Track 6: Smartphone-based Vehicle positioning without additional equipment

Organizational aspects:

Database/dataset download:

Participants can download the testing trials and scoring trials samples from https://evaal.aaloa.org/2022/data

Competitors can only use the data provided for the competition in the website.

Performing any additional on-site calibration is not allowed.

Submission of the post-processed results:

- Despite being an off-site track, we will ask to competitors to process data as if they were streamed in real time. To do so, an interface based on an API has been developed: EvaalAPI. This API will be used by competitors for sending position estimates and reading the sensor readouts: https://evaal.aaloa.org/evaalapi/
- The competition teams can calibrate their algorithmic models with the testing trials containing readings from sensors of the vehicle-mounted smartphone and some ground-truth positions. At the scoring trials evaluation stage, each team will compete using additional database files, and the ground-truth reference is not given and must be estimated by the competitors.
- The competition teams can run the scoring trials for 2 times. This lets a chance to catch-up if any issues happen. Although the competition organizers will evaluate the two trials, only the best one will be considered for the contest. For the first evaluation trial, the logfile EvaluationRun01 will be used. For the second trial, the logfile EvaluationRun02 will be used. These two logfiles correspond to two different data collection sessions.

Submission deadline of the post-processed indoor coordinates:

- Test trials will be published in website and EvaalAPI: **June 2022**
- The deadline for submitting results is: **August 2022**
- Proclamation of winners: **September 7th 2022**

Competition Goal:

The goal of this track is to evaluate the performance of different integrated navigation solutions based on the sensors of vehicle-mounted smartphone, such as GNSS, MEMS and magnetometer, etc. The test route includes both an outdoor scenario with unobstructed satellite view, one with partially obstructed view and an indoor scenario without satellite view. The outdoor scenario with unobstructed view accounts for 40% of the total test route, and is not considered for computing the evaluation score.

Main features of the competition:

- This track is done off-site, so all data for testing and scoring is provided by competition organizers before the celebration of the IPIN conference. The competition teams can calibrate their algorithmic models with several databases containing readings from sensors of the vehicle-mounted smartphone and some ground-truth positions. Finally, each team will compete using additional database files, but in this case, the ground-truth reference is not given and must be estimated by the competitors. Besides, in order to avoid using map matching method, an irregular driving route is adopted. This is an off-line competition where all competitors have the same data of the testing environment, so performing any additional on-site calibration is not allowed.

- A Huawei mate20 smartphone is used to record raw multi-sensor data, which contains the data information of all available signals recorded by the smartphone in real time in the vehicle scene. During the entire test process, the smartphone is fixedly installed at the front of the vehicle to record the motion measurements of the vehicle.
- In the typical urban road conditions, a single test process lasts about 1 hour and the test route consists of static initial alignment phase (about 5 minutes), open environment phase (about 20 minutes), obstructed environment phase where the GNSS signal is attenuated or blocked by the surrounding buildings or trees (about 25 minutes, during which the GNSS positioning results will be frequently interrupted) and no GNSS signal phase (underground parking lots about 10 minutes, no GNSS positioning results). The driving process of the test vehicle includes going straight, left/right turning, reversing and parking.
- During the measurement data collection phase, all the data of testing trials and scoring trials use the same vehicle, smartphone and smartphone installation way.
- During the test process, the smartphone is firmly connected to the vehicle body as shown below. The sensor measurement coordinate system is not coincident with the vehicle body coordinate system, so the mounting angles need to be considered.

Desired localization approaches:

Any kind of positioning algorithm is admitted.

Description of Datasets (Logfiles) :

- Each logfile is a “txt” file containing multiple rows with different types of data. Each row registers the data received from a particular sensor type in the phone at a given time. The stream of sensor data generated in the phone is stored, row by row, in the logfile in sequence as they are received. Each row begins with an initial header (4 capital letters followed by a semicolon, e.g., ‘ACC’,’MAGN’,’GNSS’ etc.) that determines the kind of sensor read, and several fields separated by semicolon with different readings. This is an extract of a real log file shown as example:

```
ACCE;0.272;71.969;-0.21787;3.76608;8.77954;3
AHRS;0.273;71.969;23.6975;3.1478;17.7537;0.19864;0.05823;0.15654;3
GYRO;0.281;71.978;-0.20586;-0.54062;-0.23213;3
MAGN;0.292;71.983;2.70000;-79.68000;-31.38000;0
GYRO;0.292;71.988;-0.14478;-0.36835;-0.20769;3
ACCE;0.292;71.989;-0.43814;3.72059;9.59357;3
AHRS;0.293;71.989;23.4482;2.5947;17.4807;0.19742;0.05278;0.15330;3
GYRO;0.301;71.998;-0.05620;-0.18570;-0.15149;3
PRES;0.313;72.003;1001.2212;3
MAGN;0.314;72.003;2.70000;-79.38000;-31.38000;0
GYRO;0.314;72.008;0.07697;0.03910;-0.08369;3
ACCE;0.314;72.009;-0.26815;4.01508;9.42837;3
AHRS;0.315;72.009;23.3222;2.3635;17.2627;0.19676;0.05030;0.15107;3
LIGH;0.315;72.010;101.0;3
```

- The detailed list of fields in each sensor's row, and one specific example, is shown next:

