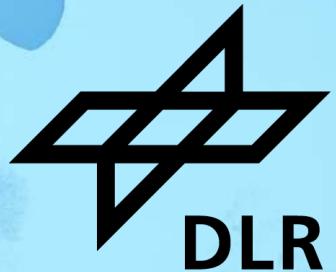
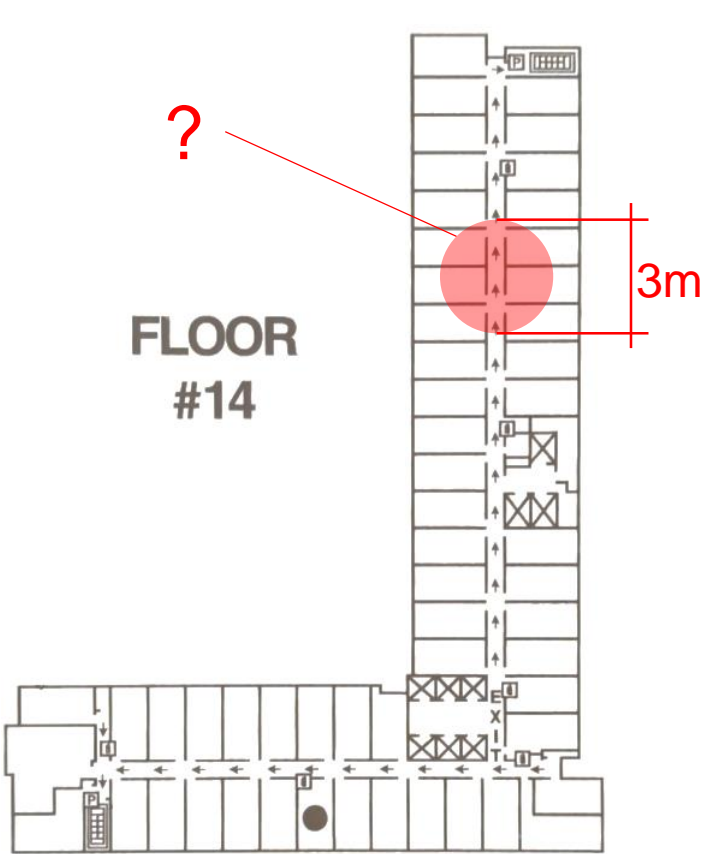
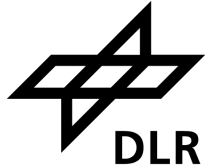


A NOVEL HEIGHT ESTIMATION APPROACH CONSIDERING BAROMETER SENSORS FOR 3D INDOOR POSITIONING

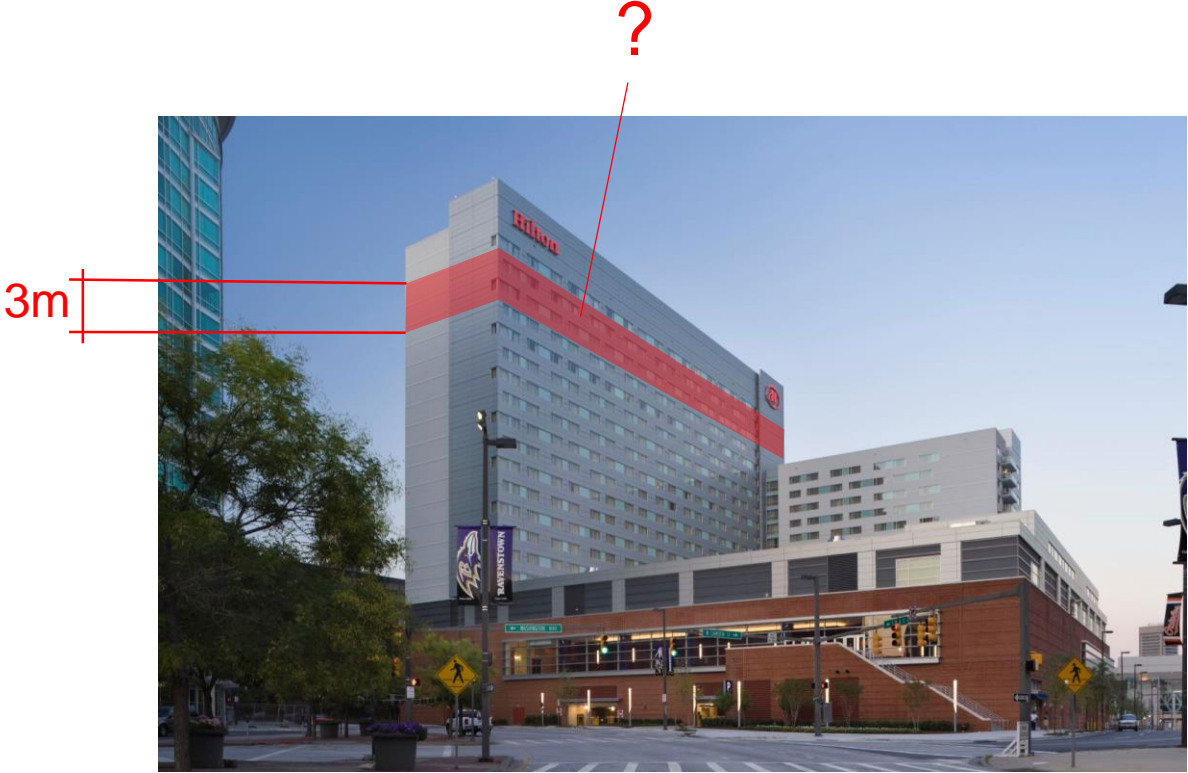
Philipp Hager, Susanna Kaiser, Christian Gentner



Why is reliable height estimation important?

