Nayef Alsindi, James Aweya, Zdenek Chaloupka, Nuha Al-Khanbashi, "A Novel Spectral-based Location Fingerprinting for WLAN Systems", Etisalat BT Innovation Center (EBTIC) – Khalifa University, Abu Dhabi, UAE, May 2012.

Localization for indoor environments has gained considerable attention over the last decade due to the enormous potential in the technology and the significant challenges facing this area of research. Practical localization solutions rely on taking advantage of existing wireless network infrastructure in indoor environments, such as WiFi/WLAN Access Points (APs) which are ubiquitous in indoor offices, hospitals, residential areas, etc. One practical localization technique that relies on the available fixed wireless infrastructure is RF location fingerprinting where location is estimated through pattern recognition techniques that compare an *online* fingerprint (composed of measured signal metrics) with an *offline* database of fingerprints in different locations. Received Signal Strength (RSS)-based location fingerprinting has been the dominant fingerprinting approach in the literature due to the simplicity and practicality of measuring the RSS in a variety of wireless technologies (such as IEEE 802.11 and UMTS). Specifically the majority of the work in the literature focuses on the pattern recognition stage of the RSS-based fingerprinting but results showed that complex pattern recognition algorithms, such as neural networks or kernel regression, perform as well as the simple nearest neighbor (NN) or k-nearest neighbor. Recognizing the diminishing gains using the RSS-based techniques, researchers have recently shifted focus to proposing improvements at the physical layer by adopting the channel impulse response (CIR) as an alternate fingerprint. The CIR-based location fingerprinting essentially turns the disadvantage of the multipath to a powerful advantage by realizing that at each location the measured CIR provides a unique signature. Thus considerable accuracy gains can be achieved by designing more accurate RF fingerprint. This can be used to significantly improve the pattern recognition stage.

In this paper we propose a novel fingerprint structure that is based on the spectral decomposition of the channel impulse response which provides a more unique/robust fingerprint that is capable of distinguishing between locations more effectively. Through extensive frequency domain channel measurements in a typical indoor environment we further validate the proposed technique and compared it against RSS and CIR-based fingerprinting. We will show that the technique combines the advantages of RSS-based fingerprinting simplicity of structure (storage and pattern recognition requirements) and improves on the robustness of the CIR-based fingerprinting techniques. Finally we will illustrate that our spectral-based location fingerprinting can be practically integrated into the architecture of popular OFDM-based WLAN systems.