMPONENTS

Fig.1:-LCD Display

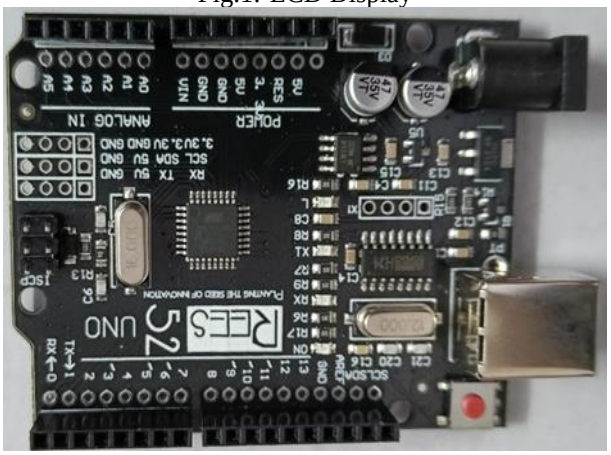

Fig.2:-Microcontroller

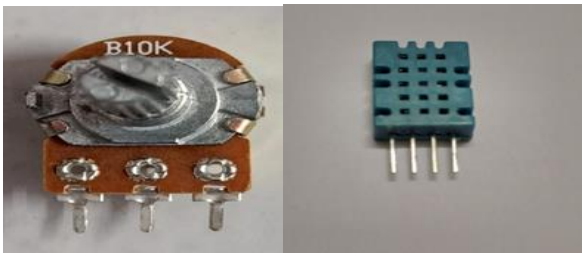

Fig.3:-Potentiometer Fig.4:-DHT11 Sensor

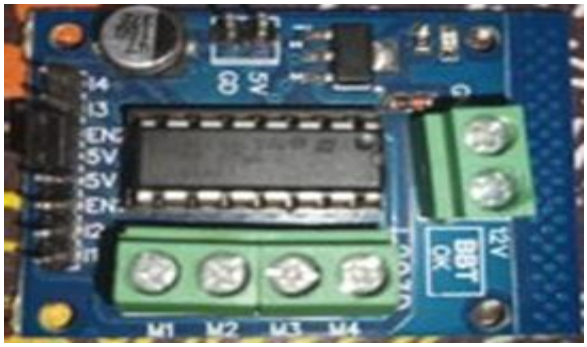

Fig.5:-L293D Motor driver

Fig.6:- Combination of Peltier plate

Fig.7:-DC Cooling Fan

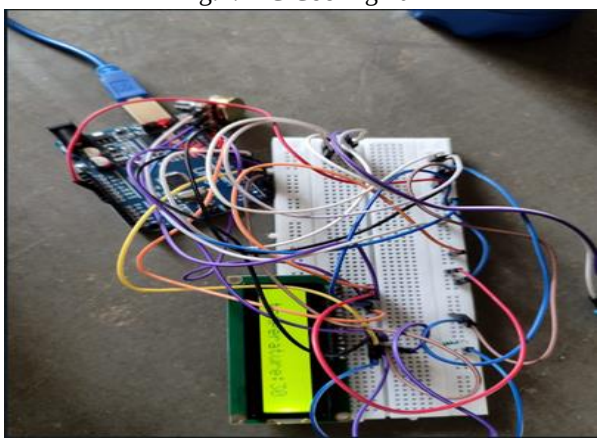

Fig.8:-Temperature display circuit

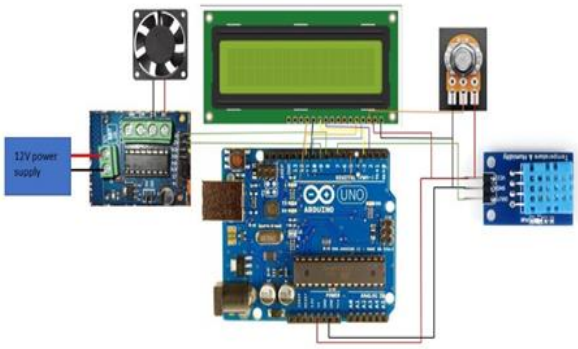

Fig.9:-Motor driver circuit diagram

III. RESULTS AND DISCUSSIONS

In our first try with the Peltier plate, the temperature dropped very low, thanks to the Li-ion battery. Then with the help of the fan, the temperature dropped even further and was maintained for a long time.

In our first trial with the temperature sensor, it did not perform well. So, we replaced it with DHT 11 and it gave satisfying results.

After all tests with the temperature sensor and Peltier plate, we installed both of them in the box of the fridge and we got the temperature result of 4℃.

IV. PROCEDURE FOR PAPER SUBMISSION

A. Review Stage

In our first result, the temperature dropped to 8℃, so we used Aluminum foil internally to avoid heat exchange and, colored the whole box white externally, we used pre-cooled cold drink cans to check the results. The temperature was maintained for 3 hours.

