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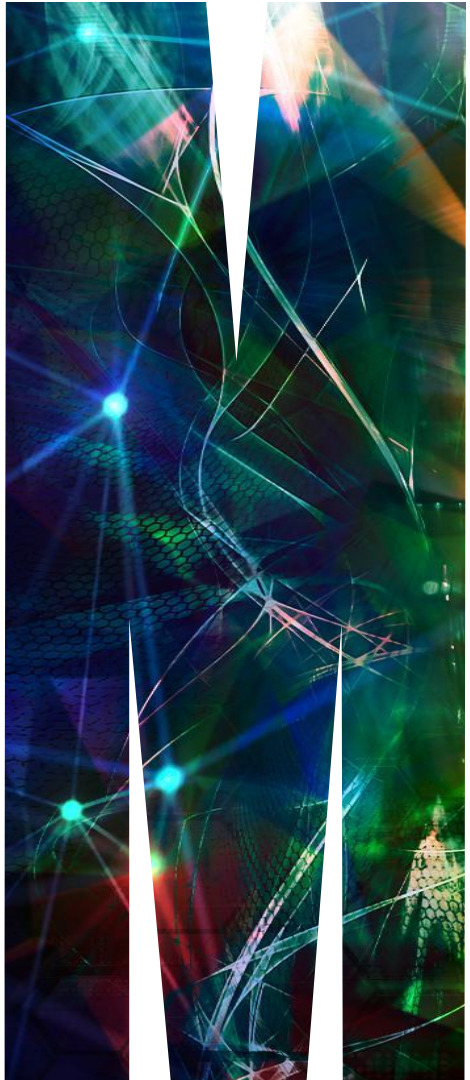
Interactive Showcase 1: Motion Capture System *(and Virtual reality technology)*



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Introduction: What is motion capture

- Technology used to record movements of **object** or **people.**
- Capture motion data by tracking specific point on the object/subject.
- Data can be further analysed.

Applications of Motion Capture

- **Biomechanics & Medicine**: Analyzing movement for rehabilitation.
- **Robotics & AI**: Teaching robots to mimic human motion. Recognition tool for sign language.
- **Virtual Reality**: Creating immersive experiences that respond to movement.
- **Entertainment**: Character animation for movies and games.

Introduction: What is motion capture

Common (Gold standard) measuring technology/instrument

- **Optical Motion Capture**
  - Uses cameras and reflective markers on the body.
  - Captures precise 3D movement by tracking key points.

- **Inertial Motion Capture**
  - Uses wearable sensors on body parts.
  - Records orientation and acceleration data without cameras.

Introduction: What is motion capture

Data integration

- A robust motion capture system must allow **seamless integration of multiple data sources** to enhance analysis and understanding of movement.
- **Force Plate Data**
  - Measures ground reaction forces during movements.
  - Essential for analyzing balance, stability, and force distribution.
- **Inertial Measurement Unit (IMU) Data**
  - Tracks acceleration, orientation, and rotation of body segments.
  - Provides movement data even outside camera range.
- **Electromyography (EMG) Data**
  - Measures muscle activation patterns.
  - Important for studying muscle engagement during activities.

Introduction: What is motion capture

Benefits of Multi-Source Integration

- **Improved Analysis**
- **Enhanced Precision**
- **Broader Applications**

Potential of Artificial Intelligence in motion capture

1. **Markerless motion capture**
   - Fall detection (without markers)
   - Pose estimation
   - Sign language translation

2. **Movement analysis and recognition**
   - Classification of similar movement patterns (walking, jumping, etc)
   - Injury prevention, estimating risky movements

3. **Learn from demonstration**
   - Robots can learn movement techniques from humans
   - Manufacturing, healthcare and personal assistance

Potential of Artificial Intelligence in motion capture

In our lab:

- Estimate the amount of torque needed to support a sitting to standing motion
- Identify trends in muscle decline across age group and gender
- Identify fall risks among individuals during ADL

The How’s of motion capture

Motion capture marker placement

Anatomical lower body joints

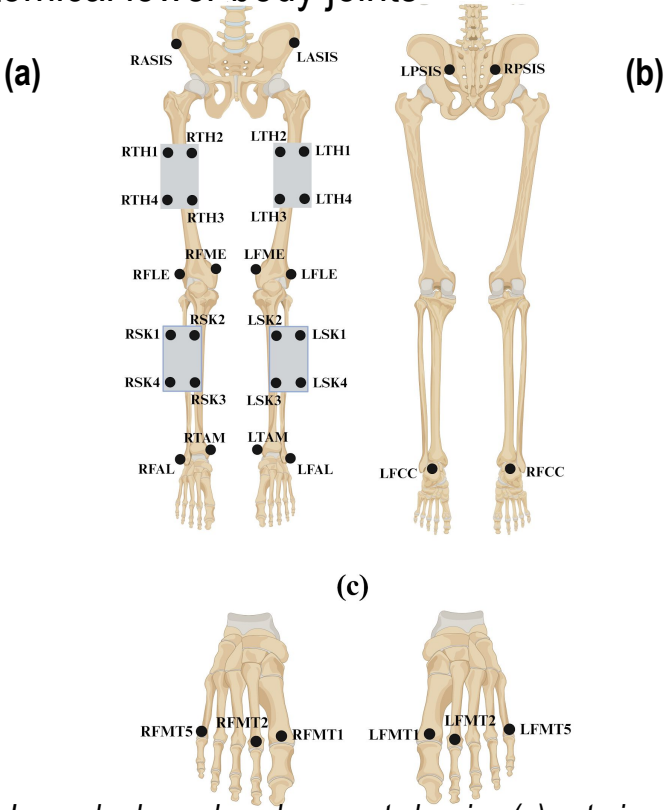

Fig. 1 Lower body marker placement showing (a) anterior and (b) posterior views and (c)anterior foot view.

