Track4 "Foot-Mounted IMU based Positioning (off-site)" special features

Organizational aspects:

Database/dataset download

- Participants can download the databases (logfiles) from this site: http://evaal.aaloa.org/images/2020/track4/
  Competitors can only use the data provided for the competition. They are not allowed to perform any additional on-site calibration.

Submission of the post-processed results

- After processing the evaluation logfiles, participants must submit the position estimates to the contact points of the corresponding track. Each submission must fulfill the format detailed in Section "Description of the Output File".
- A participant team can upload up to 3 different contributions, which will be evaluated by the competition organizers. Although the three alternatives will be evaluated on the final test set, only the best one will be considered for the contest.

Submission deadline of the post-processed indoor coordinates

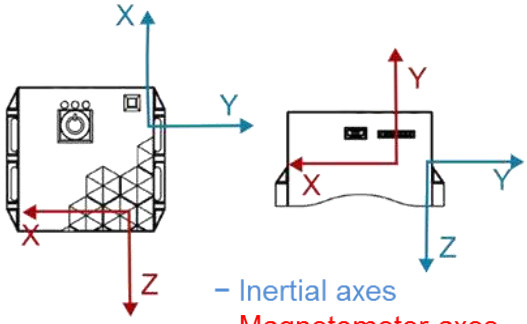
- **The deadline** for submitting the post-processed results is: **NOVEMBER 30th 2020**

Scope

Many indoor navigation systems have been developed for pedestrians and assessing their performances is a real challenge. Benefiting from a reference solution that is accurate enough to evaluate other indoor navigation systems and assist novel research is of prime interest. According to ISO18305:2016 two different ways can be used for assessing indoor localization system: "Off-line surveyed test point" that is commonly used, or "reference system" with an accuracy at least one order of magnitude better the system you want to test. The scope of this track4 is clearly focused on the second way of assessing.
This track4 is based on the same material as previous competitions hold during IPIN2018 and IPIN2019.

Competition Goal

The goal of this competition is to evaluate how good up-to-date INS algorithm is. Each competitor will be given a dataset logged with PERSY (PEdestrian Reference SYstem).



Description of Datasets (LogFiles)

Each LogFile is composed of the following files:

- HKBxx_mag.csv : magnetometer data from an Honeywell HMC5983 sensor
- HKBxx_sti.csv : accelerometer / gyrometer / inclinometer from a Sensonor STIM300 IMU
- HKBxx_ublox.ubx : GNSS rawdata and NMEA (GGA/ZDA) from a Ublox NEO-M8T receiver

- HKBxx_INFO.txt : parameter of acquisition.

With xx being an integer number.

Column	HKBxx_mag.csv	HKBxx_sti.csv
1	GPS Time of Week (ToW) in second	GPS Time of Week (ToW) in second
2	Mag X (Gauss)	Acc X (m/s²)
3	Mag Y (Gauss)	Acc Y (m/s²)
4	Mag Z (Gauss).	Acc Z (m/s²)
5	-	Gyro X (rad/s)
6	-	Gyro Y (rad/s)
7	-	Gyro Z (rad/s)
8	-	Inc X (m/s²)
9	-	Inc Y (m/s²)
10	-	Inc Z (m/s²)

Sample of HKBxx_mag.csv

```
468159.9399756390,-1.763636,-0.688636,-0.052273
468159.9462234838,-1.770455,-0.677273,-0.054545
468159.9524873283,-1.811364,-0.681818,-0.054545
468159.9587211735,-1.793182,-0.688636,-0.050000
468159.9649740182,-1.827273,-0.661364,-0.050000
468159.9712228630,-1.765909,-0.684091,-0.045455
468159.9774877075,-1.881818,-0.661364,-0.059091
468159.9837235526,-1.747727,-0.675000,-0.050000
468159.9899743974,-1.863636,-0.656818,-0.047727
468159.9962232422,-1.815909,-0.659091,-0.043182
```

