THERMOGRAPHIC IMAGE PROCESSING FOR MONITORING OF SOLID SURFACES

Cotoi Alina, *"Constantin Brâncuşi" University of Târgu*-Jiu, ROMÂNIA
Borcoşi Ilie, *"Constantin Brâncuşi" University of Târgu*-Jiu, ROMÂNIA

ABSTRACT: In this paper, the authors present some steps and limitations that should be taken into consideration before processing of thermographic images when monitoring solid surfaces. In image processing, the operator should first take into account external factors and limitations that may influence the image processing, which could lead to missinterpreting of thermographic images and correct their influence.

KEY WORDS: thermography, monitoring, solids, image processing.

1. INTRODUCTION

In [1, 2, 3], the authors were taught that before taking a thermographic image, the thermography inspector should first take into account 3 factors, that cannot be changed after the image is taken:

- setting the temperature domain on the camera before taking the image;
- focalizing the object to be monitored (optical focalization);
- centering the target to be monitored (image composition).

After taking the three factors into account, further on, the autors discuss in this paper about the influence of reflected thermal radiation and some limitations in image processing.

2. REFLECTION OF THERMAL RADIATION [4, 5]

Also, function of the material the monitored objects are made of, their surface reflects thermal energy around them. The smaller the emissivity of the material, the bigger the radiation reflected.

In order to compensate for the radiation reflected in the object and the radiation emitted from the atmosphere between the camera and the object, a parameter is used, called reflected temperature. If the emissivity is low, the distance to the object big and the object temperature relatively close to that of the reflected radiation, it will be important to set and compensate for the reflected temperature correctly [2].

The following figures exemplify very well the powerful "print" left by the reflected temperature on thermographic images.

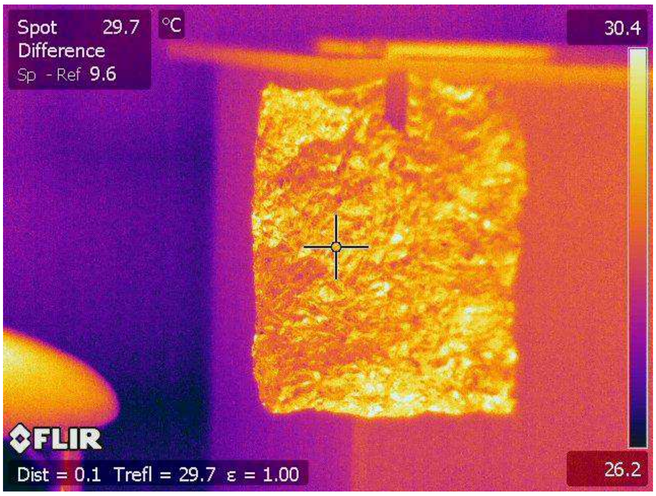

Figure1. Thermogram taken with Flir Systems ThermaCam B620 of an aluminum foil which reflects thermal radiation [3]

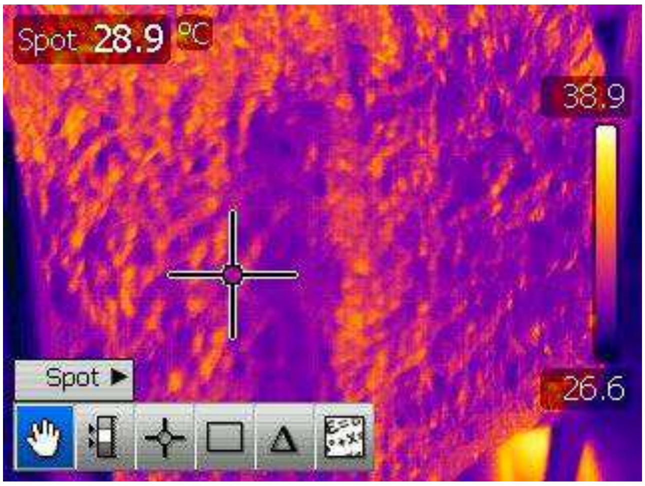

Figure 2. Thermogram taken with Flir Systems ThermaCam B400 of an aluminum foil which reflects thermal radiation [3]

