A Small-Aperture, VHF Direction Finding System Exploiting Biomimetic Antenna Arrays

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Direction finding (DF) systems are used in a wide range of applications including electronic warfare, spectrum management, and indoor/outdoor navigational systems. Most direction finding systems use antenna arrays and take advantage of the physical separation between the elements of the array to detect the direction of arrival of the signal. At low frequencies such as the HF, VHF, and UHF bands, however, the large wavelength necessitates the use of large antenna arrays if conventional DF techniques are to be used. Therefore, developing techniques that can be used to perform precise direction finding with small-aperture systems is of particular interest for DF systems operating at low frequencies in the HF through UHF parts of the EM spectrum.

In this paper, we propose a compact, small-aperture direction finding system that uses the recently-developed concept of biomimetic antenna arrays (A. Masoumi, Y. Yusuf, and N. Behdad, IEEE Trans. Antennas and Propag., 61, 2500-2510, 2013). It has recently been demonstrated that a two-element biomimetic antenna array composed of two receiving elements separated from each other by a small distance is able to significantly increase the small input phase difference between the two antennas and result in a large output phase difference compared to a regular antenna array occupying the same area. Using this concept, we have developed a direction finding system operating at the FM broadcast band (88-108 MHz). This frequency band is chosen because of the availability of low-cost, commercial off-the-shelf components as well as broadcast stations with precisely-known locations that can be used to perform field tests and characterizations. The system is composed of two receive antennas coupled together using a passive external coupling network. The outputs of the coupling network are connected to a two-channel balanced receiver designed using commercially available components. The received signals are down-converted to the IF frequency of 10.7 MHz and the IF signals are used for performing the direction of arrival estimation. The dimension of the whole system is 150 mm $\times$ 150 mm $\times$ 150 mm ($\approx 1/20\lambda_\circ \times 1/20\lambda_\circ \times 1/20\lambda_\circ$) where $\lambda_\circ$ is 3 m at the frequency of 100 MHz. Details of the design process of this system along with simulation and measurement results will be presented and discussed at the symposium.