Abstract

This thesis deals with certain aspects of using indoor wireless networks for surveillance purposes.

In the last decade, wireless local area networks (WLANs) have been widely deployed in indoor environments like o_ces or campus buildings. The main functionality of these indoor WLANs is to provide network connections to mobile terminals including laptops and handheld devices. However, we realized that when one such indoor environment is empty during evenings, the indoor WLAN in the environment can be turned into a sensor network for detecting physical intruders. The intrusion detection is based on detecting the transient variations in the wireless channel caused by the movement of the intruders.

In Part I of this thesis, the idea of using indoor WLANs for intrusion detection is demonstrated by an implemented multi-node system. Under the constraint of using today's commercial, o_-the-shelf hardware, the signal of interest of this application is the received signal strength index (RSSI) information. We derive maximum likelihood estimators, and we derive change detectors based on the generalized likelihood ratio test (GLRT) method. The performance of the detectors is analyzed using asymptotic theory in statistics. To prevent performance degradation due to slowly drifting parameter values, we propose different strategies to track and update the parameter estimates. The experimental results obtained from the implemented prototype surveillance system show very promising detection capabilities.

In Part II of this thesis, we investigate the issues of using the channel estimates of orthogonal frequency division multiplexing (OFDM) based WLANs for intrusion detection.

Using high-precision channel sounder device, we did a set of multi-node multiple-input multiple-output (MIMO) wireless channel measurements in a typical indoor o_ce environment. The measurements cover di_erent intrusion cases. These measurements enable us to investigate the performance of such systems at di_erent bandwidths, number of antenna elements, etc. Based on discrete wavelet transform (DWT), we apply GLRT detectors to detect transient variations in the OFDM channel's impulse response. We show that the detection performance of such systems is much better than the RSSI-based system demonstrated in Part I, and the detection performance improves when the number of antenna elements increases. We also show that di_erent intrusion events can be classi_ed by pattern classi_cation methods with a small probability of error classi_cation, and this reveals the potentials of positioning and tracking of intruders with such systems.