Ph.D. in Information Technology:

Brenna, Trigilio and Mauri Final Dissertations

DEIB Alfa Room

January 13th, 2016

11.30 am

First Ph.D. presentation and discussion:

Dr. Stefano BRENNA – XXVIII Cycle

"Ultra Low-Power Analog and Mixed-Signal SoCs for Smart Sensors Applications"

Supervisor: Prof. **Andrea LACAITA**

Abstract:

The relentless miniaturization of microelectronic technologies is leading to drastically reduce power consumption thus making possible the design of sensor nodes for distributed sensing or the integration of multiple sensing systems in portable, consumer electronic devices.

In these systems low-power low-noise front-ends have to acquire, digitize and transmit information. To improve energy efficiency design solutions should be found to keep power consumption as low as possible and improving the efficiency of all the circuit blocks. A/D converters with energy efficiency better than 20 fJ/conversion step must be investigated as well as high efficiency transceivers for short range radio links. To meet the recent trends of consumer and in general portable electronic applications, three different efficiency oriented designs were presented in this work. Two earth magnetic field sensing systems to support the development of indoor navigation systems and a multichannel wireless neural probing systems with state-of the-art efficiency. In particular, both a 3-axes Lorentz force based and a 3-axes AMR magnetic field sensing readout integrated circuits were designed in CMOS 0.35μm to provide the signal amplification and digitalization.

The Lorentz force based sensing system is the first presented in literature with an integrated readout electronics, works with a 3V supply, achieves a resolution of 28mGa and a programmable full-scale-range up to 24Ga with less than 1mW power consumption per channel. Thanks to better sensor characteristics, the AMR sensing system is designed to achieve 4mGa resolution, a full scale range of 10Ga drawing only 180μW per-axis from a 1.8V power supply and it is currently under measurements.

The neural probing system is fabricated in 0.13μm process, features 64 channels, each comprising a low-noise amplifiers and an 10bit 6fJ/cstep efficiency ADC. The systems is provided with an UWB wireless link able to transmit a 20mbps bit stream to a 7m far receiver. The overall system power consumption is equal

to 965μW from a 0.5V supply, it is the lowest among multichannel (>32) systems and it is achieved with the widest transmission range.

Second Ph.D. presentation and discussion:

Dr. Paolo TRIGILIO - XXVIII Cycle

"Development of an ASIC for SiPM Readout in SPECT Applications"

Supervisor: Prof. **Carlo FIORINI**

Abstract:

Various examples of Silicon Photomultiplier (SiPM) readout circuit can be found in literature, mainly aiming to the achievement of high precision timing measurements (e.g. for positron emission tomography) or to high-energy physics experiments.

This work presents the development of a SiPM readout ASIC for low energy gamma spectroscopy, in the 100-300 keV range. The circuit is part of a novel Single Photon Emission Computed Tomography (SPECT) system, designed to be compatible with a pre-existing magnetic resonance (MR) apparatus.

A multichannel ASIC, for the readout of the 36-pixel SiPM photodetection plane featured by the single SPECT module, is presented along with the associated experimental results obtained in the SPECT module tests. Furthermore, the development of a prototype ASIC with an improved filtering strategy of the input signal is discussed.

The present doctoral work is part of the INSERT project, funded by European Community under the FP7-HEALTH program (Grant agreement 305311), aimed to provide an improved brain tumour clinical diagnosis.

DEIB Conference Room

January 13th, 2016

h. 15.30

Ph.D. presentation and discussion:

Dr. Andrea MAURI – XXVIII Cycle

"Methodologies for the Development of Crowd and Social-Based Applications"

Supervisor: Prof. **Marco Brambilla**

Abstract:

Even though search systems are very efficient in retrieving world-wide information, they cannot capture some peculiar aspects of user needs, such as subjective opinions, or information that require local or

domain specific expertise. In these scenarios the knowledge of an expert or a friend's advice can be more useful than any information retrieved by a search system. This way of exploiting human knowledge for information seeking and computational task is called Crowdsourcing. The main objective of this work is to develop methodologies for the creation of applications based on Crowdsourcing and social interaction. The outcome is a framework based on model-driven approach that allow end user to develop their own application with a fraction of the effort required by the traditional approaches. It guarantees a strong control of the execution of the crowdsourcing task by mean of a declarative specification of objectives and quality measures. A prototype has been developed that allow the creation and execution of task on various platforms.

Validation of the approach has been carried out with quantitative and qualitative analysis of results and performance of the system upon some sample scenarios, where real users from social networks and crowdsourcing platforms have been involved. In this work the ROAMFREE sensor fusion library, a general framework for position and attitude determination, has been developed. The resulting system is independent from the specific platform/sensor configuration and it allows to fuse information from multiple heterogeneous and asynchronous sensors in real time. Moreover, the framework allows for offline trajectory smoothing to estimate unknown sensor calibration parameters, such as biases, distortions, displacements and kinematic parameters. Under the hood, the library solves a max-likelihood optimization problem over an hypergraph where node represent robot poses at different time instants, and edges are non-linear constraints associated with sensor readings. The resulting system has been successfully employed on multiple autonomous mobile robots, both in indoor and outdoor environments.

Second Ph.D. presentation and discussion:

Dr. Dong HAN – XXVII Cycle

"Calibrating a Varying Camera from Silhouettes and Background"

Supervisor: Prof. **Vincenzo CAGLIOTI**

Abstract:

In this thesis, we consider the scenario where a smooth 3D object of unknown shape is observed, against a background plane with unknown patterns, by an uncalibrated, moving camera with varying intrinsic parameters. Starting from the acquired images, we address the problem of recovering i) the value of the camera intrinsic parameters for each image, ii) the camera motion and, iii) the 3D reconstruction of some points on the object surface. The problem is particularly interesting in prosthetics, or custom cloth, shoe manufacturing, where the 3D model of a smooth textureless object is to be obtained. The smoothness of the object makes it difficult to identify image correspondences, due to the continuously varying contour generator as the camera viewpoint moves. In addition, using, e.g., consumer cameras (e.g., those provided with tablets or smart phones), often the auto-focus property of the device is active letting the intrinsic camera parameters vary between acquisitions. Therefore, calibration methods, such as Zhang, cannot be applied. We propose a new framework that could calibrate a fully varying camera from background and silhouettes of smooth objects, not requiring more than two frontier points per view-pair. The epipole positions in each image pair are first estimated by finding two epipolar lines that are tangent to the object silhouette with the help of the plane induced homography. The projective reconstruction of the image sequence is then robustly computed from the estimated epipolar geometry. A flexible self-calibration algorithm using the absolute dual quadric is employed to determine the camera intrinsic parameters and to upgrade the projective reconstruction to metric. The proposed algorithm does not depend on the assumption of orthographic or affine cameras to find epipoles thus is applicable to generic projective cameras with both varying focal length and principal point. Experiments with both synthetic and real images are carried out and good calibration accuracy is achieved.