Lab Report-5
INFRARED IMAGING

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Goal

The ultimate goal is to study the application of IR imaging towards temperature measurements and to observe the influence of several parameters on the efficiency of these measurements.

Apparatus Used

PC Computer
IR Camera – Cedip SC7000
Electronic circuit to test
Digital Thermometer
Hotplate
ThermaCAM Researcher software
Industrial parts and electronic circuit altair software

Software

Altair Software

Documentation

Technical manual of the camera

About IR Camera

Cedip SC7000 IR camera is speci_cally designed for academic and industrial research and science applications as well as integrators who require a exible camera with high sensitivity, accuracy, spatial resolution, and speed at an a_ordable cost. IR camera are used for Infrared Thermography which usually detect radiation in the long-infrared range of the electromagnetic spectrum (roughly 9 to 14 micrometers) and produce images of that radiation, called thermograms. Since infrared radiation is emitted by all objects with a temperature above absolute zero according to the black body radiation law, thermography makes it possible to see one's environment with or without visible illumination.

Figure 1: IR Camera

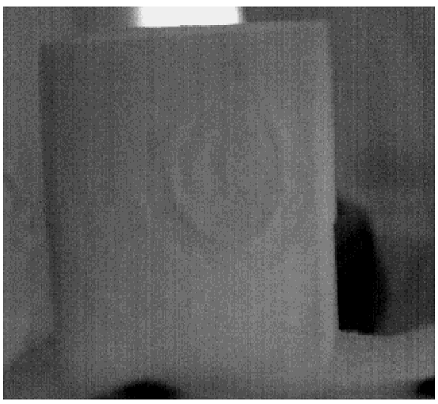

Figure 2: Captured image by IR Camera

Defect detection of an electronic circuit

The Camera is connected to the PC via Ethernet port and controlled using Altair Software. Then the camera is selected to initiate our measurement. We select a colour palette to view the temperature of the object in the scaled range. The camera lens is adjustable in order to focus the objects.

Then, we tried to examine the defects in an electronic circuit. When the electronic circuit is ON, the electronic components in the circuit gets heated up thereby emitting infrared radiation. The amount of radiation emitted by an object increases with temperature. The infrared camera captured the view of the amount of radiation emitted.

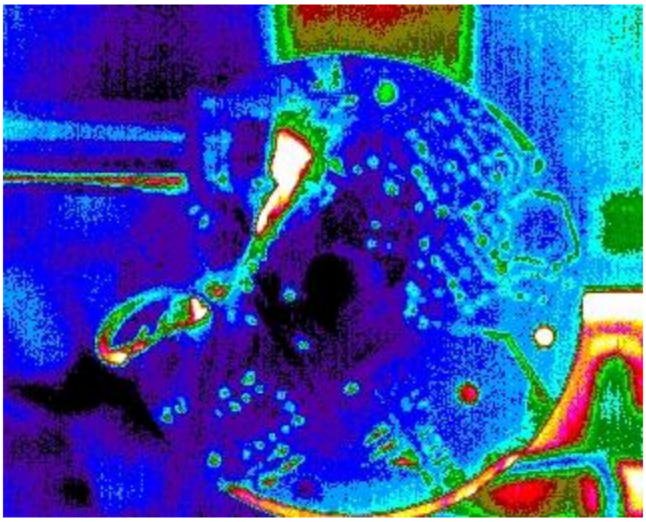

Figure 3: Defect on the electronic circuit

Here, in this circuit shown in Figure 3, the IC heated up quickly since it was faulty. Maximum temperature of this point is around 58℃.

Estimation of Emissivity

The C.A 1875 tutorial bench comprises of a hot plate with several targets having different surface conditions which is made of different materials like polished steel, stainless steel, laminate, red copper, aluminium, brass and black plate that are affixed to the front of bench using magnets.

Before starting the bench, we captured a frame of the bench with IR camera. This is shown in the figure 4. We can see that temperature of black pate and laminate is high than others. We started to heat the hot plate and when the temperature is stabilized, we captured the frame of hot plate as shown in Figure 5.

