Device-free indoor localisation

ABSTRACT

We present a device-free indoor localisation capable recognition system. The system requires the installation of a single transmitter and receiver in each distinct room. Rooms are clustered via non-overlapping frequencies. In-room localisation is achieved via learning of relative changes in the time-domain signal strength.

1. EXTENDED ABSTRACT

Localisation of non-cooperating individuals has been investigated for several years now. High accuracy has been achieved, for instance, by radio tomography [3] as well as via RSS fingerprint maps [1]. Also, Zhang et al. could demonstrate a high accuracy of below 1m for the simultaneous tracking of five moving targets by isolating the LoS path between nodes [4]. However, also from less complex, time-domain systems some localisation capabilities have been reported [2]. This demo shows the potential of the localisation via time-domain signal strength features from pairs of software defined radio (SDR) nodes in limited range indoor scenarios.

2. SYSTEM DESCRIPTION

Our system employs pairs of transmit/receive software defined radio devices that continuously transmit an RF signal.[1] Fluctuation in the relative time-domain signal strength is translated by the system to movement in various areas in a room. In order to mitigate interference from transmitters in neighbouring rooms we employ a clustering approach in which each room represents a cell. Devices operate on frequencies from 800MHz to 1.1 GHz and will be configured to non-overlapping frequencies in different rooms. Signal streams will be processed for each device-pair separately and classification results are transmitted to a mobile device that then displays the detected location of individuals. The fluctuation in the signal modulated to the wireless carrier is sampled at the receiver at 70Hz. Features are then calculated from this signal stream at the receiver. In this system, we utilise the count of signal peaks within 10% of the maximum, the mean difference between subsequent maxima, the count of zero crossings, the variance and the mean as features to classify activities. This set of features is the result of a feature selection and manual feature reduction we conducted on a total of 17 features and their pair-wise combination. Since absolute signal strength might differ on consecutive days, relative signal-strength fluctuation is utilised. For this, all features are normalised to the mean signal strength experienced over a longer time period.

[1] We employ USRP software defined radio nodes (http://www.ettus.com)

3. REFERENCES

[1] M. Seifeldin, A. Saeed, A. Kosba, A. El-Keyi, and M. Youssef. Nuzzer: A large-scale device-free passive localization system for wireless environments. *IEEE Transactions on Mobile Computing (TMC)*, 12(7), 2013.

[2] S. Sigg, M. Scholz, S. Shi, Y. Ji, and M. Beigl. Rf-sensing of activities from non-cooperative subjects in device-free recognition systems using ambient and local signals. *IEEE Transactions on Mobile Computing*, 99(PrePrints), 2013.

[3] J. Wilson and N. Patwari. See-through walls: Motion tracking using variance-based radio tomography. *IEEE Transactions on Mobile Computing*, 10(5):612–621, 2011.

[4] D. Zhang, Y. Liu, X. Guo, M. Gao, and L. M. Ni. On distinguishing the multiple radio paths in rss-based ranging. In *Proceedings of the 31st IEEE International Conference on Computer Communications*, 2012.