Design and realization of a wearable posture correcting device

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International Student Conference
2021
Moratuwa
Sri Lanka

Introduction

The Problem

- Sustaining poor seating posture for long time periods can cause musculoskeletal disorders..
- Office employees are especially susceptible to this, since a majority of their workday is spent seated..
- Active efforts may fall short, since deviations can occur subconsciously..
- Therefore, people can immensely benefit from a device which reminds them to maintain a healthy posture..

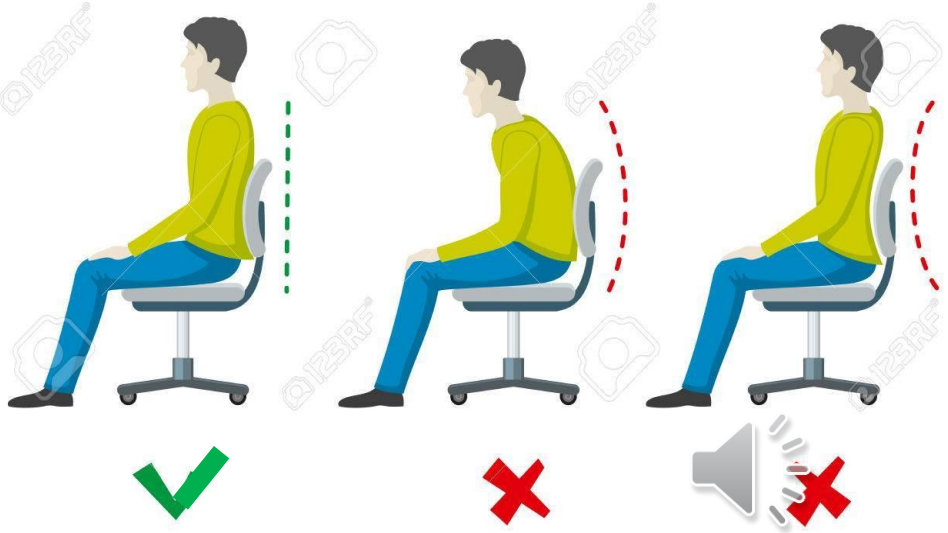


Figure 01: Different seating postures

Related Work

- Posture correction devices exist on the market, but most are limited to only measuring a single parameter..

- But proper posture should be determined more rigorously..

Figure 02: Existing electronic posture correcting devices

- A large amount of research has been conducted on electronic wearable posture correction, mostly based on IMU technology..

- Flex sensors appear to present a better alternative, but so far, research has been limited..

Objectives

- **Design** a device which monitors all the major parameters required for defining a proper posture..
- **Incorporate** flex sensors into the device, rather than solely relying on IMUs..
- **Implement** a feedback method into the device, which will aid the user to maintain proper posture..
- **Analyse** the overall feasibility and performance of the device..

