A Frequency Reconfigurable Self-Adapting Conformal Array for Changing Surfaces
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Abstract: Conformal antennas placed on complex surfaces are receiving more attention as a method to increase the coverage of modern wireless communication systems. Furthermore, frequency reconfigurable antennas are being used in the development of multi-band multi-radio wireless platforms to simplify designs. In this project, theoretical development and a new 1 x 4 frequency reconfigurable self-adapting conformal array antenna that can be attached to changing conformal surfaces is presented. This conformal array consists of four reconfigurable microstrip patch antenna elements, a reconfigurable sensor circuit used to measure the curvature of the conformal surface and voltage controlled phase shifters. These phase shifters are controlled by the reconfigurable sensing circuit to implement phase compensation to autonomously recover the pattern in both bands of the reconfigurable 1 x 4 array as the wedge- and cylindrical-shaped surface on which the array is attached changes shape. Throughout this project, analytical computations, simulations in CST and measurements are compared and shown to agree.

Target of the project: In this project, the benefits of self-adapting conformal antennas and reconfigurability are combined into one design. In particular, the objective of this project is to simulate the antenna array in CST by providing the correct phase at each element (when it is attached to the deformed surface as shown in Fig.2) and a prototype for validation. The antenna array consists of reconfigurable microstrip patch antennas each individually connected to voltage controlled phase shifters with identical SMA cables (flexible cables were chosen for placement on various surfaces). The wedge- and cylindrical-shaped surface deformation is measured by a new reconfigurable sensing circuit that does not require signal processing. The circuit then in turn provides an output voltage that drives the voltage controlled phase shifters to implement phase compensation [1] at both switching frequencies. By choosing the appropriate circuit design, the array in Fig.1 can autonomously preserve the radiation pattern in both frequency reconfigurable bands using phase compensation. With the introduction of this array, designers will be able to develop wireless communication systems for much more complicated and compact surfaces. For example, in enclosures and the requirement of having a phased-array antenna on flat surfaces could be relaxed.

Fig. 1. Topology of the frequency reconfigurable self-adapting conformal antenna (R1 = 1.0 MΩ, Rgain = 4.0 kΩ - connected between pins 1 and 8).

Results: A drawing with the dimensions of the reconfigurable patch is shown in Fig. 4(a). The reconfigurable antenna switches between f1 and f2 by changing the electrical length of the radiating patch. The antenna was simulated in CST [2] on a 1.524mm thick TMM4 Rogers Substrate [3] with analytical computations, simulations in CST and measurements are compared and shown to agree. Good agreement can also be observed; indicating that the antenna is autonomously correcting the radiation pattern in both operating bands on three different conformal surfaces.

Fig. 3. Measured and simulated S-parameter values for the single frequency reconfigurable patch.

References:
2. 'CST Microwave Studio. Darmstadt, Germany', 2012