A New Class of Colorful Textile Antennas for Wearable Electronics

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Wearable devices are required to be flexible, conformal, and robust to withstand daily wear and repetitive washing/drying. To overcome these challenges, we recently developed a new class of conformal antennas and electronics based on automated embroidery of conductive threads (E-threads). These E-threads consist of 7 to 664 metal-coated polymer filaments twisted together into a single thread. Thus, E-threads are only silver or copper in color, as attributed to the metal used to coat their filaments.

Integration of textile antennas and electronics into colorful logos or other esthetic shapes (e.g., flowers, animals, etc.) would significantly enhance their unobtrusiveness and wide adoption. To do so, former works demonstrated logo-type antennas realized via 1) manual cutting of copper tape adhered to fabrics, and 2) screen printing of conductive inks on fabrics. However, these approaches suffer from delamination and ink surface rupture after repetitive flexing. To address these concerns, robust logo-shaped antennas were recently implemented using embroidery of conductive E-threads. Nevertheless, these embroidered antennas did not incorporate any color. Color was only placed in the embroidered area that surrounded the antennas.

In this work, we propose a new approach for realizing colorful textile antennas and electronics. The embroidery process relies on unicolor E-threads in the bobbin of the sewing machine to weave the antenna on the back side of the garment. Concurrently, a colorful assistant yarn is threaded through the embroidery needle of the sewing machine and used to secure or "couch" the E-threads onto the fabric. Doing so, the colorful shape appears in the front side of the garment. The developed textile antennas are highly flexible and conformal, lightweight, mechanically robust, and exhibit similar performance to their copper counterparts. Geometrical precision as high as 0.1mm has been achieved by employing very thin E-threads and sewing the predetermined pattern using very high stitching density. This dense embroidery reduces physical discontinuities and achieves surface conductivity nearly that of copper. The proposed antennas can be unobtrusively integrated into clothing or other accessories for a wide range of applications (e.g., wireless communications, Radio Frequency IDentification, sensing, etc.).

At the conference we will present several antenna examples using the aforementioned embroidery process.