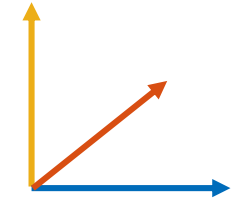
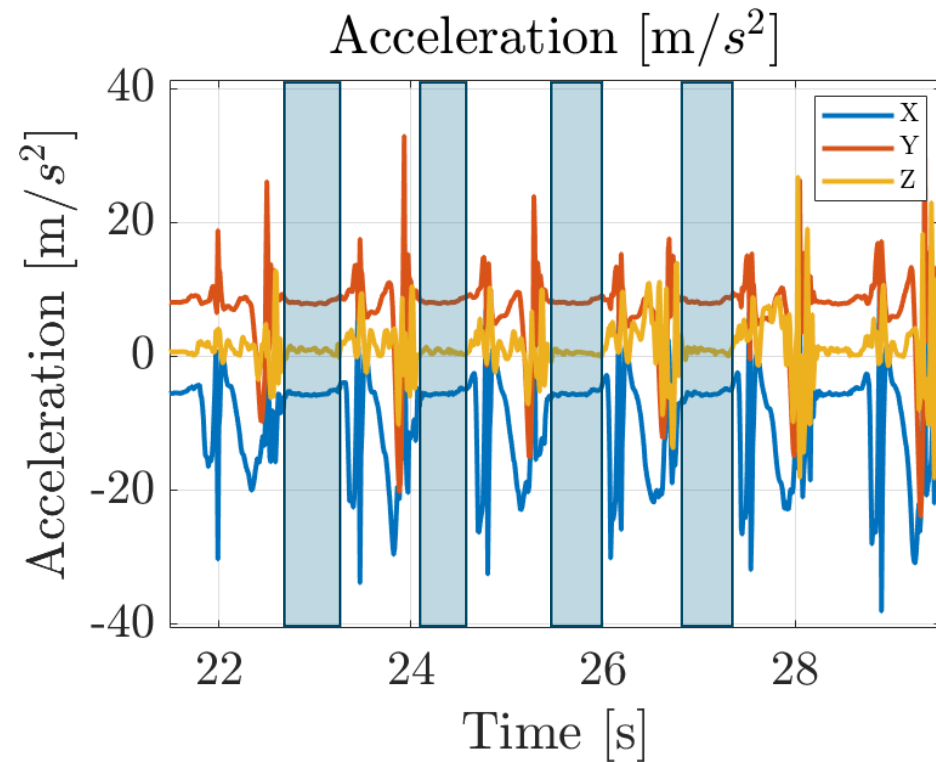
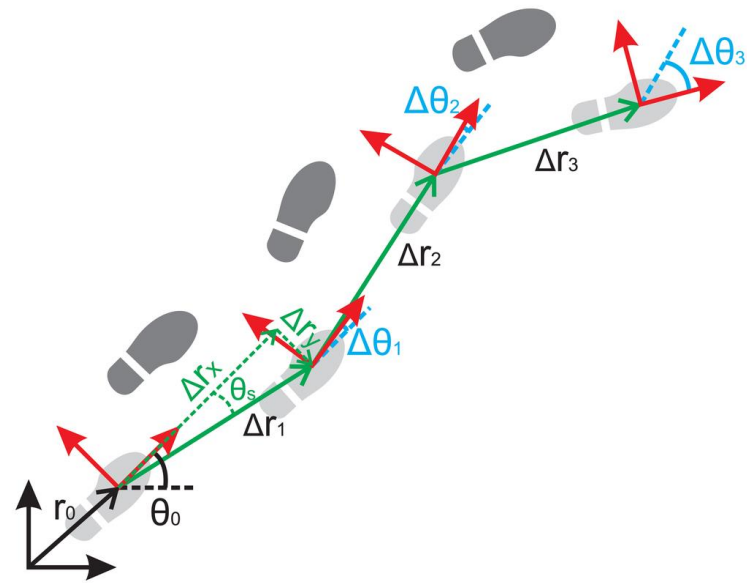
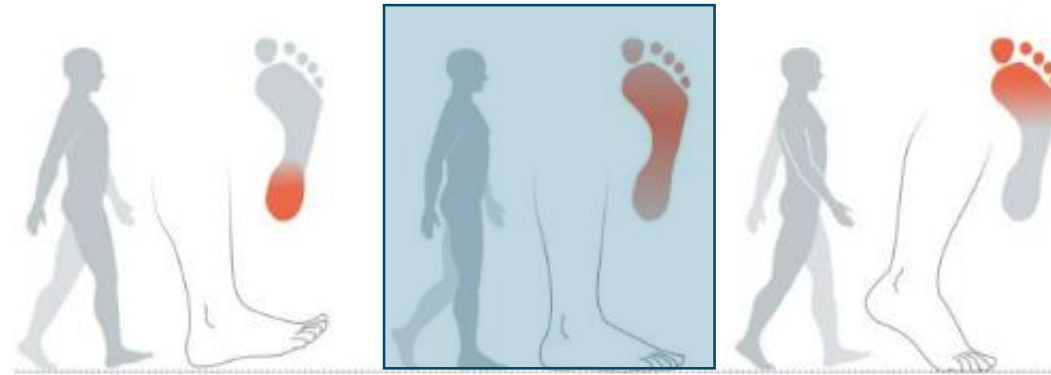
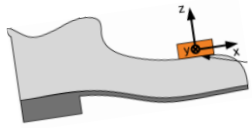


Hilten Baltimore Inner Harbor



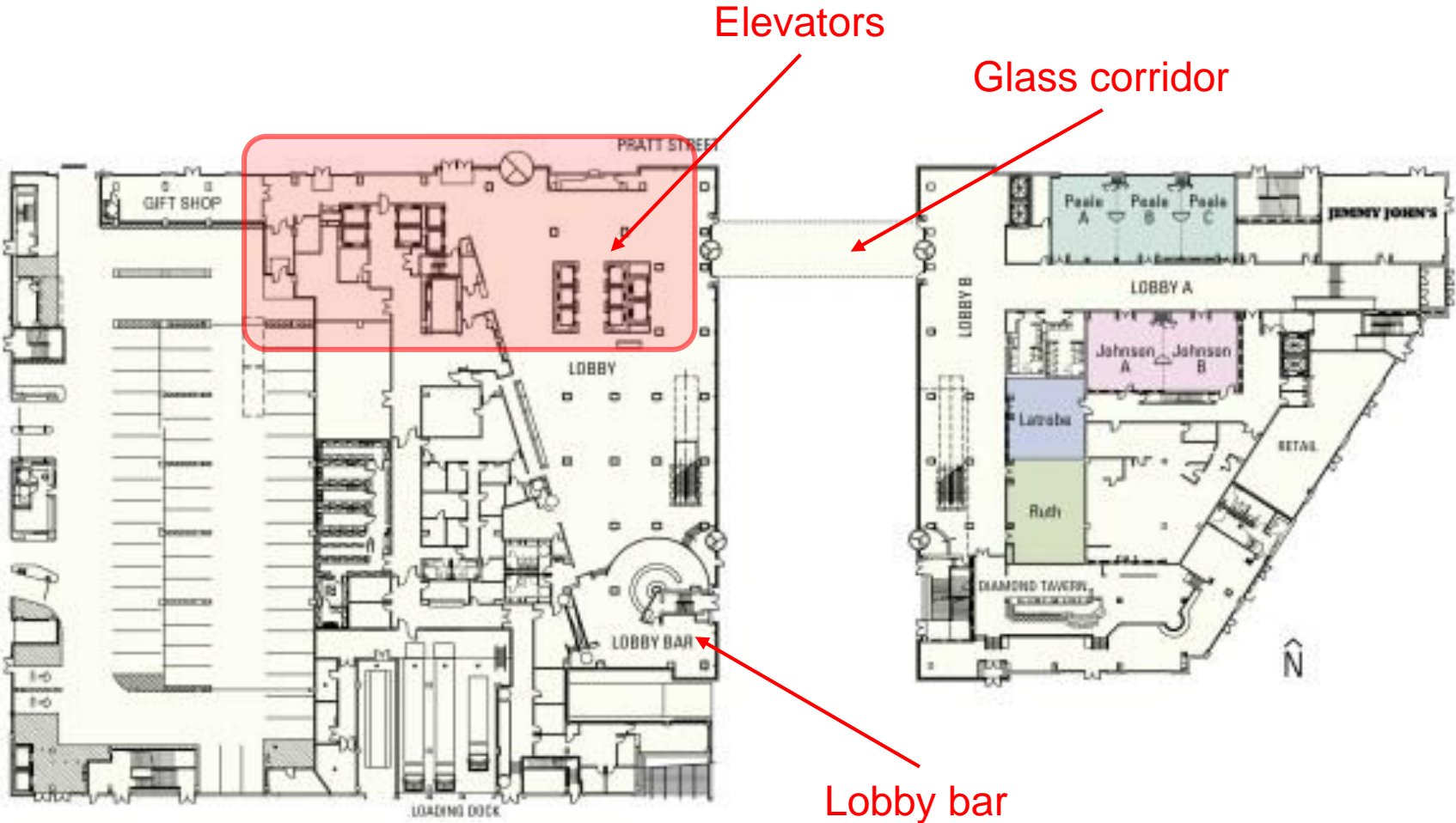
allstatefloors.com

Pedestrian Dead Reckoning (PDR)



