Passive RFID for Wearable System between a Patchable Tag and a Textile Reader

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In recent times, various wearable systems aimed at monitoring biomedical signals or human body movements have been proposed. The electronic skin (e-skin), which is patched to the body's skin using a minimization technology is under development. However, studies on the development of an optimized wireless communication between the garment-type wearable system and the electronic skin are limited. In the past, the communication environment between wearable devices has been configured using Bluetooth or Wi-Fi. The e-skin, however, must be designed with minimal size while being capable of measuring biomedical data using low power. The passive Radio-Frequency Identification (RFID) technology is suitable for such minimization because it allows communication between the reader and the battery-free receiver tag with low power. The passive RFID, however, is not acceptable in the wireless communication for wearable systems because of its short read range of a few centimeters.

This study proposes a 13.56-MHz passive RFID technology that applies electromagnetic inductive coupling to optimize wireless communication between the e-skin and the textile reader integrated in the smart garment. The textile reader integrated into the garment is embroidered with electro-conductive thread, and the tag patched to the body as an e-skin is manufactured with Flexible Printed Circuit Board (FPCB). A matching circuit with a high Q-factor is integrated into the front part of each antenna to improve the read range between the tag and the reader. For minimization, a textile reader antenna with a turn number of two and a line interval of 0.5 mm was manufactured with a conductive yarn of diameter 0.3 mm made by twisting metal thread and fiber, and a tag antenna of line width 1.27 mm, turn number of two, and an interval of 0.508 mm was made of FPCB. The signal loss with varying read range after patching the reader and tag on the arm, was simulated using the Computer Simulation Technology (CST), a commercial tool to interpret the electromagnetic field. The maximum range of the wireless communication that matched with 13.56 MHz was found to be 14 cm. The signal loss in the proposed wearable wireless communication was minimized using the high Q-factor of the matched circuit, and resulted in a 42 % increase in the transmission efficiency. The read range was measured in the identical condition except for the reader being embroidered with only textile thread, and was compared with the values from simulations. The measured read range and transmission efficiency in this control condition were 15.5 cm and 50 %, respectively.

By improving the read range, the proposed 13.56-MHz passive RFID is expected to be applied as an innovative method to transmit various biomedical data from an e-skin patched to the body to different garment types in wearable systems in the future.

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