BIO ENGINEERING SEMINAR

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Seminar Hall, CES

The Orchestra of Natural Micro Transducers Behind the Cricket Song

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Abstract: The all-too-familiar chirp of field crickets is actually a song that male crickets *sing* to attract mates. Surprisingly, this rather loud song is not produced by vocal chords of crickets; it is produced by very well coordinated motions and vibrations of an ensemble of clever natural transducers. These purely mechanical transducers with critical micro-scale features must work with clockwork precision to produce songs with a few KHz central frequency in a specific frequency band allocated to the particular species (yes, crickets have spectrum allocation too!). The song production unit uses another transducer as a frequency multiplier to convert the slow wing beat frequency into a high frequency impulse train. The impulse train, in turn, forces the *harp*—a thin triangular part of the wing—into resonance, modulating the subsequent motion into a beat pattern to produce the characteristic song. In this talk, I will unravel the orchestra of the transducers behind the song production that we have been studying for several years. Our study involves a careful finite element model of the harp, measurement of its material properties using sophisticated experimental techniques such as nano-indentation and atomic force microscopy, multiple simulation runs to get the vibration response of the harp, and finally, a comparison of the sound produced by the model with the sound recorded from the field crickets. The uncanny resemblance of the sound and the comparison of the frequency content provide enough evidence for trusting the model. We subsequently use our model to discover a scaling law that crickets seem to use for "spectrum allocation". The scaling law predicts geometric scaling for the harp structure that the evolutionary processes seem to have used for crickets of different sizes in order to enable them to produce songs with frequencies unique to the species. The underlying design principles for low frequency driving, frequency multiplier, and vibration amplifier have bearing on micro scale devices and are likely to be used for development of efficient MEMS loudspeakers.

About the speaker:

Dr Rudra Pratap is a Professor and the Chairperson of the Centre for Nano Science and Engineering (CeNSE), and an associate faculty of the Department of Mechanical Engineering at the Indian Institute of Science, Bangalore. Dr Rudra Pratap specializes in MEMS and NEMS design. Apart from MEMS and NEMS, his research interests include mechanobiology, sensor technology, and computational mechanics. Dr. Rudra Pratap holds a Ph.D. degree from Cornell University, USA and a B. Tech. from the Indian Institute of Technology, Kharagpur, India. He is a Fellow of the National Academy of Engineering.