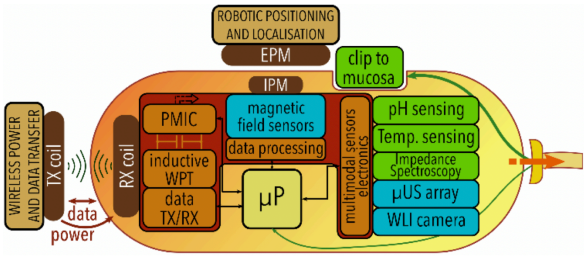
MS Thesis projects

Updated June 29, 2022

[IoT-AUTO-P3] Wireless power transfer of robotic capsule for colonoscopy.



As part of the European **AUTOCAPSULE** research project, we are working on the development of a wireless robotic capsule for colonoscopy. In particular we are developing the full electronic subsystems for wireless power transfer, wireless communication, sensor data conditioning. This thesis deals with the wireless power transfer subsystem.

Your work consists in

- Understanding the requirements of a wireless capsule for colonoscopy in terms of sensors (white light camera and ultrasound imaging), power supply, communication in collaboration with the other research partners (considering both established solutions and advanced research-stage solutions in the technical literature).
- Defining the requirements of a wireless power transfer sub-system and evaluating candidate solutions
- Contribute to the design of a new version of the wireless power receiver IC (circuit + layout) in silicon CMOS.
- Contribute to the setup of the test system for the wireless power transfer system (transmitter plus receiver)
- Contribute to the full test of the wireless power transfer system

Skills you learn:

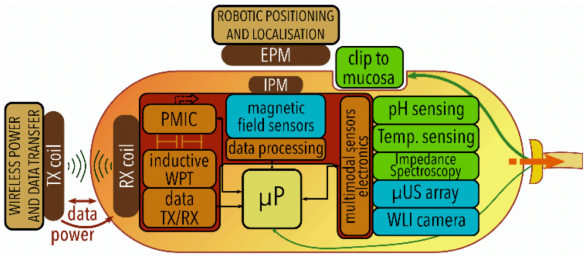
- Literature research, preparation of a briefing to guide decision making
- Definition of an Industry-level feasibility study.
- Domain knowledge on implantable medical sensors
- Design of mixed-signal integrated circuits using Cadence Virtuoso
- Design of boards for chip testing.
- Work in a team in the framework of an international research project.

Execution of the thesis work:

- The thesis work is part of collaborative task among the University of Pisa, Quantavis s.r.l. (U. Pisa spinoff), University of Leeds, University of Glasgow, IMEC.
- Duration: 5 months full time.
- Fellowship from Quantavis s.r.l. is available for the thesis.

Contact: prof. Giuseppe Iannaccone – giuseppe.iannaccone@unipi.it

[IoT-AUTO-C1] Communication subsystem of robotic capsule for colonoscopy.



As part of the European **AUTOCAPSULE** research project, we are working on the development of a wireless robotic capsule for colonoscopy. In particular we are developing the full electronic subsystems for wireless power transfer, wireless communication, sensor data conditioning. This thesis deals with the wireless communication subsystem.

Your work consists in

- Understanding the requirements of a wireless capsule for colonoscopy in terms of sensors (white light camera and ultrasound imaging), power supply, communication in collaboration with the other research partners (considering both established solutions and advanced research-stage solutions in the technical literature).
- Understanding the challenges posed by the operating conditions of the capsule in the bowel (in terms of presence of temperature, signal propagation through body tissue, biocompatibility).
- Defining the requirements of the communication subsystem, considering power constrains, datarate requirements, and propagation attenuation in the body.
- Evaluating candidate solutions and selecting the components
- Designing the subsystem using commercial integrated circuits (circuit + layout + firmware)
- Validating and testing the communication subsystem

Skills you learn:

- Literature research, preparation of a briefing to guide decision making
- Definition of an Industry-level feasibility study.
- Domain knowledge on implantable medical sensors
- Use of python or matlab for system-level simulation
- Hardware/Software design of communication PCBs

Execution of the thesis work:

- The thesis work is part of collaborative task among the University of Pisa, Quantavis s.r.l. (U. Pisa spinoff), University of Leeds, University of Glasgow, IMEC.
- Duration: 5 months full time.
- Fellowship from Quantavis s.r.l. is available for the thesis.

