Measuring the Core Temperature

William Hou, James Wang

Department of Electrical and Computer Engineering

JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

Abstract

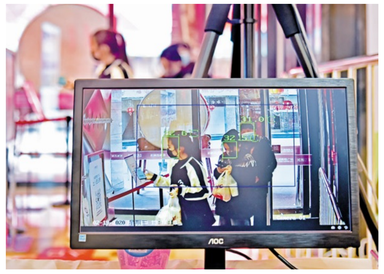
Background

It is very difficult to get a reliable measurement of the core temperature of human body without using invasive methods. However, in many scenarios, it is impractical to deploy invasive methods to obtain the core temperature. One such case is measuring the temperatures of people entering a large shopping mall, which is critical in determining whether they might have positive symptoms.

Motivation

Manually

Automatically



Solution

Our solution to this problem is to estimate the core temperature of a human body based on the surface temperature(s) of that body.

It can be divided into two main steps:

- Use an infrared camera to remotely measure the surface temperature(s) from different places on the human body.
- Feed those readings into a machine learning model, which will output its estimate of the core temperature.

Approach

Set up the infrared camera that remotely measures the surface temperatures on a human body.

→ Prepare an artificial heat source that is temperature-adjustable and place it into a human body model.

↓ Adjust the temperature of the heat source to simulate the variation of human body temperatures to generate many data points.

← Build our ML model and use the data we collected to train our network to estimate the core temperature.

↓ Once our model has been trained, it is ready to measure the core temperature given any human body.

Experiment Setup

Infrared Camera System

This is the infrared camera system that we are going to use to collect the surface temperature reading. Its precision is up to 1 decimal place. Through thorough testing on the objects with known temperature, we have verified that it is sensitive and reliable.

Artificial Heat Source

The heating pads are ideal heat sources, as they can maintain at a certain temperature for up to 12 hours. Its operating temperature is from 38°C to 45 °C , which is suitable for our experiment.

Although the ideal temperature range is from 36°C to 42 °C, we can still use the heating pad while it is slowly climbing to its stable temperature. When we insert it into our phantom, the pad will start to warm up the phantom, and then we can record the readings as the whole thing becomes stable.

Human Body Phantom

Table 2. Components.

Component	Weight (%)	Weight (g)
✔ Glycerol	11.21	89.19
✔ Deionized Water	82.95	660
Benzallkonium chloride	0.47	3.74
Silicon Carbide (Sic(-400 mesh)	0.53	4.22
Aluminium Oxide (Al2O3 (0,3µm))	0.88	7
Aluminium Oxide (Al2O3 (3µm))	0.94	7.48
✔ Agar	3.02	24.03
Sum	100	795.66

Make the Phantom

Weight the components: deionized water, Glycerol, and agar powder

↓ Mixed them in a large beaker

↓ Heat the mixture to 100 °C and keep stirring

↓ Cool it down in a fridge for at least 5 hours

↓ Liquid becomes solid

Final State

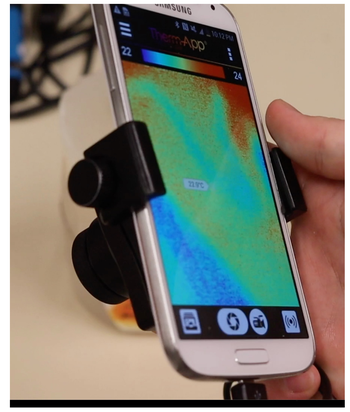
Train Our Model

Take the phantom out of the fridge and let it rest for at least 3 hours to be room temperature

↓ Wait for the heating pads to climb to desire temperature

↓ Insert the pads into the phantom and wait for the whole thing to reach stable temperature

↓ Use the infrared camera to record the surface temperature of the phantom



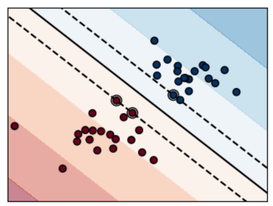
We collected 100 data points.

Our ML Model

Support Vector Machine (SVM)

- Kernel: RBF
- Decision function: ovo

Final Accuracy: 83.33%



Acknowledgement

We would like to thank Prof. Gannot and our TA Shoujing Guo for their assistance throughout this project. This project would not be successful without their valuable advice and guidance.