Department of Biomedical Engineering

VI Semester

CBM 370 - Wearable Devices

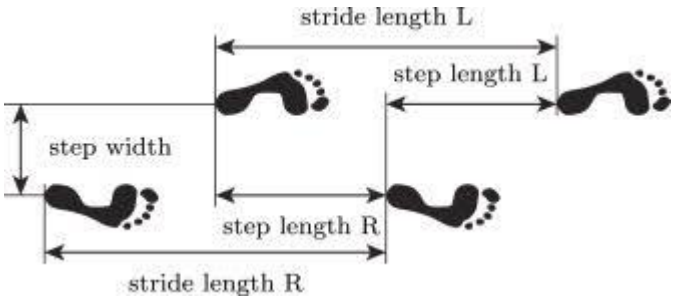
Unit- 5 APPLICATIONS OF WEARABLE SYSTEMS

5.6 Gait analysis

Wearable devices are transforming gait analysis by providing real-time, continuous, and objective data outside traditional laboratory settings. These technologies enable clinicians and researchers to monitor and assess gait parameters, offering valuable insights into various health conditions. Below are some of the applications:

1. Neurological Disorders:

- **Parkinson's Disease**: Gait analysis wearables monitor gait parameters such as stride length, cadence, and gait speed, which decline as Parkinson's disease progresses.



- **Stroke Rehabilitation**: Wearable systems monitor gait asymmetry, step length, and balance during post-stroke rehabilitation, assisting in customized treatment plans.

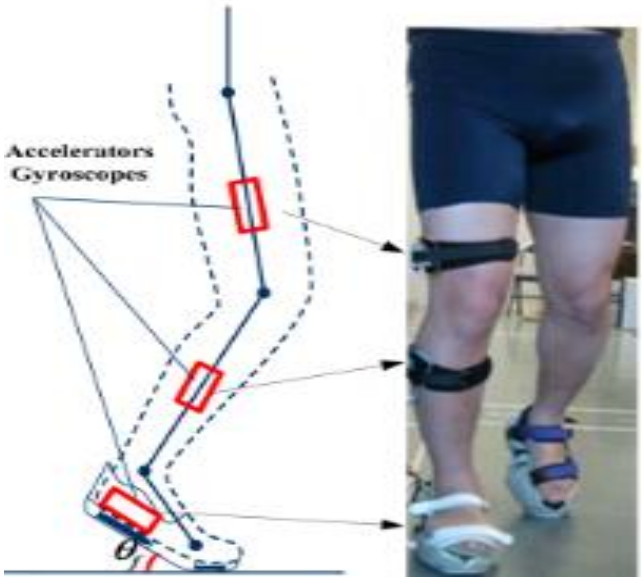


Figure 5.6.3 Kinematic measurement based on accelerators and gyroscopes. By using three pairs of accelerators and gyroscopes attached on the foot, calf and thigh separately, the angular displacements of the lower extremity were measured.

2. Orthopedic Conditions:

- **Osteoarthritis**: Wearables track joint movements, ground reaction forces, and gait patterns to manage osteoarthritis and improve mobility.

Estimating Ground Reaction Force

- **Post-Surgery Recovery**: Gait analysis wearables monitor recovery progress, measure range of motion, and detect compensations following knee or hip replacement.

3. Fall Risk Assessment:

- Wearable inertial measurement units (IMUs) identify gait patterns associated with increased fall risk in elderly populations.
- Devices alert caregivers or provide biofeedback to improve balance and stability.