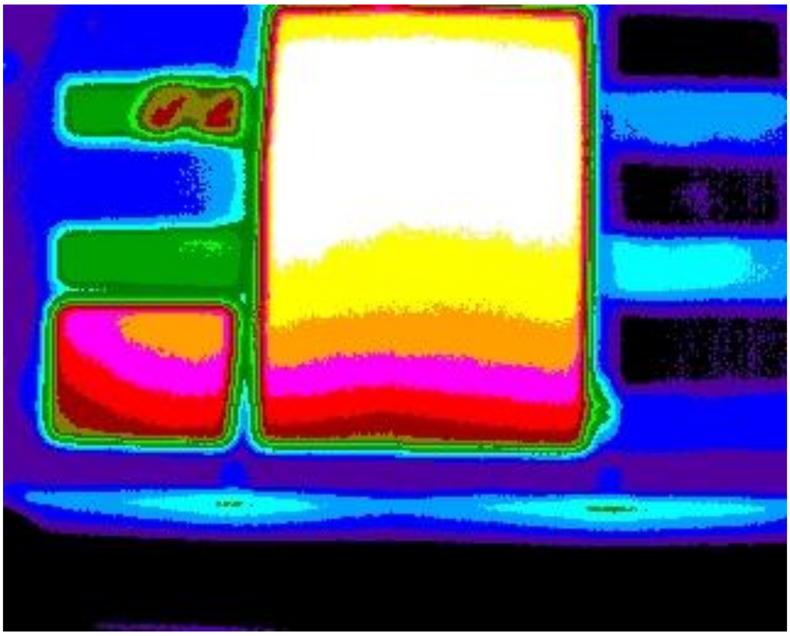

Figure 4: Hot plate bench before turning ON

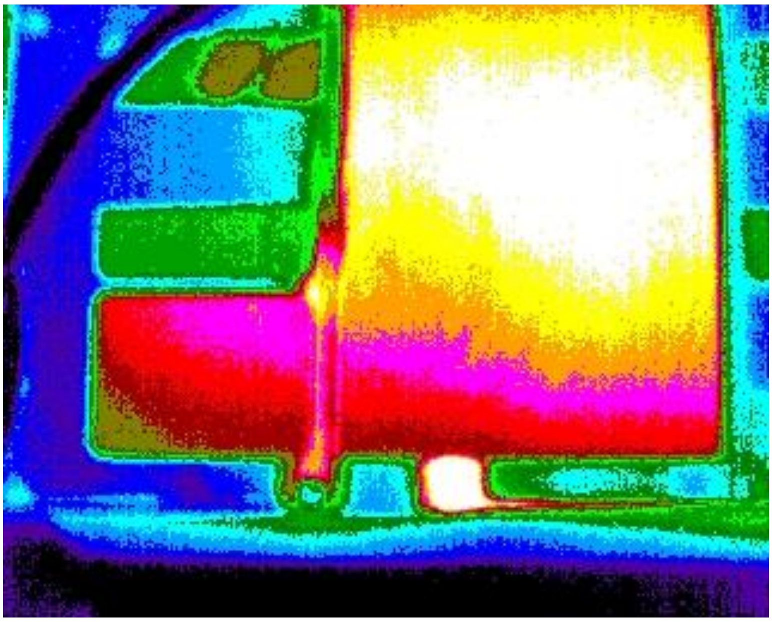

Figure 5: Hot plate bench after turning ON

Emissivity of different materials can be calculated by temperature measurement of materials and temperature measurement of a body with known emissivity. The idea is to determine the temperature of the object with the camera in the usual way. The distance separating these areas must be so small that it can be safely assumed they have the same values.