MAGN: the local magnetic field, as measured by the 3-axis magnetometer in the phone	
Format	MAGN;AppTimestamp(s);SensorTimestamp(s);Mag_X(uT);Mag_Y(uT);Mag_Z(uT);Accuracy(integer)
Example	MAGN;0.035;8902.708;-20.70000;-34.02000;-19.20000;3
ACCE: the phone's acceleration, as measured by the 3-axis accelerometers in the phone	
Format	ACCE;AppTimestamp(s);SensorTS(s);Acc_X(m/s^2);Acc_Y(m/s^2);Acc_Z(m/s^2);Accuracy(integer)
Example	ACCE;0.034;8902.708;-1.80044;6.41646;7.17303;3
GYRO: measures the phone's rotation, using the 3-axis orthogonal gyroscopes in the phone	
Format	GYRO;AppTimestamp(s);SensorTimestamp(s);Gyr_X(rad/s);Gyr_Y(rad/s);Gyr_Z(rad/s);Accuracy(integer)
Example	GYRO;0.032;8902.705;-0.22846;-0.21930;-0.05498;3
PRES: the atmospheric pressure	
Format	PRES;AppTimestamp(s);SensorTimestamp(s);Pres(mbar);Accuracy(integer)
Example	PRES;0.038;8902.726;956.4289;0
LIGH: for light intensity in Luxes	
Format	LIGH;AppTimestamp(s);SensorTimestamp(s);Light(lux);Accuracy(integer)
Example	LIGH;0.032;8902.693;292.0;0
GNSS: the Latitude, Longitude and Height estimated from GPS/BD	
Format	GNSS;AppTimestamp(s);Latit(°);Long(°);Altitude(m);Bearing(°);Speed(m/s); Acuracy(m); GPS TOW(s);SatInView;SatInUse;
Example	GNSS;0.611; 40.069708; 116.275895; 36.135;0.000;4.0;0.0; 8272.999; 17;15
AHRS: the mobile phone 3D orientation in terms of pitch, roll and yaw	
Format	AHRS;AppTS(s);SensorTS(s);PitchX(°);RollY(°);YawZ(°);RotVecX();RotVecY();RotVecZ();A

	ccuracy(int)
Example	AHRS;0.033;8902.705;41.6550;11.7495;-124.0558;0.25038;-0.26750;-0.80406;-2
POSI: ground-truth position (only in calibration files)	
Format	POSI; GPS TOW(s);Latitude(degrees);Longitude(degrees);Altitude(m)
Example	POSI; 8272.999; 40.081377, 116.261005, 35.900

- The sampling rate of each type of sensor can be different since it is dependent on the embedded sensor chips used by a particular phone. Typical sampling frequency value for the inertial data is about 250Hz, but we forced the sensor to the maximum rate.
- **Important note:** The key points (landmarks) are not publicly available in testing trial logfile and they will be inserted by the organizers using the timestamp in the scoring trial files. In Track 6, the data recording starts in app timestamp 0.

Inputs given to competitors:

- There are at least 2 sets of test data containing the ground-truth reference data will be provided for competitors to calibrate their algorithms.
- Another type of logfiles, the logfiles of scoring trials, are used for evaluation at the competition and do not contain any position reference. These logfiles contain measurements were taken following the same procedure used in the testing logfiles. The evaluation of the competitor's algorithm will rank its performance according to the metrics described in section "Evaluation criterion". In Track 6 of the IPIN2022 competition, we provide 2 scoring logfiles through the EvaalAPI https://evaal.aaloa.org/evaalapi/ . Users have just one trial to submit the position estimates for each scoring logfile.

Estimated position: +

By using the EvaalAPI web interface, you must submit position estimates with a frequency of 1 Hz, equivalent in EvaalAPI terms to `horizon=1`. The position should be formatted as a comma-separated string with 4 fields:

Field 1: Timestamp in GPS second of week

Field 2: WGS84 latitude in decimal degrees with at least 6 decimal digit resolution

Field 3: WGS84 longitude in decimal degrees with at least 6 decimal digit resolution

Field 4: Altitude in decimal meters with at least 1 decimal digit resolution

- Example:

```
22576,40.422833,117.718888,36.2
22577,40.422309,117.718466,36.2
22578,40.422226,117.718312,36.2
22579,40.422213,117.71827,36.2
22580,40.422156,117.718237,36.2
22581,40.422099,117.718204,36.2
22582,40.421969,117.718131,36.2
22583,40.421874,117.71808,36.2
22584,40.421801,117.718039,36.2
22585,40.421801,117.717979,36.2
22586,40.421783,117.71803,36.2
22587,40.421845,117.7179947,36.2
22588,40.421893,117.7179473,36.2
22589,40.42196,117.7178875,36.2
22590,40.422036,117.7178151,36.2
```

Evaluation criterion :

Following the Evaal evaluation criterion, the third quartile of 2D positioning error of output points will be evaluated, while the altitude error is not considerd in the final evaluation. The final score is evaluated only during the phases where the GNSS is attenuated or absent (that is, the last 25 + 10 minutes). During the test, a DGNSS/FOG-INS reference system with an expected accuracy of 20 cm at 1 Hz will provide the ground truth. Competitors are expected to provide an estimate at every integer second (GPS TOW).

Contact points and information:

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

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Last updated: 2 August 2022)

***We have updated the format of GNSS data, as described in Description of Datasets (Logfiles); 2022.08.02**

+ the section on the Estimated position was previously called Output format and contained obsolete reference to a CSV file. The current version correctly makes instead reference to the EvaalAPI interface