Acquisition Practical

Labs 2 - Infrared Imaging

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Introduction

Infrared radiation is an electromagnetic radiation just as radio waves, ultraviolet radiation, X-rays and gamma rays. All these forms, which collectively make up the electromagnetic spectrum, are similar in that they emit energy in the form of electromagnetic waves travelling at the speed of light. Infrared radiation (IR) is one of the three main waves of transferring heat from one place to the other, convection and conduction begin the other two means.

Objectives

The goal of this pratical work is to study the application oof IR imagong to temperature measurment and to observe the influence of several parameters on the efficiency of these measurement. We are to study on the various component reaction to the implementation of IR using the Infrared camera Cedip SC7000. We will also study camera calibration using a hot plate, estimation the emissivity, the reflection coefficients and also the active thermography.

Chapter 1

Study of the camera and Altair software

1.1 Specification of the camera

WE will be using the IR Camera - Cedip SC7000 from FLIR. This series of camera is specifically designed for academic and industrial research and science applications as weel as integrators who require a flexible camera with high sensitivity, accuracy, spatial resolution and speed at an affordable cost.

1.1.1 Features:

- LWIR spectral band.
- 320 x 256 and 640 x 512 MCT and InSb detectors.
- Close-up imaging down to 7 μm.
- 4-position and 8-position motorized filter.

1.1.2 Specifications:

- Detector type: Mercury Cadmium Telluride(MCT)
- Spectral Range: 7.7-9.3 μm
- Resolution: 320 x 256
- Detector Pitch: 30 μm
- NETD: <25 mK (20 mK Typical)
- Well capacity: 37/12 M electrons
- Operability: >99.5%
- Sensor Cooling: Internal Sterling

1.2 Software specifications

Altair software: We will be using this software for this pratical work. This software suite offers powerful and sophisticated features for scientist and engineers who want to acquire, display and process infrared images. The Altair is composed of several sofwtare tools allowing simple and conventional task as weel as more complex focal plane array management features.

1.2.1 Key Features:

- Exlusively dedicated to high end thermography
- Operate with all the FLIR HighEnd cooled infrared cameras
- Unique temperature analysis functions
- Real time storage of images on laptop at full frame rate.
- Detector raw data availability
- Multiple detector options

Chapter 2

Defect detection on an eletronic circuit

In this lab part we will detect the defection on the electronic circuit by pressing the button. In the first time we took a picture of the infrared image once the camera temperature was stabilize as you can see in the figure below.

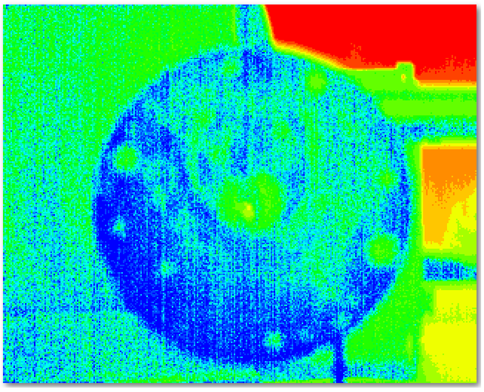


Figure 2.1: Initial image at stabilize temperature

By pressing the button which has an effect on the electronic circuit we will start to detect the defected component represented by an orange point. Find below the images showing the defect detection on the elctronic cicuit.

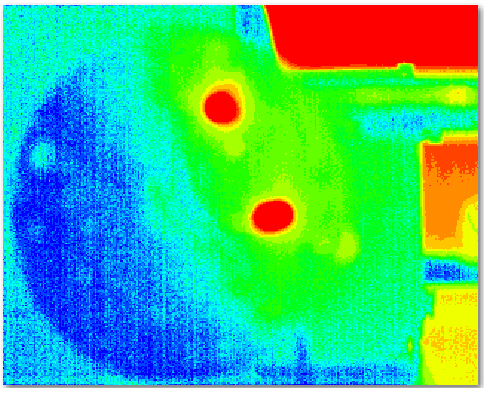


Figure 2.2: Detection of the defected component on the electronic circuit

By using the tool provided by the software Altair we were able to determine:

- the position of the defected components and the maximum temperature of each point