Sample of HKBxx_ sti.csv

```
468159.9413936038,0.973037,-0.039822,-9.691205,-0.096551,0.209446,-0.102691,0.878616,-0.026245,-9.806030
468159.9473904549,0.888735,-0.009072,-10.158242,-0.092510,0.121487,-0.118683,0.898719,-0.014653,-9.710660
468159.9538922934,1.070751,0.012644,-10.062848,-0.067220,0.078188,-0.156850,0.920395,-0.028249,-9.792823
468159.9598871445,1.193360,0.044648,-9.892860,-0.065414,0.072983,-0.196963,0.994653,0.027185,-9.784277
468159.9663939829,1.147926,0.057012,-10.037952,-0.087818,0.048152,-0.224686,1.099507,0.063140,-9.799905
468159.9724008338,1.104344,-0.010175,-9.981745,-0.102824,0.030513,-0.236167,1.128660,0.058324,-9.854417
468159.9788936725,1.120187,-0.033781,-9.874043,-0.102832,0.030752,-0.243609,1.099098,0.023119,-9.846171
468159.9848875237,1.125125,-0.071714,-9.757157,-0.111005,0.053351,-0.234590,1.100033,-0.033238,-9.813517
468159.9913943621,1.098527,-0.173467,-9.769615,-0.106166,0.065569,-0.216283,1.105233,-0.092217,-9.743791
468159.9973902132,1.083657,-0.155492,-9.841609,-0.101822,0.062026,-0.203116,1.084391,-0.159098,-9.719481
468160.0038900518,1.128791,-0.005181,-9.921329,-0.108073,0.054697,-0.211873,1.082584,-0.159163,-9.752542
```

Sample of Ublox NEO-M8T (binary and asci are mixed)

```
µb 4L Êuç- 6
$GNGGA,100215.80,,,,,0,00,99.99,,,,,,*77
$GNZDA,100215.80,19,01,2018,00,00*75
$GNGGA,100216.20,,,,,0,09,1.02,,,,,,*44
$GNZDA,100216.20,19,01,2018,00,00*7C
$GNGGA,100216.60,4713.52225,N,00137.74087,w,1,12,0.84,31.3,M,48.1,M,,*6B
$GNZDA,100216.60,19,01,2018,00,00*78
$GNZDA,100216.80,19,01,2018,00,00*76
$GNZDA,100217.00,19,01,2018,00,00*7F
$GNZDA,100217.20,19,01,2018,00,00*7D
```

Inputs given to competitors

The materials and methods provided by the competition organizers are:

- **Supplementary material:**
  - **Ublox file Parser**
    - u-center software: https://www.u-blox.com/en/product/u-center-windows
    - RTKLIB: https://github.com/tomojitakasu/RTKLIB_bin
  - **Datasheet of each individual sensors can be downloaded here:**
    - Honeywell HMC5983: http://evaal.aaloa.org/images/2020/track4/datasheet_hmc5983.pdf
    - Sensonor STIM300 IMU: http://evaal.aaloa.org/images/2020/track4/datasheet_stim300.pdf
    - Ublox NEO-M8T GNSS Receiver: http://evaal.aaloa.org/images/2020/track4/datasheet_neo-m8t.pdf
- **LogFiles**:
  - HKB08.zip : static log of several hours that can be used for sensors bias estimation http://evaal.aaloa.org/images/2020/track4/HKB08.zip
    - HKB08_mag.csv
    - HKB08_sti.csv
    - HKB08_ublox.ubx
    - HKB08_INFO.txt
  - HKB43.zip : dynamic log needed for trajectory estimation: http://evaal.aaloa.org/images/2020/track4/HKB43.zip
    - HKB43_mag.csv
    - HKB43_sti.csv
    - HKB43_ublox.ubx
    - HKB43_INFO.txt

- **Timing of expected Key Points**:
    - 67 key points will be evaluated in Track4 (from 2 to 68 ; 1 is given hereafter)
    - Key Points timestamps are expressed in GPS Time of Week in milliseconds (ms)

Key Point	GPS Time of Week (ms)	Key Point	GPS Time of Week (ms)	Key Point	GPS Time of Week (ms)
1	304306944	**24**	304809401	**47**	305354202
2	304318212	**25**	304829669	**48**	305380520
3	304341237	**26**	304841281	**49**	305524854
4	304395079	**27**	304871131	**50**	305533004
5	304399422	**28**	304889537	**51**	305542947
6	304409279	**29**	304904899	**52**	305555247
7	304415054	**30**	304917724	**53**	305581734
8	304435422	**31**	304924148	**54**	305591384
9	304448003	**32**	304955417	**55**	305599871
10	304457884	**33**	305013522	**56**	305611396
11	304481277	**34**	305030296	**57**	305622139
12	304488189	**35**	305042358	**58**	305639308
13	304531239	**36**	305090776	**59**	305654951
14	304553700	**37**	305106407	**60**	305684969
15	304609224	**38**	305126569	**61**	305723993
16	304664704	**39**	305201592	**62**	305737774
17	304673523	**40**	305251797	**63**	305831654
18	304690485	**41**	305256885	**64**	305846397
19	304732834	**42**	305295172	**65**	305881902
20	304742727	**43**	305303559	**66**	305925620
21	304751765	**44**	305319134	**67**	305963826
22	304784970	**45**	305330108	**68**	306012968
23	304799226	**46**	305346133		

