Self-Calibrating Indoor Localization Mobile Application Based on Multilateration Approach

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***Abstract*—The presented Android-based mobile application implements the multilateration approach, which relies on Bluetooth Low Energy (BLE) signals to localize the current position of the user. The multilateration approach is based on RSS measurement technique used to estimate the distance between transmitter and receiver. This technique invokes the automated calibration procedure for log-normal path loss signal propagation model. This procedure aims to avoid offline calibration phase need to adapt signal propagation model especially to particular environment. The application detects steps made by the user and movement direction via internal sensors to use it with several map-aided information to estimate distance calculation using calibrated parameters.**

The automatic calibration procedure is a part of RSS based indoor localization multilateration approach. The RSS based multilateration determines an approximate radius by measured RSS of all available BLE beacons. As pointed out above, this task corresponds to determining the distance between transmitter and receiver using a signal propagation model. The used in the application log-normal path loss model has to be calibrated by particular parameters that can be determined empirically while offline calibration phase. The developed mobile application implements automated calibration procedure to avoid prior RSS measurement process and to localize the current user position on the fly.

The BLE beacons allocated within a room have proximity zones where measured RSS level has certain range of values. This information is used as an initial information for automated calibration phase. In order to take into account proximity zones we propose to use two-dimensional path loss model. The model includes near (0.5 m) and middle (3 m) proximity zones of the beacon.

The automated calibration procedure scenario has several steps. The first one, if the user appears within a near proximity zone his/her proximity could be defined by map-aided information. The RSS level of the nearest beacon at the distance 0.5 m is known and this location is considered as the first reference point. The second step relies on the assumption that the user moves directly on the tangent to the border of near proximity zone, because we can't correctly determine the direction of user moving regarding the beacon (Fig. 1). Based on estimated initial user position the application begin to count the steps to calculate new distance at second reference point within the middle proximity zone. Also the parameters of the model could be calibrated automatically using two known reference points.

This demo application uses known BLE beacons and is sensitive to built-in smartphone sensor errors. The problem of movement direction determination is not important for described automated calibration procedure, but it is serious drawback in the common case. The map-aided localization approaches could be applied for direction determination improvement. The obvious way is to allocate the one beacon near the entrance of a room and allocate another beacons on the most probable movement direction.

Also the developed mobile application performs automatic calibration procedure for adapting the parameters of log-normal path loss model. The application processes BLE signals, shows user's proximity zone allocation using two-dimensional signal propagation model, counts his/her steps and shows new parameter values and estimated distances to the beacons. The proposed automated calibration procedure is potentially applicable for several wireless technologies like Wi-Fi and ZigBee.

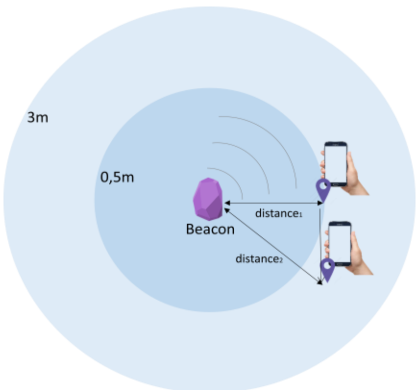

Fig. 1. The automated calibration procedure steps

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