IPIN 2023 Competition Track 5
Smartphone (Offsite-Offline)

Track chairs: Ryosuke Ichikari, Akihiro Sato (AIST, Japan)

AIST

PDR Benchmark

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25th-28th Sep. 2023, Nuremberg Germany

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Overview of the Track 5

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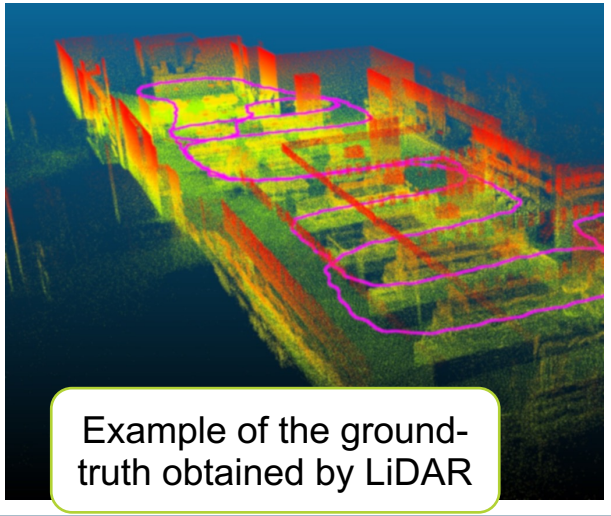
- We have organized tracking competition named PDR/xDR challenge in IPIN mainly for evaluating the method with xDR in industrial fields (Warehouse, Manufacturing, Restaurant)
- Competition task: Estimating trajectories of pedestrian in a commercial facility
- Dataset for integrated localization using PDR are provided (IMU, BLE, MAP etc.)
- Evaluating the estimates by comparing precise ground-truth measured with a hand-held LiDAR
- Evaluating practical performance of the methods by multi-faceted metrics