B. Figures

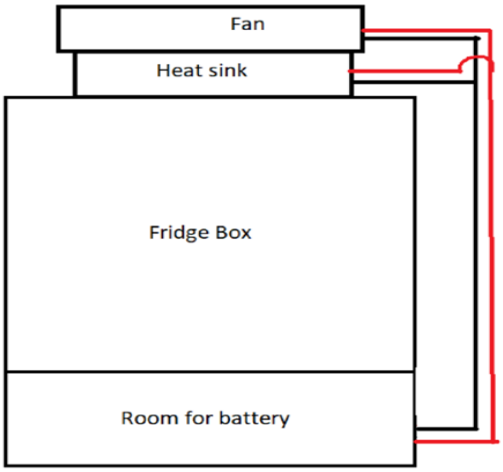

Fig.10:- Overall block diagram

V. MATH

Peltier Effect Equation: The Peltier effect equation describes the relationship between the heat absorbed or released by a Peltier plate and the current flowing through it. This equation is often used to calculate the cooling or heating capacity of a Peltier plate.

Electrical Resistance Equation: The electrical resistance equation describes the relationship between the voltage, current, and resistance of a Peltier plate. This equation can be used to calculate the electrical power consumed by the Peltier plates.

Thermal Resistance Equation: The thermal resistance equation describes the relationship between the temperature difference and the heat flow rate between two materials. This equation is often used to calculate the thermal conductivity of the materials being cooled by the Peltier plates.

Heat Load Calculation: The heat load calculation involves calculating the amount of heat being generated by the material being cooled. This calculation can be based on the mass of the material, its specific heat capacity, and the temperature change.

Cooling Capacity Calculation: The cooling capacity calculation involves calculating the amount of heat being absorbed by the Peltier plates. This calculation can be based on the change of temperature between the sides of the Peltier plates and the heat flow rate.

Efficiency Calculation: The efficiency calculation involves calculating the ratio of the cooling capacity to the electrical power consumed by the Peltier plates. This calculation can be used to find the overall efficiency of the refrigerator.

VI. UNITS

	Unit
Temperature	℃ (Degree Celsius)
Electric current	A(Ampere)
Voltage	V (Volt)
Power	W (Watts)
Heat load	W (watts)
Cooling capacity	W (watts)
Time	Minutes

VII. HELPFUL HINTS

C. *Figures and Tables*

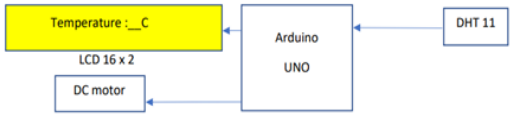

Fig.11: Flow chart of circuit working

VIII. FUTURE SCOPE

The mini portable refrigerator can be used in the future in Epidemic Prevention Stations, Hospitals & Clinics, Laboratories, Medicals, and Others. The hospitals & clinics segment is expected to hold the largest portion from refrigerators during the forecast period owing to the increasing number of patients suffering from various diseases, and rising awareness about these various diseases. Peltier plate-based small refrigerators have several potential future scopes, including:

1. Energy Efficiency: There is a growing demand for energy-efficient appliances in today's world. Peltier plate-based small refrigerators have the potential to be more energy efficient than traditional refrigerators that use compressors. Researchers and engineers are working to develop new materials and technologies that can improve the energy efficiency of Peltier plate-based refrigerators.
2. Portable and Compact: Peltier plate-based refrigerators are small, lightweight, and portable, making them ideal for use in compact spaces such as dorm rooms, small apartments, and RVs. There is a growing demand for portable refrigeration solutions, and Peltier plate-based refrigerators are well positioned to meet this demand.
3. Cooling in Extreme Environments: Peltier plate-based refrigerators can operate in extreme environments, such as in space, underwater, or in remote locations. This makes them an attractive option for a variety of industries, including space exploration, marine exploration, and military applications.
4. Noise Reduction: Peltier plate-based refrigerators are quieter than traditional refrigerators because they don't have a compressor. However, they can still produce some noise due to the cooling fan. Engineers are working to develop new technologies and materials that can further reduce the noise produced by Peltier plate-based refrigerators.
5. Green Technology: Peltier plate-based refrigerators are more environmentally friendly than traditional refrigerators that use refrigerants that contribute to global warming. The absence of refrigerants in Peltier plate-based refrigerators makes them an attractive option for those who are concerned about the environment.

Overall, Peltier plate-based refrigerators have a bright future and are expected to play an important role in meeting the growing demand for energy-efficient and environmentally friendly refrigeration solutions.

IX. CONCLUSION

Peltier plate-based small refrigerators offer several advantages over traditional compressor-based refrigerators, including reliability, cost-efficiency, and user-friendliness. They are particularly useful in rural areas and in the healthcare sector for storing syringes and medication under suitable temperatures.

In conclusion, Peltier plate-based small refrigerators are a promising technology with several benefits, such as smaller size, portability, and energy efficiency, making them ideal for use in small spaces, remote locations, and extreme environments. Additionally, the absence of refrigerants makes them more environmentally friendly. However, there are still some challenges associated with Peltier plate-based refrigerators, such as limited cooling capacity, higher initial cost, and noise production.

Despite these challenges, Peltier plate-based refrigerators have several potential future applications, including improving energy efficiency, reducing noise, and increasing cooling capacity. They are also well-positioned to meet the growing demand for portable, energy-efficient, and environmentally friendly refrigeration solutions. This technology has already found applications in various industries, including space exploration, marine exploration, and military applications. Continued research and development in this area is expected to result in further improvements in the technology, making it an even more attractive option for a wide range of applications.

Overall, Peltier plate-based small refrigerators offer a promising alternative to traditional compressor-based refrigerators, and their future looks bright. They have the potential to revolutionize the refrigeration industry, offering smaller, more portable, and energy-efficient solutions that are more environmentally friendly.

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