Athletic Recovery Device

ECE-498

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Problem Statement

- Sports cause acute injury

- Cold therapy treatment
  - RICE Method: Rest, **Ice**, Compression, Elevate
  - Application of cold surface to injured area

- At Union College
  - Plastic Ice Bags
    - ➕ Pros: Easy to use, cheap, sanitary
    - ➖ Cons: Unsustainable, lack of temp. regulation

https://www.macleans.ca/society/the-end-of-the-ice-age/

https://unionathletics.com/images/2020/5/25/union_logo_teaser_new.jpg?width=1920&quality=80&format=jpg

Current Products

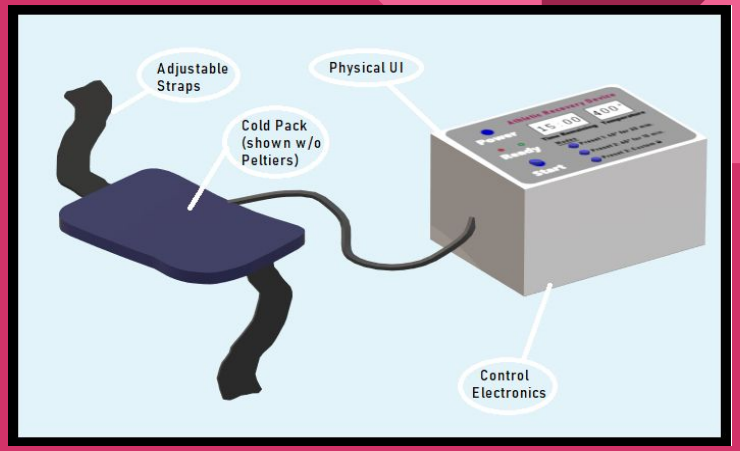
- Chemical Packs
  - ⊕ Easy to use
  - ⊖ Must be refrozen
  - ⊖ Too cold/not cold enough
  - ○ PowerPlay
  - ○ Freezer packs
- Liquid Circulation Systems
  - ⊕ Consecutive Use
  - ○ Game Ready
    - ⊕ Temperature control
    - ⊖ Expensive
  - ○ Kodiak
    - ⊖ Lack of temperature control

https://recreationofla.com/product/powerplay/

https://cdn11.bigcommerce.com/s-gpuq0v2/images/stencil/1280x1280/products/639/2890/Kodiak-cold-therapy-withpad__62594.1579814446.png?c=2

https://www.amazon.com/Game-Ready-Knee-Wrap-Size/dp/B07J5T6GPX

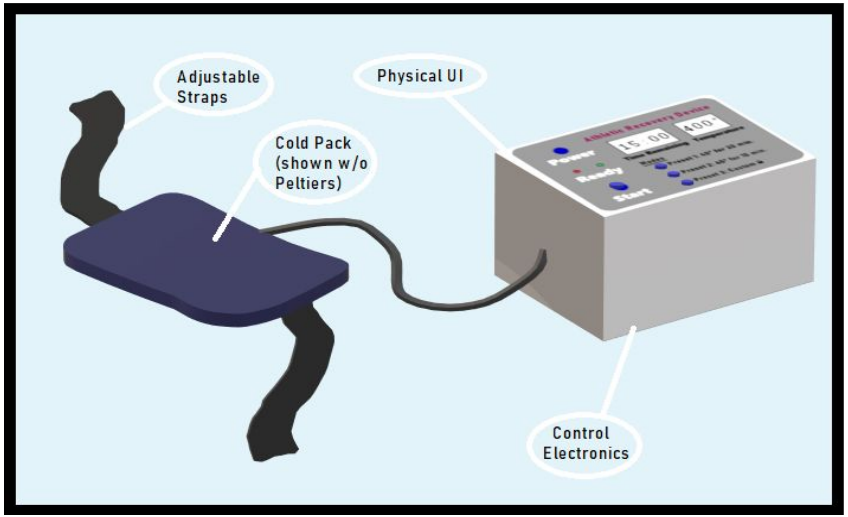
Project Goal



Our goal is to create an electronically powered ice pack with the ability to control the temperature and duration of the treatment for consecutive uses. We believe this would be a valuable and sustainable asset to the Union College training room.