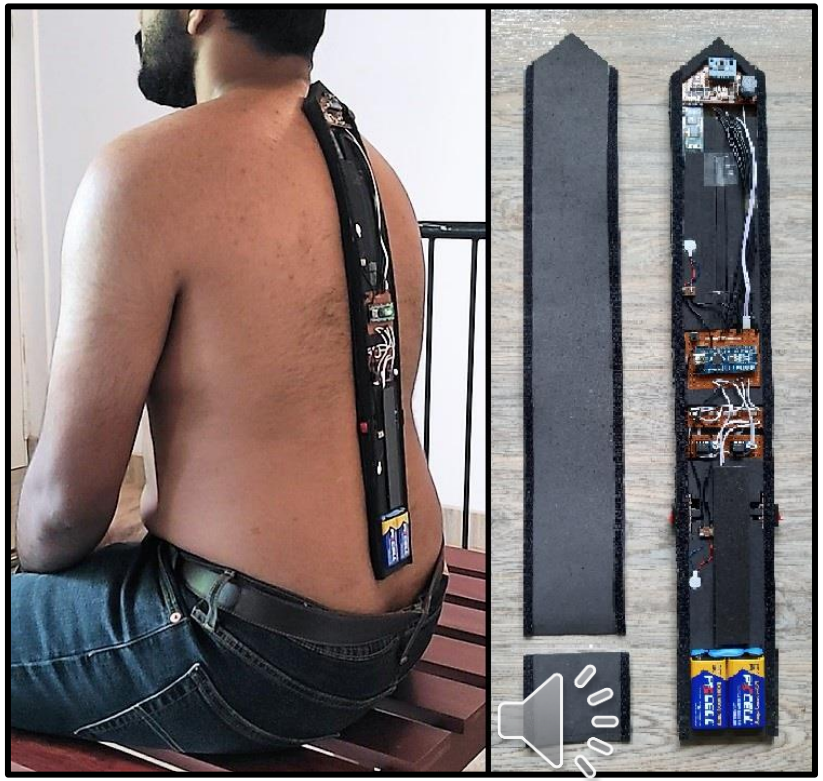


Figure 03: Fabricated device

Methodology

Physiological Background

- The neutral human spine has a distinct natural curvature..

Cervical curve → Neck region

Thoracic curve → Upper back region

Lumbar curve → Lower back region

- To identify a posture accurately, all three of these parameters need to be considered..

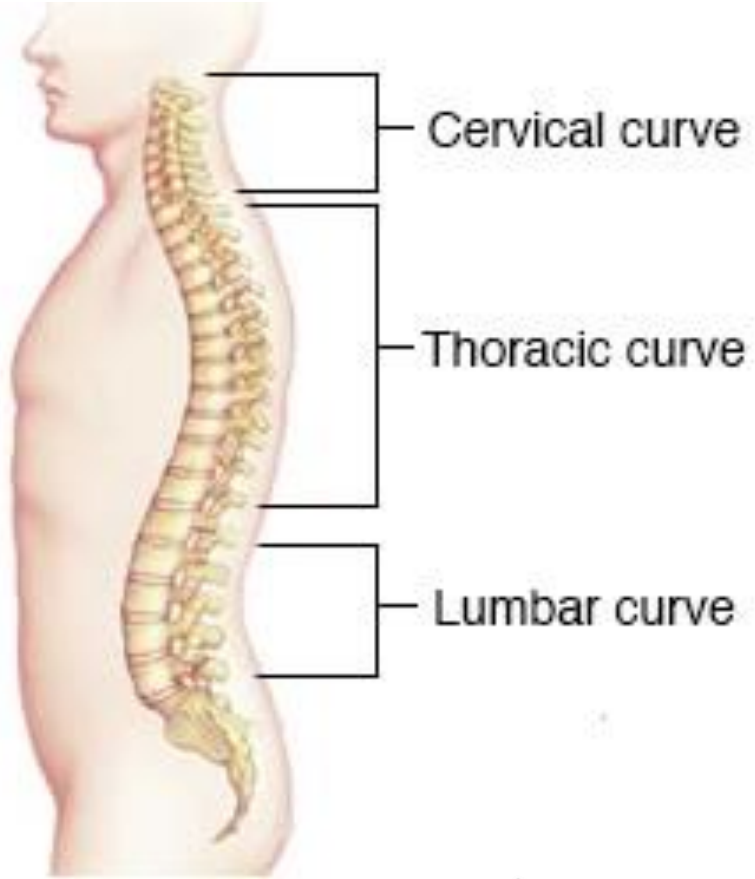
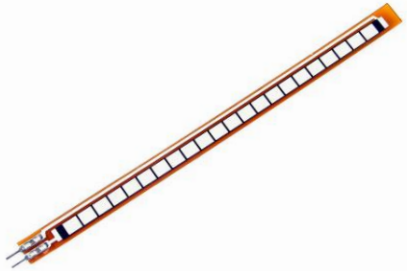


Figure 04: Natural curvature of the human spine

Main Components of the Device

- **Arduino Nano:** The microcontroller used in the device, chosen due to its small size and good performance

- **Flex Sensor:** A type of sensor capable of detecting curvature variations and bending, used to monitor the spine curves



- **ADXL345 Accelerometer:** An angle sensor to measure the inclination of the upper back

- **Additionally:** INA111 Amplifier, DC Vibration Motors, HC-05 Bluetooth Module

