A Tunable Biomimetic Antenna Array with a Wide Tuning Range

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Over the past few decades, a significant body of research has been devoted to examining compact and electrically-small antenna arrays. Generally, these arrays are used in low-frequency applications where the electromagnetic wavelength is very large or in applications where sufficient space is not available to accommodate a large array aperture. One application that uses such arrays is small-aperture direction finding systems operating at the HF, VHF, or UHF parts of the electromagnetic spectrum. Recently, biomimetic antenna arrays (BMAAs) that mimic the hyperacute auditory system of the parasitoid fly *Ormia Ochracea* were reported as a promising means of increasing the sensitivity of a small-aperture direction finding system. While the first designs of BMAAs provided higher angular sensitivities compared to conventional arrays with the same aperture sizes, this capability was achieved at the expense of sacrificing the output power of the antenna (N. Behdad, et al., *IEEE Antennas Wireless Propagat. Lett*., 10, 361-364, 2011). Then, a new coupled antenna array topology was proposed that could achieve a moderate output phase sensitivity without sacrificing the available power of the array (A. R. Masoumi, et al., *IEEE Trans. Antennas Propag*, 63 (3), 1059 - 1066, 2015). This array provided the maximum, theoretically-achievable phase sensitivity while extracting the maximum power available from the array. All of these designs, however, demonstrate the enhanced phase sensitivity and angular resolutions over very narrow bandwidths (1- 3%).

In this work, a two-element biomimetic antenna array, which is tunable over a wide frequency band is presented. To achieve this wideband tunability, a new coupling network for this tunable BMAA is proposed. The device uses a tunable external coupling network, capable of tuning to different frequencies over the frequency range of 580-700 MHz. Using an equivalent-circuit model, a comprehensive synthesis procedure is developed that allows for designing and optimizing the proposed antenna. A prototype of the proposed tunable BMAA is also designed. The array consists of two identical elements separated from each other by $0.05\lambda_0$ and the coupling network is a four-port passive external network that uses a single varactor to achieve tunability. The antenna prototype is fabricated and experimentally characterized. The measurement results show that the proposed BMAA can achieve a phase enhancement factor in the range of 1.8-2.1 over the frequency band of 580-700 MHz. This phase enhancement factor is achieved without sacrificing the available output power of the antenna array. The proposed BMAA can potentially be beneficial in applications such as small-aperture direction finding and radar systems.