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(57) Abstract :

The present invention relates to a multimodal wearable system and associated method for inference of cognitive-motor performance states through coordinated analysis of multiple physiological signal domains. The system comprises a wearable assembly configured to be worn on a body region of a user and including a sensing module disposed within a housing of the wearable assembly. The sensing module comprises a sensing assembly supported on a flexible circuit structure and includes a plurality of physiological sensing modules configured to acquire neuromuscular, autonomic, cardiovascular, and motion-derived signals from the user. Embedded processing circuitry within the sensing module is configured to perform signal conditioning, feature extraction, and multimodal convergence analysis across the acquired physiological signals. Cognitive-motor performance indices are generated based on coordinated modulation detected across two or more physiological signal domains. The system further incorporates an edge-processing architecture enabling signal processing and inference to be executed within the wearable device, thereby reducing reliance on continuous external computation. A privacy-constrained data architecture is further provided to selectively store derived feature-level data and transmit performance indicators while limiting exposure of raw physiological signals. The system further includes a power module and a charging module configured to maintain operational continuity of the wearable assembly. The invention provides a scalable and field-deployable wearable architecture capable of delivering reliable cognitive-motor performance intelligence across high-performance operational environments.

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