



Introduction to the Acta IMEKO Thematic Issue 'Infrared thermography: challenges and new frontiers'

Antonio Cannuli¹, Roberto Montanini¹

¹ Department of Engineering - Università degli Studi di Messina, Messina, Italy

Section: EDITORIAL

Citation: A. Cannuli, R. Montanini, Introduction to the Acta IMEKO Thematic Issue 'Infrared thermography: challenges and new frontiers', Acta IMEKO, vol. 15 (2026) no. 3, pp. 1-2. DOI: [10.21014/actaimeko.v15i3.2525](https://doi.org/10.21014/actaimeko.v15i3.2525)

Received September 29, 2026; **In final form** September 30, 2026; **Published** September 2026

Copyright: This is an open-access article distributed under the terms of the [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

Corresponding author: Antonio Cannuli, e-mail: antonio.cannuli@unime.it

Dear Readers,

This Thematic Issue, entitled '*Infrared thermography: challenges and new frontiers*', brings together four contributions addressing complementary aspects of these challenges. From high-temperature emissivity measurement and thermographic system performance under harsh industrial conditions to thermoelastic stress analysis and non-invasive physiological monitoring, the papers illustrate how advances in instrumentation, measurement procedures, data processing, and experimental methodology continue to extend the capabilities and application range of infrared thermography (IRT).

The first contribution, by Medici et al. [1], addresses an important challenge for thermographic systems operating in harsh industrial environments: the degradation of image quality caused by contamination of the camera lens or protective window. Dust and other contaminants can alter the infrared signal and compromise both image quality and metrological performance. The authors investigate the use of image sharpness metrics as indicators for detecting contamination and enabling self-diagnosis of in-line thermographic systems. Controlled laboratory experiments were performed by progressively introducing dust contamination while observing high-temperature steel targets. Among the investigated metrics, Histogram Entropy and the Brenner gradient showed monotonic behaviour and high sensitivity to contamination. Their combination through multiple linear regression further improved diagnostic performance, achieving an R^2 of 0.96, and the proposed approach was subsequently validated using data acquired in a real industrial environment. The work demonstrates how image-quality assessment can become an integral part of the measurement chain, providing a valuable strategy for detecting abnormal operating conditions and preserving the metrological performance of thermographic inspection systems.

A fundamental prerequisite for quantitative infrared measurements is an accurate knowledge of the radiative properties of the investigated surface. In this context, Giulietti et

al. [2] present a systematic review of spectral emissivity measurement methods for high-temperature applications. Emissivity represents one of the main sources of uncertainty in non-contact temperature measurements and becomes particularly critical under extreme operating conditions. The authors analyse direct and indirect measurement approaches reported in the literature, considering different materials, heating technologies, spectral ranges, temperature ranges, experimental configurations, and types of emissivity. The review covers applications reaching temperatures up to 2500 °C and discusses the advantages and limitations of the different methodologies from a measurement perspective. From a metrological perspective, the review also highlights the lack of standardized approaches in terms of test protocols and reference instrumentation, as well as the inconsistent treatment of measurement uncertainty reported in the literature. By providing a structured overview of current approaches and their associated measurement challenges, the paper offers useful guidance for the design of reliable emissivity measurement chains and identifies relevant elements towards future standardization of high-temperature emissivity measurements.

The third contribution, by Tribbiani et al. [3], investigates the operational limits of bolometric infrared cameras when applied to Thermoelastic Stress Analysis (TSA). TSA is a non-contact, full-field technique capable of retrieving stress distributions from the very small temperature variations generated by the thermoelastic effect. Its implementation traditionally relies on high-performance photonic detectors because of the low amplitude and relatively high frequency of the thermal signals involved. The authors explore whether a less expensive microbolometric camera can reduce the gap with a photonic reference system when appropriate acquisition and excitation conditions are adopted. The influence of acquisition duration and excitation frequency is investigated by comparing the Stress Concentration Factor obtained from the two systems. Increasing the number of acquired frames reduces noise and improves the agreement between bolometric and photonic measurements,

with an appropriate acquisition length reducing their difference from 23 % to 13 % at the same excitation frequency. Conversely, operation close to the Nyquist frequency limit significantly deteriorates the measurement quality. The study therefore provides practical indications for extending TSA towards more accessible instrumentation while clearly identifying the acquisition constraints that must be considered to preserve measurement reliability.

