

HRV-Based Physiological Modelling of Occupational Stress: A Wearable Sensor Analytics Approach

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Abstract

Occupational stress is a critical determinant of employee well-being and productivity, particularly in high-demand sectors such as information technology (IT). While traditional stress assessment methods rely on subjective surveys, physiological signals—especially heart rate variability (HRV)—offer objective insight into autonomic nervous system activity. This study presents an **HRV-based physiological modelling framework** for occupational stress detection using data derived from consumer-grade wearable sensors. Continuous heart rate signals collected from smartwatch devices were processed to extract time-domain (RMSSD, SDNN), frequency-domain (LF, HF, LF/HF ratio), and selected nonlinear HRV features. These features were integrated with contextual variables, including work hours and self-reported stress scores, to develop predictive models of stress. Random Forest and Gradient Boosting classifiers were trained to categorize stress levels, while statistical analyses examined associations between HRV metrics and perceived stress among IT professionals. The results indicate that HRV features, particularly RMSSD and the LF/HF ratio, are significant predictors of occupational stress, demonstrating strong discriminative capability across stress categories. The proposed approach highlights the feasibility of using consumer-grade wearable devices for physiological stress modelling in real-world workplace settings, without reliance on clinical-grade equipment. This work contributes to the advancement of wearable analytics and AI-driven occupational health by providing an interpretable, non-invasive, and scalable framework for objective stress assessment, with practical implications for proactive workplace well-being programs and human resource strategy in technology-intensive organizations.

Keywords

Heart Rate Variability (HRV), Occupational Stress, Wearable Sensors, Physiological Modelling, RMSSD, LF/HF Ratio, Machine Learning, Smartwatch Analytics, Autonomic Nervous System, Digital Health.