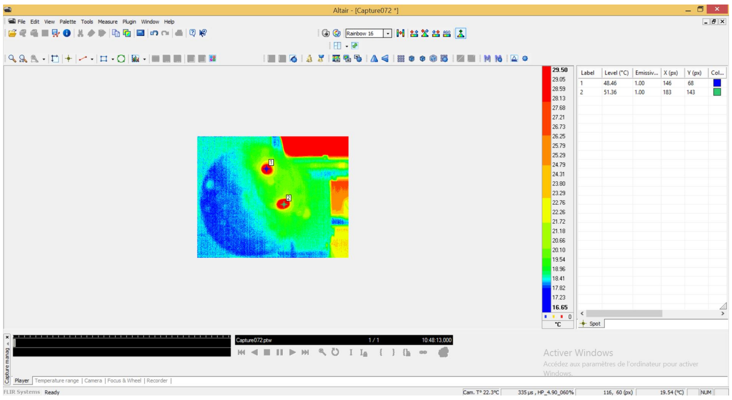


Figure 2.3: Position and temperature of the defected components

Analyze: As you can see of the figure above the position and temperature of the defeted components:

- Defected point 1: position[x=146 ; y=68] for a temperature of 48.46 °C
- Defected point 2: position[x=182 ; y=143] for a temperature of 51.36 °C

- The mean temperature of the circuit

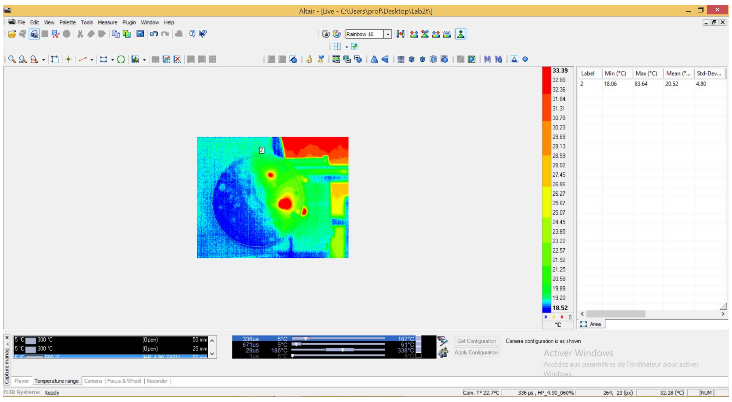


Figure 2.4: The mean temperature

Analyze: Using the tool provided by the software Altair we were able to measure the mean temperature which is 20.52 °C.

- the profile temperature

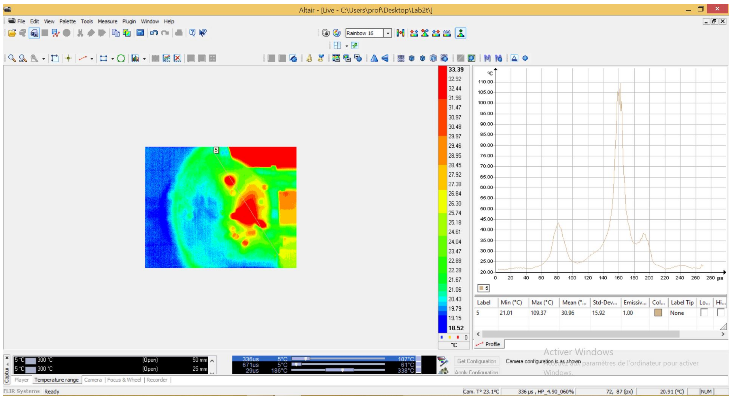


Figure 2.5: Profile temperature

Analyze: Using the tool provided by the software Altair we were able to get the graphic of the profile temperature on both defected points which provide a maximum temperature of 109.37 °C and a minimum of 21.01 °C.

Chapter 3

Camera calibration

We will be using hot plate and the digital thermometer. We will propose an experimental setup in order to realise the temperature calibration of the camera