Target site:
Commercial Facilities in Express way

Hand-held LiDAR

Measured sensor data by a smartphone mounted on waist



Example of the ground-truth obtained by LiDAR

Target Environment

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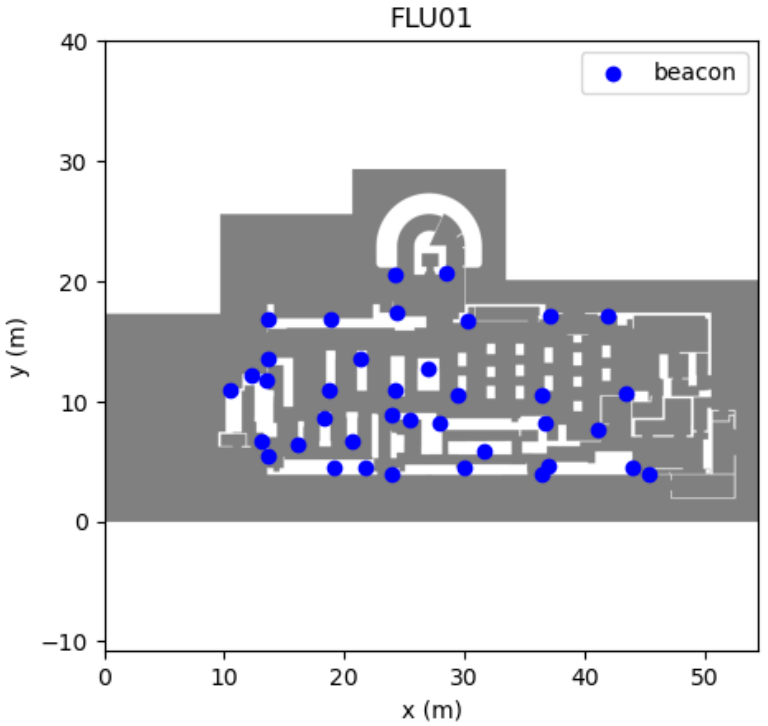
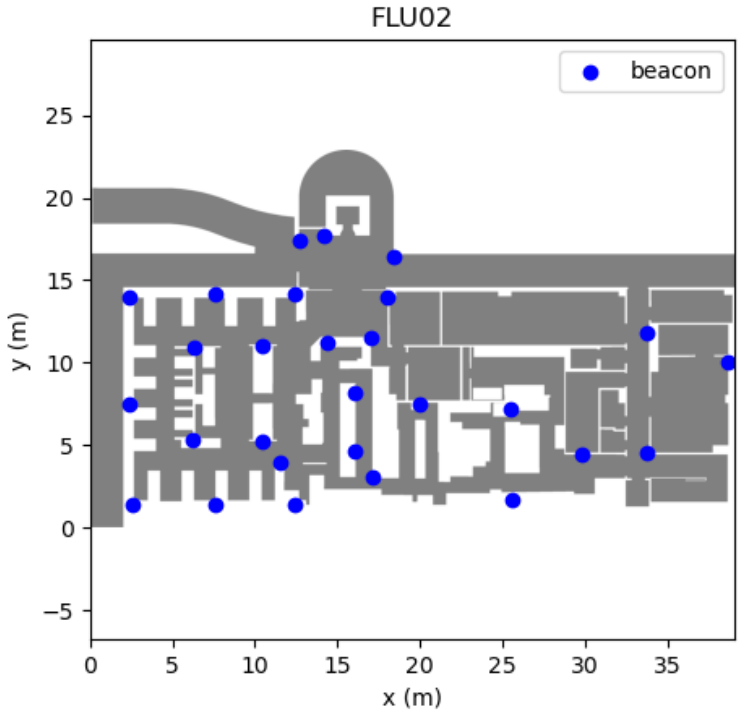
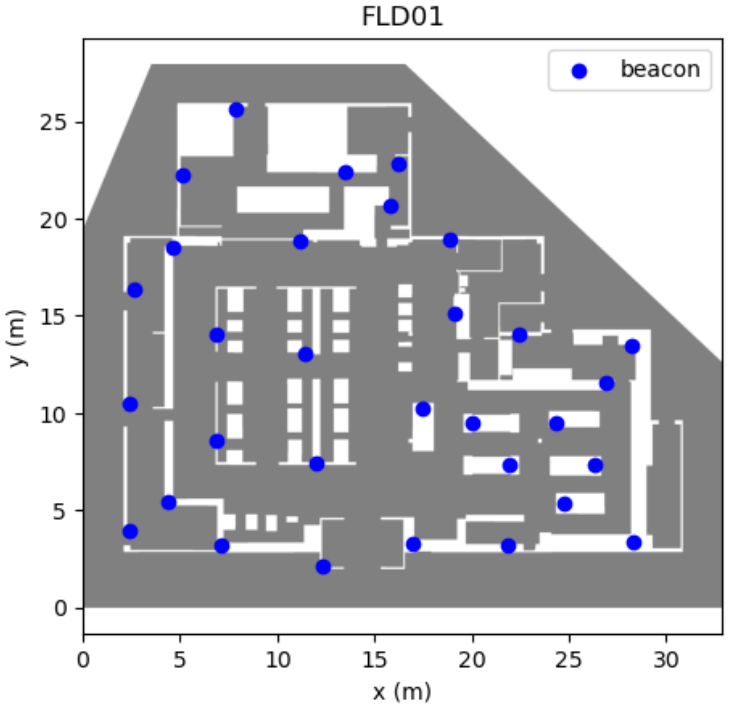
- Data measurement have been carried out in three floors of the commercial facilities in an express way service area. (Total about 2500m^2)
- Total 97 BLE tags are arranged







Evaluation Metrics

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Index	Corresponding indicators	Description (unit)
I_ce	CE (Circular Error)	**Absolute positional error between trajectory and ground truth at evaluation points (m)**
I_ca (NEW)	CA_I (Circular Accuracy in the local space)	**Deviation of the error distribution in local x-y coordinate system (m)**
I_eag	EAG (Error Accumulation Gradient)	**Speed of error accumulation from the correction points (m/sec)**
I_ve (NEW)	VE (Velocity Error)	**Error of velocity compared with correct velocity of ground-truth (m/sec)**
I_obstacle	Requirement for Obstacle Avoidance	**Percentage of points of the trajectory in walkable area**

