



IPIN 2022

TWELFTH INTERNATIONAL CONFERENCE ON

INDOOR POSITIONING AND INDOOR NAVIGATION



Track4 : Foot-mounted IMU

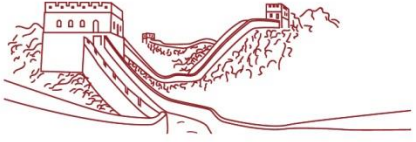
Miguel Ortiz, Ni Zhu

 Université
Gustave Eiffel



Aerospace Information Research Institute,
Chinese Academy of Sciences

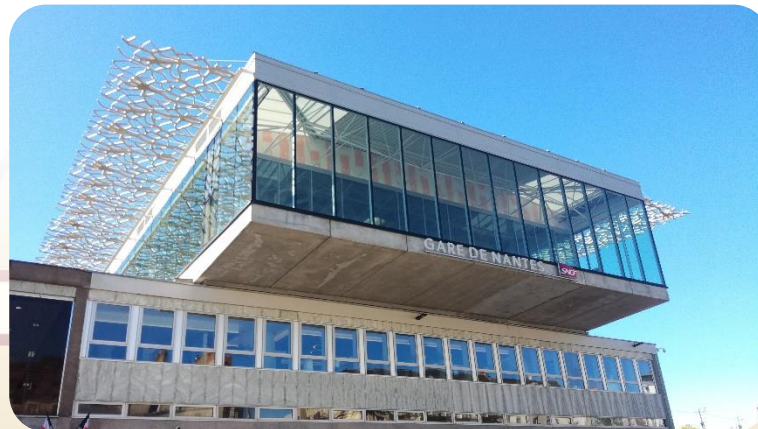
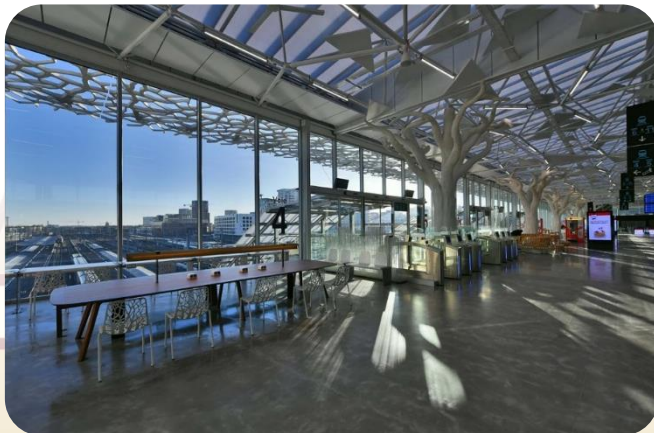


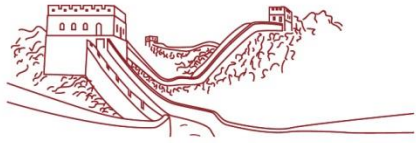


Track4 : Foot-mounted IMU

Overall description

- Nantes (France) train station
- ~1.5 km walk / ~25 min
- 95% Indoor
- 5% Outdoor (beginning / middle)
- *Quasi RealTime condition ! (like IPIN2021)*
- Active walk only
- NO Lifts / Escalator / Travelator
- Several breaks of few seconds (<10s)
- 4 floors : (R-1) R0 R1 R2





Track4 : Foot-mounted IMU



Competitors

4 teams

Team Name	Country	Organization
X-lab	China	Nanjing University of Aeronautics and Astronautics, College of Automation
Leviathan	China	Huawei
SmartFoot	China	Beihang University
CETC54-smart hardware	China	54th Research Institute of China Electronics Technology Group Corporation



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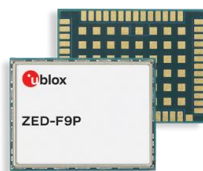


Track4 : Foot-mounted IMU

Sensor description

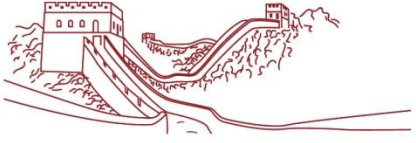
• Inputs from ULISS :

- accelerometer / gyroscope / magnetometer from a Xsens Mti-7
- GNSS rawdata and NMEA (GGA/ZDA) from a Ublox ZED-F9P dual freq. receiver
- barometer from BMP280 sensor
- temperature sensor



