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Bridge deck surface temperature monitoring by infrared thermography and inner structure identification using PPT and PCT analysis methods

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One of the objectives of ISTIMES project was to evaluate the potentialities offered by the integration of different electromagnetic techniques able to perform non-invasive diagnostics for surveillance and monitoring of transport infrastructures. Among the EM methods investigated, we focused our research and development efforts on uncooled infrared camera techniques due to their promising potential level of dissemination linked to their relative low cost on the market. On the other hand, works were also carried out to identify well adapted implementation protocols and key limits of Pulse Phase Thermography (PPT) and Principal Component Thermography (PCT) processing methods to analyse thermal image sequence and retrieve information about the inner structure.
So the first part of this research works addresses infrared thermography measurement when it is used in quantitative mode (not in laboratory conditions) and not in qualitative mode (vision applied to survey). In such context, it requires to process in real time thermal radiative corrections on raw data acquired to take into account influences of natural environment evolution with time, thanks to additional measurements. But, camera sensor has to be enough smart to apply in real time calibration law and radiometric corrections in a varying atmosphere. So, a complete measurement system was studied and developed [1] with low cost infrared cameras available on the market. In the system developed, infrared camera is coupled with other sensors to feed simplified radiative models running, in real time, on GPU available on small PC.
The whole measurement system was implemented on the “Musmeci” bridge located in Potenza (Italy). No traffic interruption was required during the mounting of our measurement system. The infrared camera was fixed on top of a mast at 6 m elevation from the surface of the bridge deck. A small weather station was added on the same mast at 1 m under the camera. A GPS antenna was also fixed at the basis of the mast and at a same elevation than the bridge deck surface. This trial took place during 4 days, but our system was leaved in stand alone acquisition mode only during 3 days. Thanks to the software developed and the small computer hardware used, thermal image were acquired at a frame rate of 0.1 Hz by averaging 50 thermal images leaving the original camera frame rate fixed at 5 Hz. Each hour, a thermal image sequence was stored on the internal hard drive and data were also retrieved, on demand, by using a wireless connection and a tablet PC.
In the second part of this work, thermal image sequences analysis was carried out. Two analysis approaches were studied: one based on the use of the Fast Fourier Transform [2] and the second one based on the Principal Component Analysis [3-4]. Results obtained show that the inner structure of the deck was identified though thermal images were affected by the fact that the bridge was open to traffic during the whole experiments duration.

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