Formulas for Scores

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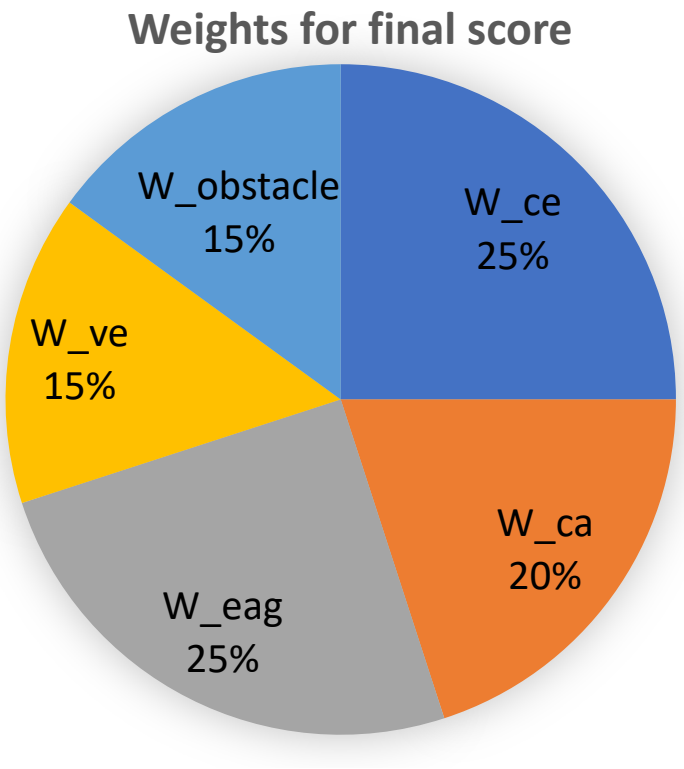
Index	Max. Score (100)	Min Score (0)	Formula
I_ce	ce < 1.0	30 < ce	100 - (100 * (ce - 1.))/29
I_ca	ca = 0.0	10 < ca	100 - (10 * ca)
I_eag	eag < 0.05	2.0 < eag	100 - (100 * (eag - 0.05))/1.95
I_ve	ve < 0.1	2.0 < ve	100 - (100 * (ve - 0.1))/1.9
I_obstacle	obs = 1.0	obs = 0.0	100 * obs (percentage of pixels)
I_i (**Final Score**)			W_ce * I_ce + W_ca * I_ca + W_eag * I_eag + W_ve * I_ve + W_obstacle * I_obstacle



Two Types of Sub-trials

- Sub-trials without BLE information
  - BLE measurement data are deleted for evaluating performance of dead-reckoning
  - Evaluating for I_eag
  - Location of Start and End points are known
  - 3 sub-trails

- Sub-trials with BLE information
  - Sub-trials for evaluation performance of integrated localization with all data
  - Evaluating for I_ce, I_ca, I_ve, I_obstacle
  - Location of Start and End points are known
  - 6 sub-trails

Teams Participated in the Track 5

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• CARELab	Nara Institute of Science and Technology (Japan)
• Dream Hunters	University of Tsukuba (Japan)
• IOT2US	Queen Mary, University of London (UK), Peking University (China)
• Kaji Lab	Aichi Institute of Technology (Japan)
• RHW	Royal Holloway University of London (UK)
• SmartLoc	Nanyang Technological University (Singapore)
• UCLab	Nagoya University (Japan)

