Velocity-Based Channel Charting with Spatial Distribution Map Matching

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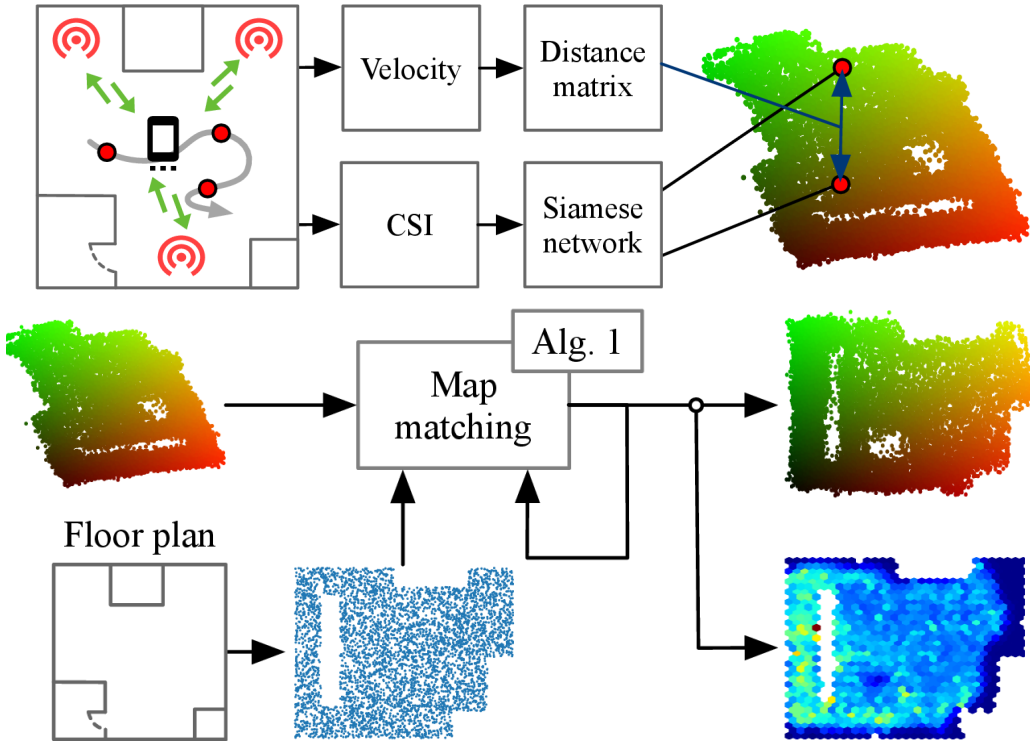
How to do accurate data-driven direct positioning in an unsupervised manner?



Stage 1 (Top) generates a channel chart based on CSI and velocity information. After the channel chart is generated, it only reflects the radio geometry up to isometries. To exploit the channel chart for localization stage 2 (Bottom) learns a linear transformation to the real-world coordinates by provided topological map information.

KEY FINDINGS

We proposed a framework for unsupervised fingerprinting only requiring velocity estimation and topological map information. Our velocity-based channel charting approach achieves accuracies of up to a CE90 of 1.16m for a 5G and 0.90m for a SIMO radio system, similar to supervised fingerprinting, even with very noisy velocity estimation and coarse map information. Hence, our approach is applicable for low-cost sensor systems like smartphone-based PDR or odometry of robot platforms in combination with CSI recordings. Our adaptive map matching enables the usage of topological map information like floor plans to learn a transformation of the local channel-charting coordinates to the real-world environment. In contrast to the state of the art, our map-matching algorithm only needs a coarse representation of the environment, as it learns to adapt the map while it aligns the channel chart to the real-world coordinates.

M. Stahlke, G. Yammine, T. Feigl, B. M. Eskofier, and C. Mutschler, "Velocity-Based Channel Charting with Spatial Distribution Map Matching," arXiv preprint arXiv:2311.08016, 2023.

M. Stahlke, G. Yammine, T. Feigl, B. M. Eskofier, and C. Mutschler, "Indoor Localization with Robust Global Channel Charting: A Time-Distance-Based Approach," IEEE Transactions on Machine Learning in Communications and Networking, 2023.