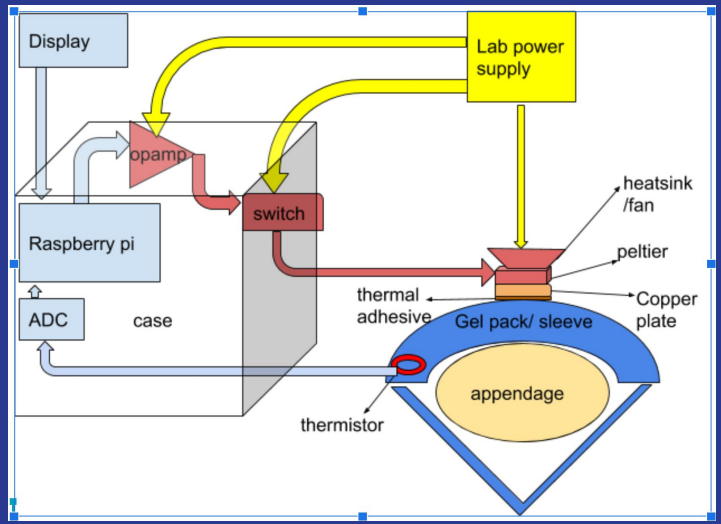
User Requirements

- User-friendly interface
  - Touchscreen display
  - Pre-programmed treatment modes
- Temperature Control
  - Reaches 4-10°C in <5 min.
  - Hold temp. for duration of treatment (10-20 min)
- Power & Safety
  - Operates with wall outlet over a span of a few hours



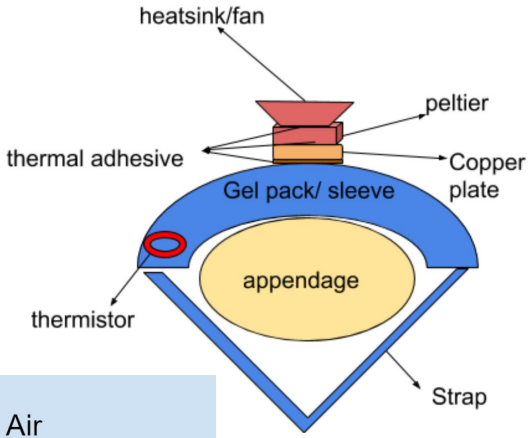
User Interface

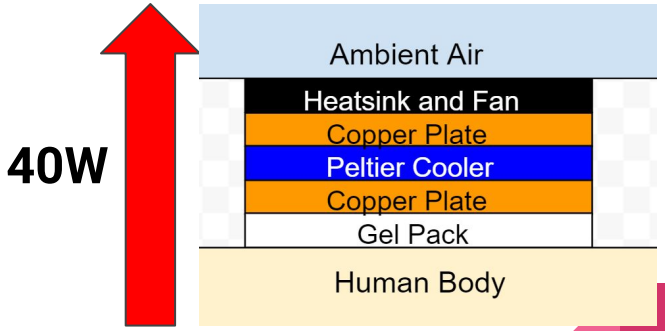
- Processing signals with RPi
  - Input: ADC with SPI
  - Output: DAC with I2C
- GUI Development
  - Tkinter
- Data Collection
  - matplotlib



Temperature Control Overview

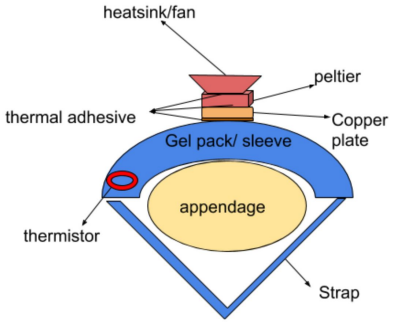
- Why use Peltier Coolers?
- Calculated power requirements
  - 40W of power
  - Peltiers need 40°C ΔT

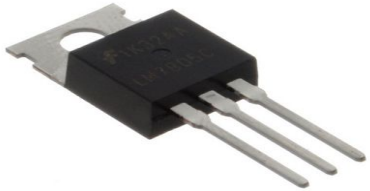




Peltier Driver Design

- Choose Variable Current Source
  - PWM inefficient
  - Op-amp control
- High Current MOSFET
- 5V Peltier