9 teams applied, and
7 teams above completed the scoring trials

Example of Submitted Trajectories

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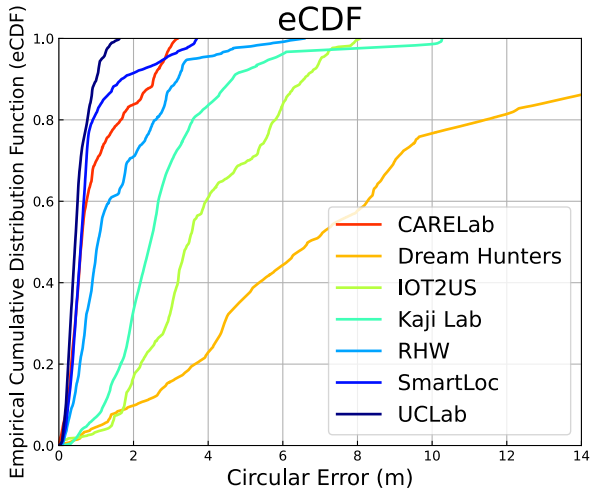
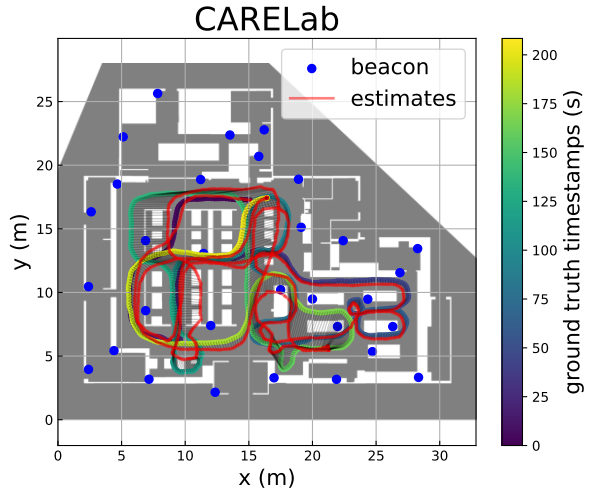
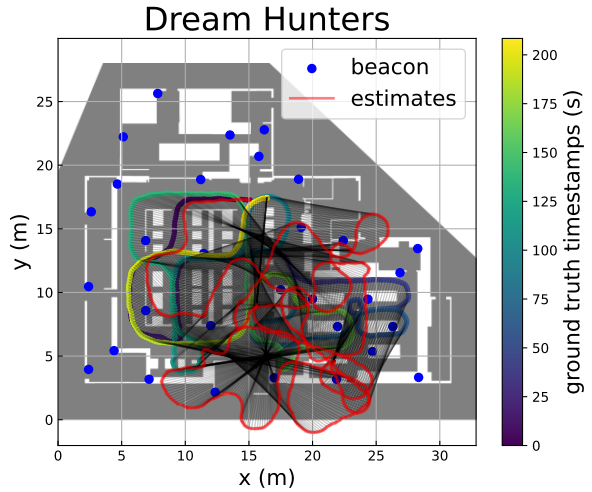
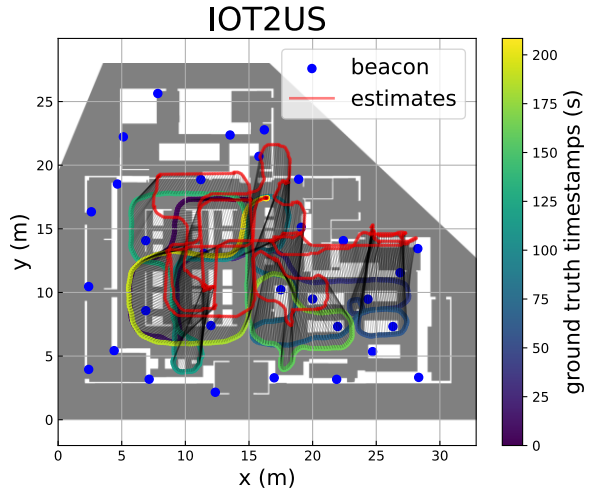
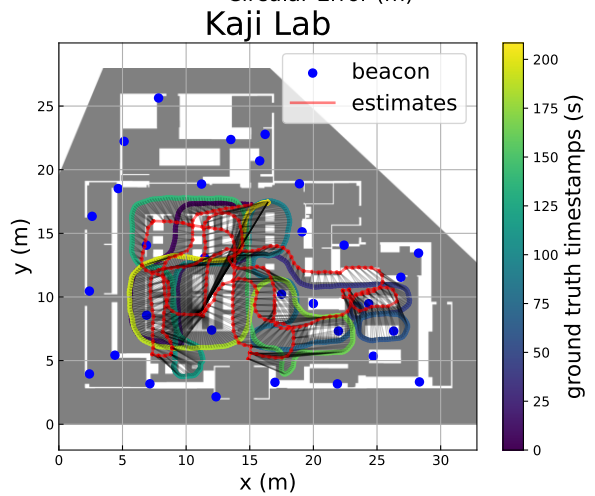
- A case of sub-trial with BLE information

