THE DESIGN OF AN IMPROVED INDOOR POSITIONING ALGORITHM WITH NEIGHBOUR FUSION

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The estimation of the position of a mobile device is known as mobile positioning/localisation. Mobile positioning has attracted considerable research interest in recent times, with a wide array of applications using the obtained position estimates. Among the multiple techniques used for mobile positioning, geometry-based positioning and database correlation-based positioning are very popular. Together with the global positioning system (GPS)-based localisation, cellular mobile systems-based positioning can produce high accuracies. However, GPS-based positioning lacks much-needed indoor coverage while cellular mobile-based positioning suffers from severe fading in indoor environments. Thus, in indoor positioning, fine-tuning techniques are used to attain high accuracies. Temporal correlation is widely explored in improving the positioning accuracy. However, with new technologies, such as fifth generation (5G) cellular mobile systems or the latest wireless sensor networks, mobile device to device (D2D) communication is possible. Together with the relaying function that is provided, D2D communication produces redundant information on location estimates. Note that with D2D communication, the location of a device/node in a network can be estimated with respect to many other nodes communicating with the considered node. Thus, these multiple estimates can harness the diversity of information that is available to produce a more accurate estimate. This technique can be viewed as a utilisation of space correlations of nodes in the network, as the position is estimated with respect to many distributed nodes communicating via differently faded channels.

In this research, we proposed a technique to harness the space correlation in multiple estimates. We took multiple estimates and averaged the readings initially. The motivation behind this scheme was that the estimation errors are observed to be Gausian distributed with zero mean and hence, an averaging of results in an error cancellation. However, a serious drawback of this scheme is that it does not consider the differences of variance in different estimates. It is worth noting that the estimates with respect to nodes that are far away, and usually associated with poor quality signals, are distributed with higher variances than that of closer nodes. Thus, by weighted averaging of estimates, a better accuracy can be attained. For three location estimates for a node given by (x_i, y_i), (x_{i+1}, y_{i+1}) and (x_{i+2}, y_{i+2}), the fine-tuned estimate $(x_{\text{fin}}, y_{\text{fin}})$ is given by,

$$x_{\text{fin}} = \frac{w_1 x_i + w_2 x_{i+1} + w_3 x_{i+2}}{w_1 + w_2 + w_3} \qquad (1)$$

$$y_{\text{fin}} = \frac{w_1 y_i + w_2 y_{i+1} + w_3 y_{i+2}}{w_1 + w_2 + w_3} \qquad (2)$$

where w_1, w_2 and w_3 weights are pre-selected proportional to the received signal strength to minimise localisation error. With unity weighting factors, this scheme converges to a simple averaging scheme. The RMSE was observed and weighted average results will only provide the least RMSE value.

A three raw estimate-based MATLAB simulation demonstrated a higher accuracy in the averaging scheme than in raw estimates. Furthermore, the weighted averaging technique produced even better accuracies and, in average, the fine-tuned estimate happened to be the closest to the actual position. This research only considered estimations in a snapshot of time. Extending the same algorithm to exploit the correlation in time-domain estimates can be expected to produce even better accuracies, which is a possible future research avenue.

Keywords: Indoor positioning, Space correlation, Weighted averaging, Diversity estimates

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