Investigation of On-body Antenna Performance Using Motion-Capture and Statistical Analysis

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Understanding how body motion affects on-body antenna performance is an important consideration for the growing field of wireless body area networks (WBAN) that require optimized antennas for practical implementations of wearable device systems. Human body motion can significantly affect the electromagnetic (EM) wave propagation between on-body antennas. Determining optimal antenna types for on-body applications is also important for WBAN implementations.

Previous works have conducted studies to compare antenna performance and characterize the on-body channel for static and dynamic cases. Alomainy et al [*Alomainy, et al., IEEE Antennas and Wireless Propagation Letters, vol. 4, pp. 31-34, June 2005*] have studied the effect of two different antenna types on radio propagation in ultrawideband (UWB) static on-body channel measurement. Yamamoto et al [*Yamamoto, et al., IEEE Trans. On Ant. And Prop., vol. 61, no. 8, pp. 4315-4326, August 2013*] were able to study shadowing effects on communication system performance using an arm-swinging dynamic phantom that can represent human walking motions in an anechoic chamber. Cotton et al [*Cotton, et al., IEEE Transactions on Antennas and Propagation, vol. 57, no. 4, pp. 980-990, April 2009*] presented a detailed first- and second-order statistical analysis of the fading experienced in single-branch body-worn systems for use in indoor body-to-body communications. Many of the studies that have compared on-body antenna performance were performed when the test subjects were in in static positions. Few studies evaluated wearable antennas during dynamic body scenarios and did not used methods to characterize motion effects on antenna performance. Furthermore, previous studies generally focused on a single antenna type and did not perform detailed statistical studies to quantify the distribution fit of different types of antennas.

This study uses a combined phantom model and human body measurement technique that utilizes antenna transmission data and body motion data to compare three on-body antenna types, which are the monopole, microstrip, and e-textile antennas. Comparisons are performed between the monopole and microstrip at 915 MHz and the monopole and e-textile at 2.45 GHz. Furthermore, a statistical analysis is conducted, and this study is able to show that the Weibull distribution PDF shows good agreement with error quantification for multiple antenna types, antenna configurations, and subjects.