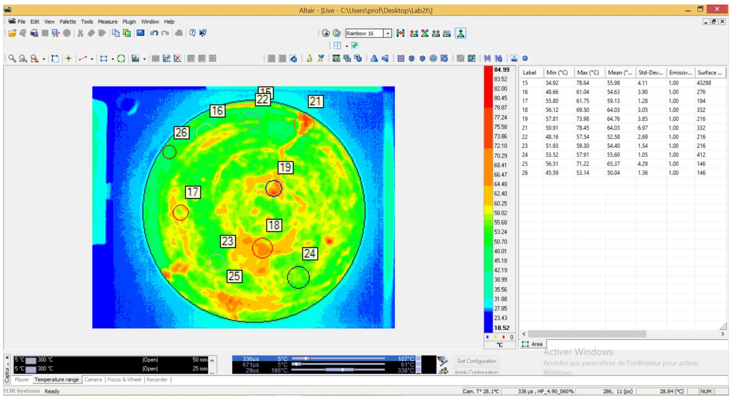
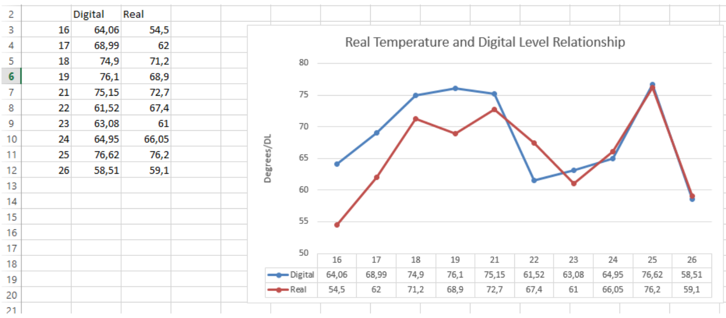


Figure 3.1: Hot plate calibration

3.1 2D graphic

On this part of the lab we had to design a 2D graphic representing the relation between the real temperature (RT) and the digital level (DL).



	Digital	Real
16	64,06	54,5
17	68,99	62
18	74,9	71,2
19	76,1	68,9
21	75,15	72,7
22	61,52	67,4
23	63,08	61
24	64,95	66,05
25	76,62	76,2
26	58,51	59,1

Figure 3.2: 2D graphic of the relation between DL and RT

Chapter 4

Estimation of emissivity

4.1 C.A 1875 Tutorial Bench

During this lab work we were using C.A.1875 tutorial bench, which comprises a hot plate with several targets having different surface conditions and made of different materials. Starting with the top left corner and going clockwise the materials were:

1. Polish steel
2. Red copper
3. Brass
4. Aluminum
5. Laminate
6. Stainless steel

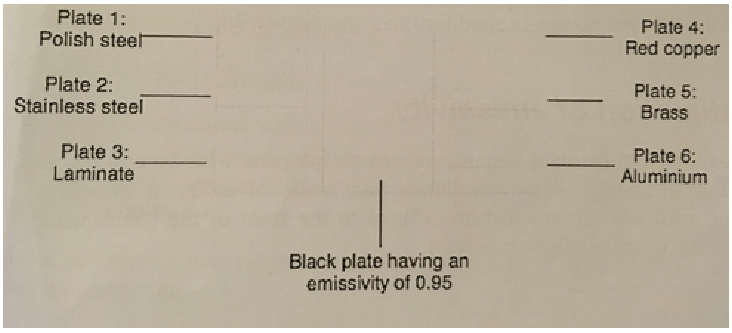


Figure 4.1: Explanation of the bench components

4.2 Before experiment

Explanation: Before starting the experiment with the bench we had to take a picture of the bench. We can observe that the color represented by the IR camera is in blue scale color meaning that the temperatureof the bench is cold. And also we are not able to distinguish the different material on the left side of the picture.

