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METAHEURISTICS IN THE AUTOMATED DESIGN OF CMOS-MEMS SENSORS FOR PLANETARY EXPLORATION.

Abstract

Being CMOS-MEMS the micro-fabrication platform in which microsystems can be developed monolithically along with signal processing stages out of a former conventional CMOS ASIC chip by means of adding a variety of materials to (or removing them from) the previously fabricated CMOS structures. In the present work some of the most common CMOS-MEMS sensing applications (i.e. inertial measurement, gas detectors, etc.) are surveyed, emphasizing on the geometry-related and topological design issues. Then, bio-inspired metaheuristic algorithms are proposed in order to assist the microsystems developer to achieve a desired performance objective at particular environmental and power consumption conditions, optimizing design parameters by computational means.

Solid-state electronic sensors such as gas detectors, while on Earth are usually intended to operate at a certain temperature range, in space or planetary scenarios would as well need to outperform low-particle-concentration environment conditions. This is why some MEMS-like CMOS sensing systems are designed to include an integrated auto-heating device taking advantage of the Joule-effect-related properties and how temperature modulates the chemical reaction rates at the circuit surface. All of these physical magnitudes are known to depend on the type of material through which an electric current is being carried and its geometry. In conventional CMOS fabrication, let's say, 0.5um 3-metal 2-polysilicon process, the design rules restrict what materials are allowed and how they interconnect to form electronic devices and mechanical structures so topology layout is the only task left where the designer can manipulate to define the functionality of the system.

Sensitivity is a parameter often wanted to be high when it comes to sensor devices, as well as the design area is preferred to be small in any micro-fabrication process due to its cost. In this work a simple genetic algorithm within the framework of evolutionary computation techniques is presented to simulate a bio-inspired process of design parameter selection looking for an optimal trade-off between hypothetical mission requirements.