Inspired by Elephants and Bees: Navigation and Water Detection with MicroElectroMechanical Systems (MEMS)

Salmah b. Karman1,2, S. Zaleha M. Diah1, Oliver Futterknecht3 and Ille C. Gebeshuber1,3

1Institute of Microengineering and Nanoelectronics, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Malaysia
2Dept. of Biomedical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia
3Institute of Applied Physics, Vienna University of Technology, Wiedner Hauptstrasse 8-10/134, 1040 Wien, Austria

How to Navigate without GPS?

• Honeybees detect polarized skylight with their compound eyes.
• They navigate using the polarization pattern of the sky, that changes throughout the day.

Learn from Nature's navigators (bees, ants, migrating birds, …)

Bio-inspired polarized light-based MEMS navigation device

MEMS Device Concept

1. The MEMS sensor array is inspired by abstractions of the respective biological functions: polarized skylight-based navigation sensors in honeybees (Apis mellifera) and the ability of African elephants (Loxodonta africana) to detect water.

2. The polarization-detection device uses light beam reactive MEMS, which are capable to sense the skylight polarization based on the Rayleigh sky model. For water detection we present various possible approaches to realize the sensor: polarization and infrasound-based ones, for localization of underground rivers and visualization of their exact routes.

Research Achievements

Winner of the 2012 AGSE Innovation Award in Recognition of Outstanding Achievements in the Field of Applied Geoinformatics

Q1 ISI Publication
-SENSORS 2012-
Link: www.mdpi.com/1424-8220/12/11/14232

Further Reading


Acknowledgement

The National University of Malaysia funded part of this work with its leading-edge research project scheme ‘Aurus Perdana’ [UKM-AP-NBT-16-2010].

Honeybee Navigation

Rayleigh sky model. Polarization pattern of the daytime sky

Input
• Compound eye
• Polarized light detection part

Signal processing
• Nerve and brain
• Polarized light signal processing

Output
• Return to the hive in a straight line (although foraging in all possible directions)

Biomimetics: Knowledge transfer from biology to engineering, resulting in novel innovative technologies

Bioinspired Water Detection with MEMS

Elephants locate underground rivers 14.3 km away and 3 m underground (with infrasound sensors)

Bees sense slight changes in polarization induced by water vapor

Bioinspired MEMS water detector for desert survival

Acknowledgement

The National University of Malaysia funded part of this work with its leading-edge research project scheme ‘Aurus Perdana’ [UKM-AP-NBT-16-2010].