DactyLoc: A minimally geo-referenced WiFi+GSM-fingerprint-based localization method for positioning in urban spaces

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ABSTRACT

State-of-the-art fingerprinting-based localization methods relying on WiFi/GSM information provide sufficient localization accuracy for many mobile applications and work reliably in urban areas and indoors.

These methods assume that each location contains a unique combination of signal strength readings. To obtain a location estimation, a mobile device gathers signal strength readings and with the help of a fingerprinting algorithm, the closest match in a reference database is found. Building this reference database requires a training set consisting of geo-referenced fingerprints. Traditional approaches require manual labelling of the reference locations or GPS information.

This work proposes a collaborative, semi-supervised WiFi/GSM-based fingerprinting method where only a small fraction of all fingerprints needs to be geo-referenced. This allows for automatic indexing of areas in the absence of GPS reception as found in urban spaces and indoors without requiring manual labelling of fingerprints.

Taking advantage of the characteristic that the similarity between two fingerprints correlates to the distance between their corresponding locations, this method applies multidimensional scaling to generate a topology estimation of the training set. With the help of a subset of geo-referenced fingerprints, the topology estimation is anchored to physical locations now serving as a reference database. Further fingerprints can be used to refine and extend the topology estimation. Hence, the covered space grows gradually.

We evaluate our approach with an urban-scale dataset and show that our method can locate a mobile device with a median accuracy of 30m. Hereby, only 7% of the fingerprints are geo-referenced. Further, the localization error decreases and converges to a value comparable to related work as new fingerprints are added to the reference database.

We see a promising application of our method by combining it with existing

fingerprinting systems to extend their functionality into areas where a GPS-based indexing is not possible.

KEYWORDS: collaborative indoor localization, WiFi/GSM fingerprinting, multi-dimensional scaling