nav4you

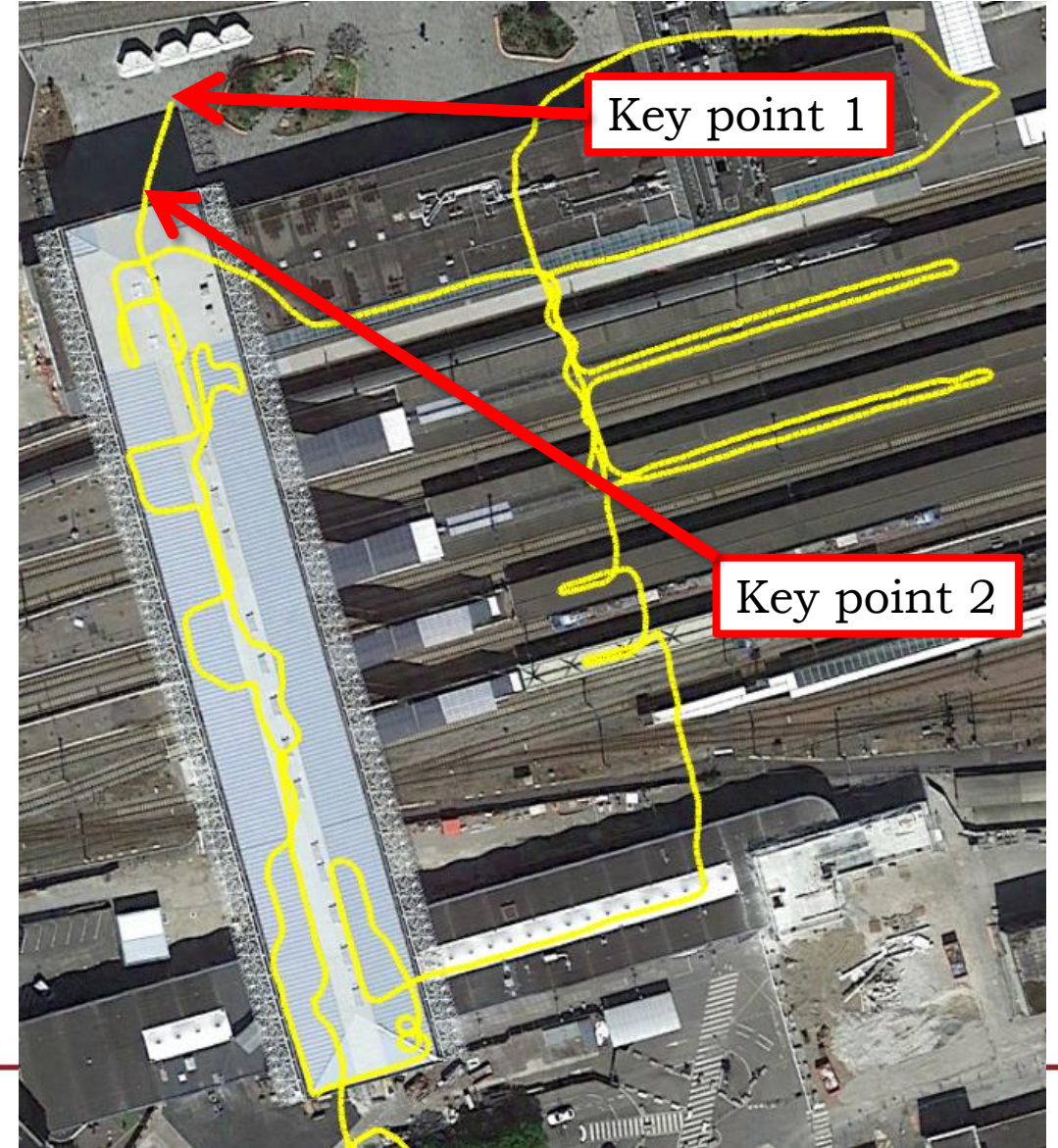




Track4 : Foot-mounted IMU

Objective

- Re-build the trajectory realized in July 2022
- Starting from a known point
- And with the help of a second given point
- 90 key points were evaluated





Track4 : Foot-mounted IMU



From: IMU (Acc,Gyro), MAG, GNSS, BARO sensors

Compute:

```
ROTA, 310061.998129000, 4.12264, -0.11782, 1.95676
ACCE, 310061.998358000, -5.08618, -8.94552, 7.51071
ROTA, 310062.003132000, 3.99029, -0.171031, 2.0577
ACCE, 310062.003346000, -4.81856, -8.90485, 7.69366
MAGN, 310062.006216000, 0.834387, 0.496714, -0.539119
GOBS, 310062.007000000, G07 24984599.602 9
GOBS, 310062.007000000, R23 22411544.490 9
GOBS, 310062.007000000, G02 24973888.141 9
ROTA, 310062.008136000, 3.82733, -0.196311, 2.14405
ACCE, 310062.008333000, -4.42163, -8.88965, 8.09426
ROTA, 310062.013140000, 3.65192, -0.187157, 2.20612
ACCE, 310062.013321000, -3.98475, -9.17112, 8.48837
```



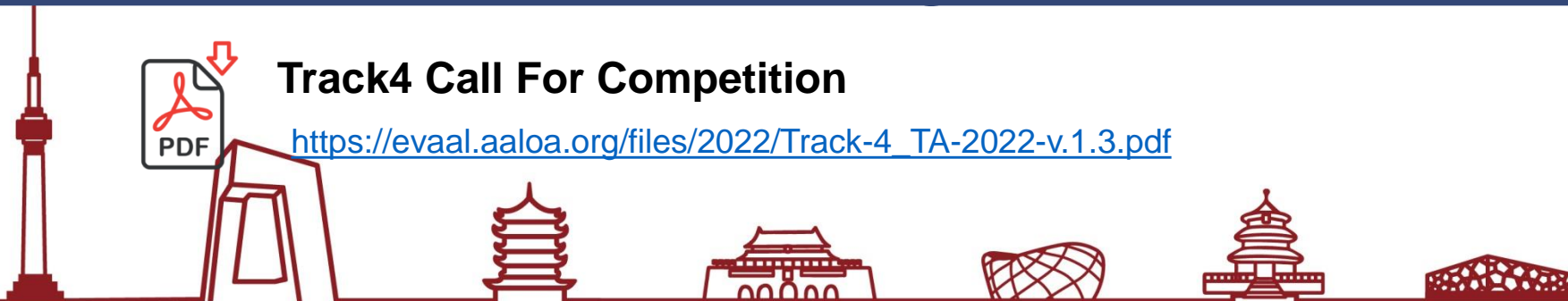
-Latitude
-Longitude
-Floor level

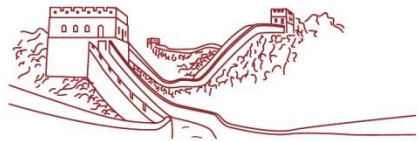
In quasi Realtime condition through the Evaal web API



