Measurement of Spinal Flexion using Wearable Sensors

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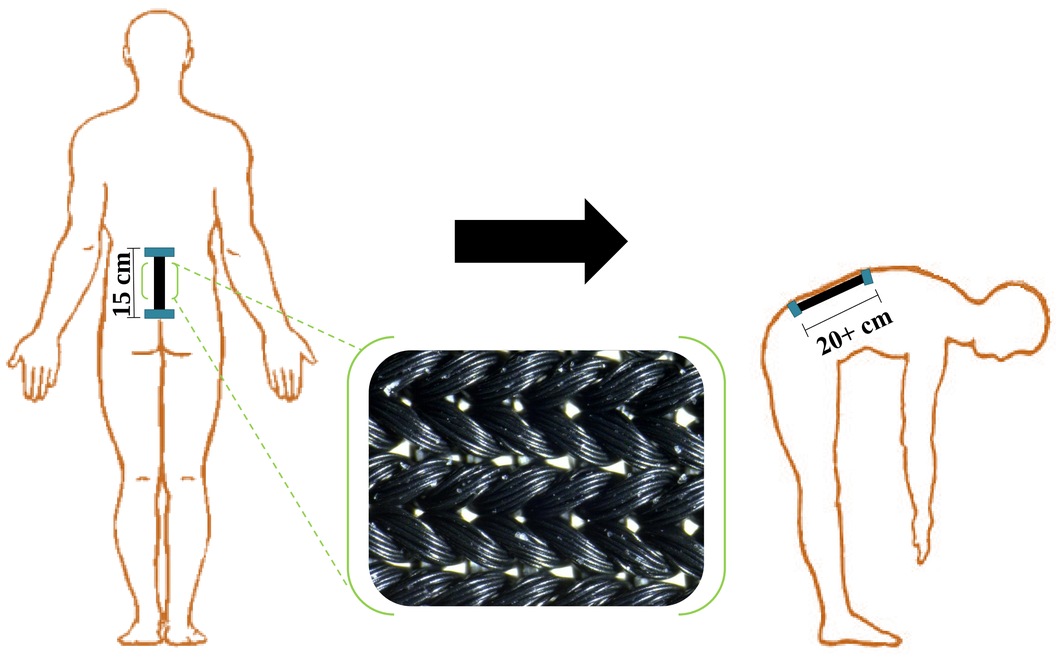
Introduction

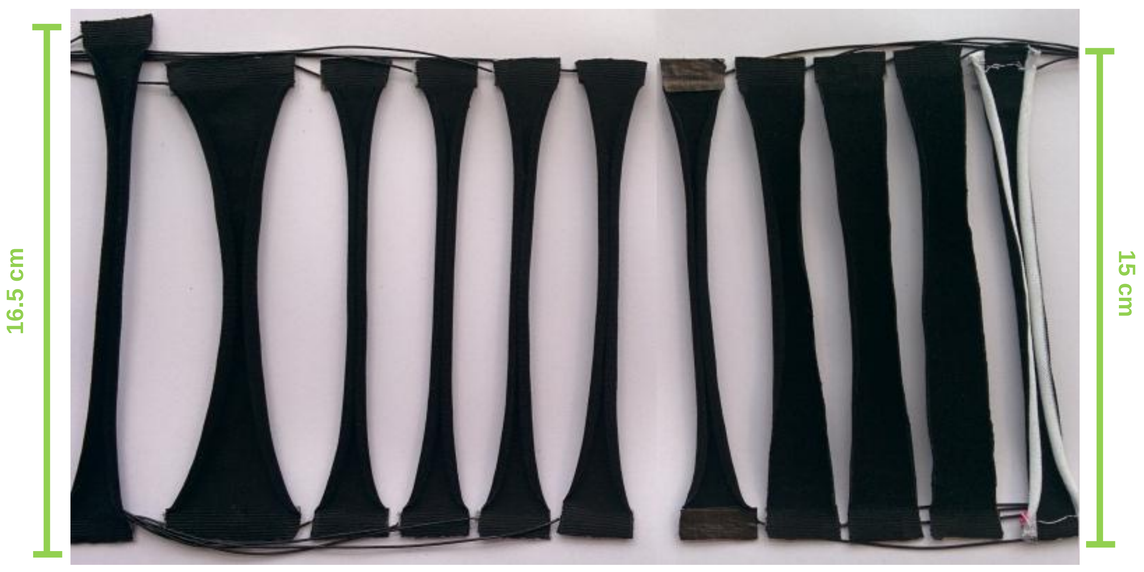
Wearable sensors have the potential to provide new methods of non-invasive physiological measurement in real-time. This work presents an alternative to the current clinical measurement of spinal flexion; the modified Schober's test. The accuracy of the test is determined by each clinician, which causes a large tendency towards error. Implementing wearable sensors and data acquisition software will not only improve the accuracy of the measurements, but the ability to analyze the data over time.

