A person’s pattern of walking, i.e. gait, is regulated by a combination of the body's muscular and nervous system. Neurodegenerative pathologies such as Parkinson’s disease can disrupt normal gait, which leads to coordination loss and quality of life restrictions. Gait analysis is an important component of a standard neurological exam, and is currently performed using physician observation or camera-based motion-capture systems. However, visual observation is prone to inter-clinician variability, and camera-based systems are expensive and unavailable in many clinics. SoleSound is a gait-analysis technology worn on the patient during operation. It consists of motion sensors embedded in a standard pair of shoes, and a computer-mounted belt. The sensors in the shoes wirelessly transmit motion and position data to the computer mounted on the belt. The computer analyzes the kinematic signals and relays information back to the shoes in the form of auditory and/or vibro-tactile feedback to the patient.

Affordable and discrete device capable of quantitative gait analysis with real time feedback mechanisms

SoleSound is able to measure a patient’s gait using force sensors and motion sensors embedded into a pair of shoes. The inertial measurement unit (IMU) mounted on the back of the shoe measures linear and angular acceleration, as well as motion, and is sensitive to nine degrees of freedom. The piezo-resistive force sensors are attached to the sole, and signal peaks in force as the center of pressure in the foot moves from heel to toe. The motion and force sensors are used in combination with the computer-mounted belt to analyze kinematic signals. The single-board computer attaches to the user’s belt and runs a real-time dataflow programming environment. The computer manages the audio-tactile footstep synthesis engine through custom-written code. After the kinematic and pressure data are processed, the feedback is synthesized and sent from the computer to the shoes through two pairs of stereo cables, resulting in coordinated audio and tactile feedback to the patient. The software also performs data-logging of pressure data and kinematic data on a microSD card.

The full functionality of the device was confirmed through experimental use by a control subject with the raw data recorded during the experiment is available in a secured server.

Lead Inventors:

Sunil Agrawal, Ph.D.
Applications:

- Clinical analysis of pathological gait
- Physiotherapy to regulate patients’ gait and posture
- Medical device for gait analysis and training at home

Advantages:

- Low cost (compared to camera-enabled gait analysis)
- Five vibro-tactile actuators embedded in sole optimized to match sole areas where the density of mechanoreceptors is higher
- Autonomous multimodal feedback (untethered from an external computer)
- Feedback output is concurrently modulated by pressure signals and motion of the foot
- Onboard power and logic enable patients to exercise on their own

Patent information:

Patent Pending

Tech Ventures Reference: IR CU14306

Related Publications:


Inventors

Sunil K. Agrawal

Damiano Zanotto