TITLE

System-On-Chip Design and Communication in Embedded Wired High-Density Sensor Networks
A Contribution from Behavioural High-Level-Synthesis and Functional Printing

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ABSTRACT

Today there is an increasing demand for miniaturized sensors embedded in sensorial materials, built from high-density sensor networks consisting of identical nodes. Each node provides some kind of sensor, electronics, data processing, and communication. High integration and miniaturization down to MEMS requires enhanced System-On-Chip (SoC) design and dedicated communication methodologies. We provide a design methodology for efficient and resource-aware SoC design using behavioural high-level-synthesis based on an imperative multi-process programming model and interprocess communication targeting both FPGA and ASIC technologies.

The SoC synthesis flow is demonstrated for an implementation of a communication protocol best suited for low resource sensor networks using delta-distance vector routing. There is no requirement for absolute and unique node addressing, and network paths are found automatically by a set of smart routing rules providing robustness against link failures. The SoC is used in a sensor network consisting of strain-gauge sensors and interconnect wires manufactured with functional printing tightly coupled to electronic parts.

The sensor network is part of a multi-degree of freedom robot manipulator arm using modular robot actuators. Furthermore, the SoC design methodology is used to implement a simple distributed data processing algorithm, transforming a passive data-source-only sensor network into a distributed data processing system performing data fusion.