Defying Newton's third law: designing a vibrotactile stimulator without recoil

Detecting subtle changes in sensitivity to touch is crucial for diagnosis, monitoring recovery, and supporting rehabilitation across numerous medical conditions. We are looking for a group of motivated students to design and prototype a **handheld, wireless vibrotactile stimulator** that can deliver precise vibrations (10–2000 Hz, 10 nm–10 µm) for **self-testing of touch sensitivity** anywhere on the human body. The device will work with a **smartphone app** to guide testing, control vibration settings, store results, and provide instant feedback on sensitivity thresholds.

The challenge
How do you make the tip vibrate without the handle vibrating too? By Newton's third law, every vibration at the device tip produces an equal and opposite force in the handle. Because our fingertips can detect vibrations in the range of tens of nanometers, even the slightest **off-target vibrations in the handle are perceptible and can interfere with an objective self-assessmen**t of another body part. In addition, **acoustic emissions must be minimized** to avoid influencing perceptual testing.

Designing this seemingly simple device thus requires **highly innovative and interdisciplinary engineering approaches**.

Working closely with **EPFL faculty**, neuroscientists from the **University of Geneva Faculty of Medicine**, and clinicians at the **Geneva University Hospitals**, you will explore **small high-speed actuators**, **closed-loop sensory integration**, and **advanced damping strategies** to overcome these challenges. The main development will take place at EPFL, with regular visits and co-supervision by research laboratories in Geneva.

Skills you'll gain
- Mechanical design for vibration isolation
- Control systems & precision actuation
- Sensor integration & signal processing
- User interface development (mobile app)
- Laser Doppler vibrometry and bench testing
- Biomedical device design principles
- Collaboration with clinicians and neuroscientists
- Balancing technical performance with usability, cost, and accessibility

Applications & impact
The device has immediate applications in **pain medicine, neurology, post-surgical follow-up, and women's health**—including **sensitivity self-testing for survivors of female genital mutilation (FGM)** to support rehabilitation and clinical care. **FGM still affects 1 in 17 women and girls worldwide**. This project is part of a broader FGM-related initiative that has been awarded the Leenaards Foundation 2025 Science Prize.

Ideal candidate
- Curious, driven, and hands-on
- Comfortable with both mechanical and electronic prototyping
- Interested in health tech, robotics, or human–machine interaction
- Strong problem-solving skills and able to work independently
- Excellent communication skills in French and English

For more detailed information, please contact: Aude.Billard@epfl.ch or Daniel.Huber@unige.ch