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Empirical Channel Modeling for WBANs at sub-6 GHz and Millimeter-Waves

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Extended Abstract

Previous studies on WBAN either focus on a theoretical analysis [1] or measure channel loss in specific situations [2]. These studies neither provide a channel model in the mm-wave band nor compare the channel at mm-waves with the competing channels at lower frequencies, which makes it difficult to compare those options for communication in WBANs.

We have investigated experimental characterization of on-body propagation in the sub-6 GHz and the mm-wave frequency bands for two parallel (vertical and horizontal) polarizations. Different locations on the body are considered including arm, leg, front, and back of the torso for two human male subjects. The channel parameters are extracted from measurements in terms of path gain, mean excess delay, and root mean square (RMS) delay spread.

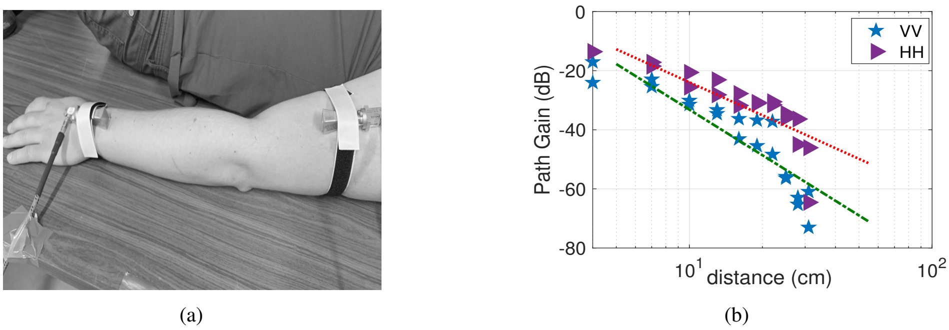

Figure 1. (a) Measurement setup on the arm of a subject at 60 GHz. (b) Example of measured path gain on the torso of a subject at 60 GHz. The fitted lines are shown vs. the measurements (markers).

We measured a minimum reference path gain of -27.6 dB for the sub-6 GHz while this value decreased to -44 dB for the mm-wave band. A path loss exponent between 2 and 6 was measured for both bands. Vertical polarization was dominant in the sub-6 GHz band. In contrast, increasing the frequency resulted in higher path gains for horizontal polarization of the antennas. The results are in good agreement with literature. Based on the results, mm-waves is the preferred choice since it provides higher bandwidths and smaller delays. For the mm-wave band, H polarization is desirable for antenna design for close distances where extensions away from the body is not needed.

The mean excess delay was smaller than 7 ns for the sub-6 GHz band and was decreased by factor 3 in the mm-wave band. Additionally, an RMS delay spread of 3 ns was obtained for the sub-6 GHz band. In the mm-wave band, line-of-sight propagation is dominant, therefore, the RMS delay spread decreased by factor 10 compared to the sub-6 GHz band.

References

[1] N. Chahat, G. Valerio, M. Zhadobov, and R. Sauleau, “On-body propagation at 60 GHz,” *IEEE Trans. Antennas Propag.*, vol. 61, no. 4, pp. 1876–1888, 2013.

[2] A. Pellegrini, A. Brizzi, L. Zhang, K. Ali, Y. Hao, X. Wu, C. Constantinou, Y. Nechayev, P. Hall, N. Chahat *et al.*, “Antennas and propagation for body-centric wireless communications at millimeter-wave frequencies: A review [wireless corner],” *IEEE Antennas Propag. Mag.*, vol. 55, no. 4, pp. 262–287, 2013.