Finally, Cannuli et al. [4] explore one of the emerging frontiers of IRT: the quantitative and non-invasive assessment of physiological responses in living subjects. The study investigates acute stress in domestic canaries (*Serinus Canaria*) by analysing surface temperature variations in different anatomical regions before and after a standardized handling procedure. Measurements were performed under controlled environmental and acquisition conditions using three regions of interest (ROIs): the beak, periocular area, and body surface. Significant region-dependent thermal responses were observed following handling, with relative temperature variations of 3.52 % in the beak, 2.99 % in the body, and 1.02 % in the periocular region. Statistical analysis confirmed a significant effect of the selected ROI on post-stress temperature, highlighting the beak as a particularly sensitive thermal window. Beyond the biological findings, the study emphasizes key measurement aspects such as ROI selection, environmental control, acquisition geometry, repeatability, and statistical validation. The results demonstrate the potential of IRT as a quantitative and fully non-invasive measurement method for acute stress assessment in small birds, provided that metrological constraints and standardized acquisition procedures are carefully considered, thereby supporting its extension towards animal welfare monitoring.

Taken together, the contributions collected in this Thematic Issue highlight both the versatility of infrared thermography and the measurement challenges associated with its continued expansion into increasingly demanding applications. The papers address different elements of the thermographic measurement chain, from the characterization of target emissivity and the preservation of image quality to detector performance, acquisition strategies, data processing, and the interpretation of thermal information in complex biological systems. They also

demonstrate that the future development of IRT depends not only on advances in detector technology, but also on robust measurement procedures, appropriate characterization of influencing quantities, and rigorous validation of the information extracted from thermal images.

We hope that this Thematic Issue will provide readers with useful insights into current developments in infrared thermography and stimulate further research aimed at improving its metrological reliability while extending its application to new scientific and industrial fields.

We hope you will enjoy your reading.

Antonio Cannuli
Roberto Montanini
Section Editors

REFERENCES

- [1] V. Medici, M. Martarelli, G. Pandarese, N. Paone, Assessing the effectiveness of sharpness metrics to determine the presence of contamination on thermographic cameras in harsh environments, *Acta IMEKO*, vol. 14 (2025) no. 2, pp. 1-13.
DOI: [10.21014/actaimeko.v14i2.1944](https://doi.org/10.21014/actaimeko.v14i2.1944)
- [2] N. Giulietti, G. Cosoli, R. Napolitano, G. Pandarese, G. M. Revel, P. Chiariotti, Spectral emissivity measurement for high-temperature applications: a systematic review, *Acta IMEKO*, vol. 14 (2025) no. 1, pp. 1-17.
DOI: [10.21014/actaimeko.v14i1.1846](https://doi.org/10.21014/actaimeko.v14i1.1846)
- [3] G. Tribbiani, T. Truffarelli, T. Zara, R. Marsili, A. Gaspari, L. Fabbiano, G. Rossi, Exploring the operational limits of a bolometric camera for thermoelastic stress measurements using a photonic reference camera, *Acta IMEKO*, vol. 13 (2024) no. 4, pp. 1-6.
DOI: [10.21014/actaimeko.v13i4.1759](https://doi.org/10.21014/actaimeko.v13i4.1759)
- [4] A. Cannuli, A. Costa, S. De Caro, F. Fazio, V. Parrino, A. Quattrocchi, R. Montanini, Infrared thermography as a measurement tool for non-invasive stress assessment in canaries, *Acta IMEKO*, vol. 15 (2026) no. 3, pp. 1-7.
DOI: [10.21014/actaimeko.v15i3.2330](https://doi.org/10.21014/actaimeko.v15i3.2330)