Energy-efficient textile antenna systems for body-centric communication and sensing

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Within the context of smart textiles interactive fabrics systems, the development of wearable antennas based on textile fabrics has been an exciting research area for more than a decade now. The specific textile antenna design challenges involve the characterization of the conductive and non-conductive antenna fabrics; the selection of low-loss textiles; the application of an antenna topology that realizes high body-antenna isolation, as such ensuring high radiation efficiency in proximity of the human body; and the implementation of an antenna with stable radiation characteristics, coping with the adverse effects the textile antenna is subjected to when integrated into a garment, such as bending, crumpling, stretching and varying humidity conditions. By now, many excellent textile antennas have been proposed in literature. However, not many of them are found in commercial wearable systems. The three main impediments for market penetration are: reliability issues of the connections between the textile and the electronic components; the lack of dedicated textile antenna mass production techniques; and the availability of compact rigid fully integrated wireless nodes, for which currently no textile counterparts exist. In this presentation, we will present some novel design paradigms that may overcome these problems, thereby paving the way to commercial textile antenna systems.

In this presentation three new enabling technologies will be discussed that can help in bringing textile antennas to the market. First, we implement microwave circuits and antennas based on substrate integrated waveguide technology purely in textile materials. The application of rectangular-waveguide-like structures in a planar low-profile topology provides excellent antenna-body isolation and also enables compact integration of active electronic circuits. Second, we leverage this property to come to a pervasive integration strategy where transceiver, microcontroller, memory and power management system circuits are directly integrated onto the textile antenna feed plane. Moreover, energy harvesters may be placed directly on top of the antenna patch, without reduction in radiation performance. Third, we exploit the large area that garments offer to deploy multiple textile antenna modules, distributed over the human body. Multi-antenna processing may then be applied to increase the reliability of the wireless body-centric channel, by countering multipath fading and body shadowing and/or by increasing the data throughput.

We will outline a number of applications that may benefit from this novel design paradigm. These will range from wireless off-body communication by rescue workers during interventions, over satellite-based localization, to remote sensing by body-worn radars.