Simulation and Measurement of Dynamic On-Body Creeping Wave Propagations

Yang Li(1), Brian Garner(1), and Garrison Benton(2)
(1) Baylor University, Waco, TX, USA
(2) Baylor Scott and White Health, Dallas, TX, USA

In recent years the study of electromagnetic (EM) wave propagation over the human body surface has attracted much attention due to emerging wireless body area network (WBAN) technologies for remote health monitoring applications. Accurate modeling of wireless on-body propagation channels can not only provide rapid and reliable estimates of channel characteristics such as attenuation index and propagation speed, but can also lead to electrically-small, power-efficient wearable antenna designs. To date, EM wave propagations over a static (i.e., non-moving) human subject have been well-studied. However, there is limited research studying the dynamic motion effects (e.g., walking, jumping, running, etc.) on body wave mechanisms, which are of great importance for optimizing sensor performance during daily activities.

In this presentation we show both simulation and measurement results to illustrate the dynamic arm-swinging effects on the on-body creeping wave mechanism. First, we measured complex transmission data S_{21} around the torso of a non-moving human subject to establish the baseline of our study. Then we repeated the measurements while recording motion of the left arm of the subject swinging back and forth. Comparison between the above two measurements provides an estimate of the additional creeping wave transmission loss due to arm movement.

To corroborate the measurement results and improve our understanding of the perturbance of the creeping wave, we developed a dynamic 10-cylinder human phantom model to recreate the recorded arm swinging motion and to simulate near field effects over the body surface using full-wave tool CST Microwave Studio. Simulation results show good agreement with the measurement data. From these results we successfully extracted creeping wave propagation and attenuation constants over the arm range of motion.