2D Demonstration

Hilton Baltimore Inner Harbor



eventsinamerica.com

Experimental Setup

Hardware

Xsens MTi 630



3D-Accelerometer
3D-Gyroscope
3D-Magnetometer
Barometer
Temperature

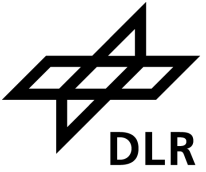
Raspberry Pi
Zero



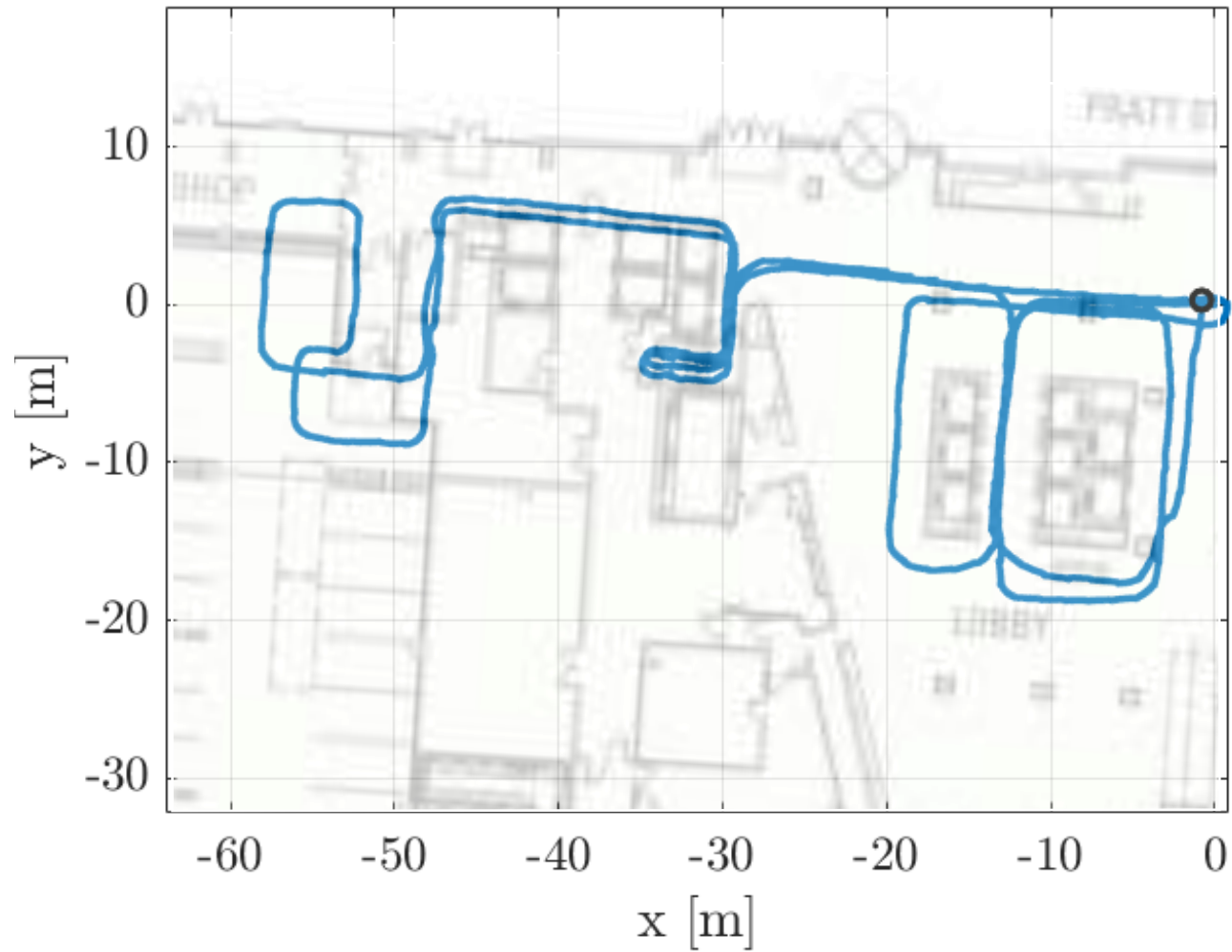
movella.com
raspberrypi.com

2D Demonstration

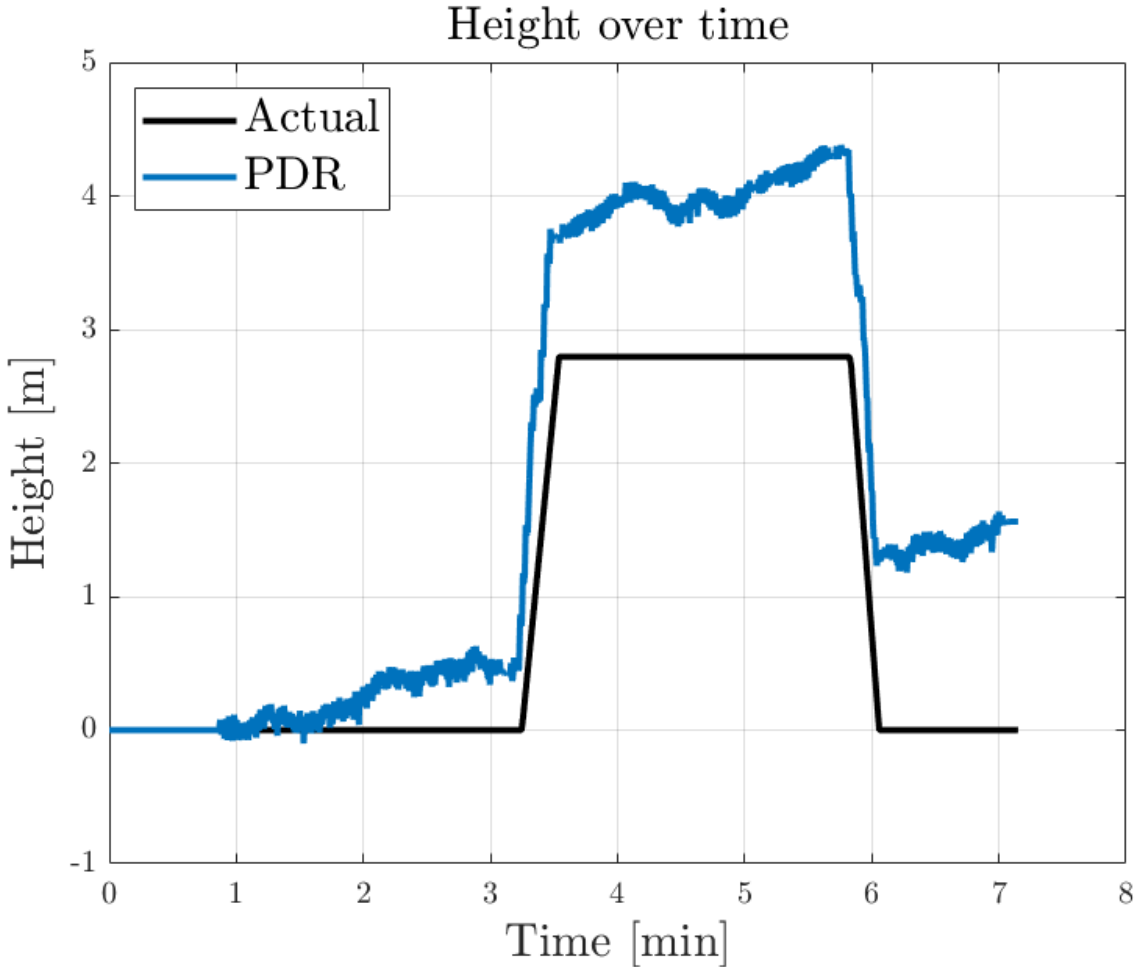
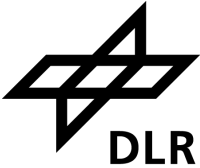
Hilton Baltimore Inner Harbor