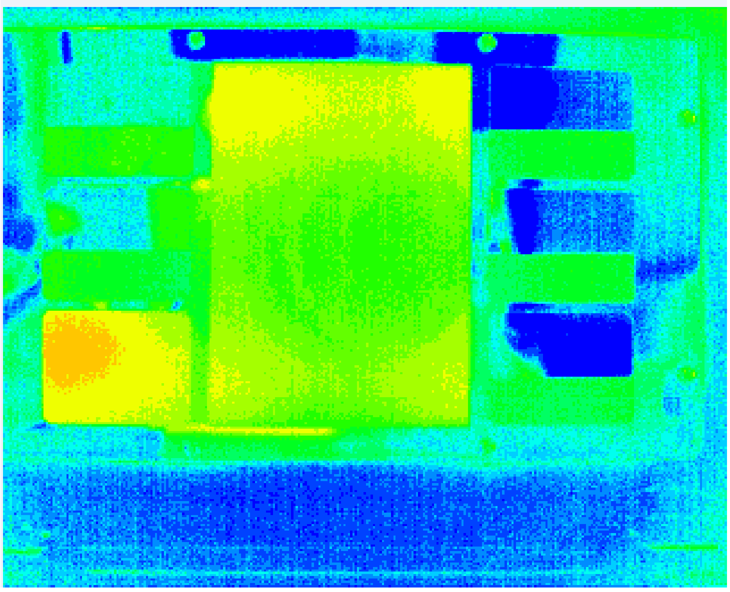


Figure 4.2: Bench before experiment

4.3 Start the bench

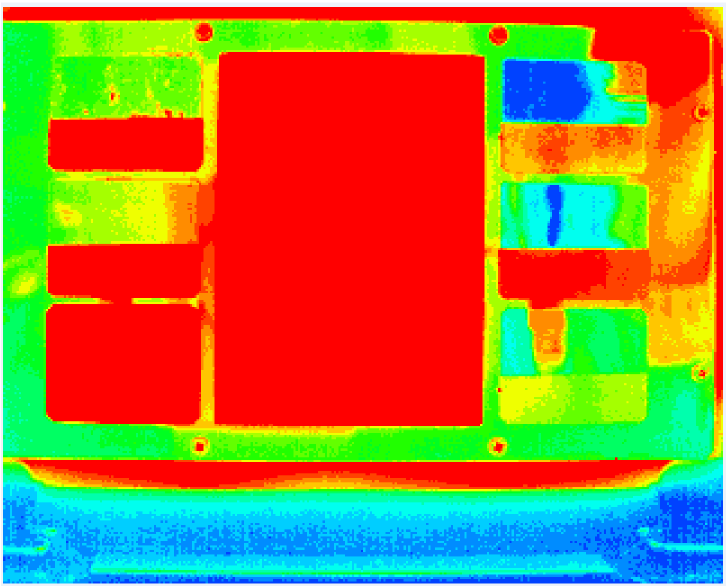


Figure 4.3: Starting the bench

Explanation; The figure above show the bench started at a stabilze temperature.

4.4 Emissivity of the bench materials

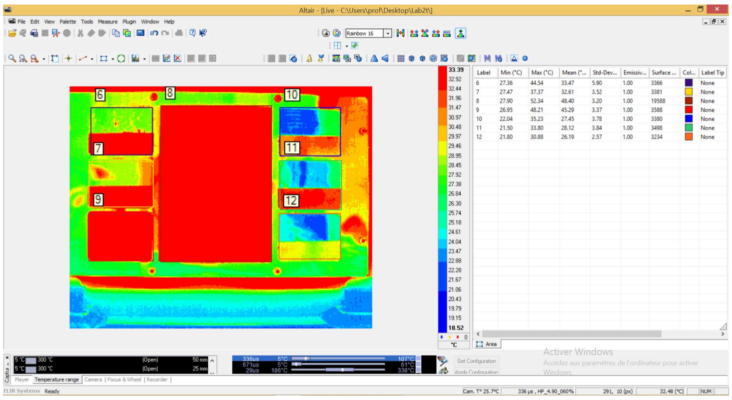


Figure 4.4: Emissivity of each material of the test bench

Explanations: In the middle of the bench was a black plate with an emissivity of 0.95. Temperature of the bench oscillates between 50 and 55 with the maximum working temperature of 60. As a result of the task to determine the emissivity of each material of the bench we acquired these results:

- Polish steel = 0.95
- Red copper = 0.943
- Brass = 0.95
- Aluminium = 0.949
- Laminate = 0.949
- Stainless = 0.95

The same measurements were taken using Black PVC and a Glass Plate. Corresponding results are:

- Glass = 0.51
- Black PVC = 0.6

Chapter 5

Transmission and reflection coefficients

During this task we were asked to propose an experimental set up for the estimation of the transmission coefficient of the glass plate and PVC. For that we put first the glass plate and then PVC in front of the bench, and installed the sensor in front of it. Then, with a 1 minute time interval, we saved the statistical information derived by the sensor from the scene. These data will allow ass to calculate the needed parameters.

