Insect-Inspired Electrically Small Antenna Arrays

Nader Behdad
Department of Electrical and Computer Engineering
University of Wisconsin-Madison

Despite the tremendous amount of research conducted on antennas over the past decades, several fundamental problems in this area remain practically unresolved. Achieving super-resolution and super-directivity from electrically-small antenna arrays are among these challenges. While we have not yet been able to overcome these problems, nature provides us with examples of biological organisms that have addressed similar problems. In particular, the sense of directional hearing of small animals seems to be most germane to the problem of super-resolving electrically-small antenna arrays. In this talk, I will discuss our study on designing electrically small antenna systems that are based on the hearing mechanisms of small vertebrates and insects. The motivation for studying these organisms stems from the fact that some insects benefit from hyperacute directional hearing capabilities, even though their bodies and the separation between their two ears are all significantly smaller than a wavelength. In particular, in spite of its extremely small body size and the small separation between its two ears, a parasitoid fly, *Ormia Ochracea*, can detect the direction of arrival of an incoming sound wave with a 1°-2° angular resolution. In this presentation, I will discuss the analogies that can be drawn between the hearing mechanism of this insect and an antenna array composed of two isotropic radiators with an element spacing that is 140 times smaller than the operational wavelength. Subsequently, I will present methods for implementing such biomimetic antenna arrays along with measurement results of several prototypes. The talk will be concluded by a discussion of various applications of such antenna arrays and the potential use of this concept in developing high-gain, ultra-miniature antenna arrays.