//www.tutorialspoint.com/basic_el
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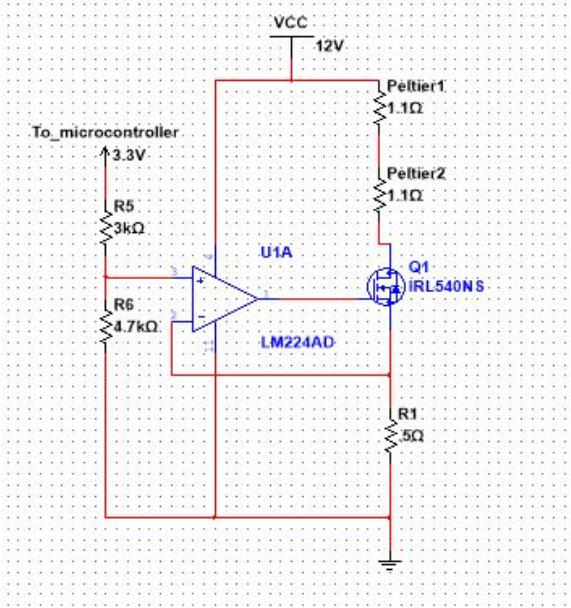

https://images-na.ssl-images-amazon.com/image
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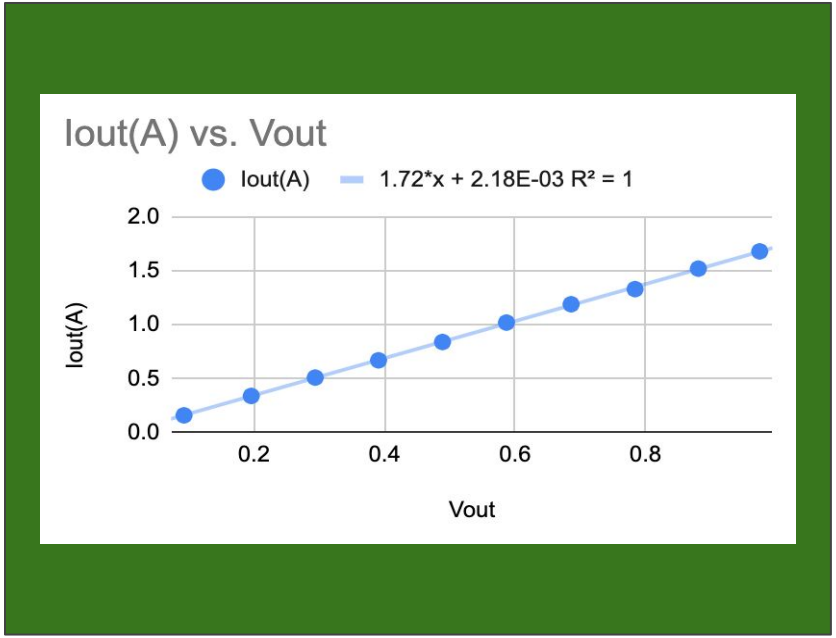
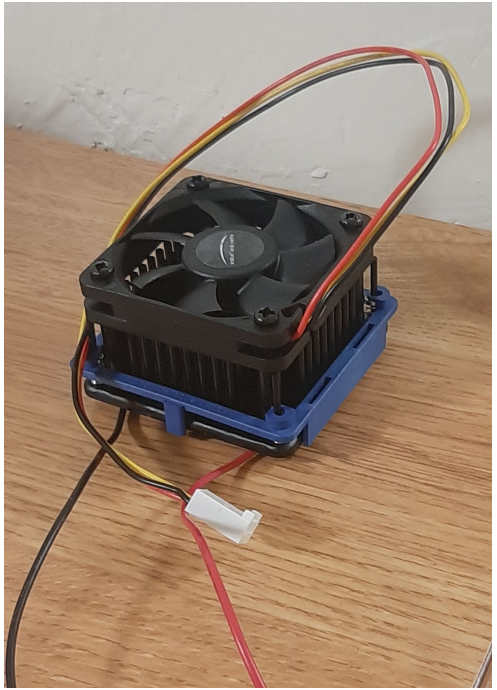
Current Source Testing

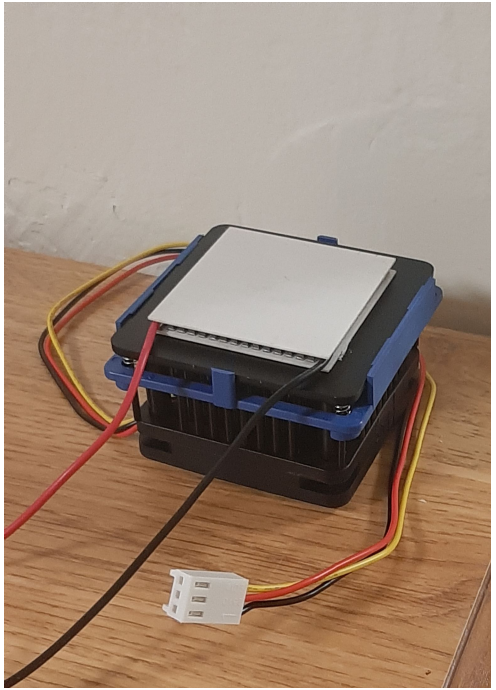
- Experimentally found || Resistance
- Varied input voltage
- Low current to protect breadboard
- Pulsed Test Plan