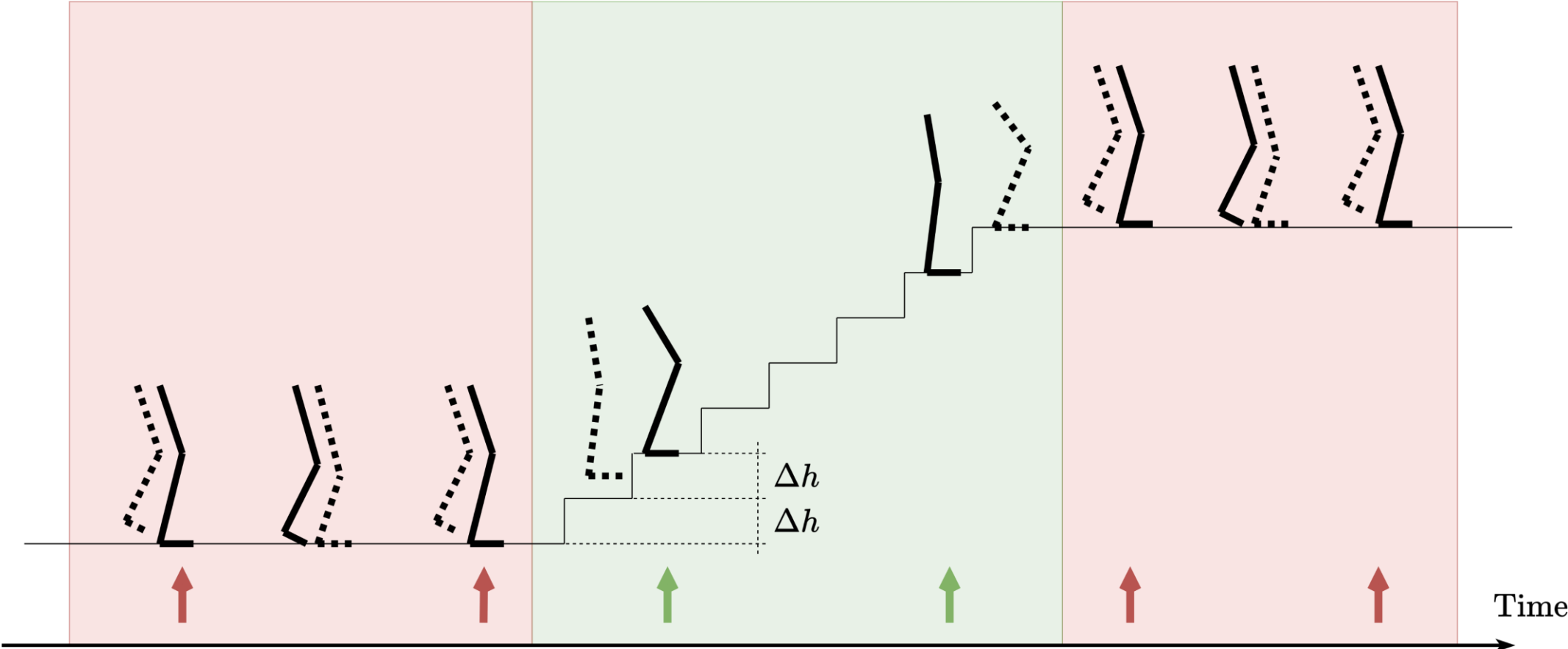
Position



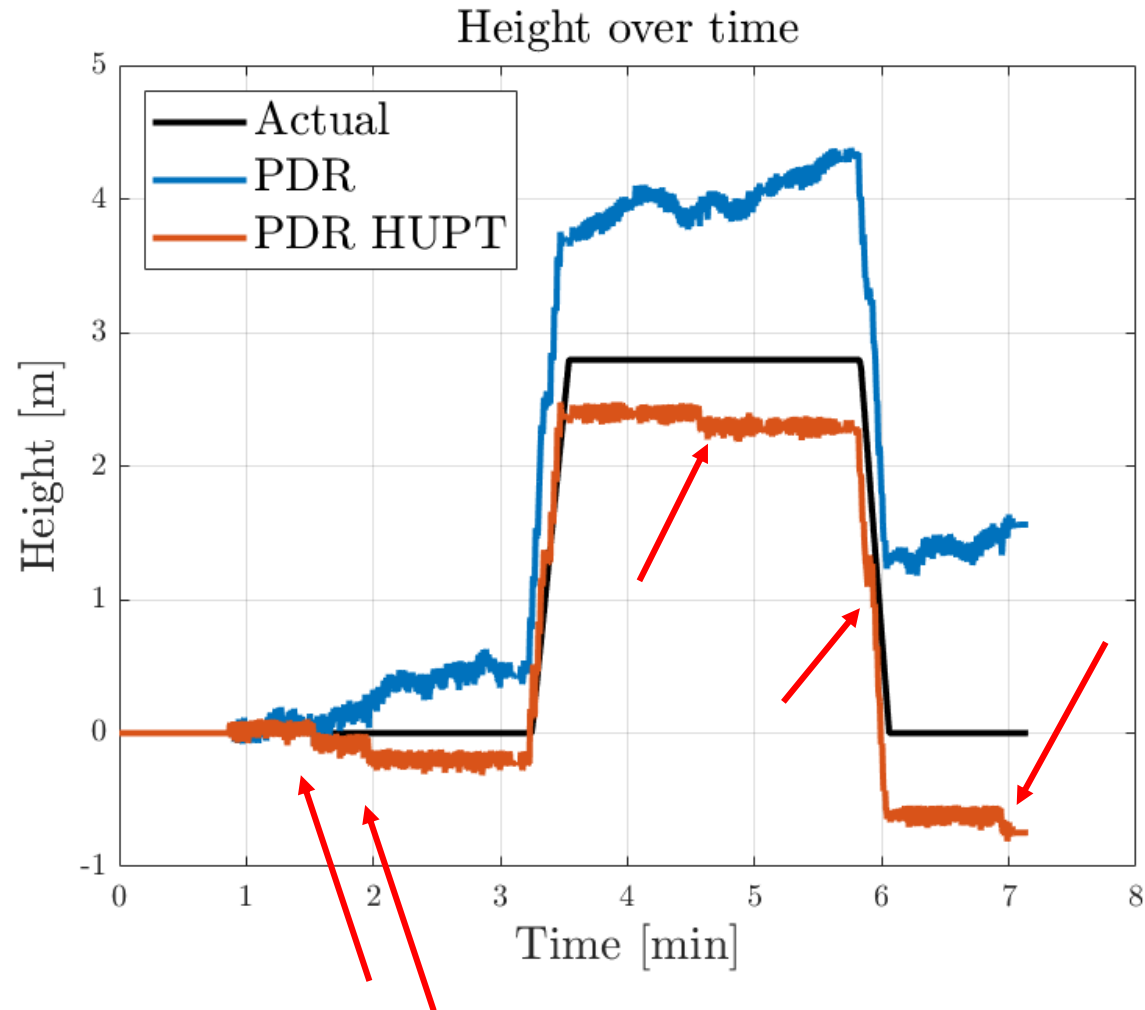
From 2D to 3D: PDR-Based Height Estimation



Height Update at Stair Climb (HUPT)