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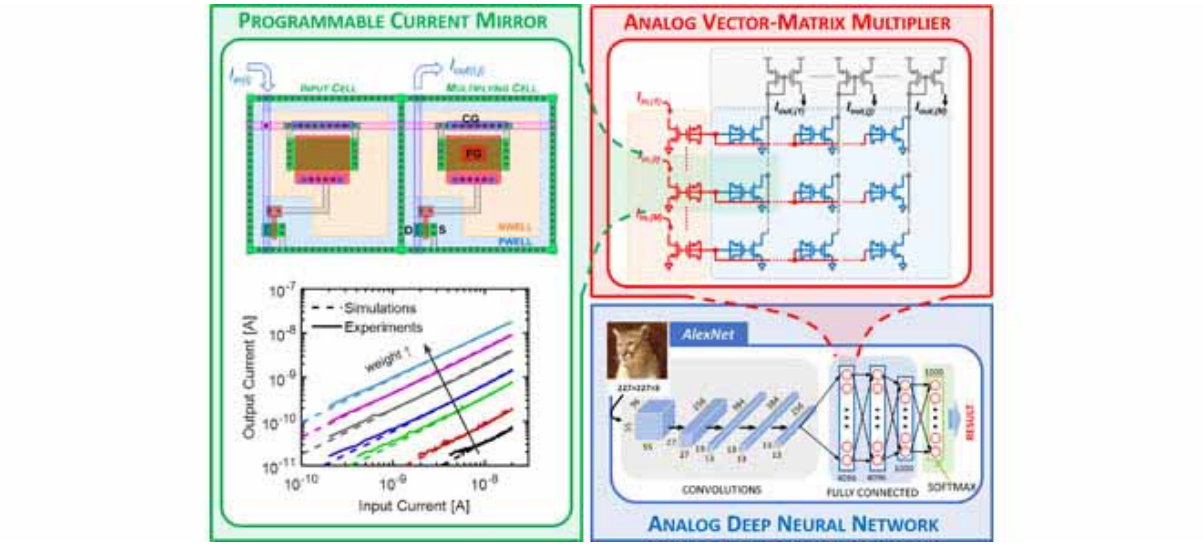
[AI-QUEF-CL] Design of a mixed-signal machine learning chip.



As part of the European **QUEFORMAL** research project, we are working on the design of analog integrated circuits for machine learning based on logic-in-memory circuits. In this thesis, we focus of a small complete neural network.

Your work consists in

- Understanding the operation of a deep neural network
- Understanding the operation of neural network integrated circuits based on analog computing or on single-bit digital computing (considering both established solutions and advanced research-stage solutions in the technical literature).
- Evaluating different implementations for a convolutional layer of a neural network at the system level (using python or matlab) and comparing them in a technically sound way.
- Design a demonstrator of a small but complete analog neural network to the physical level in SOI CMOS (circuit and layout design to tape out).
- Demonstrate the operation of the designed subsystem on the basis of full simulations (pre- and post-layout).

Skills you learn:

- Literature research, preparation of a briefing to guide decision making
- Definition of an Industry-level feasibility study.
- Domain knowledge on machine learning chips.
- Use of python or matlab for system-level simulation
- Design of mixed-signal integrated circuits using Cadence Virtuoso
- Work in a collaboration team in the framework of an international research project.

Execution of the thesis work:

- The thesis work is part of collaborative task among the University of Pisa and Quantavis (U. Pisa spinoff),
- Duration: 5 months full time.