The object is adjusted so that the area with unknown emissivity is very close to an area of known emissivity. We were using the average temperature in the reference area because the average temperature area is the one where there is usually a spread of temperatures within the area, especially for materials with low emissivity.

$$Emissivity\ of\ material = \frac{Temperature\ of\ material * Emmisivity\ of\ black\ plate}{Temperature\ of\ black\ plate}$$

$$Emissivity\ of\ stainless\ steel = \frac{24 * 0.95}{55} = 0.4145$$

$$Emissivity\ of\ laminate = \frac{48 * 0.95}{55} = 0.8290$$

$$Emissivity\ of\ red\ copper = \frac{20 * 0.95}{55} = 0.3454$$

$$Emissivity\ of\ brass = \frac{24 * 0.95}{55} = 0.4145$$

$$Emissivity\ of\ aluminium\ = \frac{32 * 0.95}{55} = 0.5527$$

Transmission and Reflection Coefficients

The transmission coefficient of a black PVC material can be measured using the same setup. Here, firstly we need to introduce black PVC material in between the black plate and the IR camera and measure the temperature of black plate. This temperature is compared with the temperature measured without the PVC in between of them.

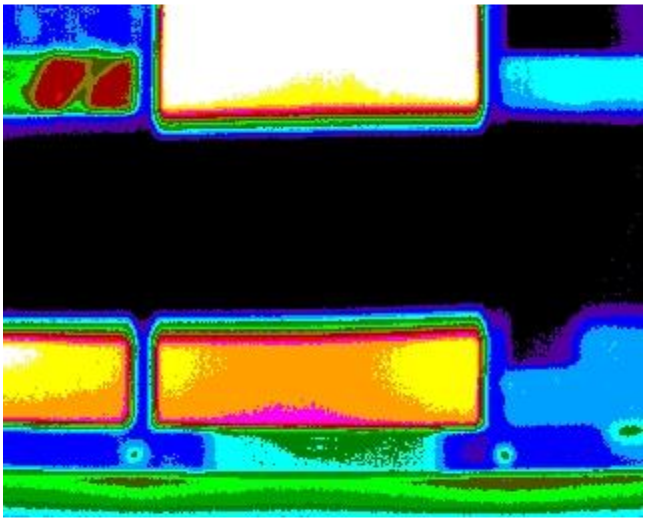

Figure 6: Black PVC in between Camera and Hot Plate

$$Transmission\ coefficient\ of\ black\ PVC = \frac{Temperature\ of\ black\ plate\ with\ black\ PVC}{Temperature\ of\ black\ plate\ without\ black\ PVC}$$

$$= \frac{26}{55} = 0.4727$$

Now, we measured the coefficient of copper. The copper plate is placed before the black plate, the temperature of black plate is measured as a reflection from copper plate. Then temperature of black plate is measured directly.

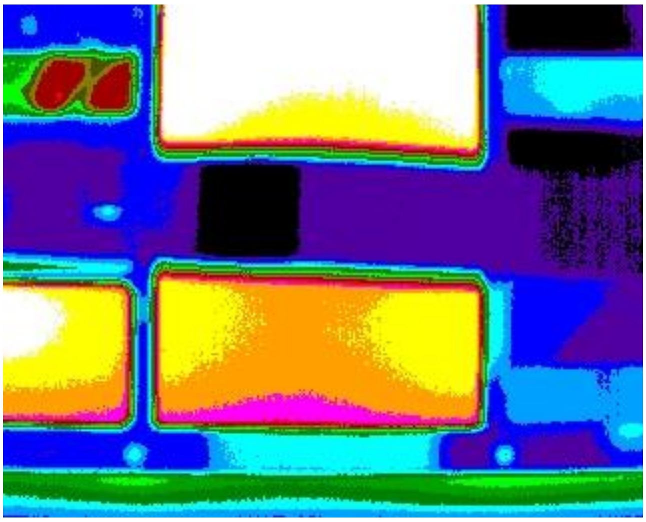

Figure 7: Copper Plate in between Camera and Hot Plate

$$Reflection\ coefficient\ of\ Copper = \frac{Temperature\ of\ black\ plate\ in\ copper\ reflected\ view}{Temperature\ of\ black\ plate\ without\ copper\ reflection}$$

$$= \frac{42}{55} = 0.7636$$

Conclusion

This technique is widely applied in different field like military and space, astronomy, life sciences, environment, medical and commercial applications. The advantages of infrared thermography as a surface thermal radiation measurement technique is that it is used to detect spatial variations in the measured surface temperature pattern. In this experiment the technique was employed to detect defects in electronic circuits and to measure the transmission and reflection coefficients of materials.