

# Biomimetic MEMS to assist, enhance and expand human sensory perceptions - A survey on state-of-the-art developments

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## Abstract

Current MicroElectroMechanical Systems cover the range of human sensory systems and furthermore provide data of even more signals. Not only signals that are too weak for human perceptions, but also signals, which are not covered by the human sensory system can be recognized and converted through MEMS. Biomimetics, which is an interdisciplinary knowledge field at the crossing point of biology and technology as well as the arts<sup>1</sup>, is a promising method in the development of emerging MEMS. Nowadays it includes architecture

and design, surface and materials technologies as well as sensors, medical engineering and management<sup>2</sup>. Applying certain principles from the biological sensory systems to technological strategies is an encouraging approach to assist, enhance and expand human sensory perceptions.



X<sub>1</sub> ... Signals too weak for Human Sensory System (Strength)  
X<sub>2</sub> ... Signal types not covered by Human Sensory System (Type)

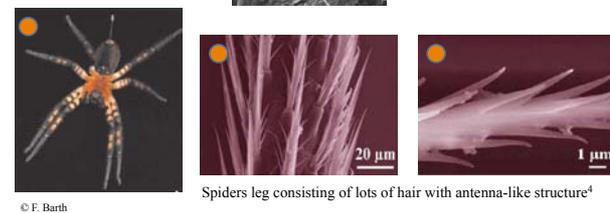
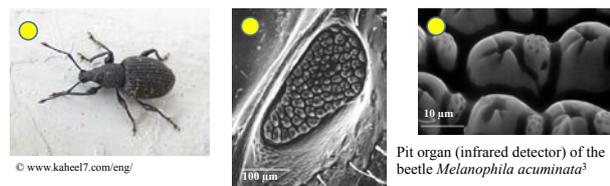
| Senses                         | Animals with extraordinary sensory systems   | Available MEMS sensors  |
|--------------------------------|--|---|
| Sight                          | mantis shrimp, butterflies, birds, fish  | 3D Motion MEMS Sensor, Beast X-3 MEMS Gyro System, MEMS ASIC Photo Chip ...             |
| Infrared Sensing (Temperature) | pit vipers, boas, pythons, forest fire-seeking beetles ●   | 3D MEMS IR Antenna, MEMS Microbolometer, MEMS Temperature Dependent Element ...         |
| Hearing                        | dogs, cats, mice, bats, elephants, whales, dolphins  | MEMS Microphone, Voice Interface, MEMS Oscillator ...                                   |
| Olfaction (Smells)             | dogs, moths, mice, ticks, sharks   | MEMS Gas Sensor, MEMS Electronic Nose ...   |
| Vibration Sensing              | spiders, cockroaches, sand scorpions, harbour seals ●  | MEMS Pressure Sensor, MEMS Shock Sensor, MEMS 3-Axis Digital Output Acceleration Sensor |
| Magnetic Sense                 | birds, invertebrates, molluscs, fish, wales, sharks, sea turtles, cows, deers, salamanders, geckos, earthworms | MEMS Magnetometer, MEMS Geomagnetic Sensor, MEMS Magnetic Sensors ...                   |
| Electroreception               | electric fish (torpedo rays, skates), sharks, rays, eels, catfish, lungfish                                    | MEMS Electroreceptor, MEMS Neural Control, MEMS Electrolocator ...                      |

## MEMS-based sensory opportunity:

- Implanted MEMS photochips in special glasses that allow vision in the UV spectrum.
- IR detecting MEMS for blind people that allow to “see” their endothermic environment (through absorbing energy from the surrounding in the form of heat).
- Annunciator of forest fires or alternative excellent heat measuring devices.
- Detectors for earthquakes, volcanic eruptions, tsunamis, typhoons or nuclear explosions through ultra- and infrasound sensors.
- MEMS olfaction for disease detection or smooth gathering.
- Electrosensing MEMS could be used in devices for target location and orientation in muddy waters, blood and other places with special conditions.

## Outlook

- Information about the respective bandwidths for natural and technologically available sensors will be collected.
- A push pull analysis of the market needs concerning MEMS will be performed and process definition will be made.
- Key processes in the determined sensory areas are defined with focus on existing standard technology and sensors.



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