GPS time of week being the same as ones used in datasets, excepted those are in ‘s’ instead of ‘ms’.

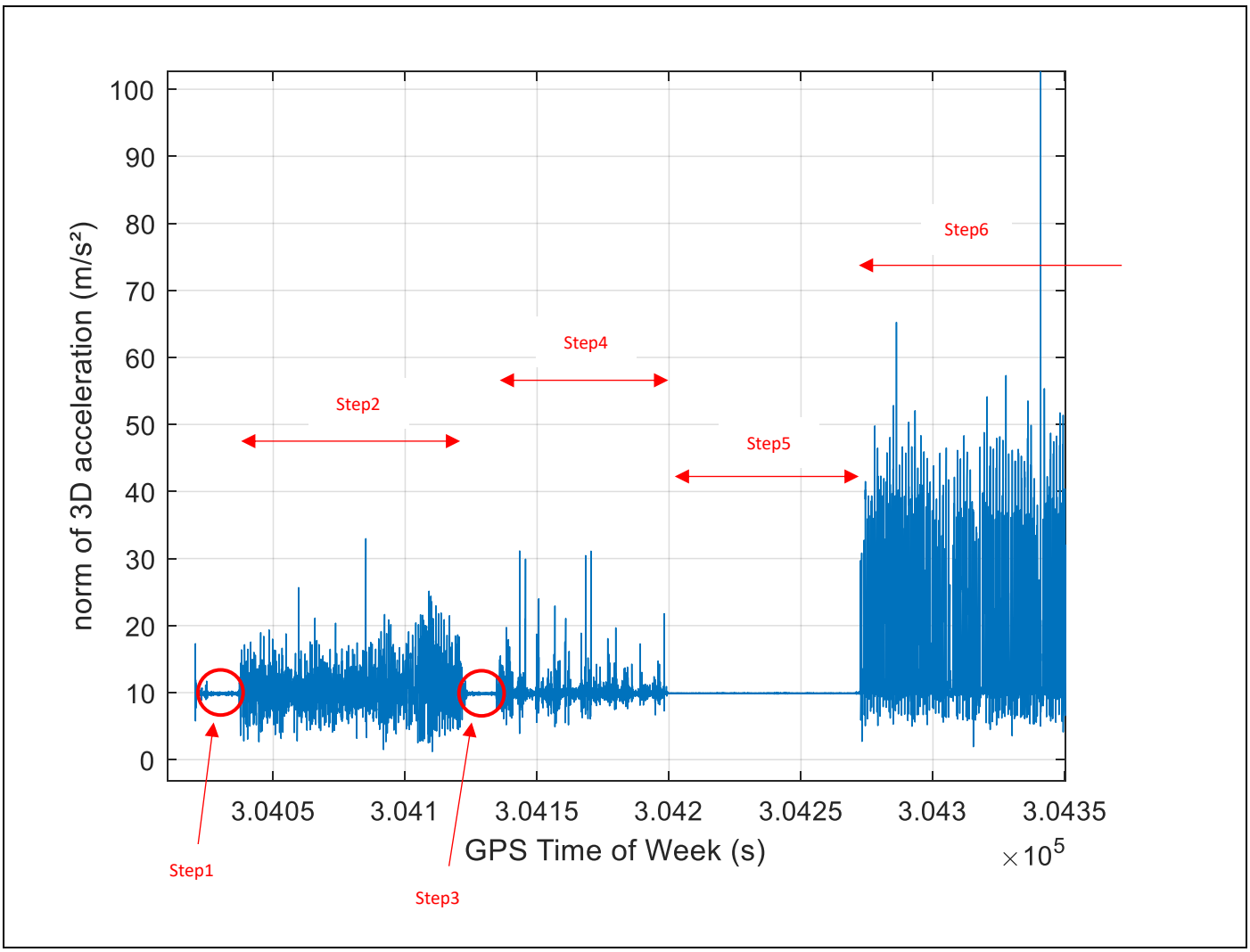
The output format as described in the chapter “Description of the Output File” here after shall be used. The table above shall be used for columns 1 & 5 of output location file, as illustrated here after:

```
304306944,141.346893310,43.070755004,-1,1
304318212,141.346908569,43.070758815,1,2
304341237,141.347000152,43.070770262,2,3
…
306012968,141.347020152,44.070770262,2,68
```

Note: column 1 will not be assessed, and thus can be slightly different from the expected time. What is important is to put correctly the right key point id in column 5.

