Computer Science & Engineering Department
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Arctic Spark Thermal Monitoring

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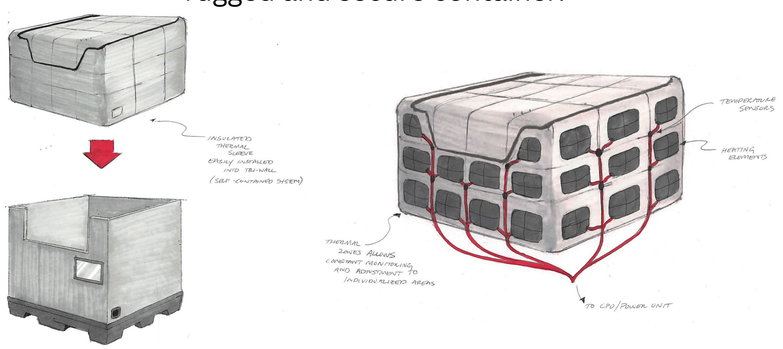
Project Overview

The Arctic Spark program aims to enhance the US Air Force's ability to operate in cold weather environments by providing a self-contained and self-regulating thermal control solution. Operating in austere environments poses a challenge due to the use of sensitive medical supplies and advanced technological equipment. Our program has developed a cutting-edge technological platform capable of detecting and selectively regulating the temperature of a three-dimensional space. This helps maintain optimal temperatures and ensure the integrity of mission-critical supplies.

Our platform consists of a standard hard-sided shipping container that has been modified with a 10-inch internal insulation layer. This creates a storage area measuring 36" x 36" x 36", which can be further divided into multiple configurable thermal zones. This allows for precise temperature control and the ability to accommodate different types of mission-critical supplies, all within a rugged and secure container.



Technical Specifications

Hardware:

Raspberry Pi 4

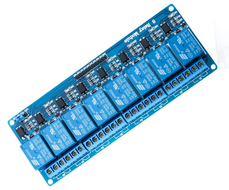
- Connectivity via Bluetooth, LAN or WiFi

DS18B20 Temperature Sensor

- Unique 28-digit ID number
- Returns temperature readings as a string

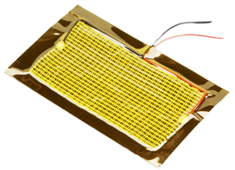
8 Channel DC 5V Relay Module

- Allows independent control of 8 circuits simultaneously



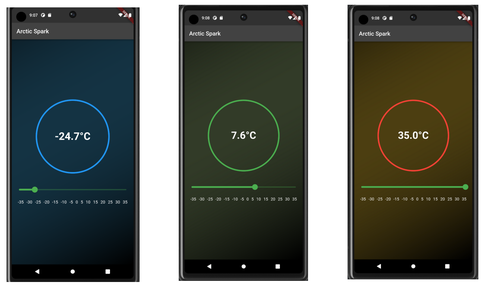
Carver Scientific Thermal Pad

- Prototype heating element with thermal reactive properties
- Operates with 12V power source



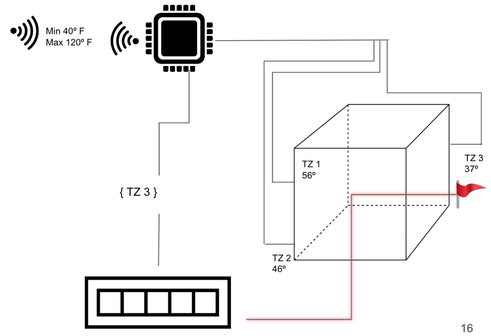
Software:

The mobile application, developed using the Flutter framework and Dart programming language, provides users with a simple interface to regulate and observe temperature fluctuations within a designated container.



Process

- The Raspberry Pi 4 identifies the sensor locations using the following code:
  - *sensor_locations = glob.glob('/sys/bus/w1/devices/28-*/w1_slave')*
- Subsequently, each sensor is assigned to a "Thermal Zone" data structure, which includes:
  - Assigned Sensor
  - Dedicated GPIO output / thermal element
  - Temperature data logs
  - Error Logs
- The system then acquires the minimum temperature thresholds for each zone from the user input.
- Upon initiating operation, the system diligently monitors each zone, ensuring that none approaches a -15°C buffer of the specified minimum temperature.



When zones breach the designated threshold, a signal is sent to the relay, enabling the flow of power to the heating element. Conversely, if zones reach or surpass their buffer limit, the signal to the relay is discontinued, resulting in the termination of power to the respective zone's heater.

Program Output

```
06:01:04
--------
Zone 1 reading: 12F  -11C
Below Threshold
Heating ACTIVE
Zone 2 reading: 15F  -9C
Below Threshold
Heating ACTIVE
Zone 3 reading: 14F  -10C
Below Threshold
Heating ACTIVE
Zone 4 reading: 18F  -7C
Zone 5 reading: 17F  -8C

06:01:04
--------
Zone 1 reading: 12F  -11C
Below Threshold
```

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