Demo: Platform for Benchmarking RF-based Indoor Localization Solutions

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ABSTRACT

This demonstration presents a user-friendly web-based platform that supports intuitive remote benchmarking of different indoor localization solutions. It reduces the barriers for experimental evaluation and fair comparison of their performance across a set of testing environments. The platform is aimed at addressing the limitations in the current praxis of publishing indoor localization research evaluated only in local, potentially biased environments. To this end, it provides a holistic support for the benchmarking process offering: (i) multiple pre-collected raw data-traces from different RF technologies, (ii) high-level interface to control remote wireless testbed facilities, and (iii) a set of tools for creating, storing, comparing and visualizing the performance results of multiple indoor localization solutions.

1. INTRODUCTION

Over the last years, the number of indoor localization solutions has grown, many of which use a wide variety of different technologies and approaches. Unfortunately, there is currently no standardized evaluation method for comparing their performance. As a result each solution provider evaluates their solution in their own, proprietary environment using proprietary evaluation metrics. These facts are partly caused by the complexity required for correctly evaluating an indoor localization solution, which requires technical expertise to efficiently setup large-scale experiments, to control the experimental environment, to gather the necessary performance data and to calculate output metrics using standardized methods. The proposed platform [2] addresses these shortcomings by proving user-friendly standardized tools. It has been created to cope with the fact that, although a significant number of experimental testbed facilities is available [1], evaluating the performance of a localization solution under controlled conditions using standardized performance metrics has proven to be very complicated for researchers that have no —or limited— experience with experimental research. This platform solves this issue by providing an open software solution that implements user friendly methods to realize the full performance analysis cycle. The benchmarking platform implements the standardized evaluation methods described in the EVARILOS Benchmarking Handbook (EBH) [3] and is aligned with the upcoming ISO/IEC 18305 standard "Test and Evaluation of Localization and Tracking Systems".

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2. BENCHMARKING PLATFORM

This demo focusses on the web-platform whereby users can create & download raw data-traces and visualize their achieved benchmarking results. Once the user is logged in, a home screen (Figure 1) gives an overview of the core functionalities of the platform. These are classified in chronological steps.

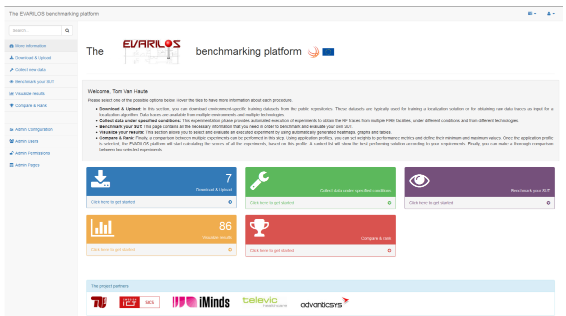

Figure 1: Home screen of the benchmarking platform

1. **Download & upload**: In this section, you can download environment-specific training datasets from the public repositories. These datasets are typically used for training a localization solution or for obtaining raw data traces as input for a localization algorithm. Data traces are available from multiple environments and multiple technologies. The key element for exchanging data are protocol buffers,[1] a language- and platform-neutral extensible mechanism for serializing structured data. Users can download raw data-traces and upload their estimated coordinates using the protocol buffers.

2. **Collect new data**: This experimentation phase provides complete automated execution of experiments on participating (or on integrated) remote testbeds to obtain new, custom defined RF traces. These settings are configurable:

[1] https://developers.google.com/protocol-buffers/

(a) Timeslot: the user needs to select an available timeslot when the experiment will be executed.

(b) Testbed: the platform is testbed independent, as such the user can select a testbed with specific environmental specifications. At the moment, three testbeds with different wall types are available: brick walls, plywooden walls and an open space environment with many metal obstacles.

(c) Approach: depending on the testbed, multiple technologies (WiFi, Sensor, Bluetooth, etc.) are available. Additional configurations like channel and transmission power are also configurable.

(d) Interference pattern: our platform has the capability to select a pre-defined interference pattern. Different realistic scenarios are evaluated and recorded in order to reuse and simulate these realistic interference scenarios.

(e) Evaluation path: finally, most testbeds provide fully automated driving robots making repeatability become possible, which enables the user to select a predefined track. This can be a fine grid which can be interesting for fingerprint solutions or just a small evaluation track for testing purposes.

Due to these flexible and easy configurations, experimenters can collect new and interesting raw data without having to interact with the testbed equipment at a low operational level, which is typically outside the expertise of the researchers working on indoor localization solutions. Furthermore, these datasets can be reused by multiple algorithms.

3. **Benchmark your Solution Under Test (SUT)**: This section contains all the necessary information that you need in order to benchmark and evaluate your own entire SUT. It describes an API interface of the platform.

4. **Visualize your results**: This section allows you to select and evaluate an executed experiment by using automatically generated heatmaps, graphs and tables (Figure 2).

5. **Compare & Rank**: Finally, a comparison between multiple experiments can be performed in this step. Using application profiles, you can set weights to performance metrics and define their minimum and maximum values. Once the application profile is selected, the platform will start calculating the scores of all the experiments, based on this profile. A ranked list will show the best performing solution according to your requirements. Finally, you can make a thorough comparison between two selected experiments (Figure 3).

3. DEMONSTRATION

In this demonstration, we will show the power and user-friendliness of this benchmarking platform. Initially, we will show how a new raw data-trace can be obtained by defining the parameters described above with a few clicks. Once the data-trace is recorded, the platform will serialize this data using protocol buffers. We can download it from the platform and use this as an input for the benchmarked indoor localization algorithm. Once the algorithm has processed this data, estimated coordinates will be the outcome. These estimations can be uploaded (or sent using the API) to the platform. The platform will use an engine to process and compare the coordinates with the ground truth and calculate multiple metrics. In a next step, the engine will store these results in a database which can be accessed by the user. In this way, it becomes easy to visualize the results of a certain SUT. After selecting the experiment that needs to be visualized, a heatmap, multiple graphs and a table with details will be presented. These visualizations can be used to facilitate publishing performance results. Finally, the platform features a comparison tool: after selecting a user-defined application profile, the engine will calculate the scores of all experiments and rank them. The user can select two or more experiments for a detailed comparison.
An extended version of the demo can be found at:
https://youtu.be/-jxTn4r7B3c.

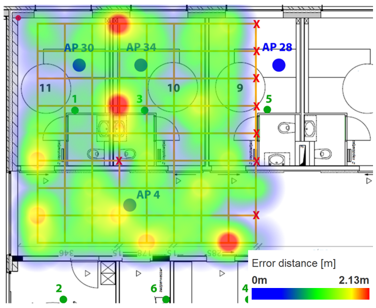

Figure 2: The platform uses heatmaps as core concept for visualization of the spatial distribution of the accuracy.

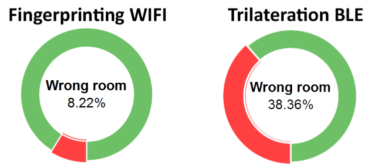

Figure 3: One element that is displayed when "Compare & rank" is used to evaluate multiple solutions at once.

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4. REFERENCES

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