Simulation and Measurement of Dynamic On-Body Electromagnetic Wave Propagations with Motion Capture Techniques

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Wireless body area network (WBAN) technology plays an important role in the field of long-term and remote health monitoring. Some technical challenges need to be overcome in order to improve the usability of WBAN systems in real world scenarios. One particular challenge associated with WBAN implementation is to realize miniaturized and power-efficient wearable antenna design, which requires a thorough understanding of electromagnetic wave propagation over human body surface. Previous works have shown that, for a non-moving human subject, ground waves are the dominant propagation mechanism for line-of-sight (LOS) scenario, and the creeping waves are dominant for non-line-of-sight (NLOS) propagations.

However, as the human subject begins to perform daily activities such as walking and sitting, on-body propagation mechanisms may experience significant changes with different body positions (Gallo *et. al*., *IEEE Antennas and Wireless Propag. Lett.*, 7, 321-324, 2008). In this work, we present a motion capture based simulation approach to investigate dynamic on-body wave propagations. Experimental 3-D motion capture data, a simplified 10-cylinder model, and full wave simulation tool are combined to simulate on-body wave propagations during activities such as both arm swinging and boxing. The simulation results are validated using in-situ measurement data collected for both male and female subjects. We also examine different transmitting and receiving antenna placements on body surface, such as chest-back and chest-wrist, and their effects on the channel performance. Finally, the computational efficiency of the simulation approach is discussed and a more efficient simulation framework is proposed.