Device Internal Layout

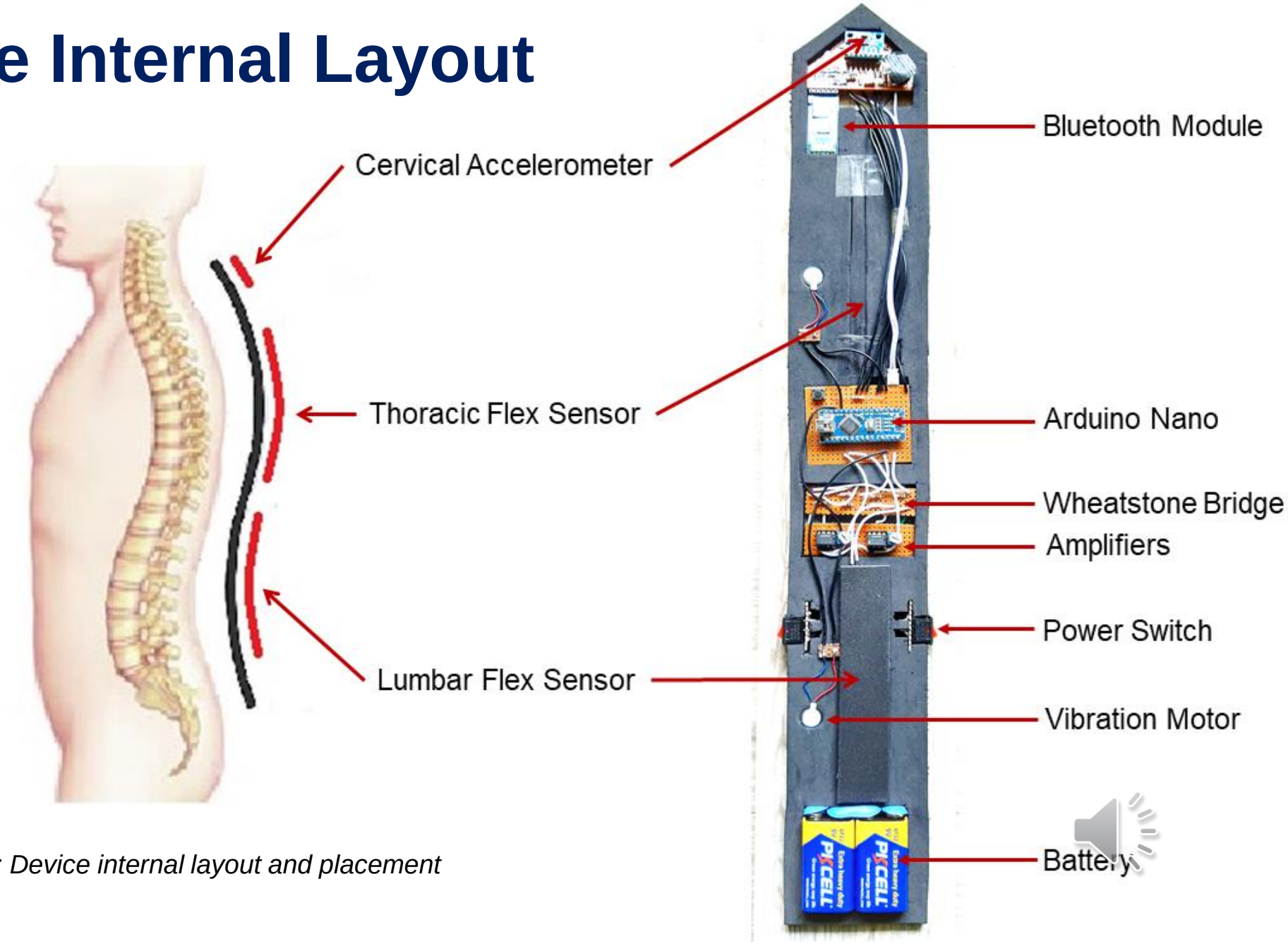
