

xDR Challenge2023

~PDR and BLE with LiDAR based GT~

xDR Challenge is a series of indoor localization competition by PDR benchmark standardization committee mainly focused on integrated indoor localization methods with dead-reckoning. xDR Challenge 2023 will be held as an official competition track of IPIN 2023 (**Track 5**). Our track is categorized as "off-site, off-line" track, which means that we provide datasets for indoor localization to competitors and the competitors are asked to submit estimated trajectories of targets in certain time limit. Target field of this year's competition is commercial facilities and the targets of localization are pedestrian walking in the field. We arranged totally about 100 BLE beacons in the field for correcting error of PDR. We adopted LiDAR for collecting ground-truth of position of the targets. We will evaluate the estimated trajectories of the target by utilizing multi-faceted evaluation metrics with the precise ground-truth data by LiDAR.

(URL:)<https://unit.aist.go.jp/harc/xDR-Challenge-2023/index.html>

Important Dates

Technical annexes published	April
Application	May
Test trials published	June
Result submission due	The middle of September, 2023
Winner proclamation:	25–28 September, 2023 (During IPIN Conference)

★ Overview

xDR Challenge 2023 ~PDR and BLE with LiDAR based GT~ (Hereafter referred to as xDR Challenge 2023) will be held as a sequel competition of PDR/xDR Challenge series which had been hosted by PDR Benchmark standardization committee. As in previous years' competitions, the xDR Challenge 2023 will be held as an official competition tracks of the IPIN conference. There are three categories of tracks in IPIN 2023 competition. Our track is categorized as an "**Off-site, Off-line**" track.

The **off-site competition** means that

- Competition organizers have conducted measurement and prepare dataset for the competition, and
- The dataset measured will be provided to competitors, and
- The competitors are required to estimate the targets movement by applying their own algorithm and submit the estimated results.

The **off-line competition** means that

- the competitors are not required to submit the results in real-time, but to submit in certain (longer) time limit, and
- the competitors can obtain whole data of each sequence for applying global optimization while constraining with provided information.

The datasets of our track consists of sensor data required for the PDR-based indoor localization. The data are measured in the commercial facilities in a highway rest spot. We measured pedestrian movement by using Android devices. We collected sensor (gyro, accelerometer, magnets sensor) data as well as the BLE signals from the BLE beacons.

Similar to the previous PDR/xDR Challenges, submitted trajectories will be evaluated by multi-faceted evaluation metrics. It is notable that we collected highly precise ground-truth of the targets movements by using a hand-held LiDAR. The detailed evaluation metrics will be announced at a later date.

xDR Challenge 2023 will be conducted closely together with other tracks of the IPIN competitions under a common schedule. We also adopt common tool named EvAAL API for sharing dataset and receiving results. As aligned with other tracks, real competition will be conducted at a day in the middle of September 2023. We will provide test dataset in same format with the real dataset for allowing the competitors to prepare and adjust localization algorithm/systems before the real competition.

We look forward to your participation!

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xDR Challenge series



★ Competition Details

Target Environments: Commercial facility

This year's target environment is a commercial facility. This facility is an express way service area. It has two buildings; one is two-story and the other is one-story. We utilized MyBeacon (Aplix) as BLE beacons. BLE signals are emitted every 0.1 sec. The beacon locations will be provided as (x, y, z) location in coordinates of the floor map.

Measuring Devices and Data Distribution (tentative)

9-axis IMU sensor data used for the competition is measured by AQUOS Sense 6 (SHARP). The ground truth of the location was measured with a hand-held LiDAR (GeoSLAM ZEB-Horizon) at approximately 100 Hz. The ground truth will be disclosed only for training data. The data will be distributed over EvAAL API. Overview of the provided data are shown in Table 1.

Table 1. Overview of the data

Data type	Measuring device	Rate	available in development dataset	available in scoring dataset
Acceleration	AQUOS Sense 6	Approx. 100 Hz	yes	yes
Angular velocity	AQUOS Sense 6	Approx. 100 Hz	yes	yes
Magnetism	AQUOS Sense 6	Approx. 100 Hz	yes	yes
BLE RSSI	AQUOS Sense 6	Emitted from beacons at 10 Hz, recorded when received by AQUOS Sense 6.	yes	yes
Ground truth location (x, y, z)	ZEB-Horizon	Approx. 100 Hz	yes	no
Ground truth orientation (quaternion)	ZEB-Horizon	Approx. 100 Hz	yes	no
Ground truth floor name	-	1 floor name for each dataset	yes	no

Requirements for competitors

The competitors are required to estimate the movement (trajectories) of the subjects walking in the facility by using their original indoor localization algorithm. We believe that PDR-based indoor localization algorithm is a suitable for tracking the subjects as targeted in this competition. We provide the sensor data required for the PDR-based indoor localization algorithm as the dataset of the off-site competition. We asked the subjects to bring Android device to collect sensor (gyro, accelerometer, magnets sensor) data as well as the BLE signals from the BLE beacon. The competitors are required to submit results of the indoor localization. We will evaluate the submitted results by our multifaceted evaluation metrics.

Evaluation Framework (tentative)

We are standardizing evaluation of indoor localization especially for algorithms based on xDR in the PDR benchmark standardization committee. The evaluation framework applied in this competition was determined according to the discussion in the committee. PDR benchmark standardization committee (PDRBMS) is discussing and proposing standard evaluation framework for evaluating indoor localization methods or systems. The final evaluation metrics and integrated index will be calculated with indicators and negative check(s). The brief introduction of the evaluation indicators and negative checks is as follows;

- Evaluation Indicators (Tentative)
 - Circular Error (CE) : Absolute 2D error compared with ground truth points.
 - Circular Error Distribution Deviation (CEDD) Circular Accuracy: Evaluating distribution of error in 2D error space. Distance between the peak in the error space and origin (0,0) will be evaluated.
 - Error Accumulation Gradient (EAG): Evaluating speed of error accumulation from correction points when true positions are limitedly provided.
 - New error evaluation of position and/or velocity compared with precise GT
- Negative Check Criteria (Tentative)

- Requirements for Validity of the Trajectory: checking if points consist of trajectory are in valid area

In addition to our evaluation indicators, CE75 will be provided as a reference, for consistency with the other IPIN competition Tracks. Note that the CE75 is NOT used for determining the winners. The evaluation frameworks and scripts for calculating scores for determining the winners will be provided from our GitHub account. The evaluation scripts can calculate CEs with arbitrary percentiles.

★ Reference

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- Ryosuke Ichikari, Katsuhiko Kaji, Ryo Shimomura, Masakatsu Kourogi, Takashi Okuma, and Takeshi Kurata: Off-Site Indoor Localization Competitions Based on Measured Data in a Warehouse, *Sensors*, vol. 19, issue 4, article 763, 2019.
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- Masakatsu Kourogi and Tomohiro Fukuhara: Case studies of IPIN services in Japan: Advanced trials and implementations in service and manufacturing fields in special session "Value Creation in LBS (Location-Based Services)", *IPIN 2017*.

★ Organizing Committee

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