ChroniSense: Developing a Wearable Device for the Dynamic Detection, Tracking, and Mitigation of Chronic Pain

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Chronic pain is the leading cause of disability worldwide, compromising the ability of over 750 million individuals to navigate their lives aid-free, yet current management options remain largely unaffordable, ineffective, and stigmatized. To address this issue, a cost-effective (~$70), long-term, wearable device that continuously measures electrical impulses of the heart (ECG) and electrical activity of the muscles (EMG) was constructed to detect two key indicators of pain in real-time, namely stress and muscle tension. For stress, algorithms were implemented to extract crucial features of the ECG, and Random Forest techniques applied to a dataset encompassing over 60,000 unique samples yielded a 95% classification accuracy in the binary determination of stressed or normal states. For muscle tension, thresholding was utilized to distinguish between three distinct stages of muscular function, relaxed, contracting, and tense, correctly identifying tension in 93% of 200 simulated trials. The efficacy of the device was then evaluated through testing on 10 individuals experiencing pain, and found to detect subjective pain episodes based on stress and muscle tension with an accuracy of 91% along with false positive and false negative rates of 8% and 5% respectively. Two-tailed paired t-tests further validated the feasibility of the aforementioned approach in detecting the presence of pain, revealing a statistically significant difference between ECG and EMG values collected during self-reported pain episodes and normal conditions ($p<0.05$). Thus, the system was deemed a success, encompassing highly reliable, affordable, and accessible pain detection that may be seamlessly paired with non-invasive therapeutic modalities to provide dynamic pain relief.

Awards Won:

Fourth Award of $500