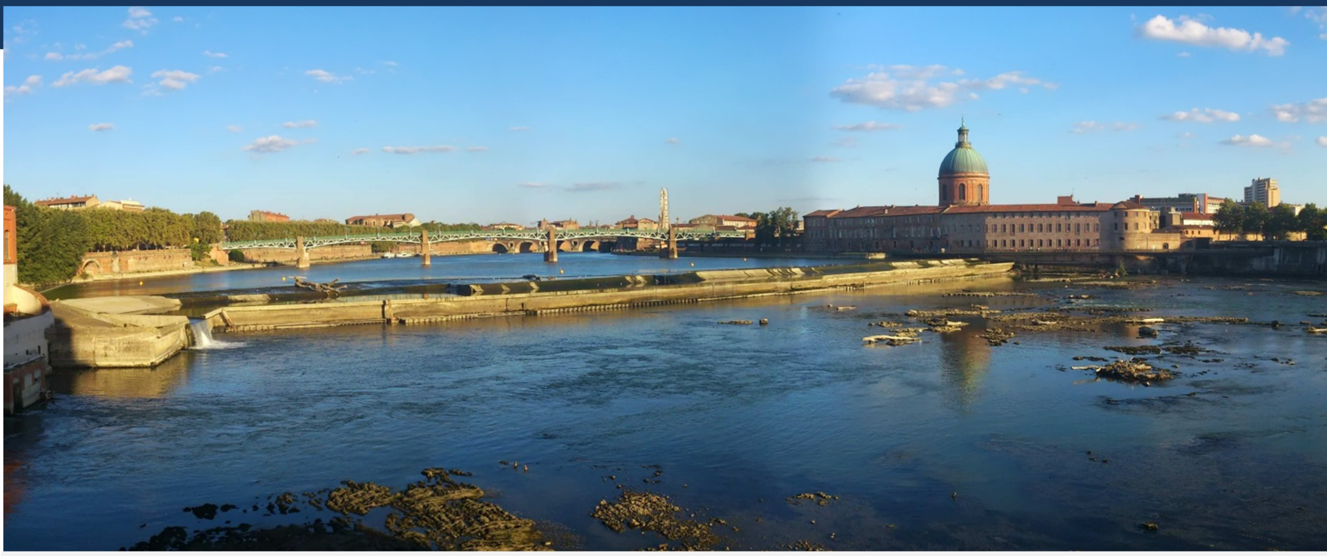

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Evaluating Stress Through Thermal Imaging Cameras

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Content

There is evidence that a high cognitive workload may hamper human performance. In the context of piloting, it is important to investigate the factors that induce such situations. This can be done using sensors that capture behavioral and physiological responses. However, used sensors are often cumbersome and require physical contact (EEC, fNIRS). We need sensors that can operate and access physiological parameters uninvasively. In this sense, thermal imaging-based physiological monitoring is an active research topic. It grants remote and unobtrusive access to the distribution of the temperature on the surface of objects and skin, by interpreting the emitted electromagnetic radiations reflected on the surface. Therefore, physiological behaviors can be remotely evaluated through thermal cameras. Recent developments of small and pervasive devices provide affordable mobile thermal image cameras.
The human face is often considered as the area of most marked temperature fluctuation (Ziegler, 2006). It is assumed that skin temperature is tightly linked to the blood irrigation of tissue. Modulation of this irrigation reflects the thermoregulation of nervous system responses. Most proposed techniques used a region-of-interest (ROI) to delineate the area where the temperature is calculated. The location of the ROI implicitly defines the type of physiological behavior to study. As an example, a ROI on the nose area is used to quantify stress from the temperature variation in the area (Cho. Nose Heat: Exploring Stress-induced Nasal Thermal Variability through Mobile Thermal Imaging. December 2019). This is limited in its requirements to define a fixed region to track, hence, it requires the participant to remain still during the tasks. In our approach, we use a robust method that tracks human face, and then yield the exact position of the nose via facial landmarks detection. All skin regions do not respond similarly to thermal stimulations, therefore, we will further investigate other areas (forehead, periorbital).
The current research extends earlier works on cognitive workload through thermal imaging to the piloting context. In our setup, the face of 20 participants will be tracked in a realistic flight simulator, using a deep-neural-network-based approach, and a facial landmark detector to retrieve a polygon that represents the nose. A custom tracker is employed to assess the validity of the captured nose region. We are therefore able to capture changes in temperature of participants while they are performing the experiment tasks with a normal freedom of movement. We use an Optris 400 IR camera with a temperature range between -20° to 900℃ (error range = 2℃), sampled at 80Hz, covering a spectral range of 7.5-13 micrometers, with a resolution of 382 x 288 pixel.
While this study provides evidence of the benefit of thermal imaging for knowing when demanding events occur during a flight or air traffic activities, an in-depth evaluation with different tasks, different sensors, different illuminations or multi-features tracking would be interesting. Moreover, our method can be used to derive other parts of the human body that could become interesting ROIs to investigate. We hope this study will engage the community to explore the approach further.

Keywords : Mental workload, Acute stress, Emotion, Fatigue