Physical Simulation Based on Bat's Pinna Structure and Its Deformation Binaural Sound Signal Measurement Experiment of Greater Horseshoe Bat

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The current productive upsurge of bat research mostly concentrated on animal behaviors, passive sound measurements and numerical calculations. This research filled the blanks with its physical simulation approach, realistic yet controllable to conduct comparative experiments. Measurement was conducted on a 3D printed bat head physical model based on principles of echolocation. The ultimate goal is to find out the effect of pinna, draw critical parameters and apply them into the R&D of adaptive & biomimic antenna. First, Greater Horseshoe Bats were caught. The digital shape of bat head sample was then obtained and printed out using photosensitive resin. An ultrasound speaker was set before the 3D physical model and ultrasound probes were inserted in ear canals. By rotating the model with servomotors, the space distribution of sound pressure amplitudes was recorded and analyzed. And same steps were repeated under different frequencies, also to decrease error. The resulting space distribution revealed that the received sound amplitude is evidently largest in a precise direction, indicating strong directivity of receiving acoustic signals. In comparative experiments, the direction of receiving largest amplitude varied according to changes in frequency. Bat rotates head and deforms pinna to change the directivity, adjust to diverse frequencies and achieve more accurate echolocation. This conclusion is closely linked with the future of smart-antenna, which focuses on changing direction of receiving signals to adapt to diverse frequencies and achieve higher amplitudes & sensitivity. Plus, the subtle deformation of bat’s pinna while changing the direction of whole pinna could substitute traditional ways of rotating the whole radar to change the direction of receiving.

Awards Won:

First Award of $5,000

Intel ISEF Best of Category Award of $5,000

Philip V. Streich Memorial Award to the London International Youth Science Forum

Acoustical Society of America: Third Award of $1,000