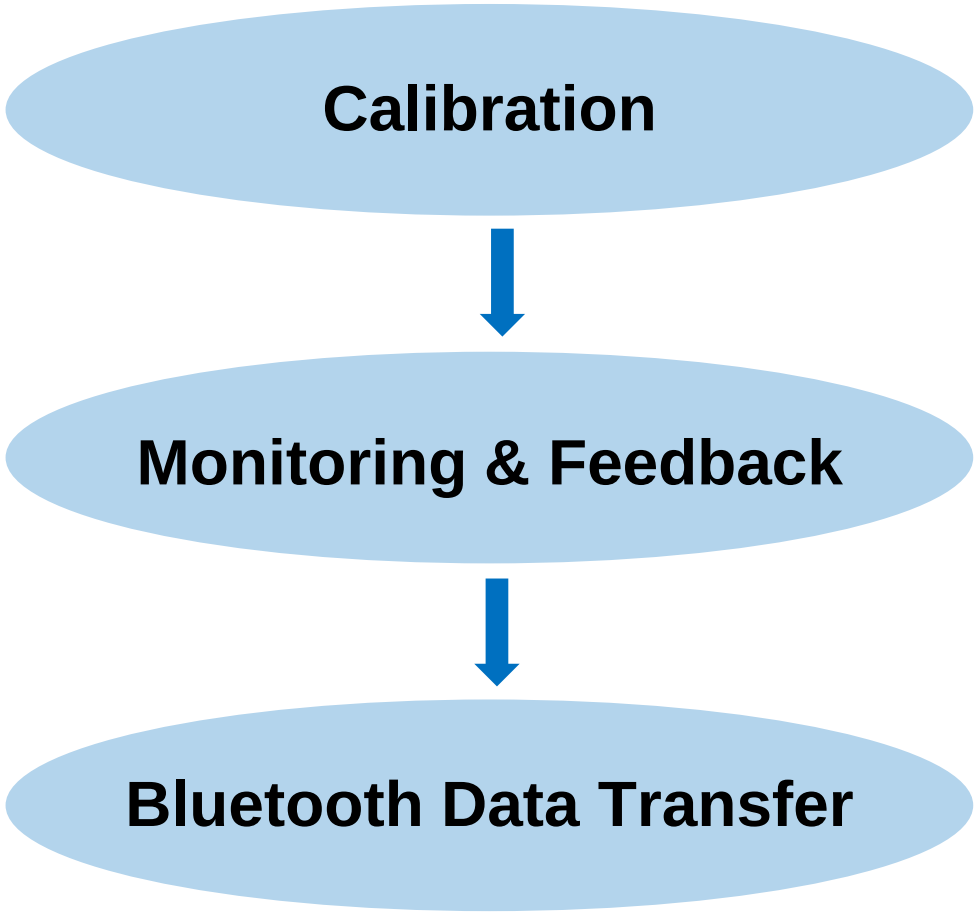


