Spine *Align*

Project Overview

SpineAlign is a discreet wearable that sits on the upper back, between the shoulder blades. It detects when posture drifts from a calibrated baseline and delivers gentle haptic biofeedback through a brief vibration to remind the user to straighten up. Built for the millions of students and desk workers whose posture slowly worsens through long sitting hours, SpineAlign aims to prevent the chronic lower back pain that comes from years of unnoticed slouching.

The Problem

- Roughly 80% of Americans experience lower back pain in their lifetime, costing the U.S. an estimated $60 billion a year
- Sustained poor posture is a leading cause, and it's invisible to the person doing it
- Existing posture aids are bulky or rely on the user checking an app

Our Solution

- A small wearable that adheres to the upper back, between the shoulder blades
- Tracks spinal curvature in real time using an inertial measurement unit
- Vibrates briefly when posture deviates beyond the user's baseline; haptic nudge rather than a screen notification

How It Works

1. An IMU sensor measures back angle continuously
2. An ESP32 compares each reading to a calibrated baseline
3. A coin vibration motor gets triggered

Key Specifications

- MPU-6050 IMU + XIAO ESP32-S3 Sense microcontroller
- 10 mm coin ERM vibration motor
- 3.7 V, 1000 mAh LiPo battery
- 3D-printed PLA housing, ~50×40×15 mm

Explore the Full Build

GitHub | CAD Files | Bill of Materials | Design Study

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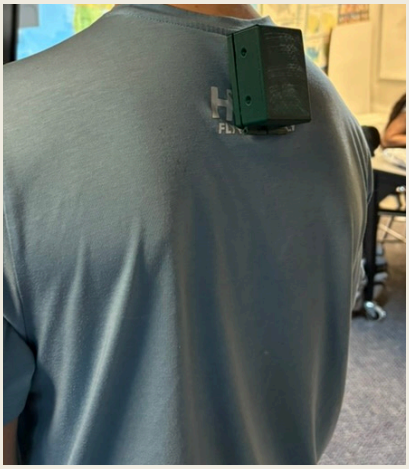
How to Use

1. **Charge**. Connect the device to any USB-C cable. The indicator LED turns green when the battery is full.
2. **Attach**. Wrap Nexcare waterproof tape and apply the device to the center of your upper back. The device can be worn directly on skin or over a thin shirt.
3. **Power on**. Slide the power switch to the ON position. The device automatically enters calibration mode.
4. **Calibrate.** Sit upright in your natural good posture for 10 to 15 seconds while the device records your baseline.
5. **Wear and work.** The device vibrates briefly when your posture deviates from the baseline.
6. **Power off.** Slide the switch to OFF when finished. Remove and discard the adhesive tape.

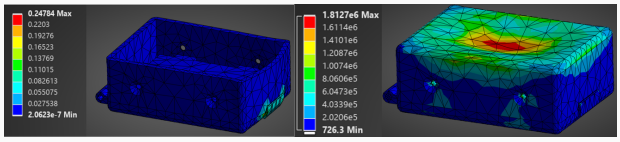


Care & Maintenance

- Recharge when the LED dims; a full charge supports 4–10 hours
- Replace the waterproof tape after every session
- One roll of tape lasts about eight weeks of daily use
- Wipe the housing with a soft, dry cloth; do not submerge or rinse
- Recalibrate any time you reposition the device on your body

Safety Warnings

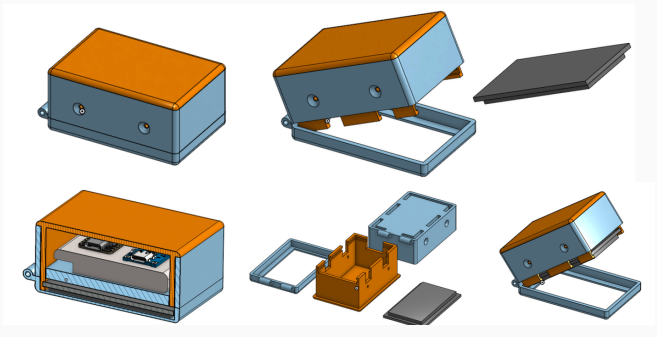
- Not a medical device. Provides posture feedback only; does not diagnose, treat, or prevent any medical condition. Consult a clinician for persistent back pain.
- Skin sensitivity. Discontinue use if redness, itching, or irritation develops at the adhesive site.
- Battery handling. Charge only with a standard USB-C cable. Do not puncture, crush, or expose to high heat. Disconnect immediately if the device feels unusually warm.
- Not waterproof. Remove before showering, swimming, or heavy perspiration.
- Not for sleep or vigorous activity. Designed for everyday seated and standing wear only.
- Small parts. Keep out of reach of children under three.
- Maximum applied load. Validated via ANSYS up to 222 N (50 lbs) of applied compressive force with peak stress under 1.81 MPa. Inspect the housing for cracks at the snap-fit features after any impact and replace if visible damage is present.



Force simulation results for Nylon PA6. Left panel shows equivalent elastic strain on the snap feature, right panel shows equivalent stress under maximum applied load.

Build Your Own

1. **3D print** the enclosure from the PLA STL files in the CAD folder
2. **Source parts** from the bill of materials total cost per unit is under $40
3. **Assemble the electronics** on perfboard per the design study wiring diagram: IMU connected via I²C to the ESP32, vibration motor driven through an N-MOSFET, LiPo battery charged through the TP4056 module
4. **Flash the firmware** to the ESP32 using the code in the project GitHub
5. **Assemble and test:** seat the electronics in the housing, attach the neoprene backing, run a calibration test on a flat surface before first wear
6. For full schematics, CAD files, and the complete bill of materials, scan the QR codes on page 1



Isometric and cross-sectional views of the top encasement (v3) featuring screws, a LiPo battery, a USB-C charging module, and an IMU.