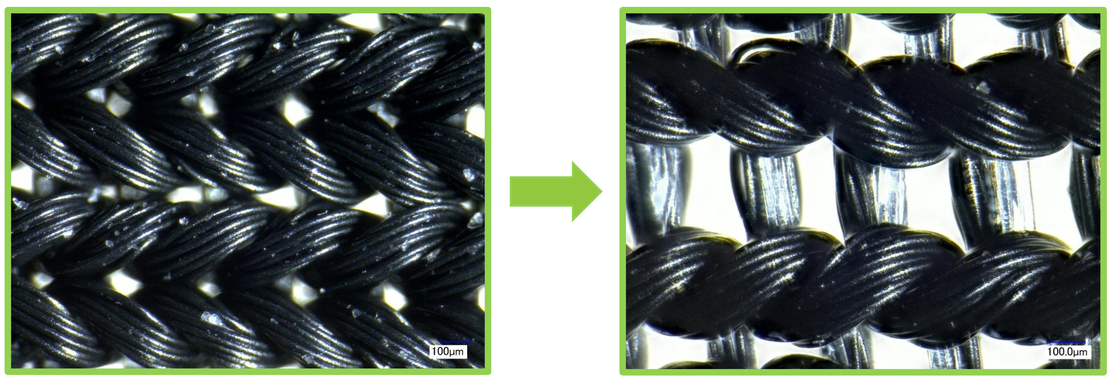
Background



We present an alternative to the current clinician measurement of spinal flexion: the modified Schober's test. By implementing a strain sensor in place of the measuring tape currently used, it is proposed that inter-observer error would be reduced and more consistent measurements would be provided over time.