Figure 05: Device internal layout and placement

Operating Process of the Device

The operation of the device can be broken down into 3 main steps.



When the calibration button on the device is pressed, the current orientation of the device is saved, and the threshold limits are set

The real time sensor values are read and compared against the threshold limits continuously, and haptic feedback is provided when these limits are exceeded

The sensor values and limits are periodically transmitted to a designated smartphone, where the user can view and track them

Device Bluetooth Application

- The Bluetooth portal for the device was developed to enable the user to interface with the device..
- The application displays the sensor values, the threshold limits and the time variation of the sensor values..
- The application interface is shown in the figures..

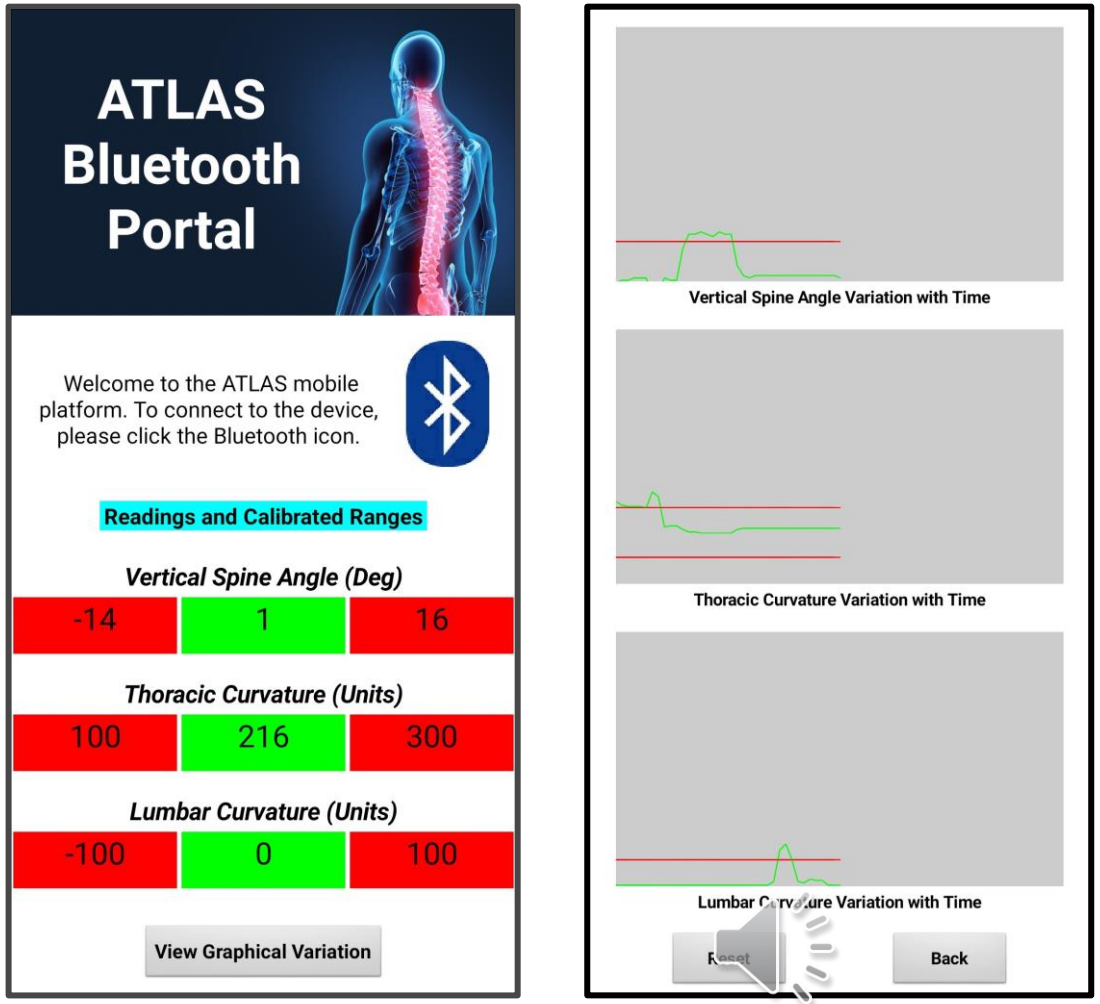


Figure 06: Smartphone application interface

90 sec

Video/
Animations ?

Results

Posture Tracking

- The sensors in the cervical and thoracic regions were tracking the posture changes to a satisfying degree of accuracy..
- However, the lumbar flex sensor was unable to detect the variations between neutral posture and slouching posture..

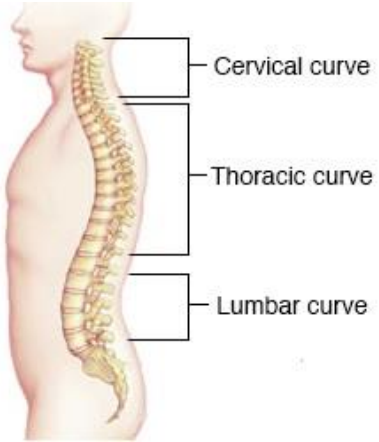


TABLE I. SENSOR READINGS OBTAINED FOR DIFFERENT POSTURES

Sensor	Lower threshold (units)	Neutral posture (units)	Slouching posture (units)	Upper threshold (units)
Cervical	60	76	47	90
Thoracic	300	342	281	400
Lumbar	-50	0	0	50

- The rubber material chosen for the device body proved to be rather stiff, hindering the sensitivity of the flex sensors..

Observations & Findings

- **Calibration feature:** This feature was working as expected, and the device was able to accurately memorize the user’s neutral spine position..
- **Haptic feedback:** Feedback using vibrations was a practical and ideal way of alerting the user with minimum intrusion..
- **Device Material:** The material chosen for the device was too stiff..
- **Adhesion:** Firmly mounting the device onto the user was difficult than anticipated..
- **Size and weight:** The device was rather bulky, which also contributed to the difficulties faced during adhering and positioning..

Improvements & Additional Features

- **Device Material:** The device body material should be replaced with a flexible and lightweight medical grade..
- **Adhesion:** Further research must be conducted to come up with a better method of adhesion..
- **Size and Weight:** Smaller electronic circuitry and more intricate fabrication methods could be used to reduce the device size and weight..
- **Intracorporeal Energy Harvesting:** Thermoelectric/ Piezoelectric energy harvesting methods could be investigated and incorporated..

Conclusions

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- An electronic posture correction device incorporating flex sensors was designed and evaluated..
- The combination of flex sensors and accelerometers was partially effective at tracking posture..
- Further research should be done after implementing modifications to the design, to fully determine the capabilities..
- Overall, the device has potential to eventually be developed into a reliable consumer product..

Thank You