Sensory systems in biology are among the most sensitive and evolved known to man. It is the aim of this project to take inspiration from biology in order to design, fabricate and characterise micro-mechanical sensing systems surpassing applicability, performance and robustness of traditionally engineered sensor-systems.

These systems will consist of arrays of similar but distinctive sensors, acting in parallel. They will be fabricated using micro-machining technology providing sensor dimensions matching the biological examples by which they are inspired. Understanding the functioning of hair-sensor arrays and fabrication possibilities of high-density hair-sensor arrays is a prerequisite to uncover a broad range of structures and the large potential for spatio-temporal flow pattern measurements. However, such measurements can only be realized when each array element is interrogated individually. Wafer-scale hair-sensor arrays with separate electrodes give the possibility to measure signals from different hairs individually and simultaneously. Reducing the complexity of interfacing hair-sensor arrays by minimizing the number of interconnects while maintaining real-time signals and large signal-to-noise ratio (SNR) is our target. Frequency division Multiplexing (FDM) technique can be used as array-addressing scheme to simultaneously retrieve signals from multiple hair-sensors without deterioration of the performance of individual hair-sensors. The virtue of the FDM scheme is especially realized with large numbers of array elements.

The multiplicity of the sensor systems allows exploiting diversity over the arrays. Since shape,
size and material determine the sensitivity of each of the sensors, variability of sensing properties can be easily obtained. This allows for mechanical filtering (i.e. individual sensors are tuned to characteristic frequencies by design).

Sensing and actuation are complementary transductive activities that can be realised in one and the same structure. Exploiting actuation, parametric mechanical amplification will be used to obtain specific filtering and signal enhancement.

Due to small dimensions noise will play an important role in the sensor systems. Rather than counteracting (thermal-mechanical) noise, sensing schemes will be devised that can profit from noise by processes like stochastic -resonance and -amplification.

Apart from measuring single physical quantities (average flow velocity, force), by nature of their distributive properties the sensor arrays will allow measuring fields (turbulence in flows, patterns in tactile sensing) and parallel mechanical signal processing (e.g. like in the mammalian auditory system where spectral decomposition is obtained by local variation of the properties of the basilar membrane).

The approach asks for a paradigm shift in sensing-system engineering with focus on parallelism, mechanical processing, beneficial use of noise and limited bandwidth. The promise of this biomimetic approach is the realization of the astounding performance of biological sensors systems harnessed in man-made sensing systems.

For related information please visit the following links:

- the Bioears project proposal

- NGC documentary "Cricket Combat" (showing some of our work)

- the CILIA consortium pages
- the **TST Cilia pages**

- the **EU CICADA site**

- the **TST CICADA site**.

- *(recent) publications*

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**Publications**

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