Department of Biomedical Engineering

VI Semester - CBM 370 - Wearable Devices

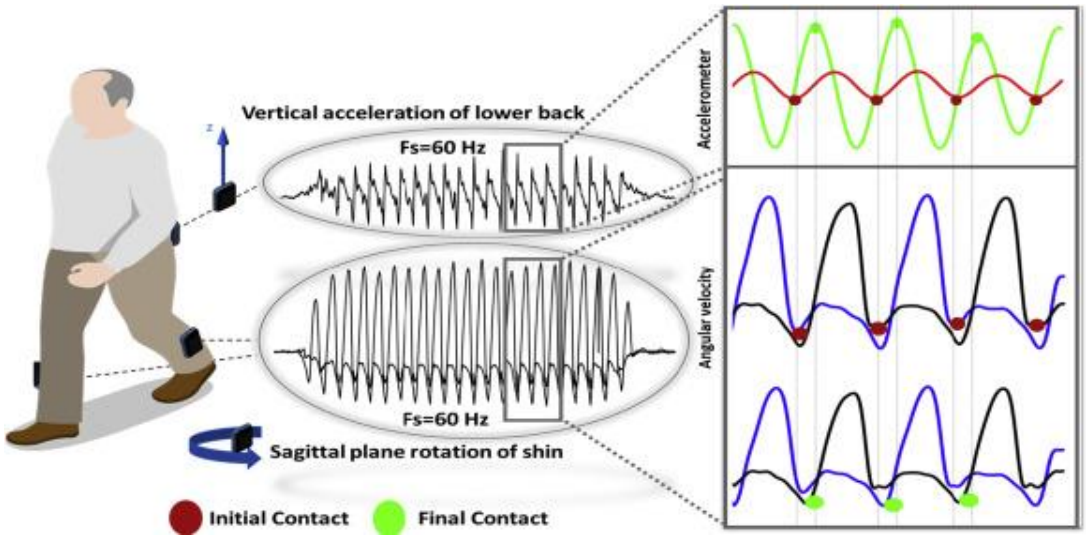
Unit- 5 APPLICATIONS OF WEARABLE SYSTEMS
5.7 Sports Medicine

Wearable devices have become indispensable in sports medicine, offering real-time monitoring, injury prevention, rehabilitation, and performance optimization. Below are some applications:

1. Performance Monitoring:

Motion Sensors:

- Devices such as accelerometers, gyroscopes, and pedometers track movement patterns, stride length, cadence, and acceleration. For example:
- Pedometers help runners improve stride patterns and endurance while reducing injury risks.
- Accelerometers/Gyroscopes analyze rotational movements in sports like gymnastics and diving, refining techniques.



- The figure represents **gait phase detection** using wearable inertial sensors.

- **Initial contact** and **final contact** are identified from signal patterns.
- The accelerometer and gyroscope data are likely being used to segment the walking cycle and extract features for gait analysis.

GPS Trackers:

- Used in running, cycling, and team sports to monitor spatial position, speed, and distance. Devices like Garmin Forerunner provide route mapping and pacing strategies.

2. Injury Prevention:

Biomechanical Analysis:

- Wearables monitor gait patterns and joint movements to detect unsafe mechanics that could lead to injuries. For instance:
- GPS-equipped wearables measure biomechanical loads to prevent stress fractures in runners.
- Motion tracking systems identify overuse injuries by analyzing changes in movement patterns.

Fall Detection:

- Wearables equipped with accelerometers detect falls and alert caregivers or medical staff, especially for elderly athletes

3. Rehabilitation:

- Wearables assist in post-injury recovery by tracking joint range of motion, muscle activity (EMG), and mobility during physical therapy sessions.
- Devices like DorsaVi monitor movement range after surgeries (e.g., knee replacements) to avoid unnecessary strain and optimize recovery.

4. Recovery Optimization

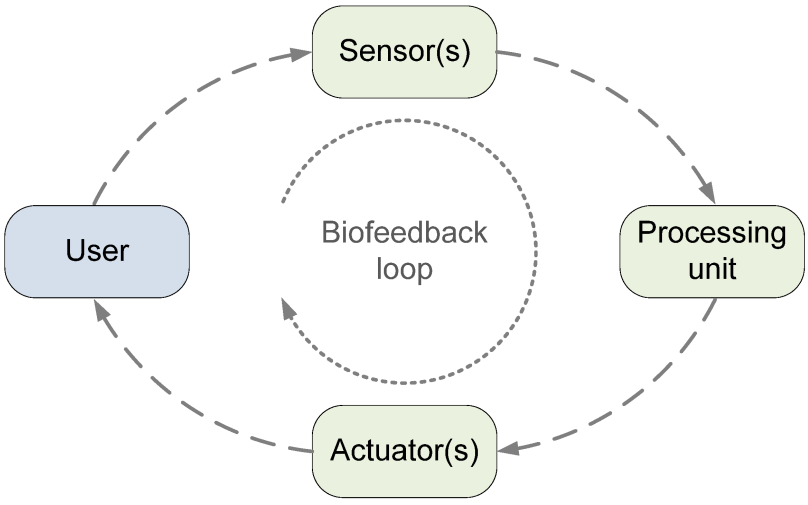
- **Heart Rate Variability (HRV**): Wearables track HRV to assess recovery quality after intense training or competition. This helps coaches adjust rest periods based on physiological data.
- **Sleep Monitoring**: Devices analyze sleep patterns to ensure optimal recovery and prevent fatigue-related injuries

5. Chronic Injury Management:

- Wearables equipped with **inertial measurement units** (IMUs), accelerometers, and gyroscopes analyze movement patterns to detect repetitive strain or abnormal mechanics that can lead to injuries like tendinitis or stress fractures
- **Pressure-sensitive insoles** and force sensors track ground reaction forces during activities like running, alerting athletes to dangerous impact patterns that may cause joint stress
- Devices with **electromyography** (EMG) sensors monitor muscle activation during rehabilitation exercises, ensuring proper technique and reducing the risk of reinjury.
- **Smart textiles** and wearable sensors measure range of motion and flexibility in injured joints, aiding in recovery progress evaluation

6. Real-Time Feedback:

Wearable devices provide instant feedback on metrics such as stride length, ground contact time, and pacing strategies during training sessions. Athletes can make immediate adjustments to improve performance without waiting for post-session analysis.



[Figure: https://www.mdpi.com/1424-8220/22/8/3006]

Figure: Sensor(s) measure the user's activity and send data to the processing unit. The processing unit analyses the data and generates feedback that is provided to the user via the actuator(s). The user responds to this feedback by correcting or changing their activity

7. Integrated Systems:

Devices like WHOOP or Oura Ring combine motion sensors with physiological metrics (e.g., heart rate, sleep tracking) to provide comprehensive insights into athlete health and performance. These systems are used by professional athletes for optimizing training routines.

Whoop 4.0

Oura Ring

- **Oura Ring Ideal for**:
  - ✓ Endurance athletes (e.g., runners, cyclists, triathletes)
  - ✓ Team sport athletes (e.g., basketball, soccer, football)
  - ✓ Combat sports (e.g., boxing, MMA, BJJ)
  - ✓ Coaches & sports scientists managing athlete recovery and health
- The **WHOOP 4.0** is a powerhouse in sports medicine**,** especially when it comes to recovery monitoring, injury prevention, and optimizing athlete performance. It’s not a traditional fitness tracker — it's more of a 24/7 biometric coach, which is why it's gaining so much attention in sports science and rehab settings.

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