Track4 Call For Competition

https://evaal.aaloa.org/files/2022/Track-4_TA-2022-v.1.3.pdf





Track4 : Foot-mounted IMU

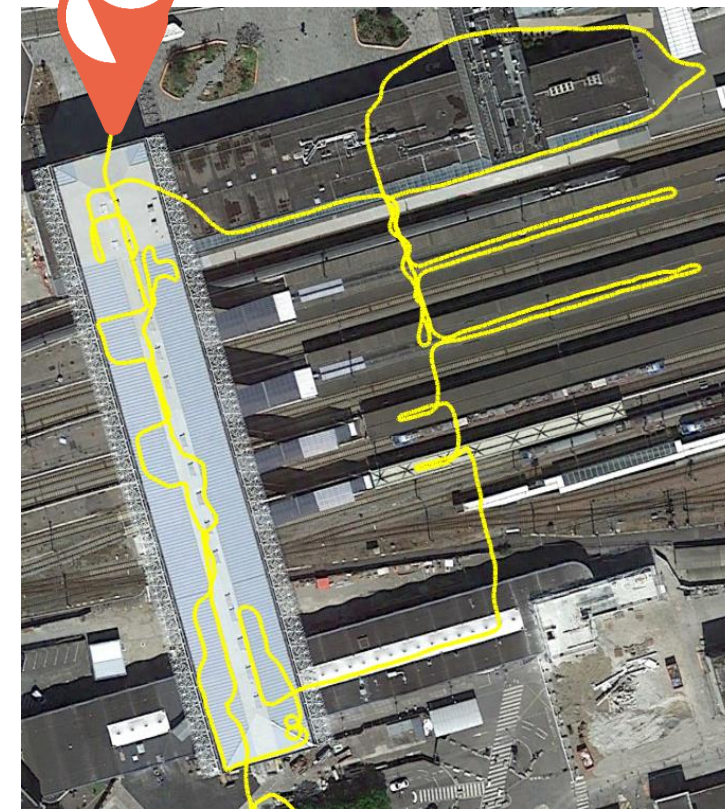
Track description

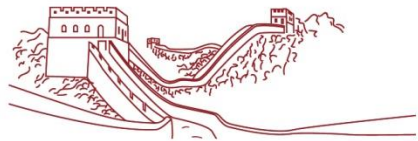


Starting point
(R0-front of Station)