5.1 Transmission coefficient

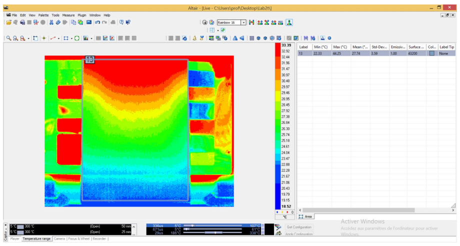


Figure 5.1: Without black PVC

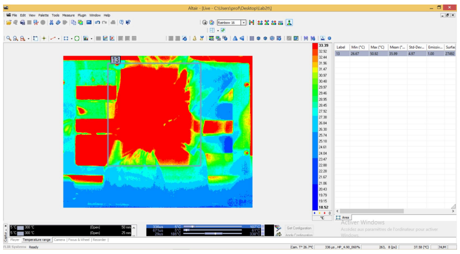


Figure 5.2: Using black PVC

5.2 Reflection coefficient

In this task we were asked to propose a method for estimating the reflection coefficient of a piece of copper. To solve this problem, we put the piece of copper with the angle to the bench, so that the reflection of the bench will fall on the piece of copper, which will be observed by the sensor. This set up will allow us to estimate the reflection coefficient of the piece of copper.

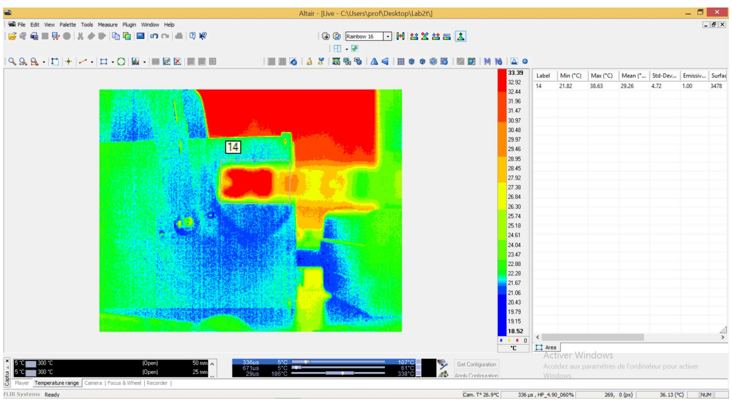


Figure 5.3: Reflection coefficient

Chapter 6

Active thermography

During this part of the lab work a halogen was used as the IR source. We observed a surface with holes with ranging depth. The task was to turn on the halogen and discern which holes are deeper observing the scene through the IR camera.According to the resulting data from the sensor, the holes on the sides are deeper the ones on the center. The surface was made of metal, so it was increasingly harder to heat it to the needed temperature, so the results of the experiment may be not completely valid.

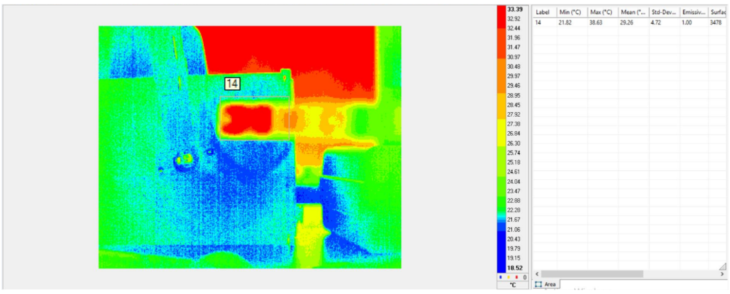


Figure 6.1: Active Thermography

Result: During this laboratory work we learned how to perform basic configuration and various measurements using IR camera. We used different infrared sources and methods to cover the range of applications and understand the process of infrared imaging better.

Chapter 7

Conclusion

This pratical work help us to understood the importance of IR camera in different domain of temperature measurement. Inrared imaging produce very good images during dark night. Some of them can even measure the temperature from along distance. Infrared camera are very useful in different domain applications, for example:

- Industrial domain, where thermal image allows to detect hot spots annoucing eletrical or mechanical failures.
- Building professionals look for insulation defect and other imperfections with a IR camera, fixing the issues provide considerable energy savings.
- Border security officers use IR camera to be able to distinguish a person 20 km away in total darkness.
- Leaks of some gases are clearly visible with a IR camera.
- And many other domain application to prove that the IR camera is very useful and helpful in different situation.

References

- **Camera Cedip SC7000 FLIR specifications** http://www.flir.eu/science/display/?id=50093
- **Camera Cedip SC7000 FLIR datasheet** http://www.flirmedia.com/MMC/THG/Brochures/RND_017/RND_017_US.pdf
- **IR Camera applications** www.flir.fr/about/display/?id=41530