Peltier Testing

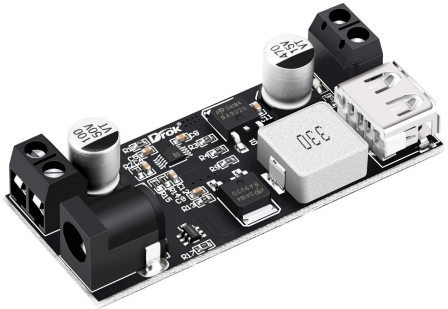
- Used less efficient peltier
- Attached to heatsink
- Reduced current
- Cold side 13°C





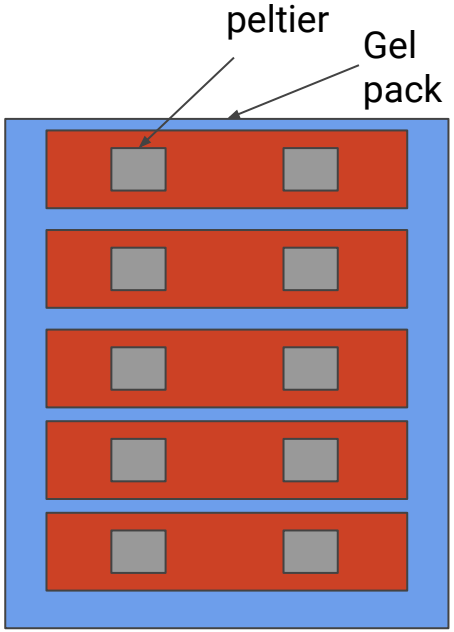
Load Requirements and Power Source

- Thermal regulation: peltiers and fan → 12VDC and 25A
- User interface: Raspberry Pi 4 → 5V DC and 3A
- Power supply = SE-600-12
- User interface regulator = Buck converter 12V to 5V
  - Step down 12VDC to 5VDC
  - Provide up to 6 amp
  - Easy connection to pi



https://www.amazon.com/Converter-DROK-Regulator-Inverter-Transformer/

https://www.digikey.com/en/products/detail/mean-well-usa-inc/SE-600-12/

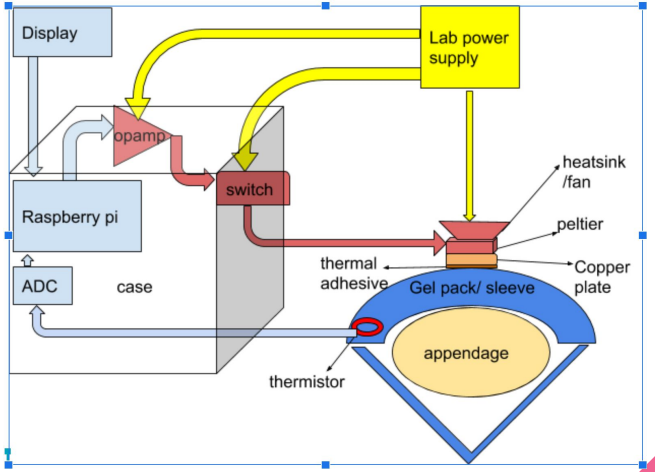


Wiring and Other Components

- Wiring
  - Chose 18 AWG - 5 conductor wire for supply peltier connection
  - 20 AWG wire for connection between Peltiers and other components
- Other components
  - Gel pack
  - Current sensing
  - Methods of attachment

