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AI and IoT-Integrated Frameworks for Stress Detection, Prediction, and Management in Faculty Communities

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Abstract

Faculty members in higher education experience significant occupational stress arising from the complex interplay of teaching responsibilities, research demands, administrative duties, and student engagement. Persistent stress adversely affects cognitive performance, emotional well-being, and institutional productivity, highlighting the need for proactive and personalized management strategies. The integration of Artificial Intelligence (AI) and the Internet of Things (IoT) provides a transformative approach for continuous stress detection, prediction, and intervention. IoT-enabled wearable sensors and environmental monitoring devices capture multi-modal data streams, including physiological, behavioral, and environmental indicators, which are analyzed using advanced AI algorithms. Machine learning and deep learning techniques identify latent stress patterns, forecast potential high-risk episodes, and enable adaptive interventions tailored to individual faculty members. Reinforcement learning frameworks further optimize stress management strategies by learning from real-time responses and contextual factors. Prototype implementations in academic environments demonstrate the feasibility, scalability, and efficacy of AI-IoT integrated systems, showing improved engagement, reduced burnout, and enhanced well-being among faculty communities. Ethical considerations, data privacy, and secure data management are incorporated to ensure trust and adoption. The proposed framework establishes a comprehensive, intelligent, and context-aware approach to stress management, offering measurable benefits at both individual and institutional levels, and laying the foundation for future research on AI-IoT-enabled occupational health solutions in academic settings.

Keywords: Occupational Stress, Faculty Well-Being, AI-IoT Integration, Predictive Analytics, Reinforcement Learning, Adaptive Interventions.

Introduction

Occupational stress has become a critical concern in higher education, affecting the well-being, productivity, and engagement of faculty members [1]. Faculty routinely navigate multifaceted responsibilities, including curriculum design, research commitments, administrative obligations, and student mentoring, all contributing to elevated levels of mental and physical strain [2]. Chronic

exposure to stress has been associated with cognitive impairments, decreased teaching effectiveness, emotional exhaustion, and long-term health risks, making it a pressing issue for both individuals and institutions [3]. Traditional assessment methods, primarily based on self-reported surveys, interviews, and periodic evaluations, fail to capture the continuous and dynamic nature of stress fluctuations experienced by academic professionals [4]. The episodic nature of these conventional approaches limits the ability to identify early warning signs, provide timely interventions, or evaluate the effectiveness of stress management strategies, highlighting the need for innovative solutions that integrate advanced technology for real-time monitoring and predictive analysis [5].

The emergence of the Internet of Things (IoT) has enabled comprehensive, continuous, and non-intrusive data collection in real-world academic environments [6]. Wearable devices, smart office sensors, and mobile platforms provide multi-modal data encompassing physiological signals such as heart rate variability, electrodermal activity, and sleep patterns, alongside environmental measurements including temperature, noise, and occupancy dynamics [7]. These rich datasets allow for high-resolution analysis of stress responses, capturing subtle fluctuations that traditional methods cannot detect [8]. IoT systems also facilitate continuous monitoring across various settings, including classrooms, research labs, and administrative offices, ensuring that stress assessments are context-aware and reflective of real-time work conditions [9]. The capability to collect and transmit such high-dimensional data in real time forms the foundation for developing intelligent frameworks that can detect, predict, and manage stress proactively [10].

Artificial Intelligence (AI) techniques enhance the analytical capability of IoT data by identifying latent patterns and modeling complex relationships among physiological, behavioral, and environmental factors [11]. Machine learning and deep learning models, including support vector machines, random forests, convolutional neural networks, and recurrent neural networks, have demonstrated high accuracy in stress detection and prediction [12]. Integration of predictive models with continuous data streams enables early identification of high-risk events and facilitates personalized intervention strategies [13]. Reinforcement learning further contributes to adaptive stress management by continuously learning from individual responses and contextual factors, refining recommendations to optimize outcomes [14]. The fusion of AI with IoT not only improves the precision of stress monitoring but also ensures scalability, enabling deployment across entire faculty communities without compromising reliability or responsiveness [15].