Effects of Body Position and Motion on On-body Wireless Channels

Erik Forrister* [(1)], George Lee[(1)], Dong Xue[(2)], Brian Garner[(1)], and Yang Li[(2)]
(1) Department of Mechanical Engineering, Baylor University,
Waco, TX 76706
(2) Department of Electrical and Computer Engineering, Baylor University,
Waco, TX 76706

Wireless Body Area Networks (WBANs), which have many potential applications including remote health monitoring for preventative health care, are networks of sensors and actuators worn on the surface of the body. However, reliable, long-term, and unobtrusive service will require sensors that provide good data transmission on and around the active, moving human body. To design optimized sensor antenna that achieve these characteristics, the small scale EM fading effects due to body position and motion for normal daily activities must be well understood. The purpose of this experimental study was to investigate EM fading effects for on-body antenna during various activities, human body types, transmission frequencies, and antenna positions (transmission channels).

EM transmission signal strength and three-dimensional body motion data were collected simultaneously using a Vector Network Analyzer (VNA) and a multi-camera Motion Capture System. The synchronized VNA and Motion capture data was recorded and analyzed at 120 Hz. Multiple adult subjects, including males and females, performed activities that consisted of left arm swing, both arm swing, rowing, boxing, hopping, and sitting motions. Each motion was recorded using a pair of quarter-wavelength monopole antennas configured in each of three ways to record transmission from: (1) the chest to the back, (2) the chest to the left wrist, (3) and the right wrist to the left wrist. The data was analyzed by plotting the signal attenuation data and the motion data in the time domain, and by plotting the signal attenuation against key motion variables for each activity.

Signal strength was observed to vary with the frequency of the antenna, the position of the antenna, and the activity performed. Signal attenuation occurs when the body is blocking the line of sight of the antennas, and the signal must creep around the body. Larger signal attenuation occurs when additional body segments block the signal. These results may guide future studies in analyzing the transmission signal strength of wireless on-body nodes on a dynamic body, and ultimately lead to the design of an unobtrusive, optimized antenna for power conservation and reliability.