Key point 2



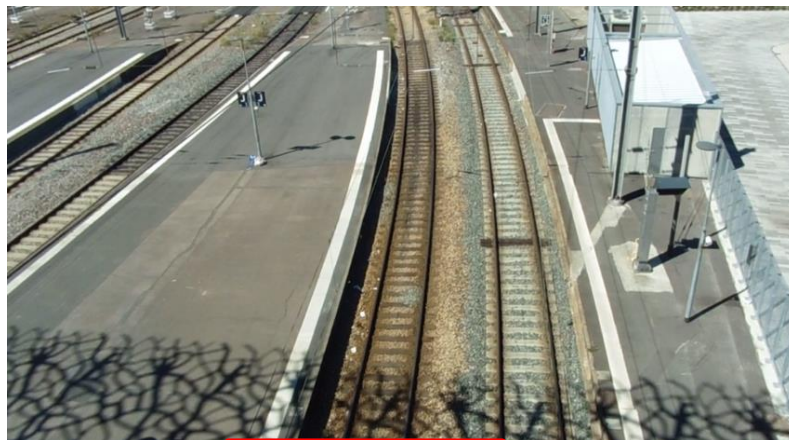


Track4 : Foot-mounted IMU

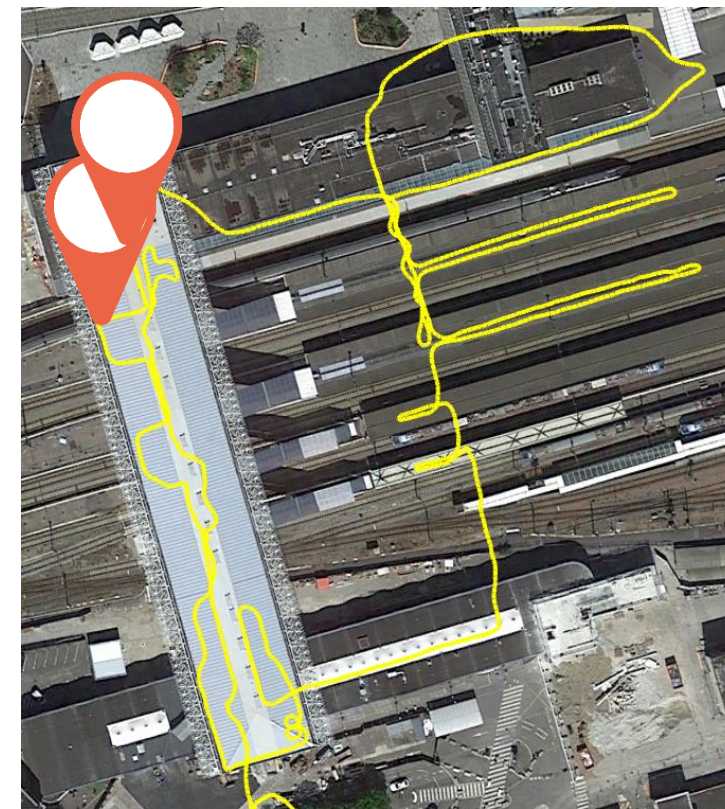
Track description



Stairs to R+2



10s break





Track4 : Foot-mounted IMU

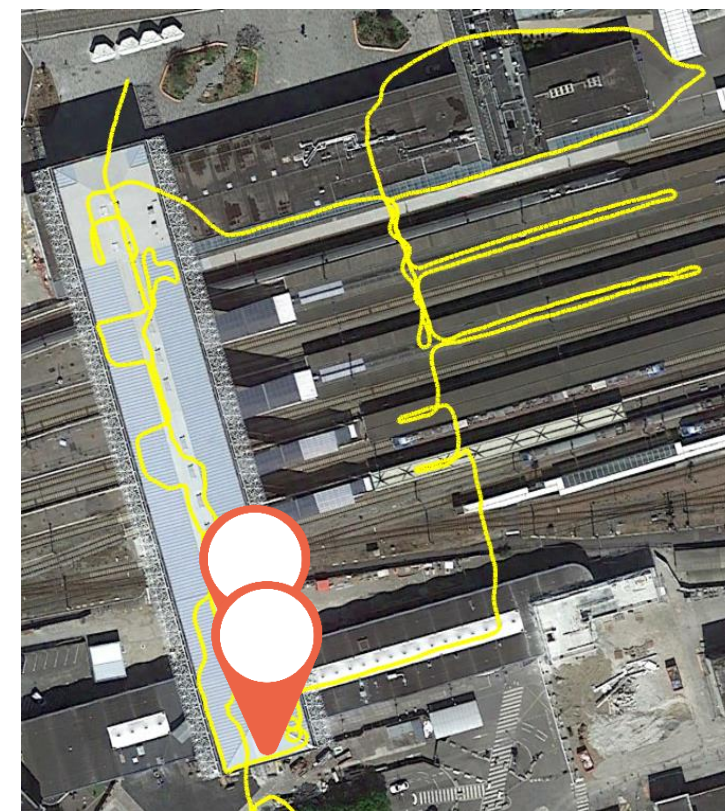
Track description

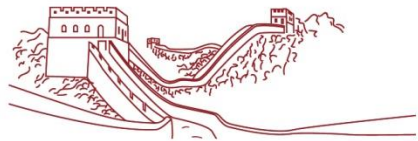


Walk R+2 near windows



Stairs to R0





Track4 : Foot-mounted IMU

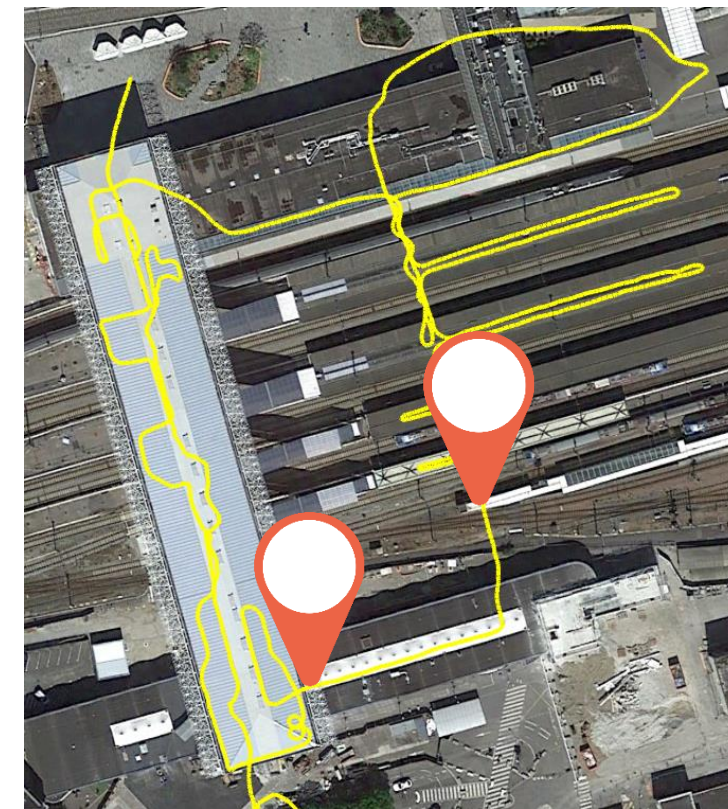
Track description

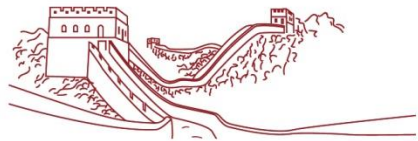


