Fingerprint based Algorithm for Indoor Localization of Mobile Phones operating in UMTS

The unauthorized use of mobile phones inside prisons constitutes a major safety concern. It enables the inmates to get in touch with the outside world for organizing a crime or unveil security relevant information. Within the scope of this thesis an innovative algorithm for detecting and locating mobile phones operating in UMTS was developed, implemented and validated to provide a secure execution of the prison sentence.

Motivation

In today's digital age almost everything is transacted over the Internet and the world is turned into a fast moving era. The associated fast and enormous information spread constitutes as a perfect stage for people with malicious intents. Multiple approaches exist to prevent the inmates of accessing this medium such as jamming systems, search operations or installations of rudimentary detection systems. All these approaches exhibit drawbacks concerning high installation costs, legal or regulatory reasons or do not uncover all smuggled devices. The only feasible solution is to detect, localize and confiscate the smuggled devices.

Methods

The detection and localization algorithm is based on the fingerprinting technique. With spatially distributed sensors the emitted communication signals of the illicit mobile phone are perceived and evaluated. Due to the wave propagation phenomena for each position in the building a different received signal strengths fingerprint originates. In a previous learning phase these reference fingerprints are determined. Then during normal operation, the current observed fingerprint is compared with the reference fingerprints and classified according to the Mahalanobis distance measure and the regression method of the k-nearest neighbors. To obtain an accurate position estimation, the mobile phone users motion is compensated using an autoregressive model for linear prediction.
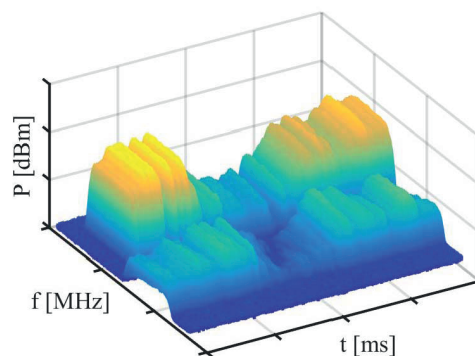
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Results and Outlook

The validation of the proposed algorithm was conducted in the prison of the castle Burgdorf. The achieved amount of correct localizations is 98.8%. With this performance the objectives are outperformed and the product development can be launched. In the prison of Bellechasse a first prototype of the system will be installed this summer.

Demonstration System Prototype

Two adjacent UMTS streams