CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
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Project Number
J0717

Project Title
How to Keep Your Cool: Controlling Thermal Comfort by Applying Temperature Impulses to the Wrist

Abstract

Objectives/Goals
In the US, space heating, cooling, and air conditioning account for 39% of energy usage in homes. The goal of this project is to find a way to reduce the amount of energy needed to make people feel cool in warm environments. More specifically, this project examines if cooling a small patch of skin can make a person feel cool without needing to cool an entire building. If successful, this method of cooling could help to reduce greenhouse gases and reduce the amount of money people spend on air conditioning.

Methods/Materials
I created a system that uses a Peltier module to apply temperature impulses to a person's wrist. The system also includes a Raspberry Pi computer, a temperature sensor, relays, a heat sink, and a fan. I created a computer program to control the impulses. The program allows the operation protocol for the impulses to be adjusted. I conducted a study in which participants evaluated the effectiveness of the system for different values of the operation protocol.

Results
The data from this experiment showed that most participants felt cooler because of the system when the settings for the operation protocol were adjusted to fit their preferences. All participants preferred a duty cycle of less than 50 percent. The duty cycle is the fraction of the cycle during which the Peltier module is powered on. Most of the participants preferred the Peltier module to be turned on only for a small fraction of time to feel cooler.

Conclusions/Discussion
My studies demonstrated that when a proper sequence of cooling impulses is applied to a small region of a person's skin, the person's perception of how cool they feel can be controlled. In my experiments, seven of the eight participants felt cooler because of the system. This project has resulted in several important findings. First, it suggests that there is a way to make someone feel cool without having to cool their entire body. Second, my data supports the theory that when the temperature of one part of the body is changed, the brain perceives that the temperature of the entire body has been changed, too. Third, my project suggests that the brain is sensitive to high rates of temperature change. This project has significant implications for people who want to reduce energy usage in their homes. This work is a step toward creating an energy-efficient, wearable system that enables people to be cooled through only a small patch of skin.

Summary Statement
This project demonstrated an energy-efficient method for controlling a person's thermal comfort by applying carefully controlled temperature impulses to their wrist with a Peltier device.

Help Received
I came up with the project idea and did the experiments. My father provided guidance on connecting the electronics and taught me how to write the python program to control the system. He also assisted me by critiquing my writing and poster.