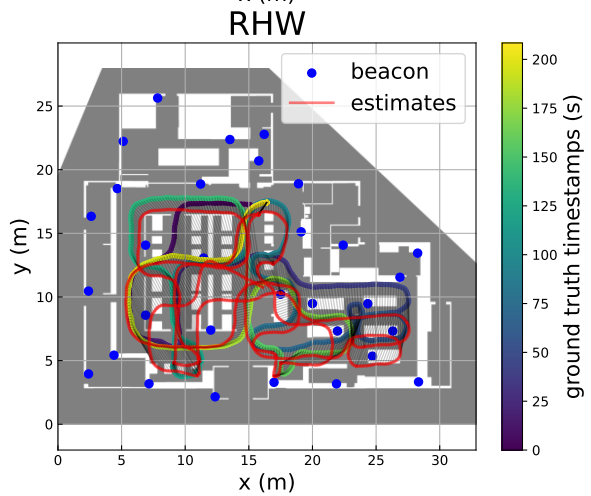


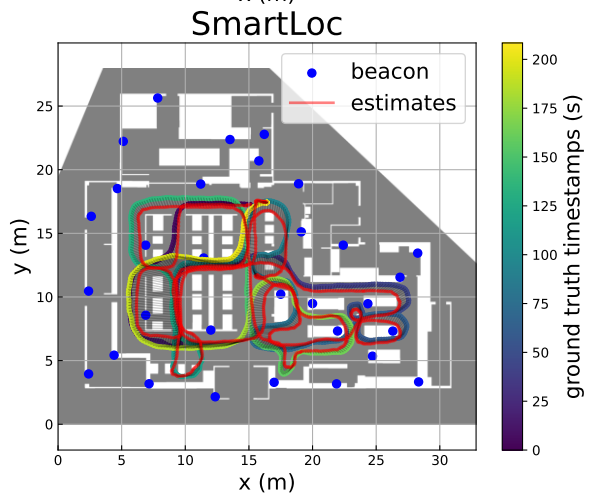


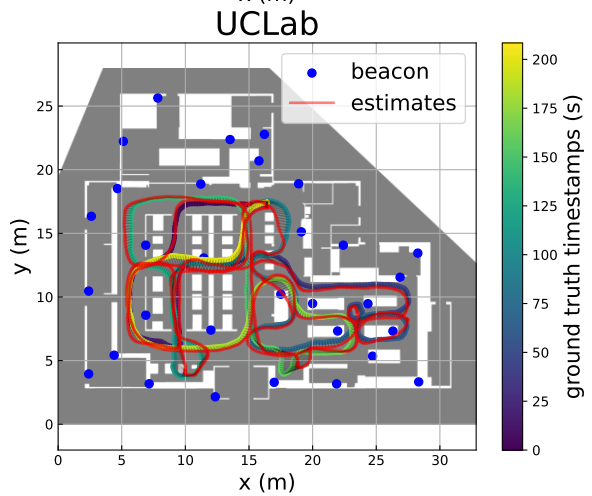












The top 2 teams competed at a high-level !

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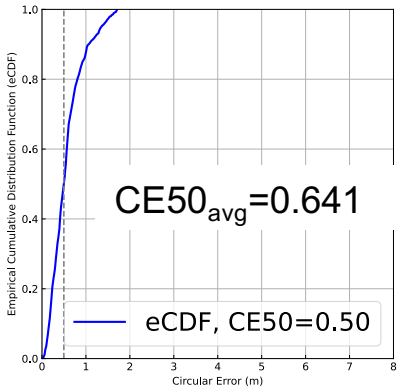
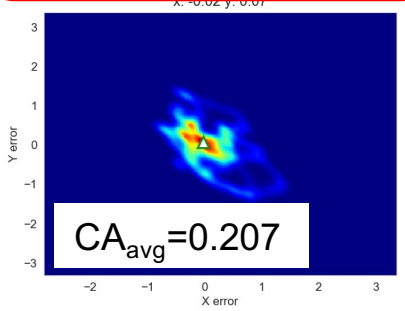
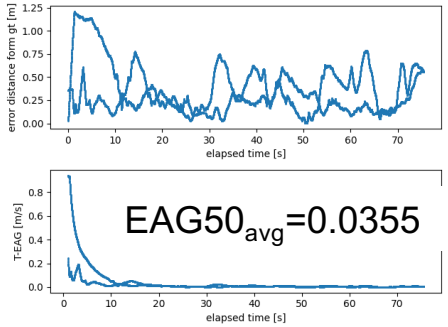
- Figures are brought from 2 sub-trials (with/without BLE info) on another floor.
- Comparison by average indices of sub-trials are provided.

