proceedings

Abstract

Preliminary Insights into Thermography-Based Psychophysiological Monitoring of Musicians During Performance†

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Abstract: Performance anxiety is a common issue among musicians, and it could be fundamental to monitor their psychophysiological states during performances through non-invasive methods to support them in managing anxiety. Hence, infrared thermography (IRT) could be a valuable tool for this purpose. The study aims to assess whether IRT can effectively monitor musicians' psychophysiological states. The facial temperature of four musicians was recorded during two conditions: rehearsal and live performance. The temperature time course was extracted from 3 regions of interest (ROIS) (i.e., forehead, nose tip, and perioral) and the following metrics were computed: skewness, kurtosis, and sample entropy. Moreover, machine learning models were applied to evaluate the presence of stress and the balance between sympathetic and parasympathetic systems. The results showed notable changes in thermal metrics in all the ROIs. Moreover, the prevalence of the sympathetic system for 50% of the rehearsal and 92% of the live performance durations was assessed. Additionally, the presence of elevated stress indicators was assessed for 6% of the duration of the rehearsals and 9% for the live performances. These results demonstrated the capability of IRT to assess modifications of the psychophysiological state of the musicians secondary to the condition of the performance.

Keywords: Infrared Thermography (IRT), Musical Performance, Psychophysiological Assessment, Artificial intelligence (AI). Machine Learning (ML)

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1. Introduction

Music performance anxiety (MPA) is a significant challenge faced by musicians, impacting their overall performance quality and psychological well-being [1]. Musicians frequently report symptoms such as palpitations, sweating, and other forms of physiological arousal during performances, which are indicative of heightened anxiety levels [2]. Such experiences can compromise both their technical skills during performances and their emotional mental health, leading to a cycle of stress and underperformance.

In this context, it could be beneficial to adopt non-invasive methods for monitoring the psychophysiological states of performers during live situations. To this aim, infrared thermography (IRT) can be a suitable tool to assess the psychophysiological conditions of musicians during concerts thanks to its non-invasive and contactless features [3]. IRT enables the measurement of surface temperature variations, which can reflect emotional

and stress-related states. The use of IRT can be particularly beneficial during rehearsals and live performances, as it provides real-time feedback and allows musicians to engage more with their emotional and psychological states as they perform. Notably, the capability of IRT to infer the emotional status of individuals can be increased by employing machine learning (ML) algorithms [4]

The present study aims to assess whether IRT can effectively monitor musicians' psychophysiological states during rehearsals and live performances exploiting ML approaches.

2. Materials and Methods

The facial temperature of four musicians (1F, age: 28 ± 9 years) was recorded during rehearsal and live performance through a physiological module called HIRA developed by Next2u s.r.l. (www.next2u-solutions.com) (Figure 1A) composed of co-registered RGB and Infrared cameras [5]. This module enables real-time monitoring of individuals' emotional states using ML models that analyze thermal features derived from specific facial regions of interest (ROIs) [6]. The temperature time course from 6 ROIS (i.e., nose tip, nostrils, nose, glabella, perioral, and forehead) was evaluated through an embedded tracking algorithm (Figure 1B) and the following metrics were computed: skewness, kurtosis, and sample entropy. Moreover, the embedded HIRA ML models able to evaluate the presence of stress and the balance between sympathetic and parasympathetic systems, trained and tested in Russo et al., 2023 [6], were used. Notably, the HIRA module was placed on the music stand at a distance of 60 cm. Although the musician does not always remain in the same position during the performance, reliable measurements can be obtained within a range of ±25 cm in distance and ±15° in angle [7]. Importantly, the emissivity of the skin was set to 0.98.

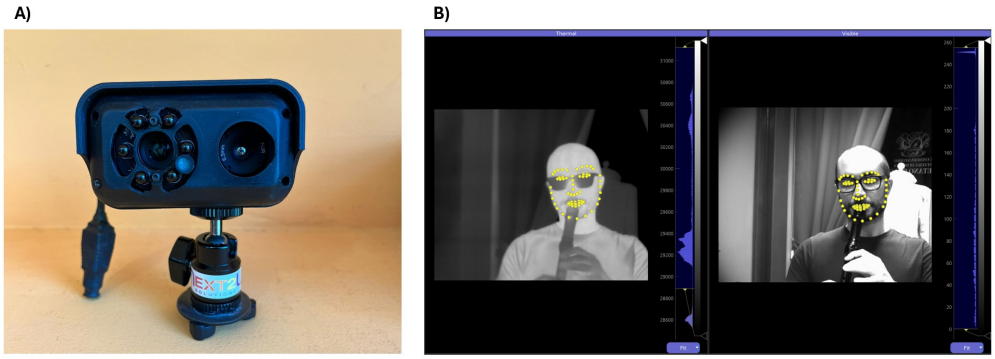

Figure 1. (A) HIRA module for thermal imaging acquisition and affective computing assessment, (B) facial landmarks tracked by the HIRA module for the regions of interest evaluation.