From 2D to 3D: PDR with HUPT



Experimental Setup

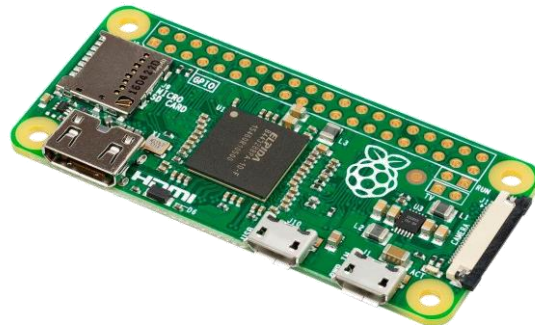
Hardware

Xsens MTi 630



- 3D-Accelerometer
- 3D-Gyroscope
- 3D-Magnetometer
- Barometer**
- Temperature

Raspberry Pi Zero



movella.com
raspberrypi.com



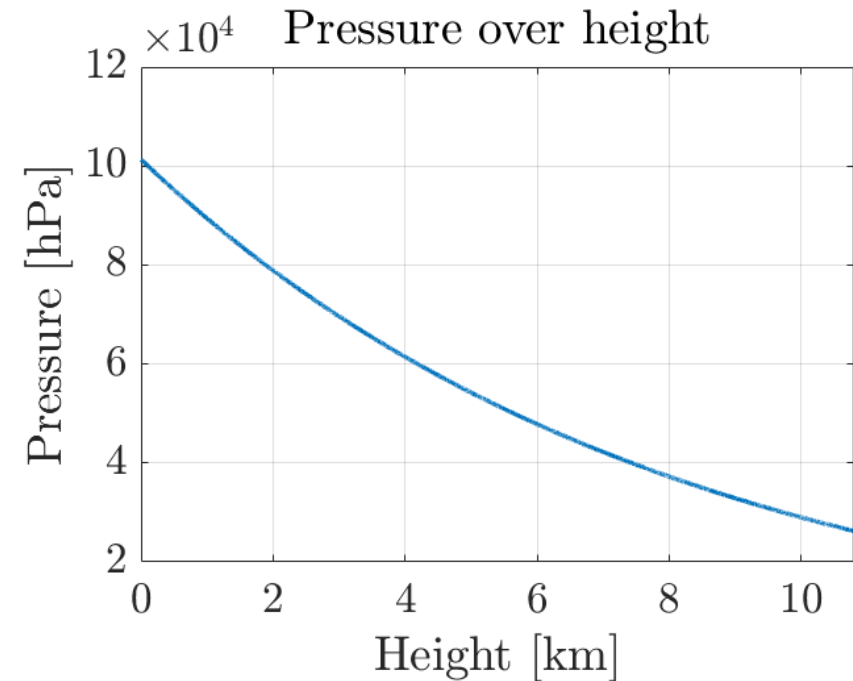
Barometric Height Estimation

Theory

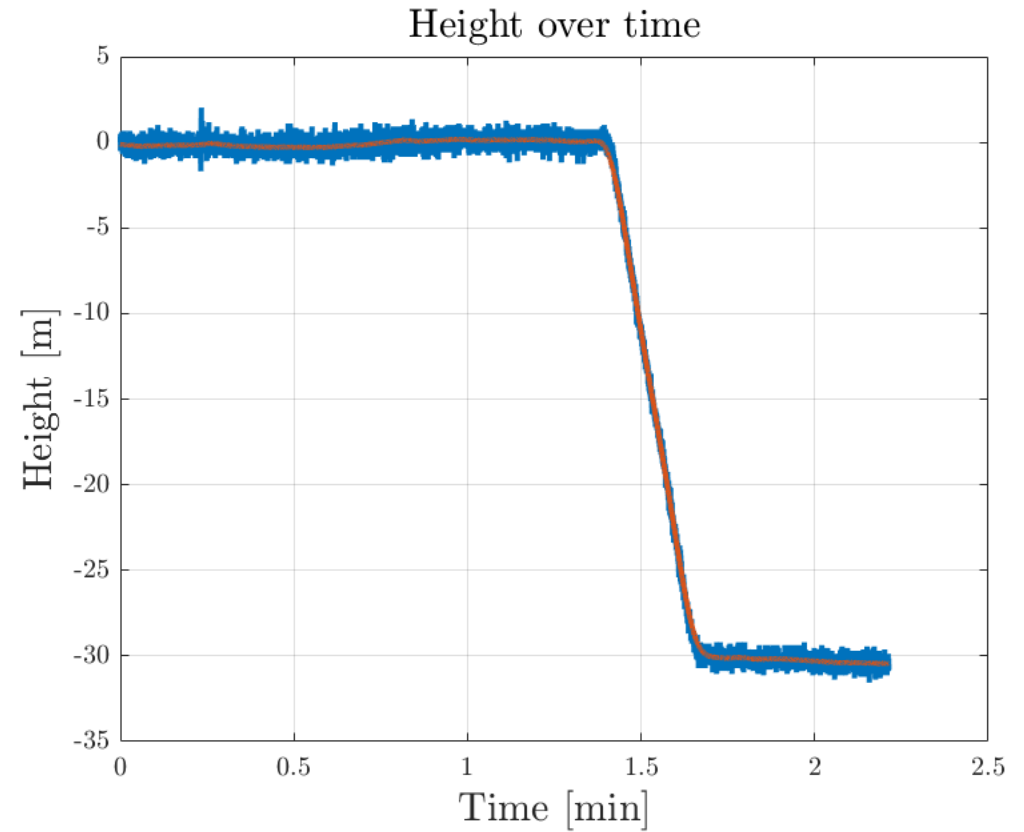
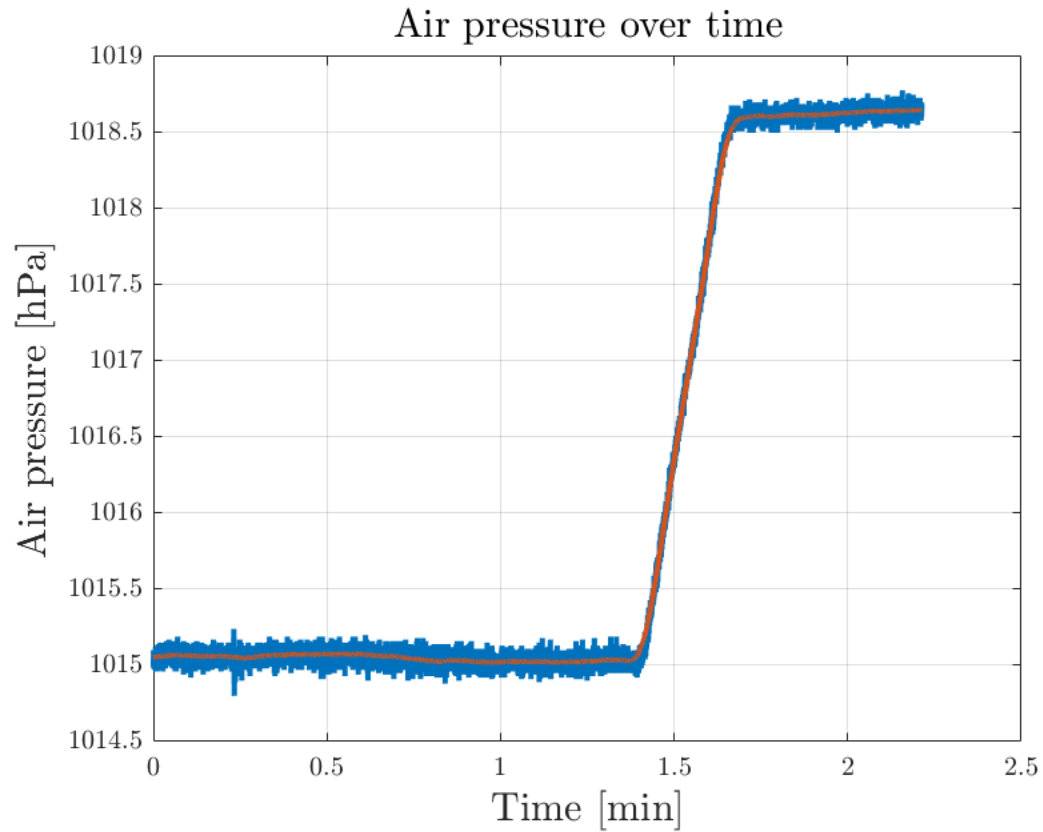
(US Standard Atmospheric Model, 1976)

