Low-Cost Wearable System Using Inertial and Pressure Sensors With Machine Learning for Posture Monitoring and Pressure Injury Prevention

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Pressure injuries are a serious health problem caused by staying in the same position for long periods. They reduce blood flow to tissues and are difficult and expensive to treat. In hospitals, 10–18% of patients and up to 29% in home care are affected. Preventing them requires regular movement, usually every 20 minutes. This project presents a low-cost wearable healthcare system that monitors patient posture and pressure distribution in real time. The system combines IMU sensors (accelerometer, gyroscope and magnetometer) placed on the chest and upper thighs with pressure sensors located at high-risk body areas such as the lower back, hips and heels. Using sensor fusion and mathematical modeling, body orientation is calculated through Euler angles (roll, pitch, yaw). At the same time, pressure data is used to generate a real-time pressure risk map of the body. Machine learning algorithms analyze both orientation and pressure data to classify positions and recommend the safest next posture to reduce pressure injury risk. If the patient remains inactive for a defined period, the system provides audio and vibration alerts. The alert stops automatically when the patient reaches one of the recommended safe positions, confirmed by gyroscope data. A web application displays real-time data such as body position, pressure risk areas, recommended movements and patient location using GPS, which is especially useful for patients with Alzheimer's disease. Experimental results show over 95% accuracy in position detection. Compared to existing systems costing over $500, this solution is highly affordable at around $50. With this system, we can monitor patients in real time and help prevent pressure injuries in a simple and affordable way.

Awards Won:
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: NOT TO BE READ -- $200 cash prize for each Enrichment award recipient
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: Mawhiba Universal Enrichment Program awards (and a $200 cash prize)