Continuous slope to R-1



Walk R-1



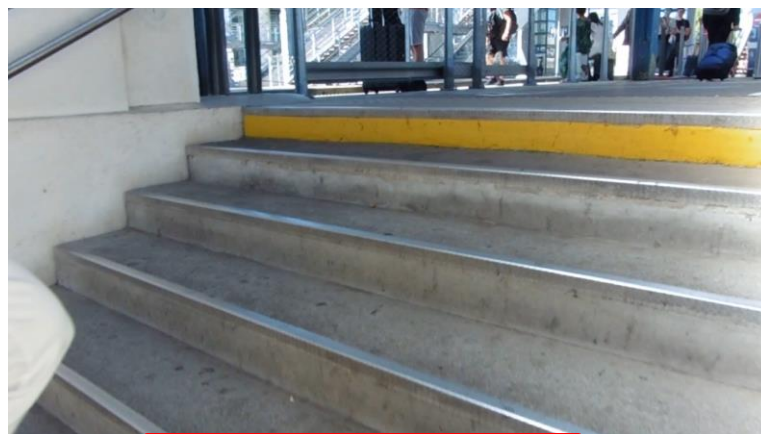


Track4 : Foot-mounted IMU

Track description

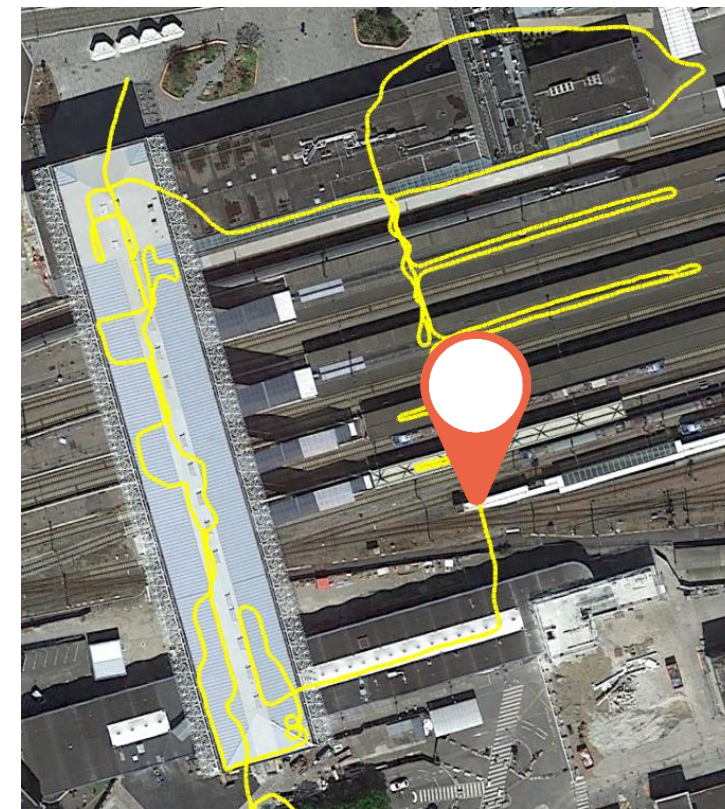


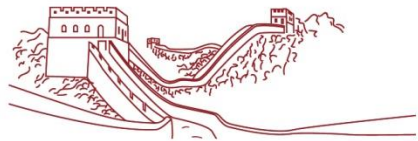
Continuous slope
R-1 -> R0 -> R-1



Stairs
R-1 -> R0 -> R-1

Several times





Track4 : Foot-mounted IMU

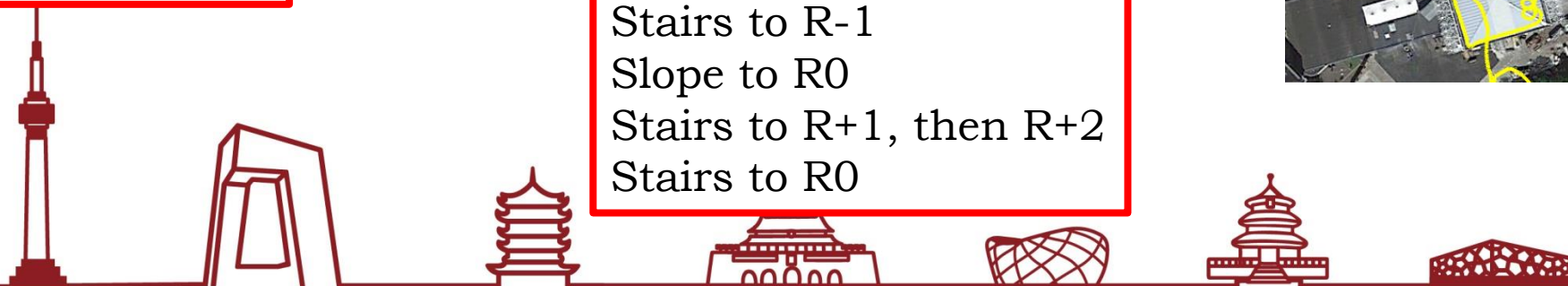
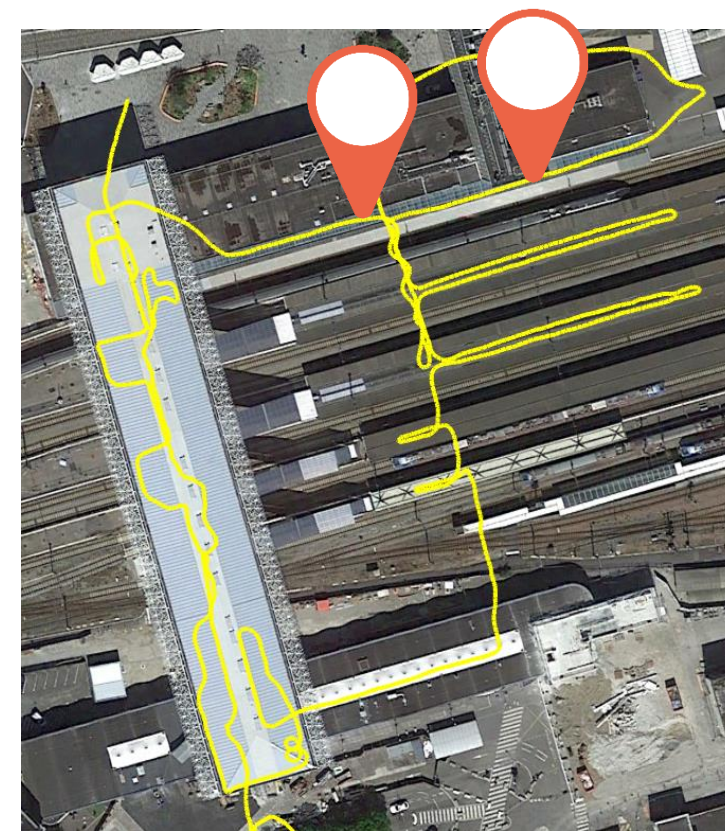
Track description

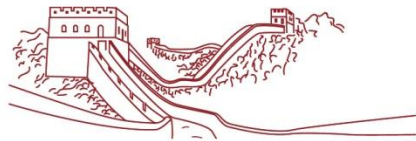


Stairs to R0 (outdoor)



