Employing Bluetooth Beacons to Provide Indoor Location for Fairs

Degree programme: Master of Science in Engineering | Specialisation: Informations- und Kommunikationstechnologien
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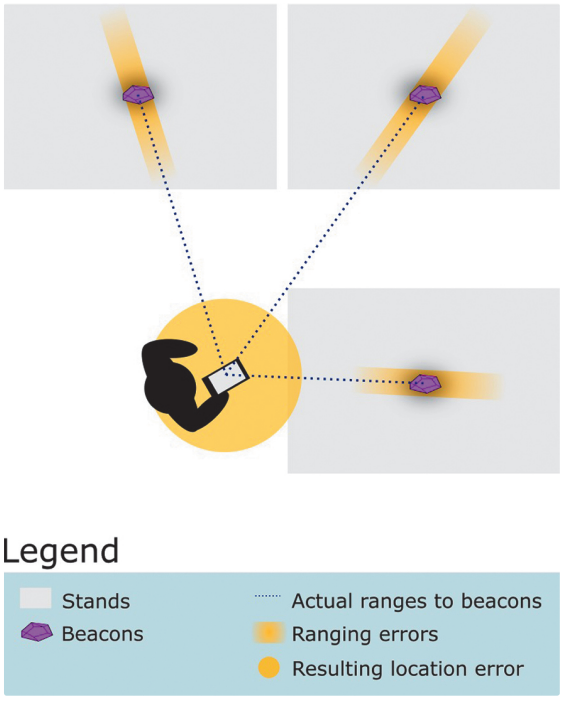
Indoor localization at events such as fairs enables navigation to specific stands, location-based content and analysis of visitor flows. We have studied how to enable such localization with Bluetooth Low Energy Beacons. We have examined different algorithms processing signal strength readings and found a nonlinear least squares algorithm to be reliable. A prototype app has been implemented and evaluated, enabling subsequent product development by the industry partner.

Situation

The «Berufsschau» is a biennial professional fair in the Canton of Basel-Country. The event has served as an exemplary use case for the scope of this thesis, with the prospect of integrating the work into a product to be deployed. The over-arching goal to create advances in indoor localization has been refined into two principal objectives:

- Evaluation of practical localization algorithms with respect to their accuracy by means of simulation and experiment
- Design and implementation of a cross platform app prototype able to localize a user using a smartphone in a large indoor area with beacons positioned



Indoor location by ranging beacons. Note the location error is smaller than the individual ranging errors.

Evaluation of Algorithms

Beacon setups and algorithms have been analyzed in terms of accuracy by sampling signal strengths with a smartphone. By means of regression modelling, the relationship between measured signal strength and distance has been examined. Applying this model on the sampled data, different ranging algorithms have been tested. A promising setup with a weighted non-linear least squares algorithm has been implemented in a deployable hybrid mobile application and evaluated in a field test. The accuracy obtained in the experiments is between 1 and 4 meters, which is sufficient for reliably locating a stand.

App Development

For app development, the Ionic hybrid platform has been used along with a typical environment and toolchain. A simplistic backend for distribution of the beacon positions was created on Firebase. With these tools and the findings concerning algorithms, a completely functional and deployable app prototype has been designed, implemented, and evaluated. It is deployable on iOS and Android devices and able to locate a visitor indoors on a map upon the push of a button.

Conclusion

The specific instance of an indoor localization solution has proved feasible and practical. A suitable algorithm for indoor localization has been found and implemented, enabling practical accuracy. Important learnings are that early exposure to the hardware and smartphone target platforms has proved valuable, and that nonlinear algorithms are remarkably sensitive to parameter changes. On a research level, the results (especially the simulation methods) provide a framework to further investigate the accuracy of various algorithms. On a practical level, the prototyping aspect of the results have been found usable for the «Berufsschau» and possibly other fairs and is being integrated into production by the industry partner.

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