Long-term Wearable Sensor Suite for Real-World Biomechanical Tracking in Prosthetics

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Real-World Tracking for Science

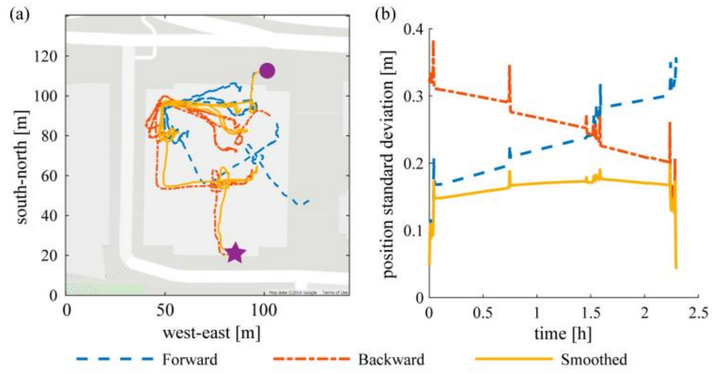
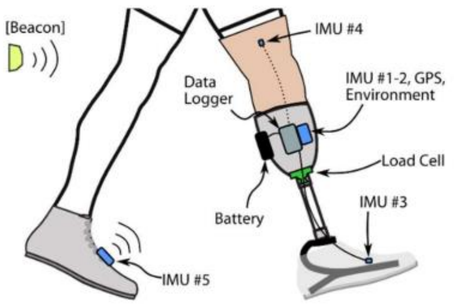


Fig 1. Comparison of forward(blue) backward(red) position and smoothed(yellow) position and its covariance [1]

- **Key Challenge: Controlled Comparisons from Real-World Data**
- **Concept: Compare only in repeatable locations and activities.**
  Key movements that are highly repeatable
- **Technical Challenge: Long-term Location Tracking**
  Fuse GPS and Pedestrian Dead Reckoning

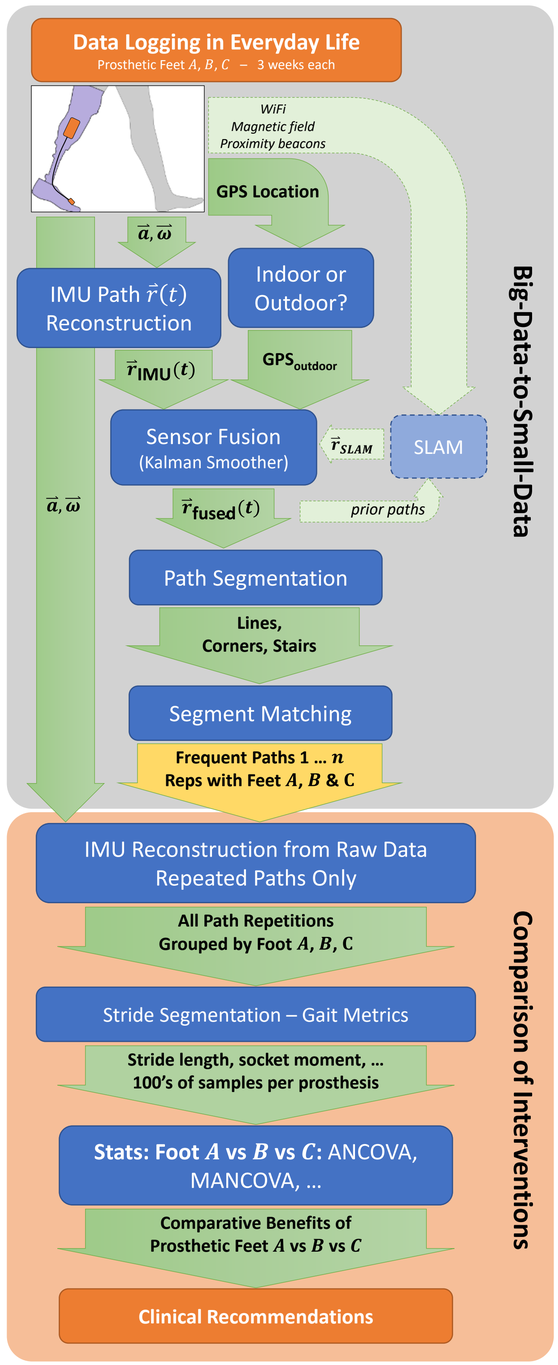
Sensor suite

How to compare them in real world?

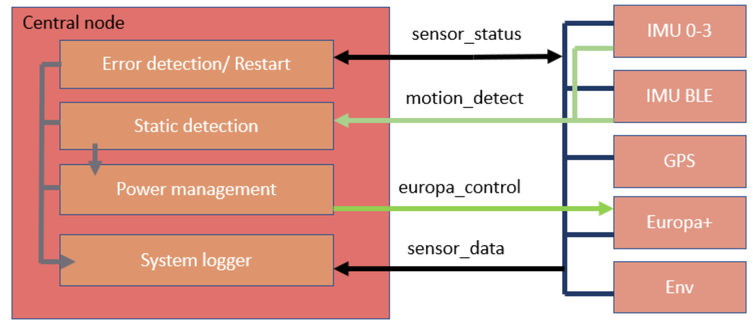


- **5 IMU**
  Redundant IMUs on shank:
  high-accuracy vs high-range
- **RTK GPS**
- **Environmental sensors**
  Elevation, indoor vs outdoor
- **Europa+ smart Pyramid**
  3-axis BLE load cell
- **RasPi Zero**
  Coordinated logging via Robot Operating System (ROS)

Method



Software Architecture



Results and Discussion

- **Lab-like scientific comparisons from everyday movement data**
- **Statistical comparison from frequently repeated path**
  Stride length, stride width, prosthetic socket load, …

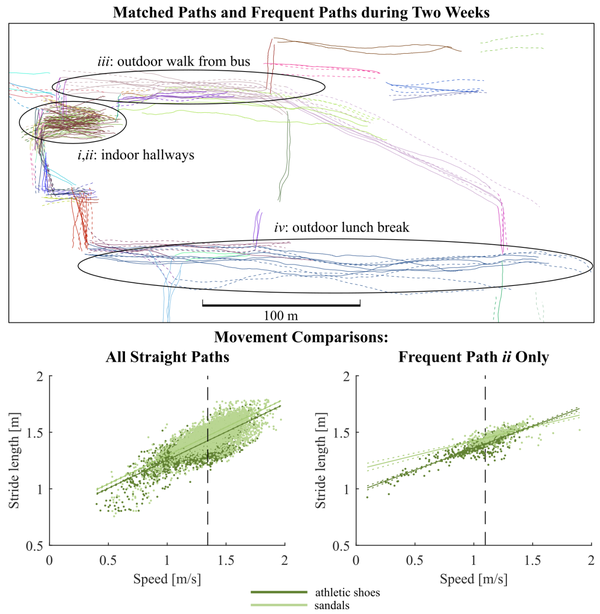


Fig 2. Frequent paths during two weeks and movement comparisons [1]

Future work

- **Prosthetics Testing**
- **WiFi/Magnetic Field SLAM**
- **Machine Learning: indoor/outdoor detection • corners • ramps**
- **Potential application: orthoses, wheelchairs, exoskeletons, etc.**

References:
[1] Wang W, Adamczyk PG (2019) Analyzing Gait in the Real World Using Wearable Movement Sensors and Frequently Repeated Movement Paths. *Sensors (Basel)*, 19(8):1925.

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