Knitted Piezoresistive Fabric Sensors



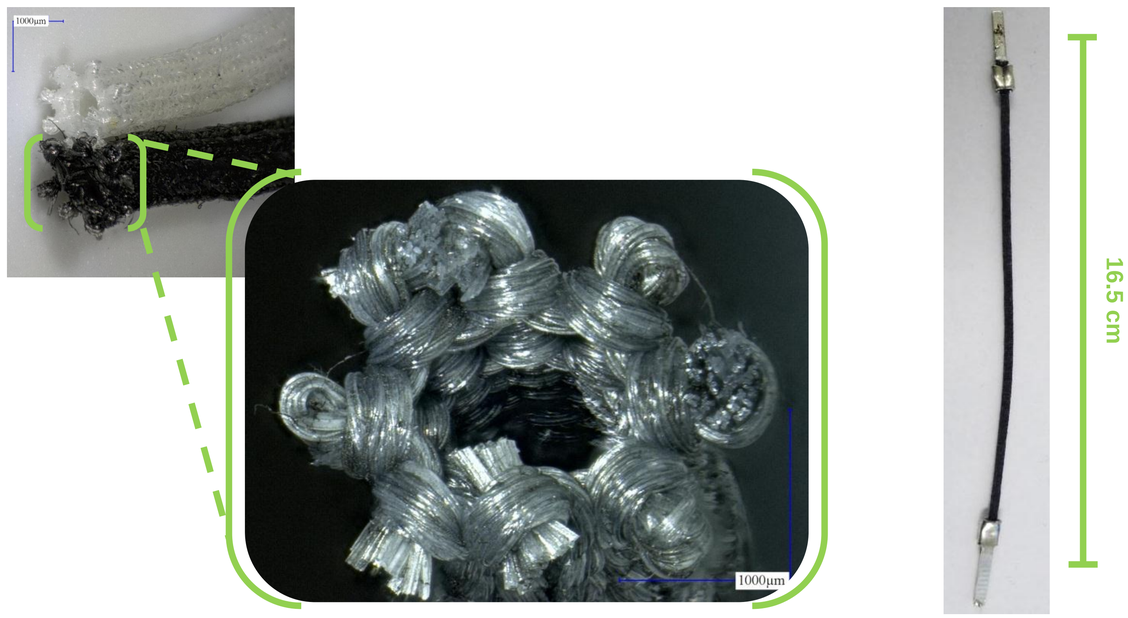


Relaxed Sensor

Stretched Sensor

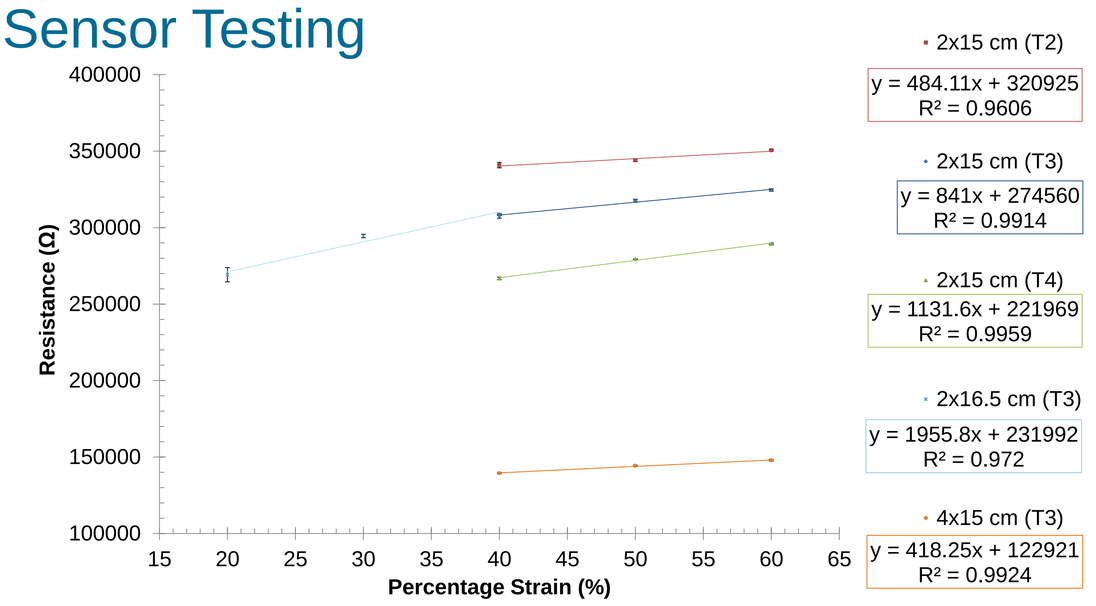
A wide variety of flat, knitted piezoresistive fabric (KPF) sensors are being tested to determine the optimum size, knit direction, and thread tension needed for this application. All sensors were tested on a Zwick 5kN tensile machine with a 0.5N pre-load and 5% increases in displacement from 0-70% strain. Sensors were held for 10 seconds between strain increases to allow for settling of the fabric.

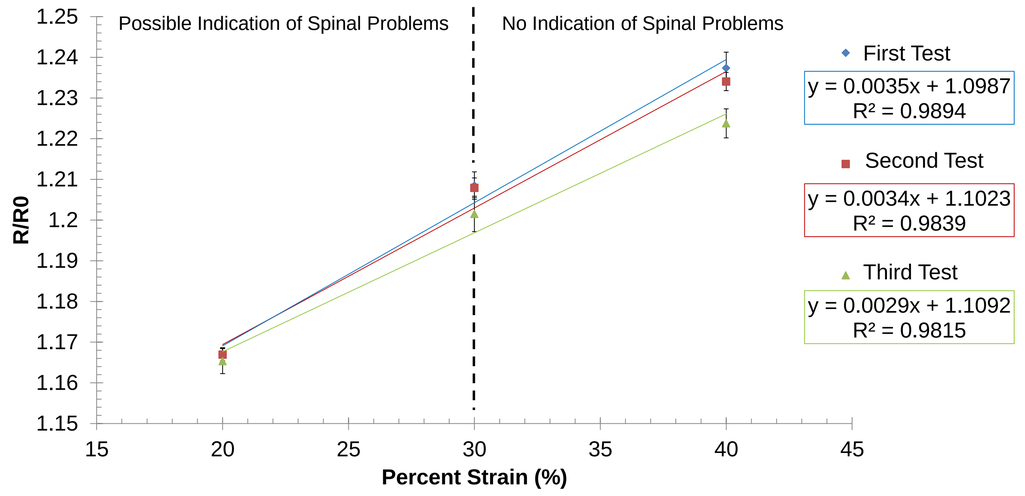
CNT Sensors



A knitted spandex cylindrical structure with integrated carbon nanotubes (CNT). A variety of sensors were produced with differing core sizes and sensor lengths. Each sensor was stretched with a linear actuator from 0% to 100% in 10% increases with a 5 second hold at each interval.

Sensor Testing





Conclusions

The results of this work will be implemented in a real-time, wearable device for measuring the flexion of the spine. Such a device is believed to increase the accuracy of measurements and monitoring of diseases over time.

Acknowledgments

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