WiFi Wave Propagation Simulation and Intrusion Detection Research

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WiFi based passive intrusion detection is a new technology realized by monitoring the changes of WiFi signals to detect whether there are intruders in the monitored area, which is widely used in intrusion detection, gesture recognition and other fields [1, 2]. However, previous studies mainly focused on monitoring the RSSI and CSI of WiFi signals, and failed to consider the impact of multi-path, time delay, angle of arrival and other parameters of radio wave propagation on the application effect, which may lead to low intrusion detection accuracy. In this paper, the simulation of WIFI radio wave propagation and intrusion detection are performed, and a simulation data set that includes different components of the channel impulse response time delay, electric field strength, angle of arrival and electric field vector parameters is established. Experimental results show that the average accuracy of intrusion detection reaches 96.5% when there is no obstruction, and 97.88% for multi-person detection in the case of partition walls.

In this work, the Wallman and Proman modules of the simulation tool FeKo+WINPROP are used to simulate the WiFi wave propagation and intrusion detection in LOS scenario, NLOS scenario and NLOS scenario with partition wall in a L-shaped corridor (as shown in Figure 1(a)). The dataset contains 1000 manned and unmanned intrusion samples under 20 multi-paths. The dataset contains 1000 manned and unmanned intrusion samples under 20 multi-paths. Each multipath contains eight characteristic data: time delay, arrival angle azimuth, arrival angle elevation, launch angle azimuth, launch angle elevation, electric field strength, and the real and imaginary parts of the vertical component of the electric field vector. For the case of no human intrusion, only one set of data can be obtained by simulation, so this paper uses adding random noise matrix $\Theta(\mu,\sigma^2)$ to increase the data when no one is invading. Here, μ represents the mean and σ is 1-5 times the standard deviation of the results of multiple repetitions. Simulation datasets were built and uploaded to Github, and CNN classifiers were employed to verify the performance of intrusion detection in different scenarios, as well as in the case of multiple partition walls. Figure 1(b) shows the classification performance of the multi-person partition wall scenario, and it can be seen that the larger the standard deviation, the worse the classification performance. Figure 1(b) shows the classification performance in the case of multiple people separated by a wall, and (c) shows the confusion matrix for identifying the number of intruders in the separated wall scenario. The above results are valuable for exploring the performance of WiFi intrusion detection and the number of intruders detected in the case of partition walls. This work was funded by the National Natural Science Foundation of China (Grant Nos. 61863035, 61963037), and Ten Thousand Young Top-notch Talents Program of Yunnan Province (Grant No. YNWR-QNBJ-2018-310)

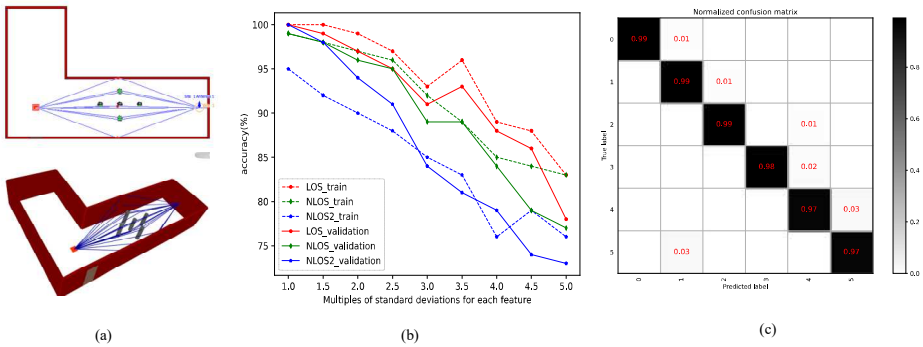

Figure 1. Experimental Scene and Results

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