MusTENG: A Wearable Triboelectric Nanogenerator for Personalized Muscle Spasticity Data for Improved Rehabilitation and Monitoring of Children With Cerebral Palsy

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Cerebral palsy (CP) is a cognitive disorder in which a child's brain cannot send direct messages to a body's muscles, resulting in impaired motor functions. It is a common childhood disability that affects up to 3.6/1000 kids in the US. Though physical therapy is widely recommended among CP patients, its effectiveness is inconsistent as therapists cannot distinguish the severity level of muscle dysfunction. This leads to two main challenges: without muscle spasticity data, children with cerebral palsy are not getting optimal exercise routines to help improve their motor functions. The second challenge is the lack of sophisticated methods available for tracking progress to help optimize the therapy plan. My system presents a novel approach by developing a new wearable Triboelectric Nanogenerator sensor that converts muscle movement and tension into electricity. The sensors were placed on the leg, where it gets readings from the thigh, hamstring and calf. Data was collected on a baseline, and simulated CP patient's where varying loads of tension was applied to the leg. Then, a 1D convolutional neural network was run, where the differential was determined through a area under the curve analysis method. This was found to directly correlate with spasticity levels of the muscle. A>84% success rate was achieved through further testing in determining muscle spasticity. The sensors ability is further used to look at muscle cohesiveness while walking and implemented into a PT-based game. Ultimately, this system develops a more efficient and effective physical therapy method through the use of quantifiable data.

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