https://www.showmecables.com/18-awg-5-conductor-600v-

https://www.amazon.com/LLPT-Conductive-Electronic-Components-TC128



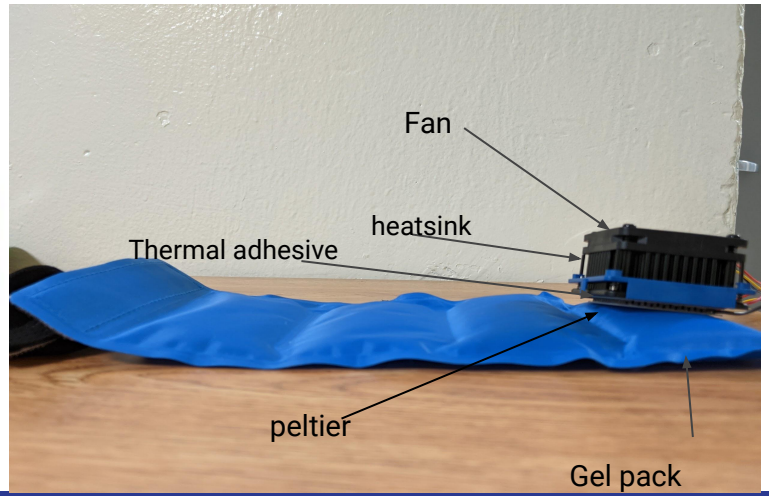
https://www.amazon.com/Injuries-Adjustable-Non-Toxic-Reusable-Rehabilitation

Future Considerations

- Case modifications
  - Cutting wire holes, external fans, place for touch screen
- Wiring medium, circuit or perfboards
- Cover for fans
- Cover for all components on sleeve

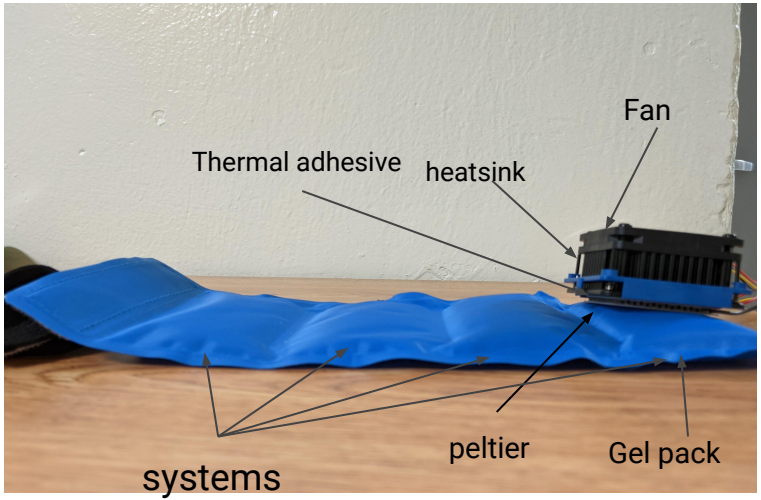
https://www.amazon.co.uk/Sunnyglade-Waterproof-Dustproof-Junction-Enclosure/dp/B07KR4PCD8

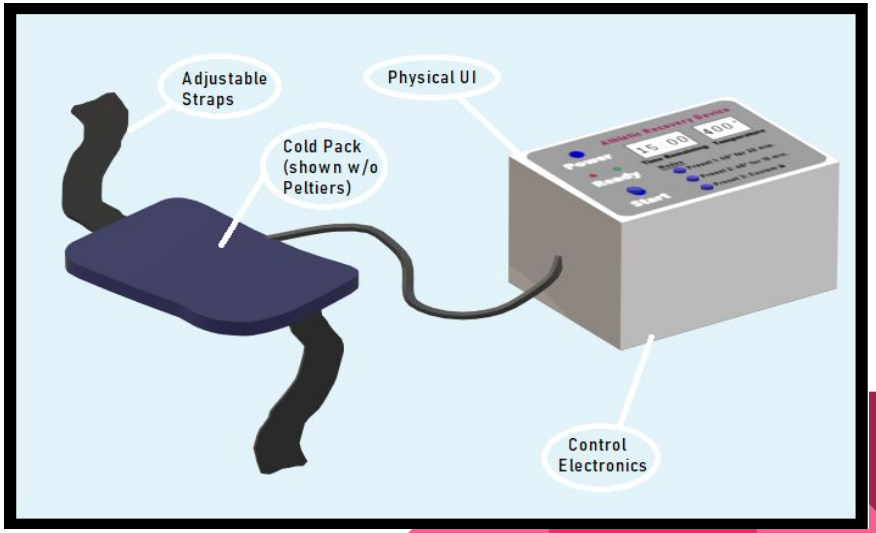
https://www.newark.com/wakefield-solutions/hsf-55-33-b-f/heat-sink-fan-0-63deg-c-w-13-8cfm/dp



Going Forward

- Scale up
- Setting up and laying out all electronic components incase, and connecting it to the sleeve
- Running tests
- Ask Trainer for feedback





Questions?