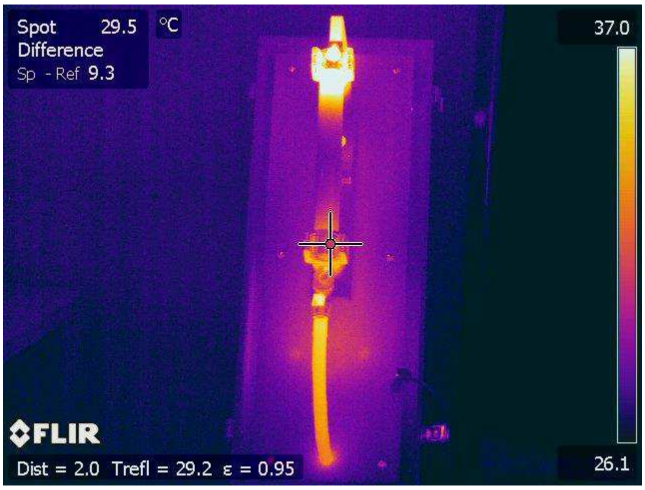

Figure 3. Thermogram of a high voltage switch heated at the superior side [3]

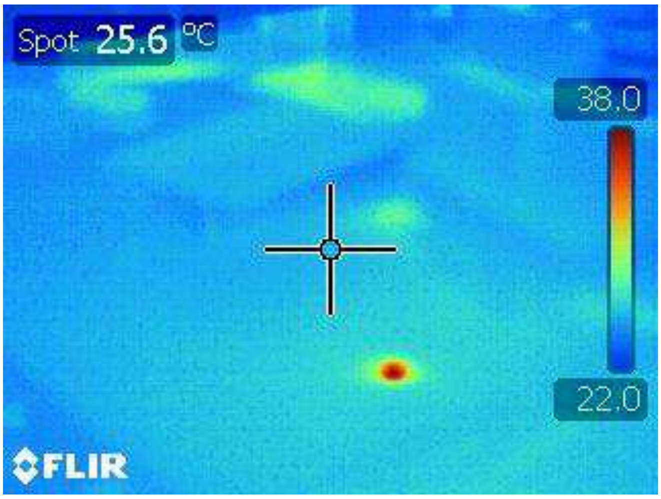

Figure 4. Thermogram of a shining porcelain table which reflects radiation of other objects

and shows a "hotter" spot where a pencil hit the surface and released thermal energy[3]

In figure 1 and 2 are thermograms taken with Flir Systems cameras which represent an aluminum foil that reflects thermal radiation. Measuring the value of reflected temperature on the object to be observed is a technique used before any thermographic measurement in order to set the correct reflected temperature on the camera. The measurement will be then made from the same position. If the amount of reflected temperature on the inspected equipments is high, a medium area value will be used, but the errors might appear in measuring. If the aluminum foil is not used and the value of the reflected temperature is very high in some parts of the thermogram, as in figure 3, the interpretation of the image can be wrong.

In figure 4 is a thermogram of a shining porcelain table which reflects radiation of the lights above and shows a "hotter" spot where a pencil hit the surface and released thermal energy. When we see the green color, for example, we may incline to say well, there is a higher temperature than the areas colored in blue. It is false. Only the spot which contains a color gradient is indeed, hotter, because it had recently hit by a pencil, and the kinetic energy of the pencil transformed into thermal energy.

Some tips to recognize reflected temperature in a thermogram are:

- the hot spot or area moves on the observed object as we move the camera.
- real heating presents color gradients, reflected heat doesn't.
- use a cardboard to shield the inspected object.
- don't stand in front of the inspected object in order to avoid your own reflection.

It is also wrong to say that if we measure the temperature difference between two components of the same type we don't need to worry in case the focalization isn't correct, or if we didn't set correctly the emissivity and reflected temperature, because the errors will be identical in both cases and will cancel themselves mutually [1].

3. LIMITATIONS IN THERMOGRAPHIC IMAGE PROCESSING

A first and very important limitation for thermographic image analysis is that the thermogram is the thermal image of the surface of the object.

