Investigation of Broadband On-Body Electromagnetic Wave Propagations

Dong Xue, Brian Garner, and Yang Li*
School of Engineering and Computer Science, Baylor University
Waco, TX 76798
Email: Dong_Xue@Baylor.edu, Brian_Garner@Baylor.edu,
Yang_Li1@Baylor.edu

Electromagnetic wave propagations over human body surface are of great interests in recent years due to the emerging medical applications of wireless body area networks (WBANs). Extensive studies have been implemented to reveal on-body wave mechanisms and it was found that: a ground wave is the dominant mechanism for line-of-sight (LOS), near-skin propagation; and a creeping wave contributes most for non-line-of-sight (NLOS), around-torso propagation. The propagation characteristics (i.e., propagation and attenuation constants) of both waves have been extracted and show good agreements with theoretical model predictions.

Most of the above studies focus on the ISM frequency band centered at 2.45GHz, and the UWB frequency band from 3 to 6GHz. While a selection of these higher frequencies results in several desirable features, such as smaller antenna size and higher data rate, the transmission loss are large and the propagation path can be blocked due to body movements. For low data rate applications, it is much desirable to utilize low frequency (<1GHz) wireless communication channels, which can lead to lower propagation loss and longer battery life of wearable sensors. However, the wave mechanisms can be more complicated since the receiving antenna is now in the near field regime of the transmitter and therefore more studies are required.

In this presentation we investigate broadband (300MHz to 3GHz) on-body electromagnetic wave propagations from measurement, simulation, and theory perspectives. First, three pairs of monopole antennas, centered at 415MHz, 900MHz and 2.45GHz, are used to measure complex transmission data for both LOS and NLOS scenarios. The propagation mechanisms are extracted and their broadband propagation characteristics are presented. Second, full-wave simulations are implemented on simplified human phantom models to corroborate the measurement results. Finally, we compare both ground wave and creeping wave theories to our measurement and simulation data to provide more physical insights behind. We have also investigated perturbations of these mechanisms due to body segment movements.