Physics 451L
Senior Lab
New Mexico Tech

Calibration and Exercises in Infrared Thermography

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Introduction

There are three primary activities in this lab:

1. Calibration
2. Heat flow
3. Emissivity

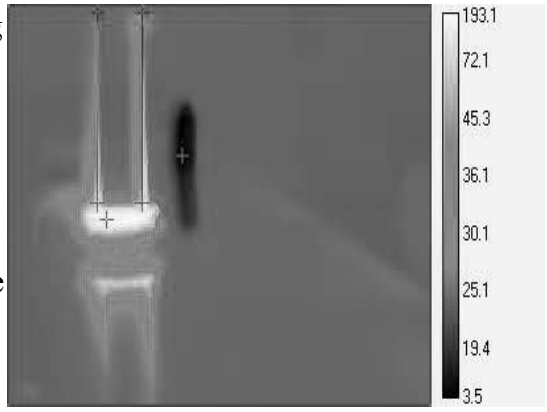
We will be using the FLIR A40 infrared camera, a Windows XP computer with firewire interface, glass thermometers, a thermocouple thermometer, and various targets and slides. You will find a notebook with documentation about the camera and the ExamineIR software to be useful resources. Please look closely at that material before proceeding.

Calibration

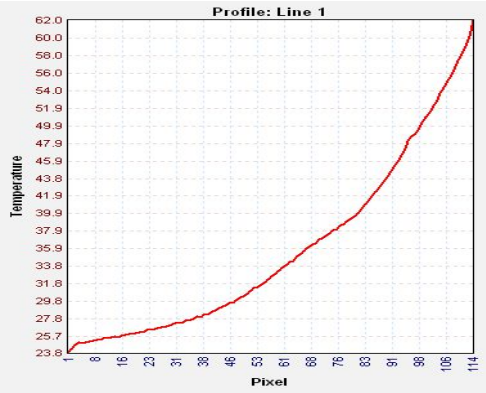
The camera has been calibrated at the factory to convert radiance intensities to temperature, but we should do this ourselves to verify accuracy and account for instrument drift. We need stable, blackbody sources for this. It will be best to use at least two containers: one with cold and one with hot water. Use the black metal cans and try make the temperature range between the hot can and the cold can as large as possible. Use the glass thermometers and thermocouples to determine the actual temperatures of both cans. Using the camera, image both cans and use the calibration option in the software. You'll have to assume a linear variation of intensity versus temperature and save the best fit calibration line for measuring temperatures during the rest of this lab

Heat Flow

Place the flat plate with two rods on the heating element, set to about 1/4 scale heating (do not exceed this or we could have a fire hazard; the temperatures will also be off scale). Wait to achieve some temperature equilibrium, then capture an image of the two rods along with their temperature profiles. Make sure that you have a way to convert pixels on the temperature profiles to an actual length. One way to do this is to have your profile run the entire length of each rod, then measure the total length with a meter stick.



Set up a heat flow equation through a cylindrical rod with a thermal gradient, accounting for thermal emission. You should be able to determine the thermal conductivity of the rod in this way. One rod is aluminum and the other is steel -- use your measurements of the thermal conductivity to determine which rod is which.



Emissivity

Determine the emissivity of copper, stainless steel, and brass by imaging the slides. You may also need a blackbody slide for control. Also, you will probably have to set up either a "cold source" or a "hot source" to reflect from the slides in order to either minimize or maximize the reflective term in the brightness equation. Use the "effective" measured temperatures to find the emissivities, and compare your results to the range of values given in the tables of the ExamineIR User Guide.

To measure the emissivities, you will need to set up the equations for measured radiances in terms of temperature and emissivity, and relate these to the "effective" measured temperature (the brightness temperature) for a blackbody that would emit the same amount of radiation.