Ensuring Validity of Radiometric Temperature Measurements Obtained in the Field Using Infrared Imagers

A.E Mudau, C.J Willers, M. Hlakola, H. Calitz, B. Theron
CSIR Defense, Peace, Safety and Security, PO Box 395, Pretoria, 0001
Email: amudau@csir.co.za - www.csir.co.za

Objective

To validate the temperature of the blackbody determined from a Jade medium wave infrared (MWIR) imagers using handheld infrared thermometer

Introduction

Temperature is one of the principal parameters of thermodynamics. It is one of the most important parameters in almost all fields of science and engineering including agriculture, biomedicine, chemical and material processing, earth and atmospheric sciences, manufacturing and remote sensing and yet remains one of the most difficult to measure. Temperature can be measured with either a contact or a non-contact measurements technique. Researchers in the Optronic Sensor Systems (OSS) group at CSIR-DPSS perform radiometric measurements to support the simulation in IR system development, evaluation and optimisation [1]. To provide accurate data on which the simulation software can make realistic predictions, reliable temperature measurements are essential. This is achieved via non-contact measurement method, using infrared imagers.


Fluke Model 574 Handheld Infrared Thermometer

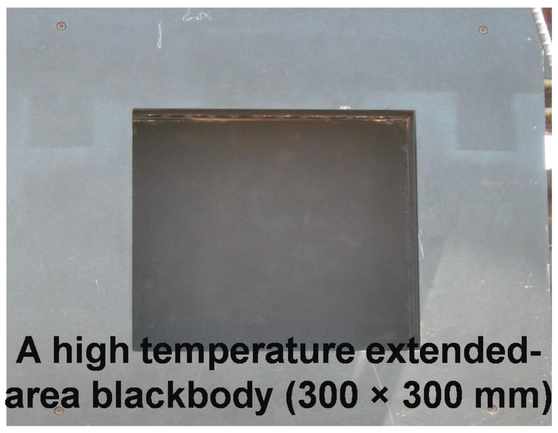
Radiation Thermometry

Radiometric temperature measurement, is the measurement of temperature based on thermal radiation. Radiation thermometry is attractive in many challenging temperature measurement situations because it is a noncontact, nonintrusive, and fast technique. This technique determines an object‘s surface temperature by measuring the amount of infrared energy radiated by the object‘s surface. The underlying principle of this technique is that at any temperature above 0 K (absolute zero) every object emits thermal radiation. Thermal radiation is governed by fundamental physical laws, such Planck’s radiation law, Wien’s displacement law, Stefan-Boltzman law, and Kirchhoff law [2].

Equipments Used

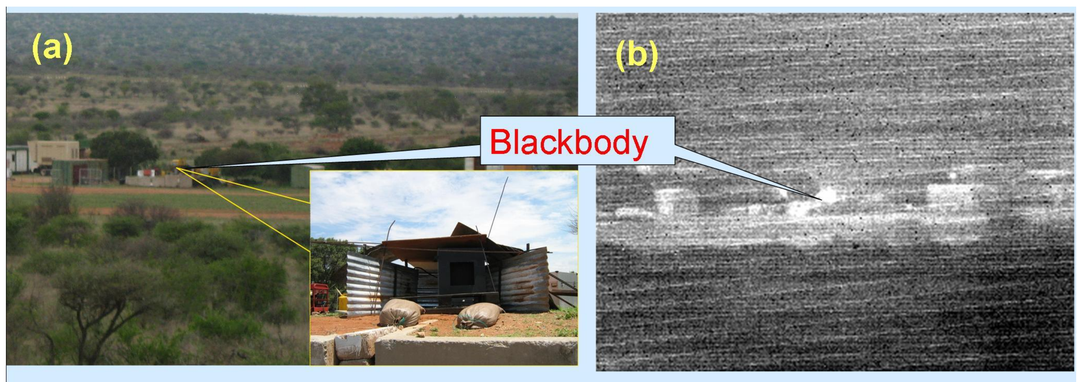
- A high temperature Electro Optics Industries extended-area blackbody
- Jade medium wave infrared (MWIR) imager
- Fluke 574 Precision Infrared Thermometer

Specifications of Radiation Thermometry	
Jade MWIR	Fluke 574 Infrared Thermometer
3.6 – 5.0	8.0 – 14.0


A high temperature extended-area blackbody (300 × 300 mm)

Blackbody Measurements

The IR images of the blackbody were acquired using Jade MWIR thermal imager located 420 m away from the blackbody and the surface temperature of the blackbody was measured using Fluke handheld infrared thermometer (approximately 15 cm).

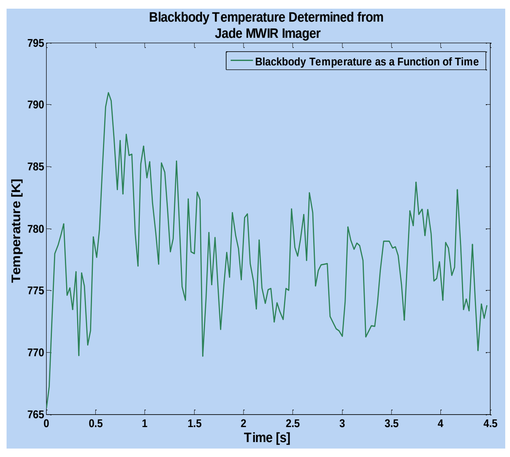


(a) Visual image and (b) infrared image obtained during the trials.

Results

The table below show the temperatures of the blackbody determined from Jade measurements together with the surface temperature of the blackbody measured using the handheld infrared thermometer. The results shown were obtained using the assumed emissivity (ε), for extended-area blackbody of 0.95.

Determined Temperature (K)		Percentage Difference (%)	The average temperature from MWIR imager with their standard deviation and the temperature measured using the Fluke 574 handheld IR thermometer.
MWIR	Fluke (±2)		
777.83 ± 4.60	751.15	1.75	
783.37 ± 3.42	752.35	2.00	



The figure on the left show the temperature of the blackbody as a function of time determined from the JADE imagers. The temperature variation versus time observed in the figure is attributed by the attenuation of the radiant output of the blackbody, optical losses, or atmospheric attenuation and non-uniformity of the surface of the blackbody..

Conclusion

The results of the infrared imager versus that of the handheld infrared thermometer were compared to ensure the validity of the infrared imager temperature measurement technique. This serves to provide confidence in the results obtained by the infrared images.

Reference

1. Willers, C.J., Wheeler, M.S. 2007a. Proceedings: IX SIGE Electronic Warfare Conference, CTA São José Dos Campos, São Paulo, Brazil, 2007.
2. Z. M. Zhang, B. K. Tsai, and G .Machin, Elsevier, San Diego, CA (2009).