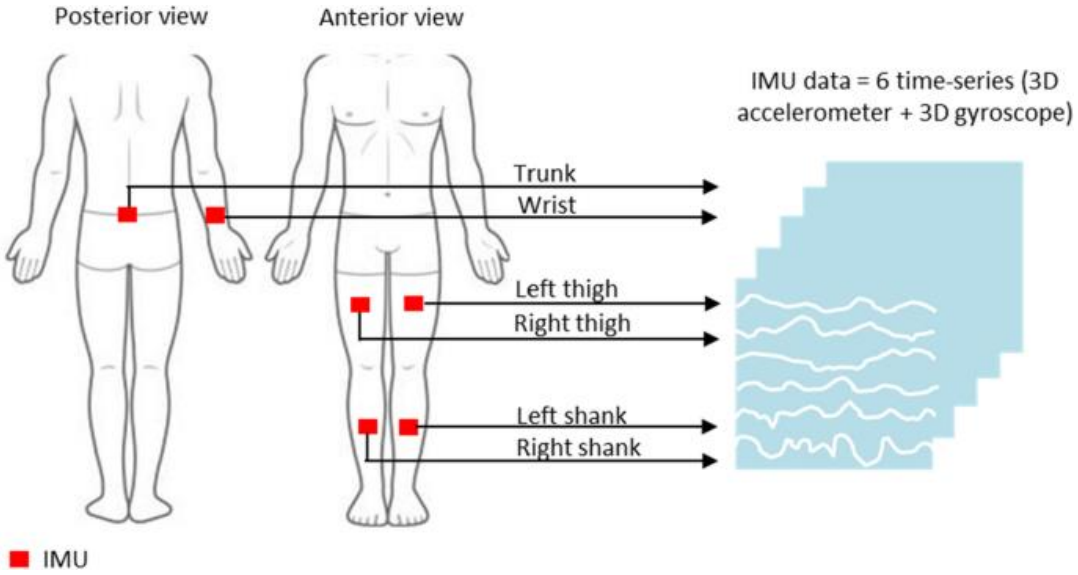


Figure. IMU Measurement Unit for Gait Analysis

4. Sports Performance:

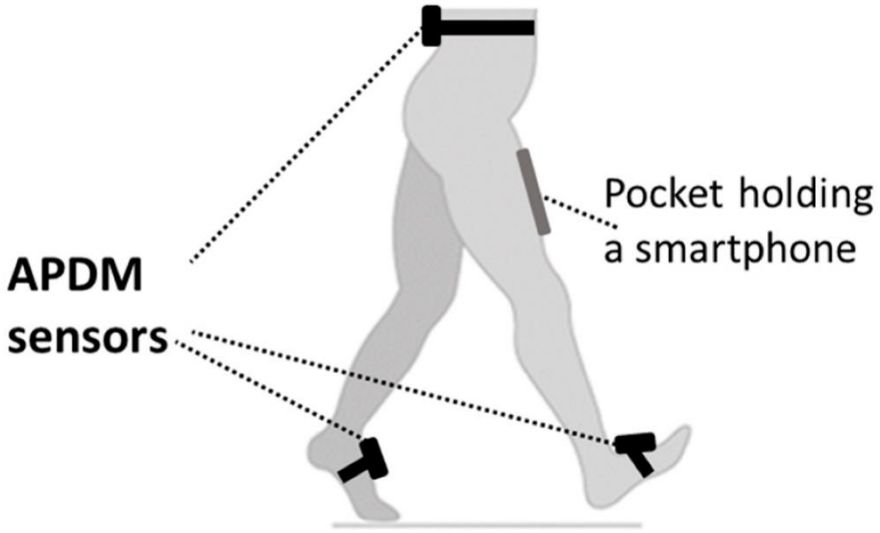
- Wearable sensors like pedometers, accelerometers, and gyroscopes track running dynamics, including ground contact time, stride length, and vertical oscillation.
- Coaches use this information to optimize training and prevent injuries.

5. Rehabilitation Monitoring:

- Smart textiles embedded with sensors monitor gait parameters during physical therapy sessions. They assist in objective evaluation and customization of rehabilitation programs.

6. Remote Monitoring

- Wearables transmit gait data to healthcare providers, allowing continuous monitoring and timely intervention. This is particularly useful for managing chronic conditions.



- **APDM sensors**: These are wearable motion sensors attached to key locations on the body—specifically the lower back, and both ankles. APDM (Ambulatory Parkinson's Disease Monitoring) sensors are typically used for capturing detailed motion data, including gait parameters like step length, cadence, and symmetry.
- **Pocket holding a smartphone**: A smartphone is shown in a pants pocket, likely used to collect accelerometer and gyroscope data as an alternative or supplement to the APDM sensors.

7. Foot and Ankle Biomechanics

- In-shoe pressure sensors evaluate plantar pressure distribution to identify biomechanical abnormalities contributing to foot and ankle problems. In-shoe pressure sensors are specifically designed to evaluate plantar pressure distribution. These devices are placed inside footwear and contain an array of sensors that measure the force and pressure exerted by different areas of the foot during various activities like standing, walking, and running.

- These sensors aid in designing custom orthotics and footwear.

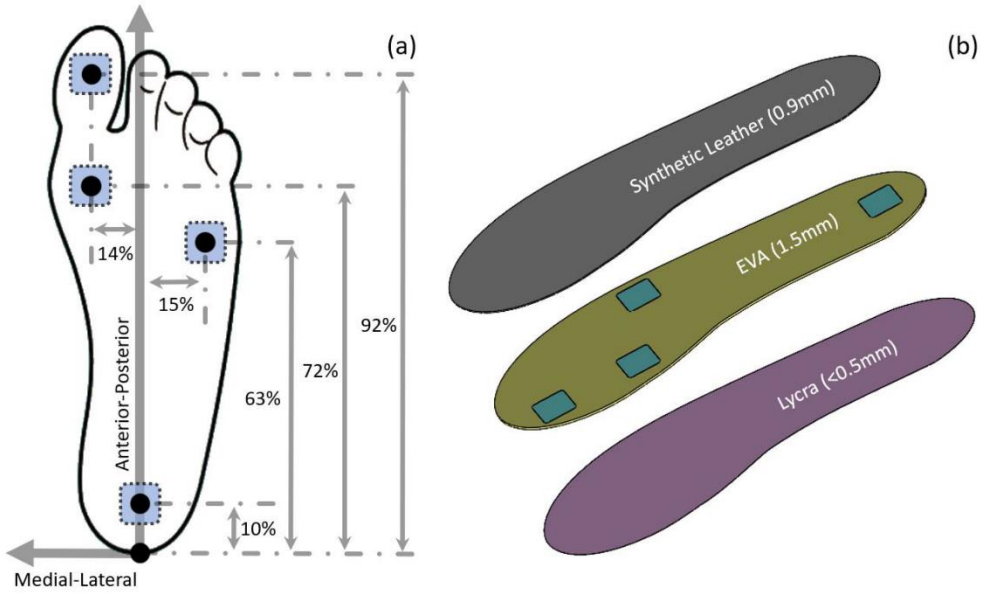


Figure 5.6.3 Location of the sensors as a percentage of foot length and width. (b) Layered sensorised insole construction. The black dots represent the geometrical centre of the sensors.

- **Smart Socks:** These are textile-based wearables with integrated sensors (e.g., pressure sensors, IMUs) to capture various biomechanical parameters.

- **Smart socks** are wearable technology embedded with sensors (like pressure sensors, accelerometers, or fabric-based sensors) that collect data on foot movement, pressure distribution, and gait. They typically connect via Bluetooth

to a smartphone or cloud system for real-time analysis. Smart socks reduce the risk of friction and friction wounds, improves circulation, accelerates recovery, has thermoregulatory effect and helps achieve goals during your workout.

****