$$H = - \frac{\overbrace{T_{M,b} R^*}^{\text{Temperature } T \text{ and universal gas constant } R}}{\underbrace{g_0 M_0}_{\text{Sea level gravity } g_0 \text{ and molar mass } M_0}} \ln \left(\frac{\overbrace{P}^{\text{Measured pressure } P}}{\underbrace{P_b}_{\text{Reference pressure}}} \right) + \underbrace{H_b}_{\text{Reference height}}$$

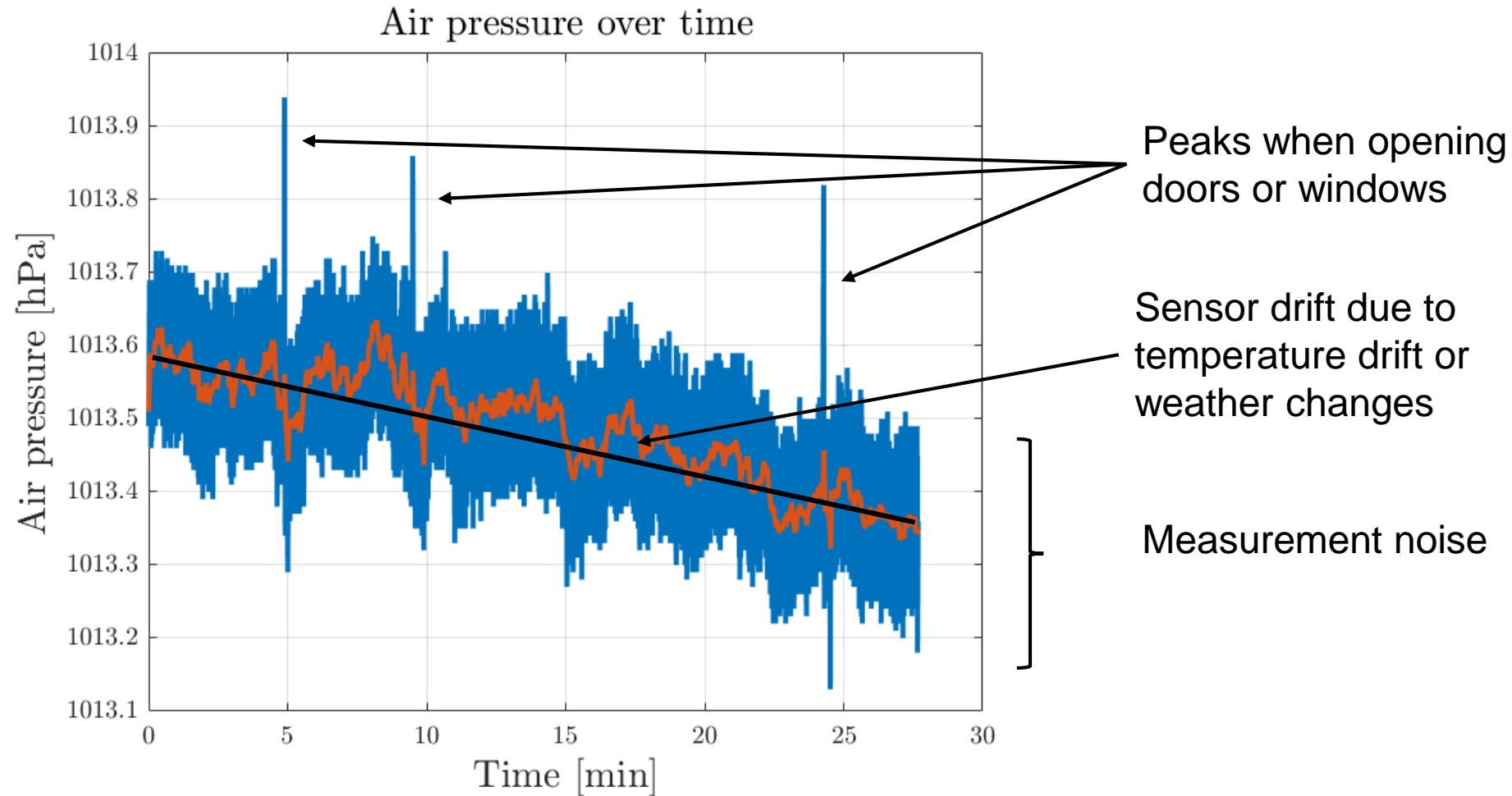
Current Elevation H



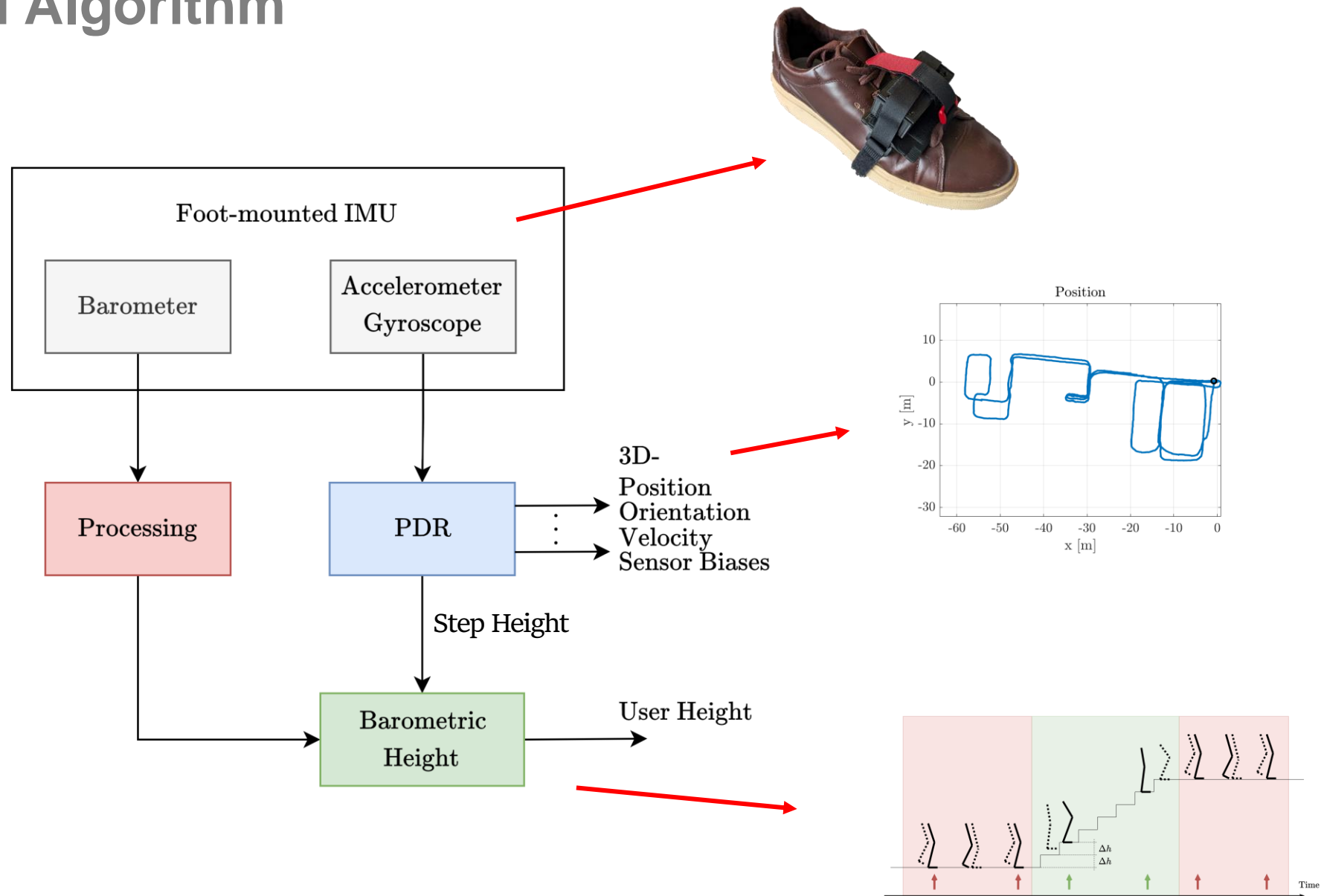
Barometric Height Estimation



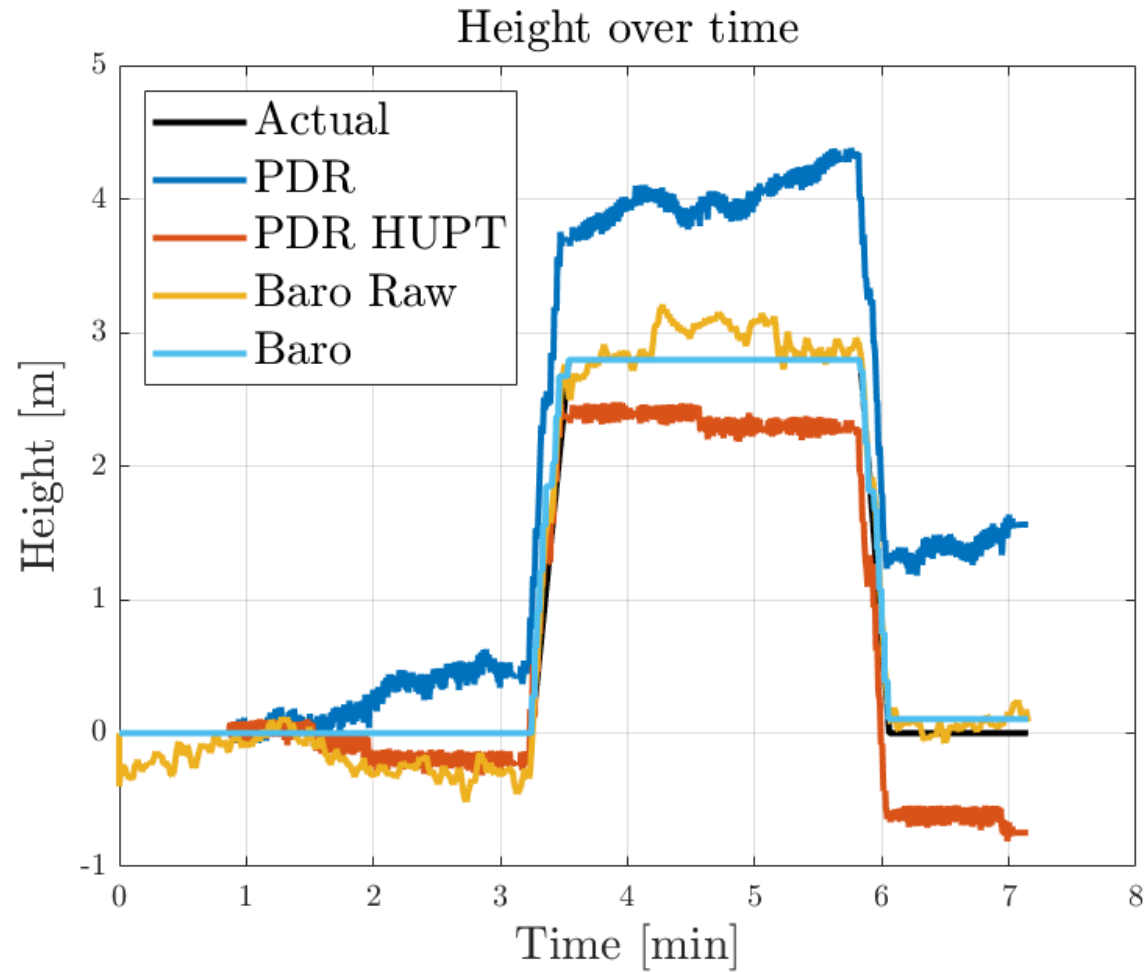
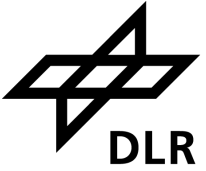
Environmental Influences on Barometric Height Estimation



