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Towards a "Navigational Sense" for Humans: Biomimetic Polarized Light-Based Navigation System

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Biomimetics is an interdisciplinary method that brings together biologists, physicists and engineers to produce optimized solutions for engineering problems. This method transfers principles of materials, structures and processes from living nature to the field of engineering, in order to, e.g., develop technological devices that can assist, enhance and expand human sensory abilities. Our presentation will discuss the concept development for a bioinspired polarized light-based navigation sensor built in miniaturized MEMS technology. This device shall be the first step towards a "navigation sense" for people. With this sensor, people could navigate without being dependent on GPS technology. Current navigation systems are mostly dependent on the global navigation satellite system (GNSS), the most fully operation system for global positioning system. The variability of function and integration of the new generation of GNSS has increased the market demand on related products. However, GNSS may be limited by the low precision of the signal in certain conditions such as in urban areas, intermittent coverage, high maintenance cost and risk of being shut down during conflict. Due to these risks, we started development of a new system that is GPS independent but possesses the GNSS performance. Our GPS independent polarization navigation sensor is a miniaturization of navigation system invented by Lambrinos and co-workers (and developed further by Chu and co-workers), and mimics the navigation of desert ants. The key components of the polarization compass consist of a polarization sensor and a log-ratio amplifier inspired by the insect polarized light sensitive photoreceptor and polarization neuron, respectively. The original device has large size electronic components such as photodiodes, polarizers, blue transmitting filters and log ratio amplifiers, and additionally needs a computer as controller. The orthogonal arrangement of the microvilli in the insect rhabdomere of the dorsal rim area has inspired the Chu group regarding development of a CMOS based wire grid polarizer which is used in a polarization sensor. Miniaturization and integration of these existing devices need to be performed through MEMS technology in order to realize the "navigation sense" in humans. Potential users of such a "navigation sense" are disabled people and people who lost their orientation or way, including children. The development of a small MEMS device (mounted *ex corpore* to avoid ethical conflicts) represents an emerging future area of growth in the field of advanced materials science and engineering.