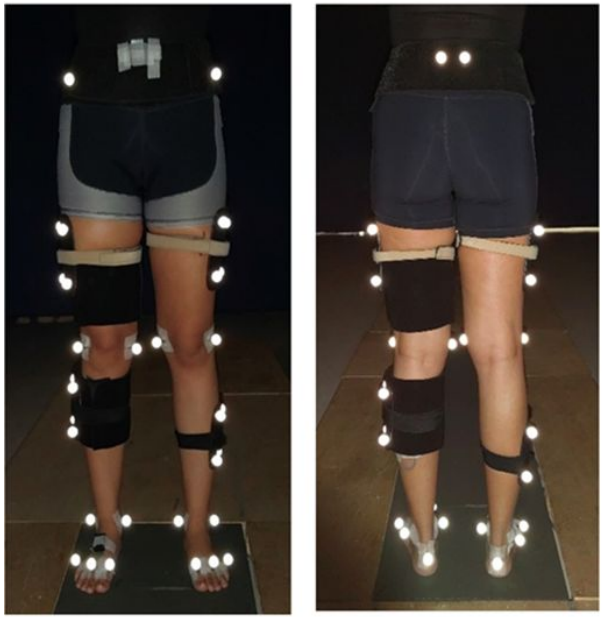

Fig. 2 Lower body marker placement on a test subject

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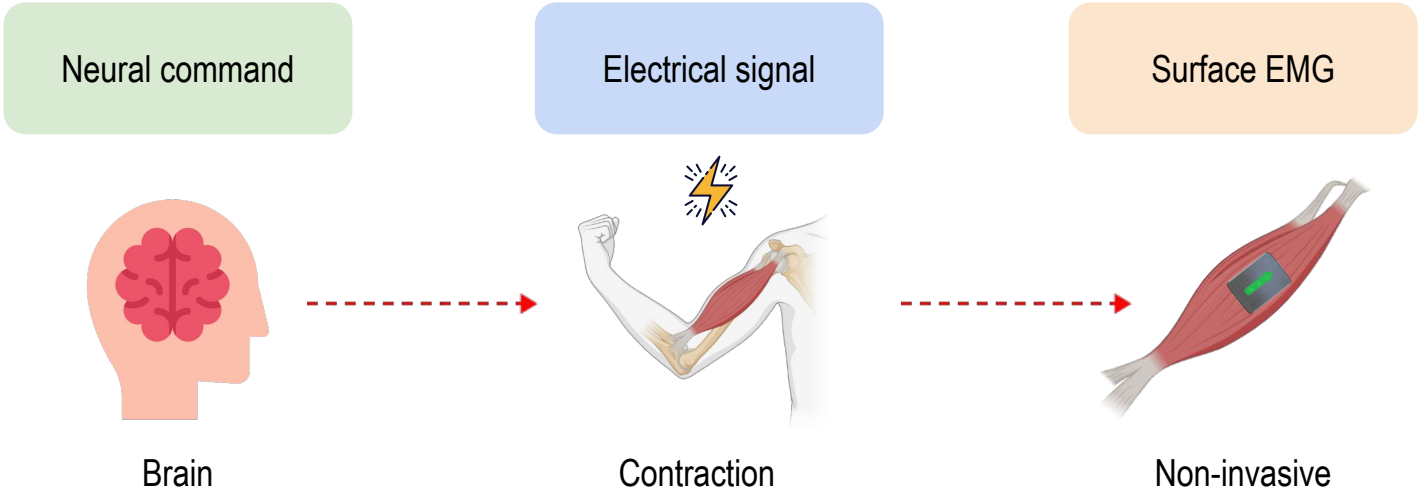
Electromyography (EMG)

- To measure and record the **electrical activity** produced by **muscles** when they **contract**.



- Diagnose **muscle impairments** and **analyze** movement patterns in sports, rehabilitation, and research.

EMG sensor placement

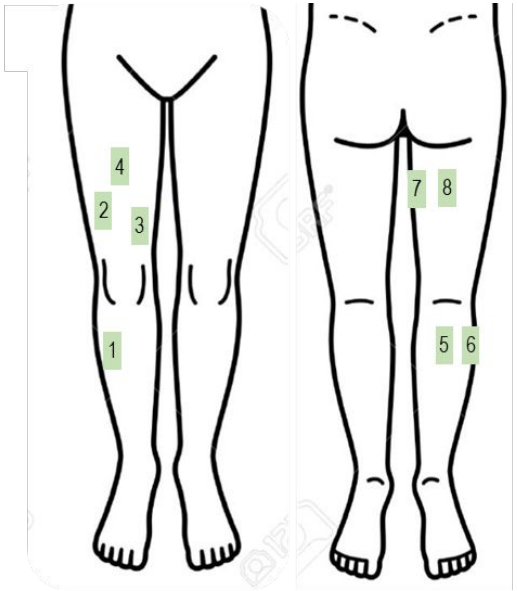


Fig. 3 Lower body EMG sensor placement

Eight dominant leg muscles

1. Tibialis anterior
2. Vastus lateralis
3. Vastus medialis
4. Rectus femoris
5. Gastrocnemius medialis
6. Gastrocnemius lateralis
7. Semitendinosus
8. Bicep femoris

Sit-to-walk (STW) motion capture dataset

- Our STW motion capture and EMG dataset is publically available and can be accessed here on Monash bridges repository.

- Experimental design details can be obtained in the publication below.

- Perera, C.K., Hussain, Z., Khant, M. *et al.* A Motion Capture Dataset on Human Sitting to Walking Transitions. *Sci Data* 11, 878 (2024). https://doi.org/10.1038/s41597-024-03740-z

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Hand-on/ Demo session