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A Multifloor Hybrid Inertial/Barometric Navigation System

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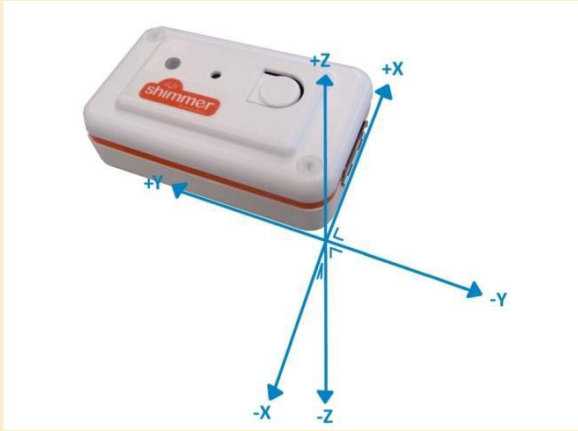
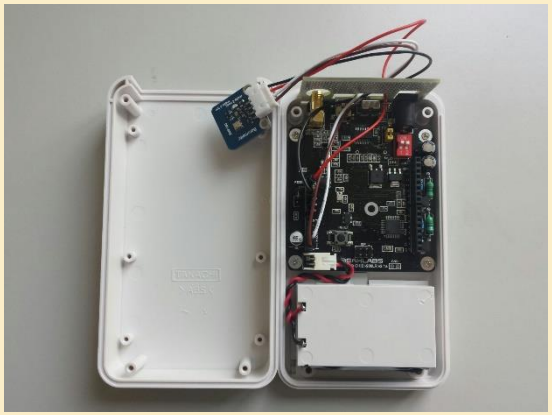
Experimental Setup - Hardware and software

- Shimmer 2r nodes
  - Small-sized, low-power, Bluetooth interface
  - 9 DOF: 3-axial accelerometer, 3-axial gyroscope, 3-axial magnetometer
  - Sampling Rate: 102.4 Hz
- Freakduino board+BMP180 barometer
- Laptop running Mathworks Matlab®





Experimental Setup - Sensors Positioning

Single sensor

Experimental Setup - Sensors Positioning

Two sensors, one foot

Experimental Setup - Sensors Positioning

Two sensors, two feet

Experimental Setup - Sensors Positioning

Four sensors, two feet

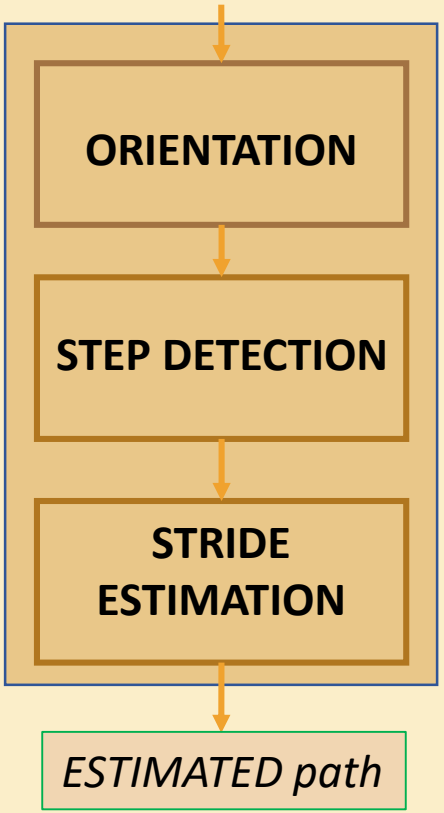
Single Sensor Navigation

ORIENTATION: data fusion of MARG sensor's signals in order to obtain its orientation in 3D space

- Reference systems: both Earth's and sensor's reference frame
- Madgwick AHRS Algorithm

STEP DETECTION: gait segmentation procedure to identify stance and stride phases

STRIDE ESTIMATION: determine the foot displacement in every stride



Multi-Sensor Navigation

Right foot

Shimmer 1 → $(p_{1,x}, p_{1,y})$
Shimmer 2 → $(p_{2,x}, p_{2,y})$

$$p_{r,x} = \frac{p_{1,x} + p_{2,x}}{2}$$
$$p_{r,y} = \frac{p_{1,y} + p_{2,y}}{2}$$