Also, according to [6], a single algorithm cannot be used to monitor with success solid objects in different processes.

In this chapter, an algorithm is used to process images from two types of processes, with different solid objects as target: a lab platform which shows a high voltage switch that was heated on the upper side.

Where the value of the color in the thermogram exceeds a certain threshold, the area containing it will be reproduced in the result picture. The threshold must be given function of the nominal parameters at which the equipment works.

For example, in analyzing a thermogram showing a house interior wall, we need to find out without looking at the picture if there is heat loss or if there are cold air infiltrations into the room and the position of that area in the thermogram. In order to develop a simple program which would determine the “if” and “where”, the algorithm should only decide if there is a difference of thermal radiation in the thermogram and to highlight that area.

After applying the algorithm, the thermographer or software should determine whether in that area there is a problem (cold air infiltration, or heat loss, because it appears in the range of colors closer to darker colors, which mean by default, colder spots).

A second example, in electrical processes we use thermography because of the advantages it offers compared to other investigation techniques.

Using the same algorithm as in the first application, the authors observe the following:

- the result given by the algorithm is wrong, because it shows that there are problems not only where they really are, but also in other areas. In this case, the algorithm we designed is limited and must be improved by making the threshold variable and to be introduced by the operator before thermogram processing.
- because of the reflected radiation from other warm or hot bodies, we can see on the thermogram a close to color pink which doesn’t have the temperature corresponding to its color. The specialist knows that. The algorithm doesn’t, thus shows the zone in the result picture as being a problem.

Applying the algorithm, we will obtain a worse result than in the previous application. This is because we applied an algorithm which indicates maximum values on a thermogram whose role is to point out that for different materials which are heated at the same temperature, the temperature scale on the thermogram will vary, though it should look the same. And this is another limit of our algorithm: for each thermogram the software needs to know the emissivity of each material situated in the thermogram, which is difficult to find out even by a thermographer. Even he would need to take several thermograms and to calculate several times in order to know the emissivity for each material.

Also, the distance must be taken into account, because the bigger the distance of measurement, the higher the risk to make wrong interpretations of the thermograms, thus resulting a wrong diagnosis.

In this chapter we only pointed out few of the limits met in algorithms for thermographic image processing in process automated diagnosis. The authors concluded from the results they obtained that either a more complex algorithm should be designed containing as many extra data included before taking the picture in order to be used for as many applications as possible, or the designed algorithms for each process have the disadvantage that may not be used to monitor other processes.

The algorithms used in this chapter are simple and need more adjustments.

The thermographer must assure that he sets all the parameters for the camera to give a very suggestive thermogram.

4. CONCLUSION

The observations made by the authors in this paper are very useful in further thermographic image processing when solid objects are monitored.

REFERENCES

[1] ITCC Training Course for Thermographer level I, București, Romania

[2] Flir Systems - User's Manual for ThermaCam™ Quick View, version 1.1+

[3] Pictures taken with Flir Infrared cameras B and T series, property of ITCC Romania, during the Laboratory of the Infrared Training Course, level I thermographer

[4] Modern monitoring and diagnosis systems in predictive maintenance – PhD thesis, Politehnica Bucharest, 2016

[5] **Alina Dincă**, Ilie Borcosi, Antonie Nicolae, „Influence Of Current Load, Reflected Thermal Radiation And *Distance In Thermograms'* Interpretation", Annals of „Constantin Brancusi" University of Targu-Jiu, 7-8 November, 2008, pag. 295-300, ISSN 1844-4856

[6] **Alina Dincă**, Constantin Cercel, Ilie Borcoşi - „Limits in Proces Diagnosis Using Thermographic Images Processing", International Conference on Industrial Electronics Technology & Automation (IETA 08) in International Joint Conferences on Computer, Information, and Systems Sciences, and Engineering (CIS^2E), December 5 – 13, 2008, Springer Link volume 4: Technological Developments in Education and Automation, ISBN 978-90-481-3656-8, pp. 529-534, DOI 10.10007/978-90-481-3656-8_96