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Innovative AI-driven framework with flexible biosensors aims to combat worker heat stress

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Houtan Jebelli holds a prototype of a wearable sensor

Assistant Professor Houtan Jebelli has been awarded a grant by the Centers for Disease Control and Prevention to spearhead a pioneering project addressing worker heat stress through the fusion of Artificial Intelligence (AI) and advanced flexible wearable sensors.

The project introduces a revolutionary heat stress monitoring framework, primarily focused on workers in heat-vulnerable industries such as construction, firefighting and agriculture. The essence of this innovation lies in its ability to predict heat-stress exposure through a sophisticated blend of machine learning algorithms and cutting-edge flexible biosensors. These biosensors are designed to be non-invasive, wireless and highly sensitive to physiological changes, offering real-time insights into workers' health.

The proposed system sets itself apart by employing advanced machine learning algorithms capable of analyzing complex physiological and environmental data. These algorithms are designed to predict potential heat stress incidents by continuously monitoring and interpreting signals such as blood flow, skin hydration, skin and core temperatures, and cardiac activity.

Central to this technology are the flexible biosensors, which represent a major technological leap. The sensors are envisioned to be non-invasive, lightweight and unobtrusive, allowing for continuous monitoring without hindering the wearer's movement or comfort. They will be capable of transmitting real-time data wirelessly, enabling immediate analysis and feedback.

One of the key challenges in existing heat stress monitoring methods is their reliance on broad environmental or working conditions, often overlooking individual physiological differences. Jebelli's project aims to address this by providing a tailored monitoring solution.

The AI component of the system will not only process real-time data but also learn from it, adapting to each worker's unique physiological profile. This level of personalization ensures that the monitoring is precise, timely and more effective in preventing heat-related illnesses.

To ensure the efficacy and reliability of this innovative system, the research team plans a rigorous testing protocol. The initial phase will involve controlled laboratory experiments to fine-tune the biosensors and AI algorithms. These tests are crucial for calibrating the system to accurately interpret physiological data and environmental factors.

Following laboratory validation, the system will undergo field testing in real-world job sites. This phase is critical for assessing the robustness and practicality of the wearable sensors and AI framework in diverse working conditions. Field tests will also provide valuable insights into the user experience and the system's integration into daily work routines.

The potential impact of this AI-driven, biosensor-based system is vast, Jebelli said. By providing early warning of heat stress, it can drastically reduce the risk of severe injuries and fatalities among workers. Furthermore, the technology has implications beyond immediate safety; it could lead to better work scheduling, improved working conditions and overall enhanced worker well-being. The success of this project could pave the way for similar technologies in other high-risk industries. The application of AI and flexible biosensors could be extended to monitor other occupational hazards, such as exposure to toxic substances or extreme fatigue, revolutionizing worker safety across various sectors.

“By integrating AI and flexible biosensors, this technology promises to deliver a more nuanced, accurate and timely approach to monitoring and preventing heat stress among workers,” Jebelli said. “As the project progresses, it holds the promise of not only safeguarding workers in high-risk industries but also of setting a new standard in occupational health monitoring.”

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Civil & Environmental Engineering

Newmark Civil Engineering Laboratory, MC-250
205 North Mathews Ave.
Urbana, IL 61801
Phone: 217-300-1271
Email: civil@illinois.edu

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