Walk indoor:
Stairs to R-1
Slope to R0
Stairs to R+1, then R+2
Stairs to R0





Track4 : Foot-mounted IMU



Ground Truth

MVN Awinda starter
Standard performance

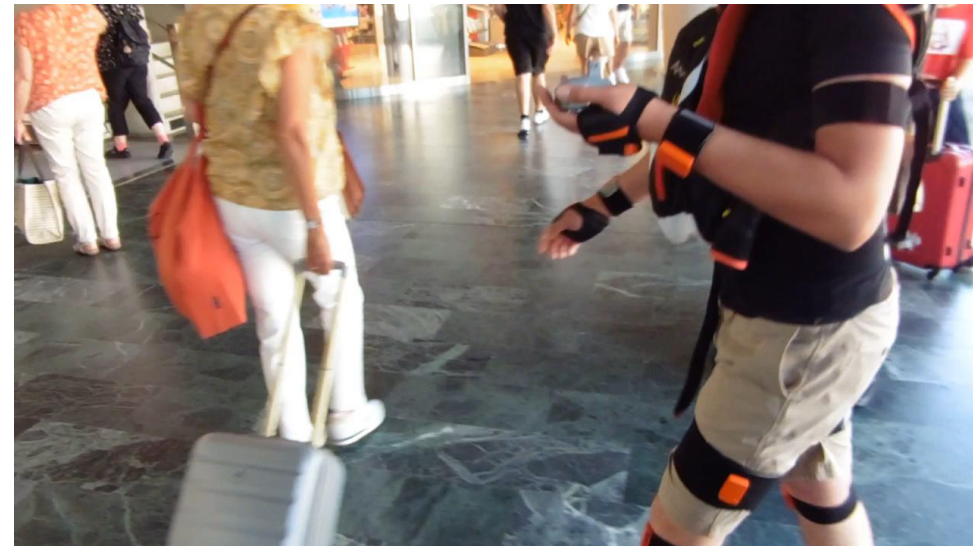
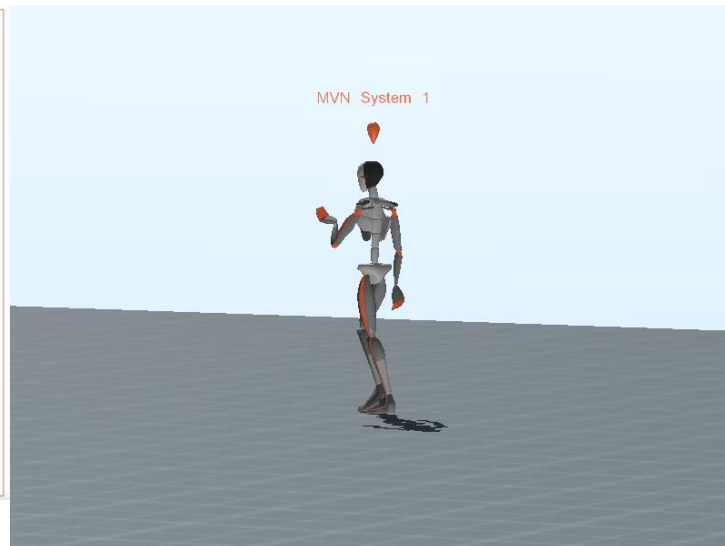


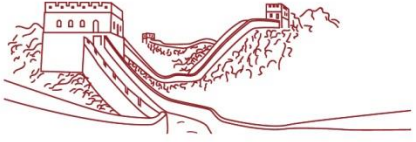
Range	~20m
Update rate	60hz
Battery life	6h
Comms	Radio protocol (Awinda)
Receiver	Awinda dongle
Hardware	17 wireless sensors T-shirt + straps
Charging	USB cable

MVN Awinda
Intermediate performance



Range	~50m
Update rate	60hz
Battery life	6h
Comms	Radio protocol (Awinda)
Receiver	Awinda station
Hardware	17(+1) wireless sensors T-shirt + straps
Charging	Charging station





Track4 : Foot-mounted IMU



Evaluation / Assessment

$$\text{Accuracy Score} = \text{3rdQuartile}\{\text{SampleError}(R_i, E_i)\}$$

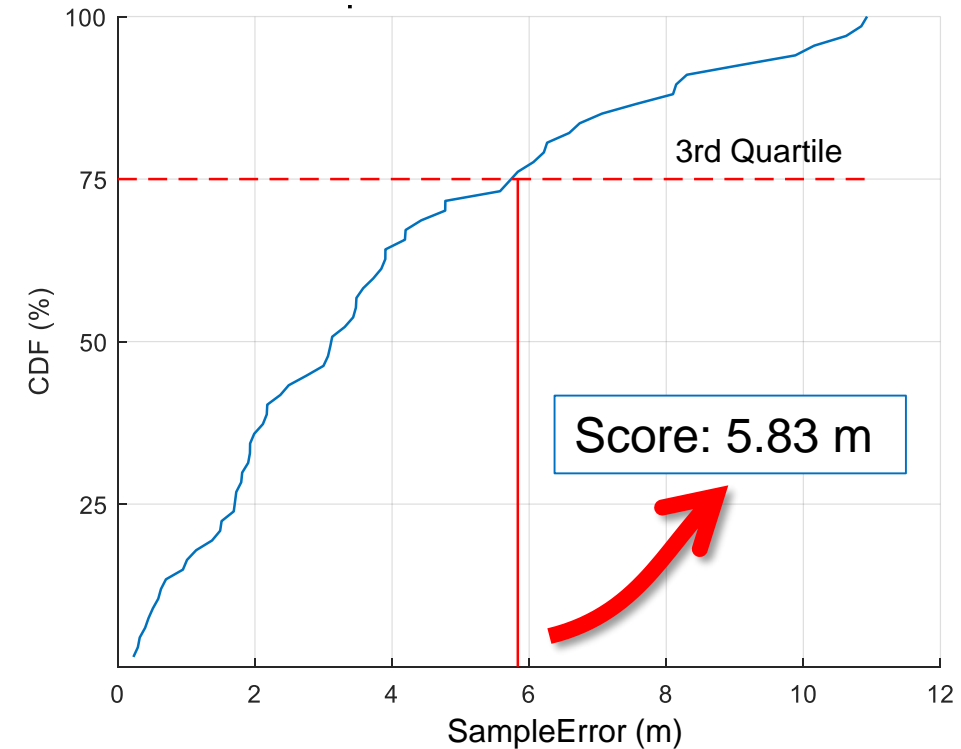
Where :

$$\text{SampleError}(R_i, E_i) = \text{Distance}(R_i, E_i) + (\text{penalty} \times \text{floorfail})$$

where:

- "3rdQuartile" is the third quartile error, in meters, of a cumulative error distribution function, i.e., the error value that includes 75% of estimations (sample errors) with a lower error.
- R_i is the actual position (ground truth).
- E_i is the predicted position by the method proposed by the contest participant.
- floorfail is the absolute difference between actual floor and the predicted one.
- penalty is used to penalize errors in estimating the floor. penalty is set to 15 m.
- $\text{Distance}(R_i, E_i)$ calculates the Euclidean distance between coordinates (longitude and latitude) of R_i and E_i .