3. Results

The results showed notable changes in thermal metrics in all the ROIs: kurtosis decreased of around 45% (Figure 2A), skewness increased of around 30% (Figure 2B), and sample entropy decreased of around 80% (Figure 2C), when comparing the rehearsal and the performance.

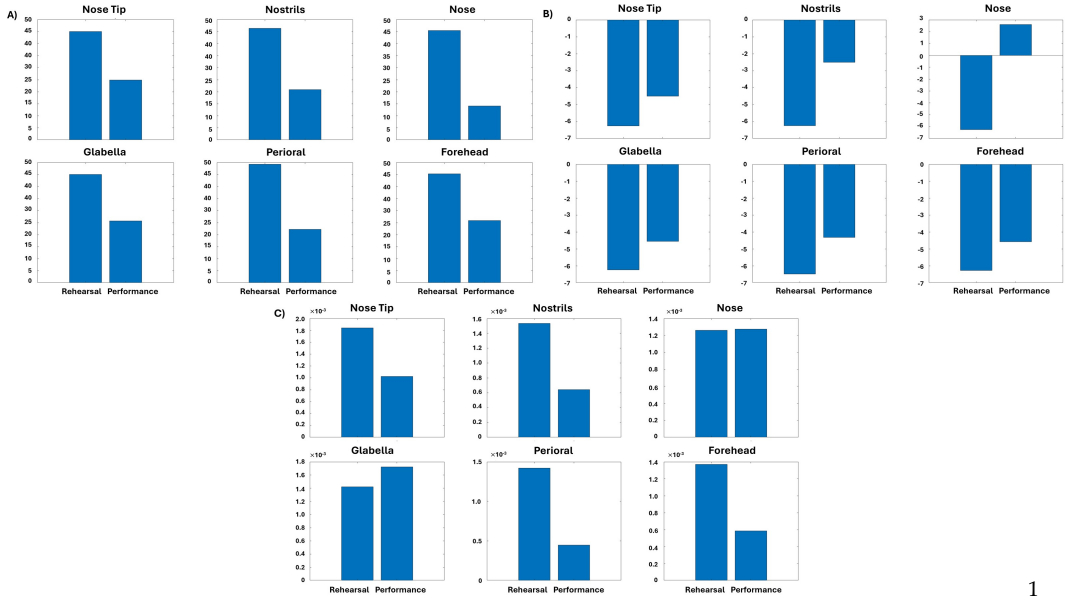

Figure 2. (A) Kurtosis, (B) skewness, and (C) sample entropy evaluated on the 6 regions of interest during rehearsal and performance.

The ML based algorithms showed a prevalence of the sympathetic system for 50% of the rehearsal and 92% of the live performance durations (Figure 3A). In addition, the presence of elevated stress indicators were present for the 6% of the duration of the rehearsals and 9% for the live performances (Figure 3B).

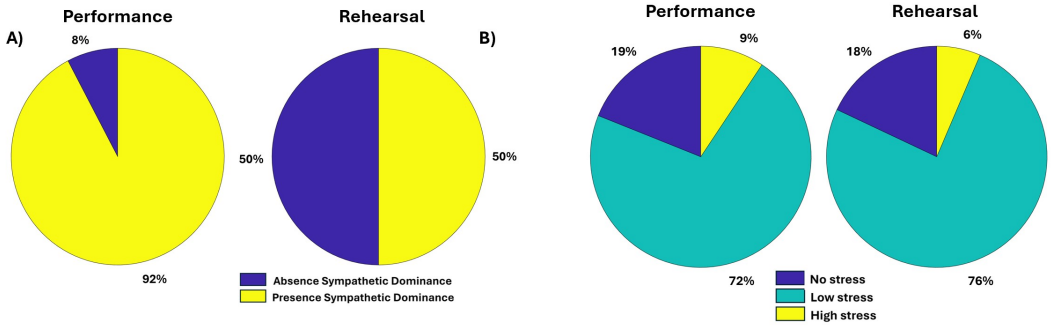

Figure 3. (A) Distribution of the sympathetic dominance and (B) stress level for the rehearsal and performance conditions.

4. Discussion and conclusions

This study provides novel insights into the use of IRT as a tool for monitoring the psychophysiological responses of musicians during rehearsal and performance. By analyzing facial temperature variations and applying ML models an evident modulation of sympathetic activity and stress levels between rehearsal and live conditions has been assesse [8]. These findings highlight the potential of IRT for scientific understanding but also for practical applications in music education and therapy. Importantly, the results suggest that even subtle shifts in performance context can yield measurable physiological responses. Such approaches may help musicians build self-awareness and resilience through biofeedback-informed training. Overall, the research paves the way for a deeper integration of technology into the artistic process, supporting well-being and expressive freedom.

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Data Availability Statement: Data are available upon request to the corresponding author

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