Knee Extension Monitoring Device for Children with Cerebral Palsy

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Cerebral palsy (CP) is a neurological disorder which impairs movement, muscle tone, and posture. Clinical studies have found differences associated with knee angles in children with CP relative to healthy children that result in difficulty walking. Unlike healthy children, children with CP are unable to extend their knees to a full 180° when walking, resulting in a crouched gait pattern. These patients must be monitored by clinicians, including physical therapists, to ensure proper knee extension. This treatment can be time consuming and expensive. According to the Center for Disease Control and Prevention, the lifetime cost for a person with CP is 1.175 billion dollars, including physician visits, assistive devices, therapies, rehabilitation, and other long term-care options. The average copay for a weekly physical therapist appointment is $30 and patients with CP would need constant monitoring of this movement, which would accrue additional costs. Existing knee angle monitoring devices on the market are expensive and not tailored for pediatric patients. Here we present a low-cost device that will allow patients to receive at-home, direct feedback based on the knee angle measurements. The patient will be notified with the percentage of steps he or she took correctly and the gait cycles will be automatically detected and classified via a software application. This recorded data can also be stored and sent to the physician for daily tracking of the patient's progress. Two approaches were compared for measuring knee angles: a stretchable strain sensor that modeled a parallel plate capacitor and resulted in a voltage drop with stretch, and a linear taper potentiometer in which the analog signal was converted to the corresponding angle. After testing both sensors, it was determined that the potentiometer system provided more precise and reliable angle measurements. Knee angle measurements for healthy gait and crouched gait were recorded and compared. In the future, we will pair our device with a step sensor to allow for a more detailed analysis of the patient's gait. We plan on testing our device clinically and this testing will be validated against the current physical therapy treatment.