Time-Domain Characterization of UWB Monopole Antenna Based On-Body to Off-Body Communication Channels

Elizabeth George * (1), Debarati Ganguly(2), Debdeep Sarkar(2), Chinmoy Saha(1), Yahia Antar(2)
(1) Department of Avionics, Indian Institute of Space science and Technology, Trivandrum, India
(2) Dept. of ECE, Royal Military College, Canada

In the present wireless age, the relevance of wearable devices has transcended from the sophisticated applications like iWatches, fitness bands and augmented reality applications to the general issues of healthcare [1] and safety/security [2], paving the way for the vision of internet-of-things (IoT). Ultra-wideband (UWB) antennas are the key enabling technology for the body area networks (BANs) comprising of several off-body and on-body wearable devices. Therefore, it is extremely crucial to assess the performance of wide-band device-to-device channels enabled with UWB antennas, which are not necessarily radiating in free-space environment. Also, for such UWB systems, one must estimate the correlation between the radiated signals in random directions and the signal transmitted in the main beam direction [3].

The present article focuses on the comprehensive time-domain characterization of UWB on-body to off-body communication channels, especially focusing on the transfer function and group delay. The simulation set-up consists of one on-body UWB monopole antenna (antenna kept on a phantom model of three layers: muscle, fat and skin) and one off-body UWB monopole antenna (antenna in free space), as shown in Fig. 1(a). The UWB antennas used in the simulation are circular monopoles of diameter 25 mm each, which operate in the FCC recommended bandwidth of 3-10 GHz. The slope of transmission phase angle against frequency provides an estimate of the group-delay ($-\Delta\Phi/\Delta\omega$), where Φ represents the phase angle and ω represents the frequency (see Fig. 1(b) for the frequency-variation of the group delay of the #Ant1- #Ant2 system).

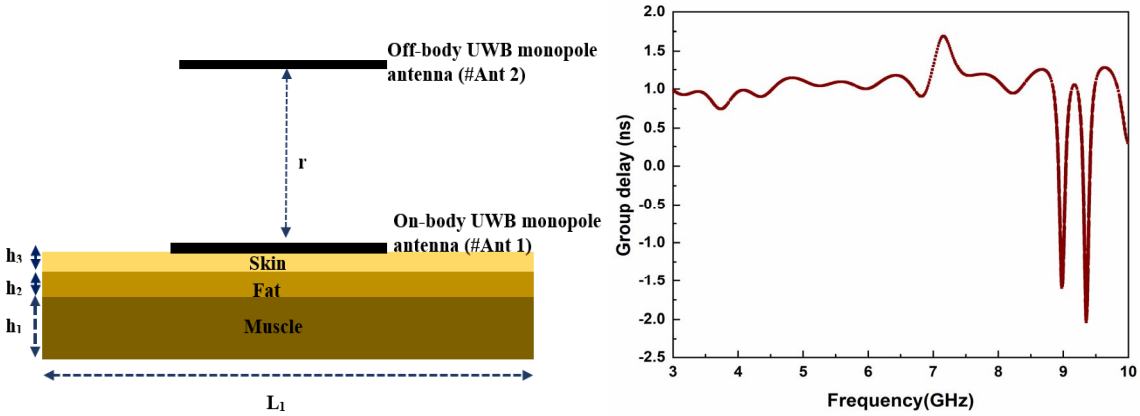

Figure 1. (a) Simulation set-up using UWB monopoles for on-body to off-body channel analysis, (b) Simulated group delay characteristics for the setup in Fig. 1(a).

References

[1] Wei Xia, Kazuyuki Saio, Masaharu Takahashi, Koichi Ito, "Performance of an Implanted Cavity Slot Antenna Embedded in the Human Arm," *IEEE Transactions on Antennas and Propagation,* **57**, 4, April 2009,pp: 894-899, doi: 10.1109/TAP.2009.2014579.

[2] Kashif Nisar Paracha, Sharul Kamal Abdul Rahim,Ping Jack Soh,Mohsen Khalily, "Wearable Antennas: A review of Materials, Structures, and Innovative Features for Autonomous Communication and Sensing," *IEEE Access,* **7**, April 2019, pp.56694-56712, doi:10.1109/ACCESS.2019.2909146.

[3] Elena Pancera, Thomas Zwick and Werner Wiesbeck, "Spherical Fideliy patterns for UWB antennas," *IEEE Transactions on Antennas and Propagation*, **59**, 6, June 2011,pp:21112119,doi:10.1109/TAP/2011.2143666.