The team with the lower "Accuracy Score" wins.



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Track4 : Foot-mounted IMU

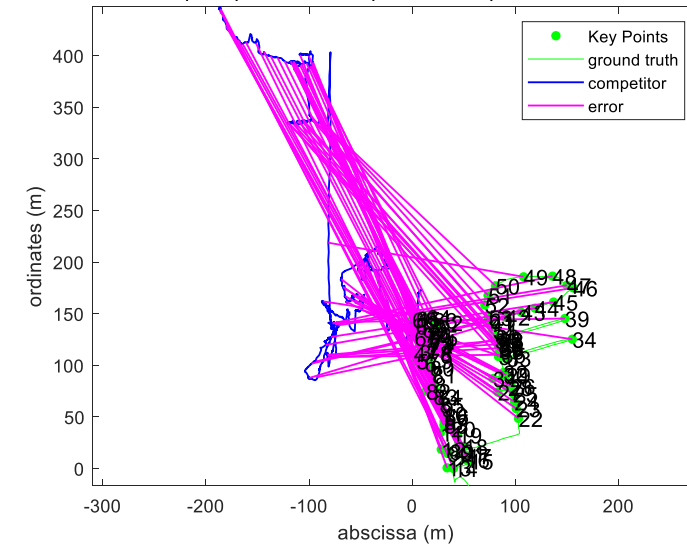


Results

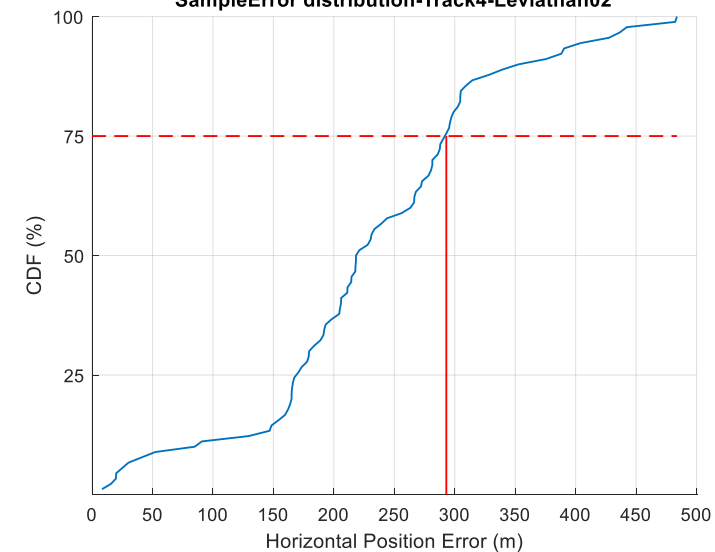


Accuracy Score	Team
293.0 m	Leviathan

Distance(Ri,Ei) for All Floor (COMPLETE)-Track4-Leviathan02



SampleError distribution-Track4-Leviathan02



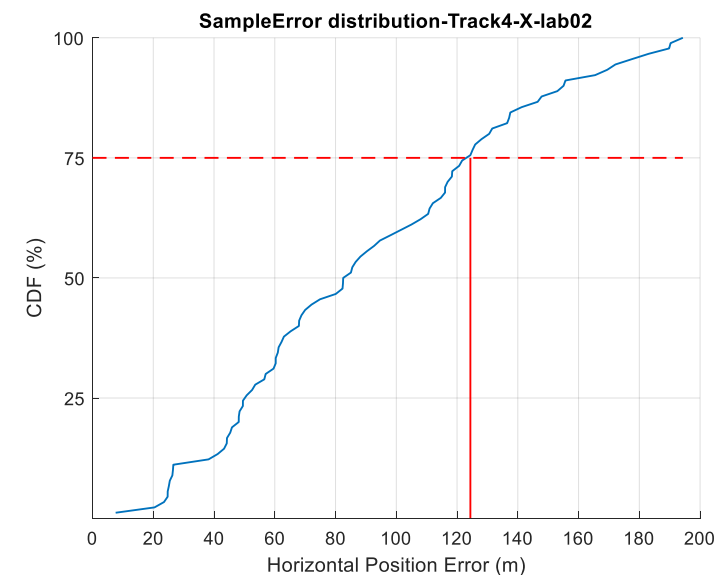
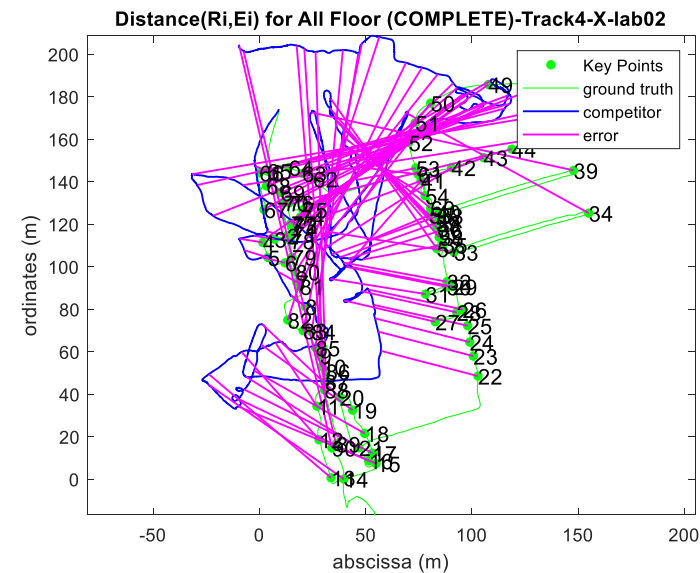


