基于 Wi-Fi 信道状态信息的免训练入侵检测系统

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摘　要：随着无线通信技术的飞速发展，Wi-Fi 已经广泛应用于公共和私人领域，基于无线技术的无设备被动入侵检测技术在智能家居领域有着广阔的应用前景.针对现有的解决方案难以解释不同场景下性能存在巨大差异，本文设计了一种基于 Wi-Fi 信道状态信息的免训练入侵检测系统，利用 Wi-Fi 设备上细粒度的信道状态信息（CSI）捕捉由人体移动引起的细微变化.为了放大这种变化，使用多重信号分类算法（MUSIC）对 CSI 时间序列的协方差矩阵进行特征分解，利用信号速度向量与噪声子空间的正交性来提取路径变化速度，并通过计算对应路径的相位差变化进行入侵检测的判断.在两个典型的室内环境（会议室和卧室）中进行评估，结果显示平均假阳性(FP)为　1.07%，　平均假阴性(FN)为 1.87%.结果表明该方法能够有效消除环境变化对于检测精度的影响，提高系统的鲁棒性.

关键词：　入侵检测；免训练；信道状态信息；多重信号分类算法；鲁棒性

Training-free intrusion detection using channel state information of Wi-Fi signals

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Abstract：　With the rapid development of wireless communication technology, Wi-Fi has been widely used in public and private fields. The wireless device-free passive human detection technology has broad application prospects in the field of home automation. Considering that the existing solutions are difficult to explain the huge performance differences in different scenarios, this paper introduces a training-free intrusion detection using channel state information of Wi-Fi signals, Which exploits the fine-grained channel state information (CSI) on Wi-Fi devices to capture the minor variations caused by human movement. To amplify such variations, the multiple signal classification algorithm (MUSIC) is used to decompose the covariance matrix of the CSI time series, and the orthogonality of the signal angular velocity vector and the noise subspace is used to extract the path change speed. and by calculating the phase difference of the corresponding path judges the intrusion detection We implemented our human detection method in two typical indoor environments (i.e., a meeting room and a laboratory) and the results demonstrate an average false positive (FP) of 1.07% and an average false negative (FN) of 1.87%. The experimental results show that the proposed method can effectively eliminate the influence of environmental changes on detection accuracy and improves the robustness of the system.

Key words：　intrusion detection; training-free; channel state information; MUSIC; robust

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