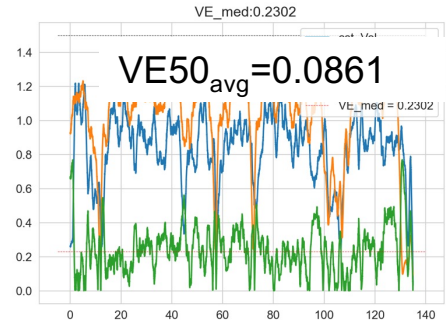
1st Place



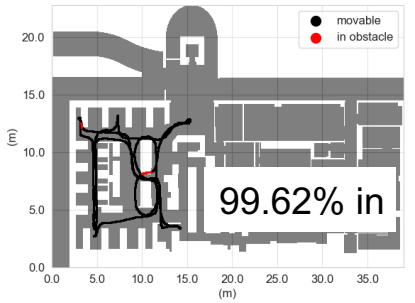
Better Avg. Score





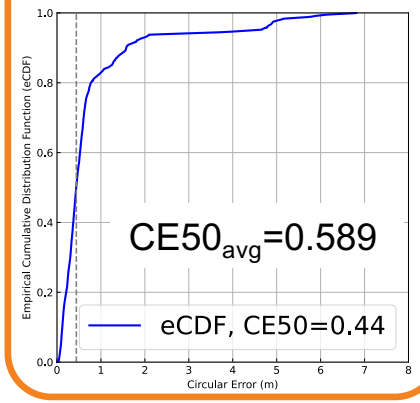


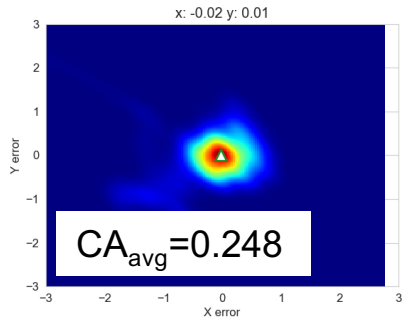
Better Avg. Score



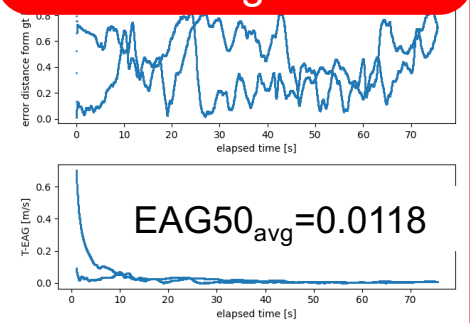
2nd Place

Got Even the Score

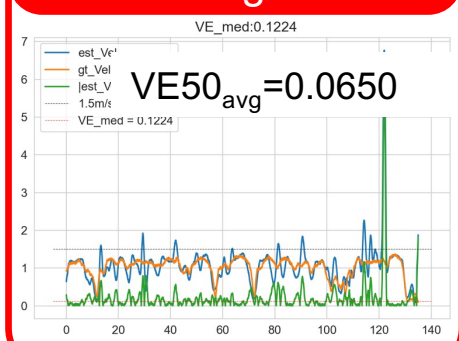


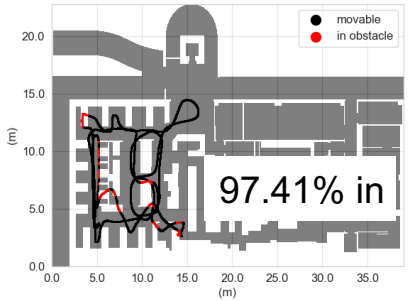


Better Avg. Score



Better Avg. Score





CE | CA | EAG | VE | Obstacle

Winner announcement …

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1

2

3

Winner announcement

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1 SmartLoc

2 UCLab

3 CARELab

Breakdown of Indicators

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Ranking	Team	I_ce (CE50/CE75)	I_ca	I_eag	I_ve	I_obstacle	Total Score
1	**SmartLoc**	100.00 (0.64m/1.27m)	97.93	100.00	99.71	99.62	99.37
2	**UCLab**	100.00 (0.59m/0.96m)	97.51	100.00	99.97	97.41	99.11
3	**CARELab**	96.11 (2.04m/3.56m)	92.18	98.85	97.96	92.60	95.98
4	RHW	96.29 (2.08m/3.41m)	78.44	98.08	99.43	84.91	91.93
5	Kaji Lab	88.55 (4.32m/6.31m)	62.51	93.02	95.55	93.48	86.25
6	IOT2US	85.42 (5.23m/6.79m)	52.00	92.97	99.42	83.26	82.40
7	Dream Hunters*	73.20 (8.77m/11.88m)	45.95	91.59	100.00	79.67	77.34

* Members include some students concurrently appointed as guest researchers of AIST.

10th IPIN Competition Track 5

WINNER

SmartLoc

Congratulations, team SmartLoc!
Thank you for participating our track, all competitors,
and thank you for supporting us, all sponsors!

Sponsors

Kawasaki Heavy Industries, Ltd.

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IPIN 2023 Competition Track5：xDR Challenge 2023

- Team SmartLoc
  - Team Member： Wang Han
  - Nanyang Technological University, Singapore
  - Email: hwang027@e.ntu.edu.sg

xDR Challenge 2023
~PDR and BLE with LiDAR based GT~

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