Track4 : Foot-mounted IMU



Results

Accuracy Score	Team
124.4 m	X-lab
293.0 m	Leviathan



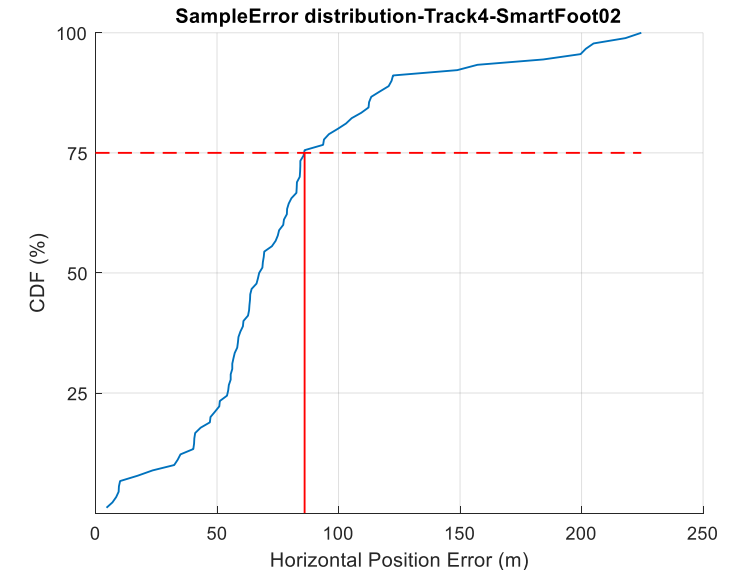
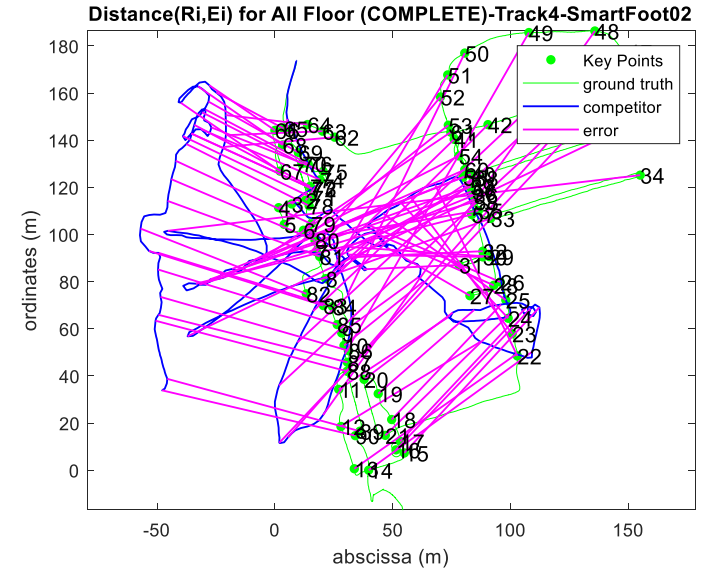


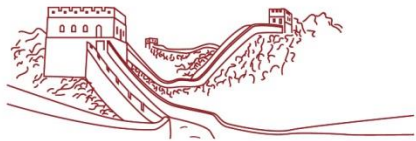
Track4 : Foot-mounted IMU



Results

Accuracy Score	Team
86.0 m	SmartFoot
124.4 m	X-lab
293.0 m	Leviathan





Track4 : Foot-mounted IMU

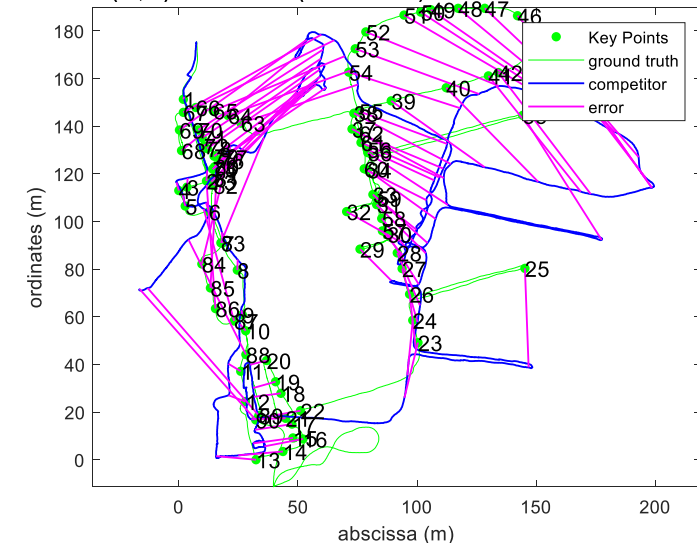


Results

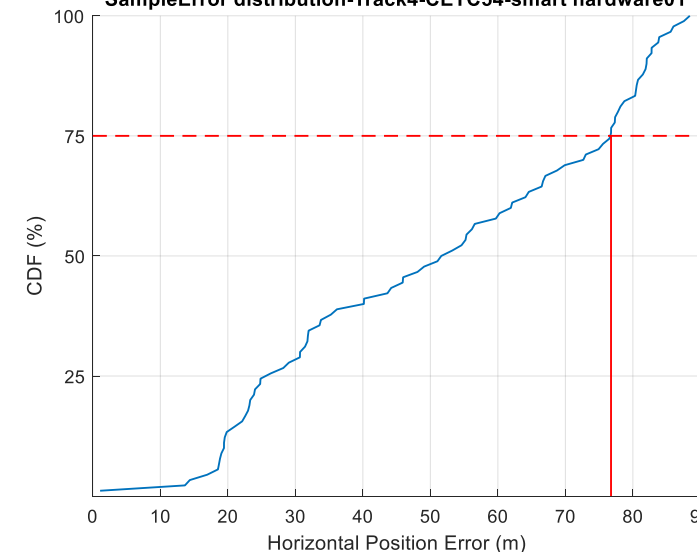
Accuracy Score	Team
76.8 m	CETC54-smart hardware
86.0 m	SmartFoot
124.4 m	X-lab
293.0 m	Leviathan



Distance(Ri,Ei) for All Floor (COMPLETE)-Track4-CETC54-smart hardware01



SampleError distribution-Track4-CETC54-smart hardware01





Track4 : Foot-mounted IMU



CONGRATULATIONS



CETC54
smart hardware



Lin Zhang



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谢谢观赏*

*:thank you for your attention