Left foot

$(p_{3,x}, p_{3,y})$ ← Shimmer 3
$(p_{2,x}, p_{2,y})$ ← Shimmer 4

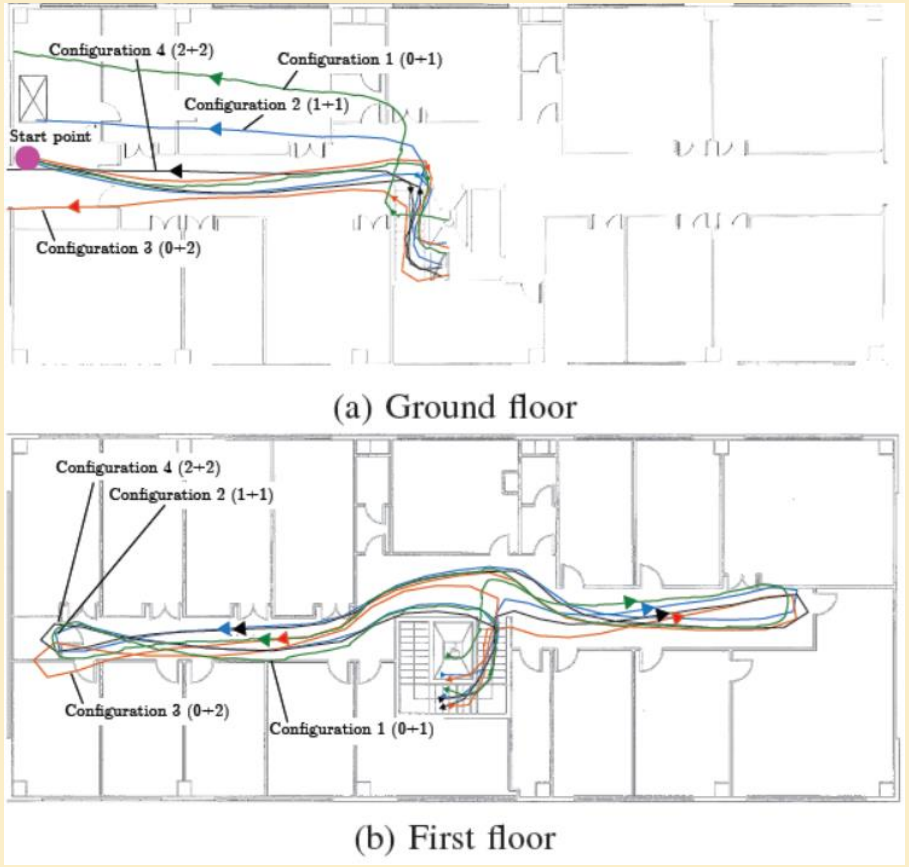
$$p_{l,x} = \frac{p_{3,x} + p_{4,x}}{2}$$
$$p_{l,y} = \frac{p_{3,y} + p_{4,y}}{2}$$

Final position estimate

$$P_x = \frac{p_{r,x} + p_{l,x}}{2}$$
$$P_y = \frac{p_{r,y} + p_{l,y}}{2}$$

Results – Multifloor Indoor

Building 2, Dept. of Information Engineering, Univeristy of Parma

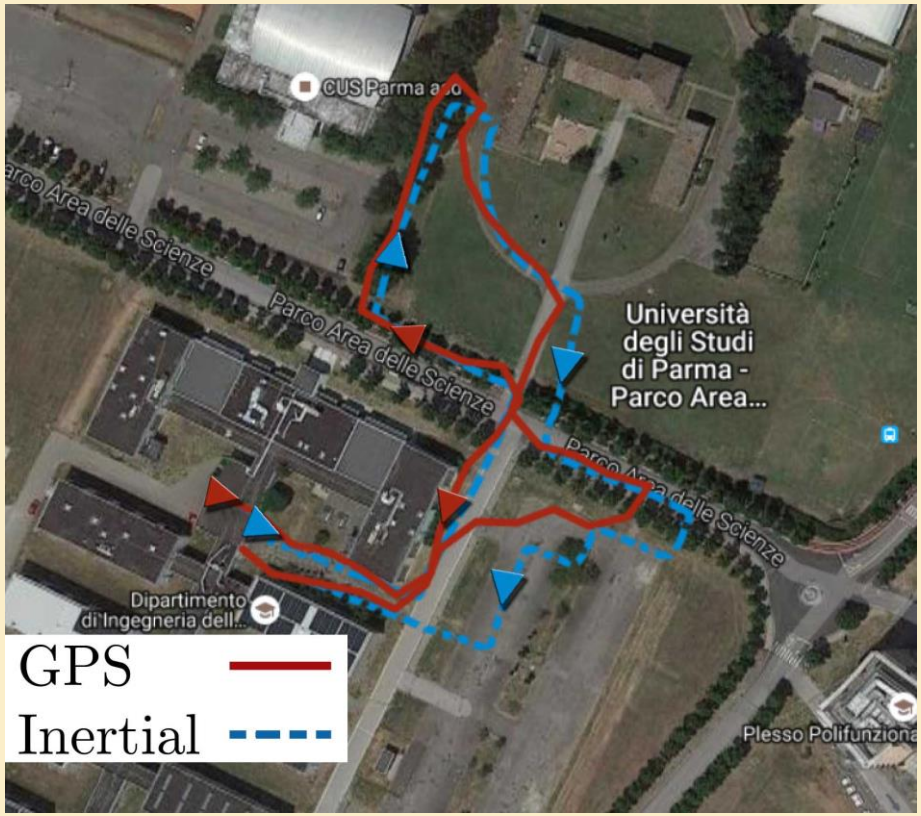


- Two floor
- 4 configurations comparison
- Correct floor changing identification
- Length ~115 [m]

Configuration	Final X [m]	Final Y [m]	Relative Error [%]
Configuration 1	-1,00	4,282	3,7
Configuration 2	-0,93	-1,45	1,72
Configuration 3	2,18	1,47	2,30
Configuration 4	0,89	0,16	0,78

Results

Scientific Area, campus of Univeristy of Parma



Conclusions and Future Works

Conclusions

- Multifloor inertial navigation is feasible
- Sensors integration can improve the system accuracy

Future Works

- Better sensor estimates integration
- Maps aided navigation

Thank you for your attention…
Questions?

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