Investigation of E-textile Dipole Antenna Performance Based on Embroidery Parameters

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With the latest growth of the smart textile market, E-textile antennas have been rapidly developed and deployed for wireless body area network applications. Compared to nontextile wearable antennas, the E-textile antennas offer improved solutions for seamless integration into smart garments by exhibiting advantages of flexibility, low mass, and low profile. As an example, E-textile patch antennas have been designed for spacesuit application when performing extravehicular activities [*Haagenson, et al., IEEE Antennas and Propagation Magazine, vol. 57, no. 4, Aug. 2015*]. To produce optimal e-textile antenna performance, it is necessary to understand the effects of fabrication parameters and potential for mass production and customization of antenna shape. In this study, embroidery was used to fabricate the antenna.

Several studies have been conducted to investigate the embroidery fabrication parameters that affect the performance of textile antennas. Acti et al [*Acti, et al., 2011 Loughborough Antennas & Propagation Conference, Loughborough, Nov 2011*] considered the effects of conductive thread density on antenna performance. Seager et al [*Seager, et al., IET Microwaves, Antennas & Propagation vol. 7, no. 14, Nov 2013*] have shown the effects of stitch pattern on the performance of embroidered microstrip patch antennas. Eike et al [*Eike, et al., Technical Considerations and Specifications for Conductive Machine Embroidery. Trends Textile Eng Fashion Technol.6(1)*] outline technical recommendations about the fabrication parameters for experimenting with conductive machine embroidery. Previous works, however, have not fully determined the effects of stitch type, stabilizer presence, and conductive threading location on e-textile antenna performance. Furthermore, many of the previous results were based on free space measurement instead of real human subject test.

This study investigates the effects of three embroidery parameters—stitch type, conductive threading location, and stabilizer—on the performance of e-textile antennas. Repeated samples of eighteen textile dipole antenna designs were fabricated at 2.45GHz for different combinations of embroidery parameters. Their reflection and transmission coefficients were measured using a vector network analyzer in both free space and on human test subject. The averaged measurement results for each antenna were compared with others based on antenna characteristics such as resonant frequency, antenna return loss and transmission gain. The results of this study identify optimum embroidery parameters which lead to superior e-textile antenna performance.