- **Description of the different phases of evaluated trajectory**:
    - Step1: 10s hand held static phase
    - Step2: 60s magnetometer calibration.
    - Step3: 10s hand held static phase

- Step4: PERSY setup on the foot
- Step5: ~60s static phase with PERSY on the foot
- Step6: evaluation track including Key Points from 1 to 68.



- **Coordinates of static phase at <u>Step5</u> :**
  - WGS84 longitude in decimal degrees: `-1.630557646 (West)`
  - WGS84 latitude in decimal degrees: `47.222862442 (North)`
  - Floor Number in integer: 0 (Outdoor environment)
- **Coordinates of Key Point n°1:**
  - WGS84 longitude in decimal degrees: `-1.631205195 (West)`
  - WGS84 latitude in decimal degrees: `47.222886681 (North)`

- Floor Number in integer: 0 (Outdoor environment)

- **Note about Maps use**
  - Even if maps are allowed in others tracks, for this one, **it is NOT**. Track chairs, in such a case, could cancel contributions of competitor.
  - Algorithms are not supposed to embed or access maps to enhance positioning.
  - As Track4 is an off-line competition, we encourage competitor to use maps in a validation purpose (only).

Description of the Output File

For each trial, you must submit a CSV file whose format is now described.

- 5 columns :
  - Column 1: Timestamp in ms
  - Column 2: WGS84 longitude in decimal degrees with at least 9 decimal digit resolution
  - Column 3: WGS84 latitude in decimal degrees with at least 9 decimal digit resolution
  - Column 4: Floor Number in integer (0 : Ground Floor, -1, 1, 2)
  - Column 5: index in integer (key point number from 1 to N. 0 represents no landmark. Each specific integer represents the specific key point)
- Comma (“,”) used as data delimiter
- No header

Example :

```
1505633871558,141.346908569,43.070758819,-1,0
1505633872089,141.346893310,43.070755004,-1,0
1505633872627,141.346893310,43.070755002,-1,0
1505633873156,141.346893308,43.070755003,-1,0
1505633873692,141.346893310,43.070755004,-1,1
1505633874227,141.346908569,43.070758819,0,0
1505633874774,141.346908570,43.070758817,0,0
1505633875316,141.346908579,43.070758819,0,0
1505633875840,141.346908569,43.070758815,1,2
1505633876372,141.346908565,43.070758819,1,0
1505633876905,141.347000132,43.070770263,1,0
1505633877448,141.347000142,43.070770261,2,0
1505633877994,141.347000152,43.070770262,2,3
1505633878532,141.347000162,43.070770263,2,0
```

Estimated position for key point 1

Estimated position for key point 2

Estimated position for key point 3

Evaluation will only take into account the estimated position at each indexed key point position, so that each track is considered as a series of key point positions (from 1 to N).

Evaluation criterion

The final metric will be based on the accuracy for the correct floor detection and the horizontal positioning error. In particular, the score for comparing the different location systems will be based on the following equations:

$$\textbf{Accuracy Score} = 3\text{rdQuartile}\{\text{SampleError}(R_i, E_i)\}, \forall \text{ groundtruth reference in all final test sets}$$

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

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.
- $\mathrm{Distance}(R_i, E_i)$ calculates the Euclidean distance between coordinates (longitude and latitude) of R_i and E_i.

The team with the lower "Accuracy Score" wins.

Contact points and information

For any further question about the database and this competition track, please contact to:

- Miguel Ortiz (miguel.ortiz@univ-eiffel.fr) at the University Gustave Eiffel, France.
- Ni Zhu (ni.zhu@univ-eiffel.fr) at the University Gustave Eiffel, France.

Introduced changes

For any further question about the database and this competition track, please contact to:

Version 1.0	August 19th	Initial Submission