Interpolation in RFID-based Medical Navigation

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Introduction

Navigation systems are important parts of current medical equipment for surgery. State of the art is the use of optical or electromagnetic devices, but recent developments also brought RFID-based localization into discussion. In this work we investigate the possibility of position interpolation through machine learning algorithms on RFID signal data.

Methods

We ran experiments with the amedo PRPS tracking system for medical applications, taking a total of about 1,400,000 measurements at 55,000 different positions in a test volume of human size. The observed volume was overlaid with grids of different sizes, and positions on the grid were used for training while tests for error evaluation were performed on the complete dataset. For the interpolation, we implemented a “Nearest Neighbor (k-NN)” algorithm as well as “Support Vector Regression (SVR)”.

Results

Measurements on linear paths showed a higher accuracy in central parts of the datasets, especially for SVR (1.4 mm vs. 2.9 mm overall; 5 mm grid). Here, for some datasets, the interpolation produced results better than theoretical reference values. Using 2-NN or 3-NN usually resulted in the best overall accuracies (2.0 mm; 5 mm grid).
For volume data, recorded accuracies mostly showed better values even over complete datasets (up to 1.2 mm; 5 mm grid). Again, SVR benefitted most and outperformed theoretical references. In general, an accuracy of 2 mm could be achieved, if at least 8 mm grids were used.

Conclusion

Data from the PRPS system is currently unfit for a direct mapping to positions in space. However, on mm-scale the measurements are distinctive enough for use in a learning algorithm. Providing extensive volume data, even a calibration on sparse grids can lead to accuracies sufficient for many medical applications. With increasing number of positions, the SVR algorithm becomes clearly superior, while 2-NN is a better choice for work on a small dataset.