Skin Blood Flow Based on a Thermal Sensor

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Objective

- **Develop a thermal blood flow meter that tracks the average energy needed to maintain the skin surface temperature at 42°C**

Background

Thermoregulation and modulation of cutaneous blood flow levels are critical components of human body homeostasis. As a result, poor blood flow rate can occur in patients with medical conditions causing amputations and infections.

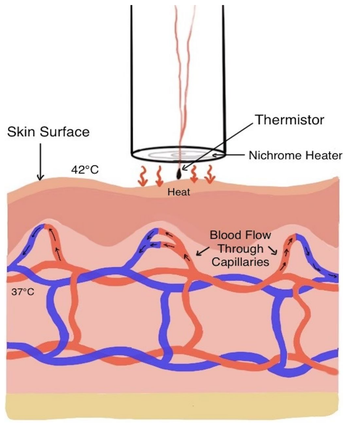


Fig 1

Methods

Artificial Skin Model

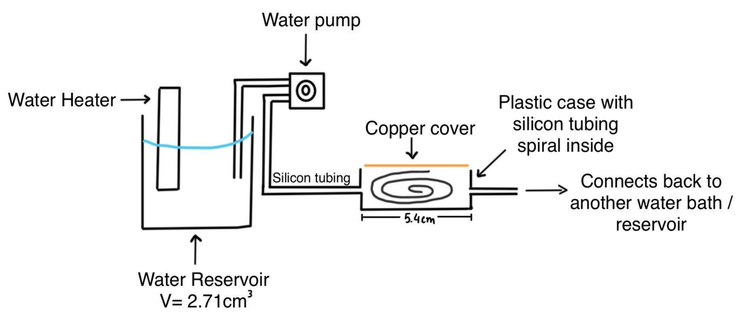


Fig 2

- Replicates the blood perfusion through the skin of a human body; consists of a water reservoir, pump and flow chamber to resemble the skin.

Thermal Probe

- Composed of a nichrome wire that heats up the surface of the flow chamber until it reaches 42 °C as voltage is delivered to it.
- Uses a thermistor that measures the temperature of the skin model.

Circuitry

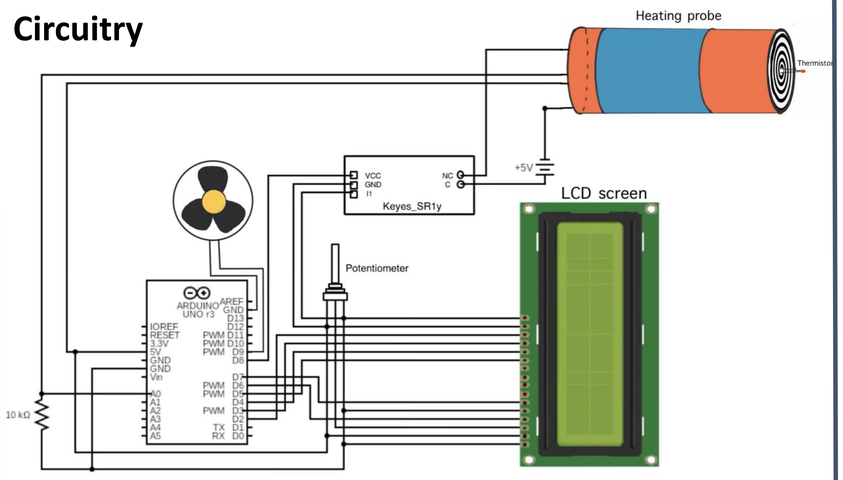


Fig 3

Acts as a control system by connecting different electrical systems.

- Arduino Uno- a microcontroller board that allows for the circuit to be switched on and off depending on the temperature of the heating probe.
- Relay-closes and opens the circuit electronically to protect the Arduino from high voltage and current values needed to power the nichrome wire in the heating probe.
- LCD- displays the temperature of the nichrome wire on the heating element.
- Thermistor- creates a temperature sensor and temporarily adjust the resistance value based on temperature change.
- Fan- assists in the cooling of the device
- Computer- uses the Arduino software to perform calculations of power, energy, and time and outputs the results and graphs.

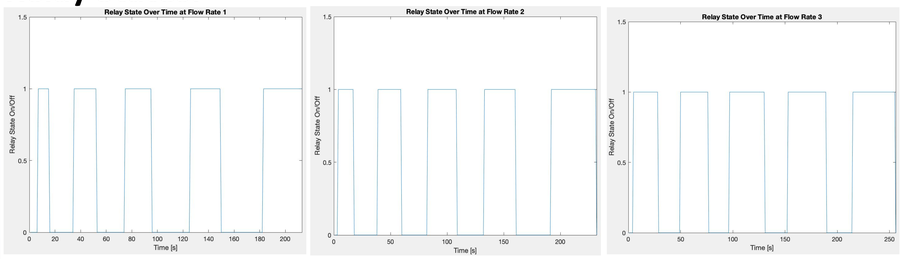
Software

- Matlab - Designed to output the relationship between power and water flow rate.
- Arduino Code- Designed to control the relay and switch the voltage on an off depending on the temperature reading from the thermal probe.

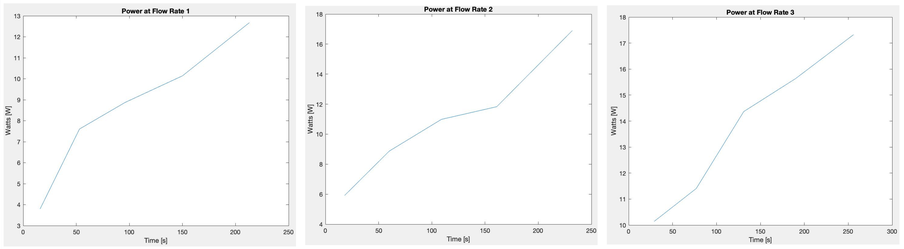
Results

Thermistor Calibration: ensured that as the temperature went up, resistance values went down.
Water Pump Calibration: allowed for the measurement of different flow rates depending on the setting levels.

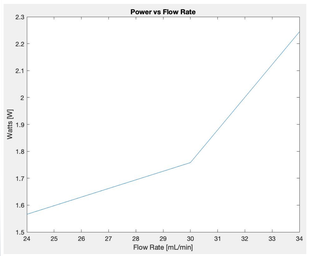
Relay States:



Power vs Time:



Power vs Flow Rate:



We achieved our ultimate goal of collecting data that further proves the relationship between the energy input and water flow rate. This shows that a higher flow rate requires a larger amount of power to heat it.

Conclusion

- **The device accurately measures blood flow when tested on the artifical skin model using power, energy, and time calculations.**
- **The current device could be connected to a battery source to offer portability and convenience.**
- **Currently, there isn't a cost-efficient and portable blood flowmeter. Data collection on patients could prove that this device offers a new approach in assisting diabetic patients monitor blood flow.**