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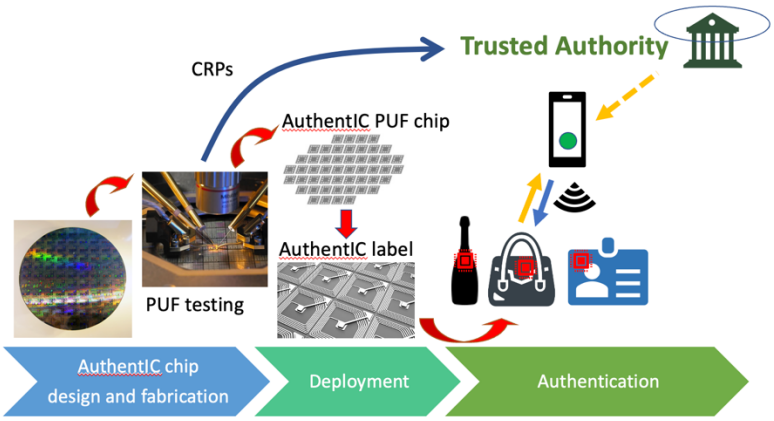
[CYBER-AUT-PUF] Design of a high entropy physical unclonable function chip for secure key generation.



As part of the European **AUTHENTIC** research project, we are working on the design of mixed-signal integrated circuits for secure cryptographic key distribution based on logic-in-memory circuits. In this thesis, we focus on the design of a high entropy physical unclonable function (PUF).

Your work consists in

- Understanding the operation of a PUF and of possible implementations (considering both established solutions and advanced research-stage solutions in the technical literature).
- Understanding the details of cryptographic key generation, use, and distribution.
- Evaluating different implementations and comparing them in a technically sound way.
- Contribute to the design the of a CMOS PUF down in 65 nm CMOS technology (circuit and layout)
- Contribute to the preparation of the validation tests for the PUF.

Skills you learn:

- Literature research, preparation of a briefing to guide decision making
- Definition of an Industry-level feasibility study.
- Domain knowledge on hardware cyber security systems.
- Design of mixed-signal integrated circuits using Cadence Virtuoso
- Work in a collaboration team in the framework of an international research project.

Execution of the thesis work:

- The thesis work is part of collaborative task among the University of Pisa, Quantavis (U. Pisa spinoff).
- Duration: 5 months full time.
- Fellowship from Quantavis s.r.l. is available for the thesis.

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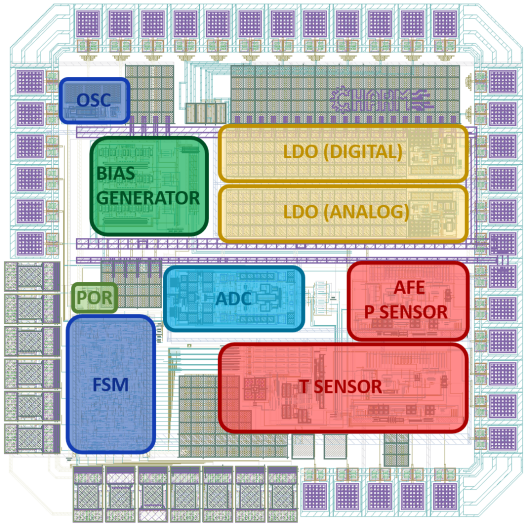
[IoT-CHARM-HT1] IoT sensors for extremely high temperature



As part of the European **CHARM** research project, we are working on sensors in extremely challenging industrial environments. In particular we want to develop high temperature and pressure sensors industrial applications, pushing standard CMOS technology up to 300 C (above the normal operating range) with the use of temperature-compensation techniques.

Your work consists in

- Understanding the requirements of temperature and pressure sensors for applications in high temperature environments (industrial plants, space exploration, mining)
- Understanding the techniques for designing silicon integrated circuits operating at high temperature (300 C).
- Contribute to the design of mixed-signal integrated circuits operating at up to 300 C, above the maximum temperature at which the CMOS process is qualified (175 C) [circuit design and layout]
- Contribute to the design of a high temperature PCB hosting the chip.

Skills you learn:

- Literature research, preparation of a briefing to guide decision making
- Domain knowledge on design of chips for operation at high temperature
- Design of mixed-signal integrated circuits using Cadence Virtuoso
- Design of PCB
- Work in a collaboration team in the framework of an international research project.

Execution of the thesis work:

- The thesis work is part of collaborative task among the University of Pisa, Applied Materials (USA and Italy), Quantavis s.r.l. (U. Pisa spinoff), TUDelft, and the CHARM consortium.
- Duration: 5 months full time
- Fellowship from Quantavis s.r.l. is available for the thesis.

Contact: prof. Giuseppe Iannaccone – giuseppe.iannaccone@unipi.it