Novel Stretchable and Wearable Hand Gesture Sensors & Antennas

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The continuous monitoring of a hand gesture is a very challenging application due to the demanding requirements for robustness, accuracy, efficiency and cost effectiveness. Although several vision-based gesture sensors have made great progress in human action recognition, the human hand is a smaller object with more dexterity and is more easily affected by segmentation errors. In this paper, we will present novel chipless RFID-based stretchable hand gesture sensors utilizing stretchable silicone-based electrically conductive adhesives (silo-ECAs), that effectively create a "smart-skin". The hand sensor uses wearable multi-resonator spectral signatures to encode data and provide a unique ID for every hand gesture. In addition, we will discuss numerous wearable energy harvesting configurations for near- and far-field harvesting applications, including WBAN and localization systems.

The proposed hand sensor is built on a silicone rubber. Silicone rubber features a unique combination of biocompatibility, patternable fabrication method, high elasticity, and a low dielectric constant, which makes it an excellent candidate for stretchable electronics substrates. The selected Elastosil M 4642 has a low dielectric constant and dissipation factor while it has an elongation at break of 787%. A ground plane of ECA is located beneath the silicone which isolates the hand gesture sensor from the human body. The largest challenge for stretchable electronics, especially RF devices, is that the conductivity has a significant drop under a certain mechanical strain. In order to minimize the conductivity change under strain, a 80 wt% silver filled ECA is produced in house. The shape and morphology of the silver fillers are carefully engineered to achieve an initial conductivity value of 1.51×10^{6} S/m. After embedding ECA onto the silicone substrate, the conductivity reduces to 5.03×10^{5} S/m.

A proof-of-concept wearable wireless hand-gesture RFID-based sensing tag requires preferably an omni-directional or wide-beamwidth wideband antenna. The chosen microstrip-fed trapezoidal antenna has a simple structure and a large bandwidth. The microstrip line is designed around a 50 ohm impedance at 2.3 GHz. The trapezoidal antenna is matched to the microstrip line, which then transfers the power through the multi-resonator system. Preliminary results about inkjet- and 3D-printed wearable prototypes will conclude the paper.