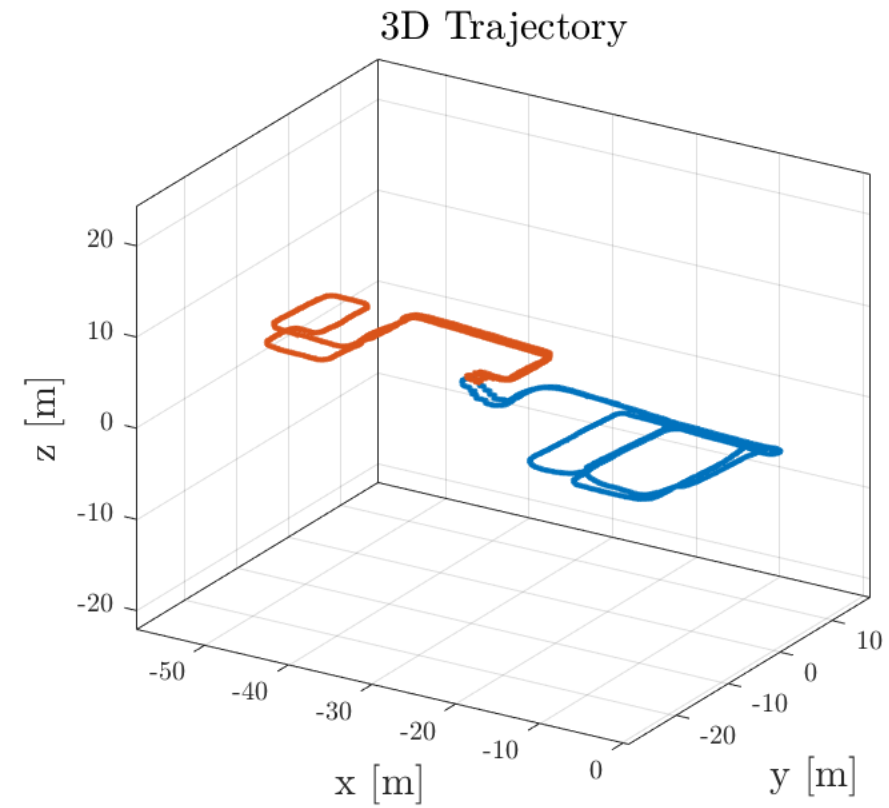
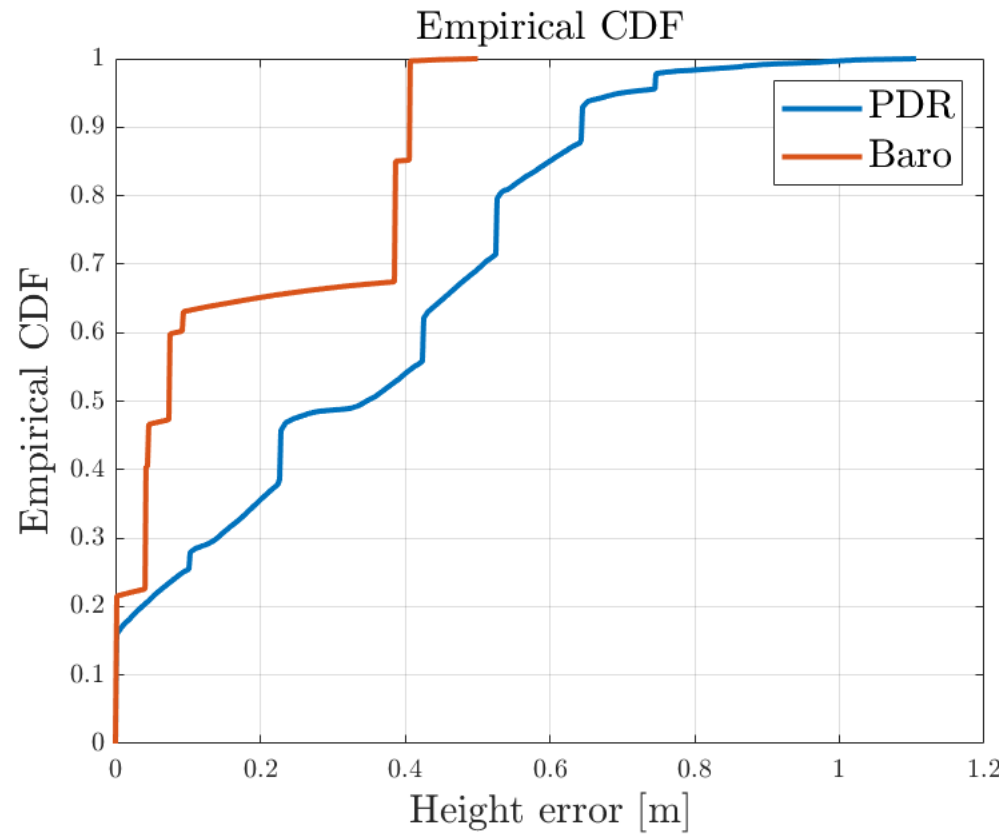
Proposed Algorithm



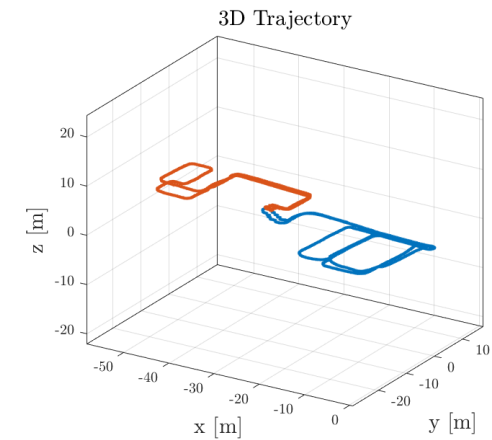
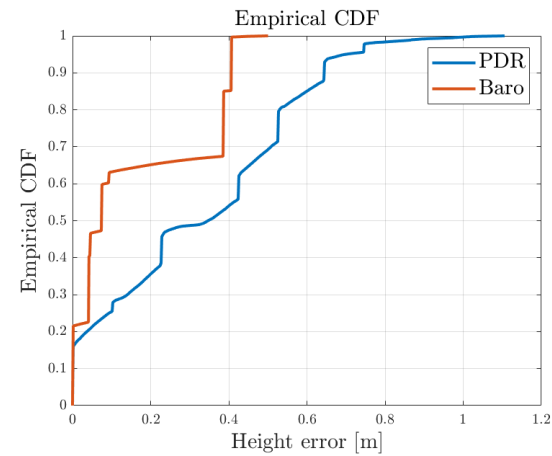
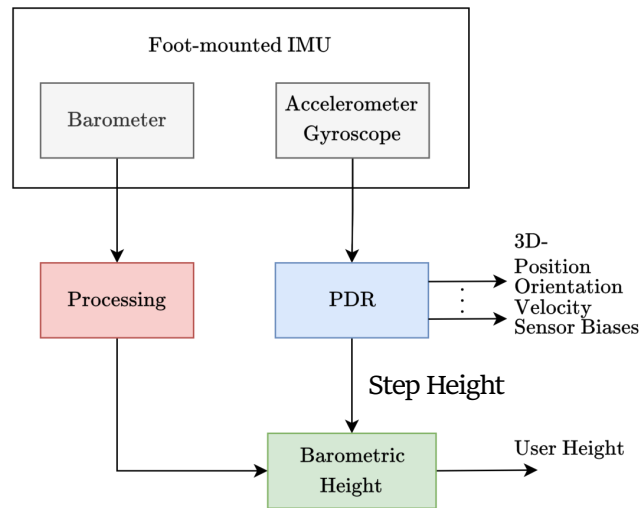
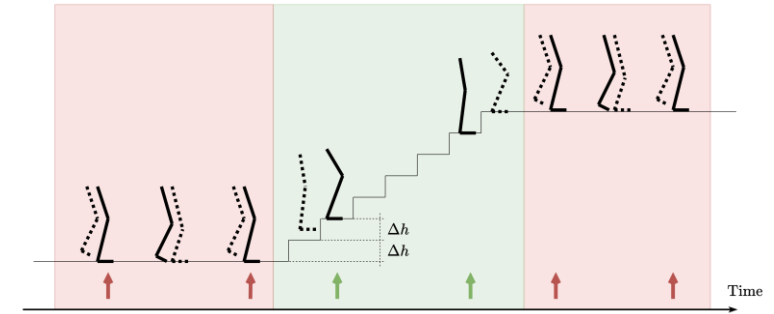
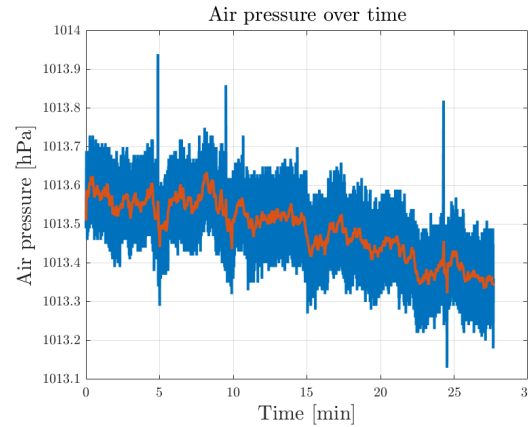
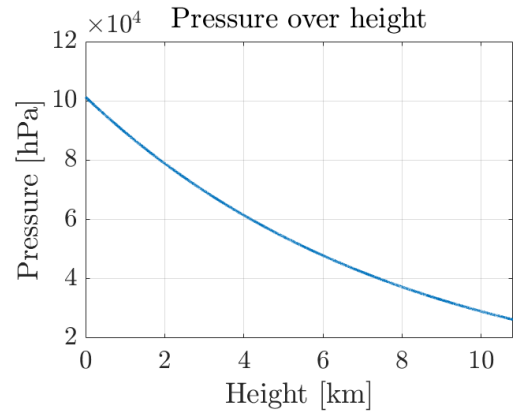
Experimental Results



Experimental Results



Conclusion



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