URSI AP-RASC, Sydney, Australia, 17-22 August 2025

Revisit to Basics of Body-Centric Wireless Communications

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In recent years, the technology and various systems of human body communication (HBC) have been developed and widely used in many different applications including healthcare, nursing, sports, games, assistive tools for workers, and so on. HBC utilizes the human body as a transmission medium to transmit or receive wireless signals serving as one of promising physical layer solutions for body area networks (BANs), as shown in Fig. 1 [1].

HBC can be implemented in a wide range of smart and small wearable devices, such as healthcare bands, smart watches, smart glasses, smart shoes, etc. These devices contain transmitters/receivers for wireless communication. Equivalent circuit models including a number of resistors and capacitors have been usually employed for a practical design of such transmitters/receivers [1]. However, the design is sometimes sensitive to changes of device locations, human-body size and shape, surrounding environments, etc.

In our laboratory, we have intensively studied body-centric wireless communications including HBC numerically and experimentally over the wide frequency range. Figure 2 shows simulation models for the study on frequency dependence of the communication channels between wearable devices mounted on the human body in the range of 3 MHz to 3 GHz [2]. All the results are obtained by numerical analyses based on the finite-difference time domain (FDTD) method. A transmitter (Tx) is located at the central point of the human body, and it generates electromagnetic fields around and inside the human body. A receiver (Rx) is attached at different points of the human body, and its received voltage can be calculated. With these basic models and techniques, we can design and optimize such wearable devices and predict characteristics of the communication channels. Furthermore, we can estimate specific absorption rate (SAR) distributions inside the human body. Another important point is that these techniques may provide insights into how to reduce interference between two adjacent BANs.

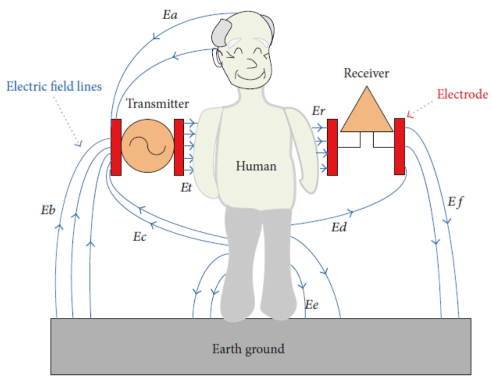
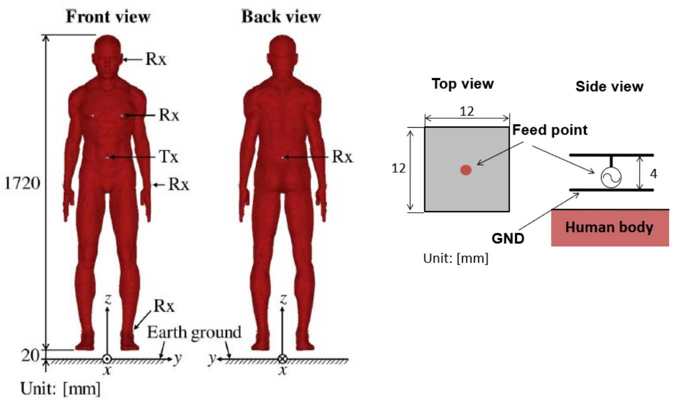


Figure 1. Capacitive coupling HBC (Fig. 2 of [1])



(a) Human-body model (b) Transmitter and receiver

Figure 2. FDTD simulation models (from [2])

1. J. F. Zhao, X. M. Chen, B. D. Liang, and Q. X. Chen, "A Review on Human Body Communication: Signal Propagation Model, Communication Performance, and Experimental Issues," *Wireless Communications and Mobile Computing*, **2017**, Oct. 2017, doi:10.1155/2017/5842310.

2. K. Ito, N. Haga, M. Takahashi, and K. Saito, "Evaluations of Body-Centric Wireless Communication Channels in a Range From 3 MHz to 3 GHz," in *Proceedings of the IEEE*, **100**, 7, pp. 2356-2363, July 2012, doi: 10.1109/JPROC.2012.2190129.