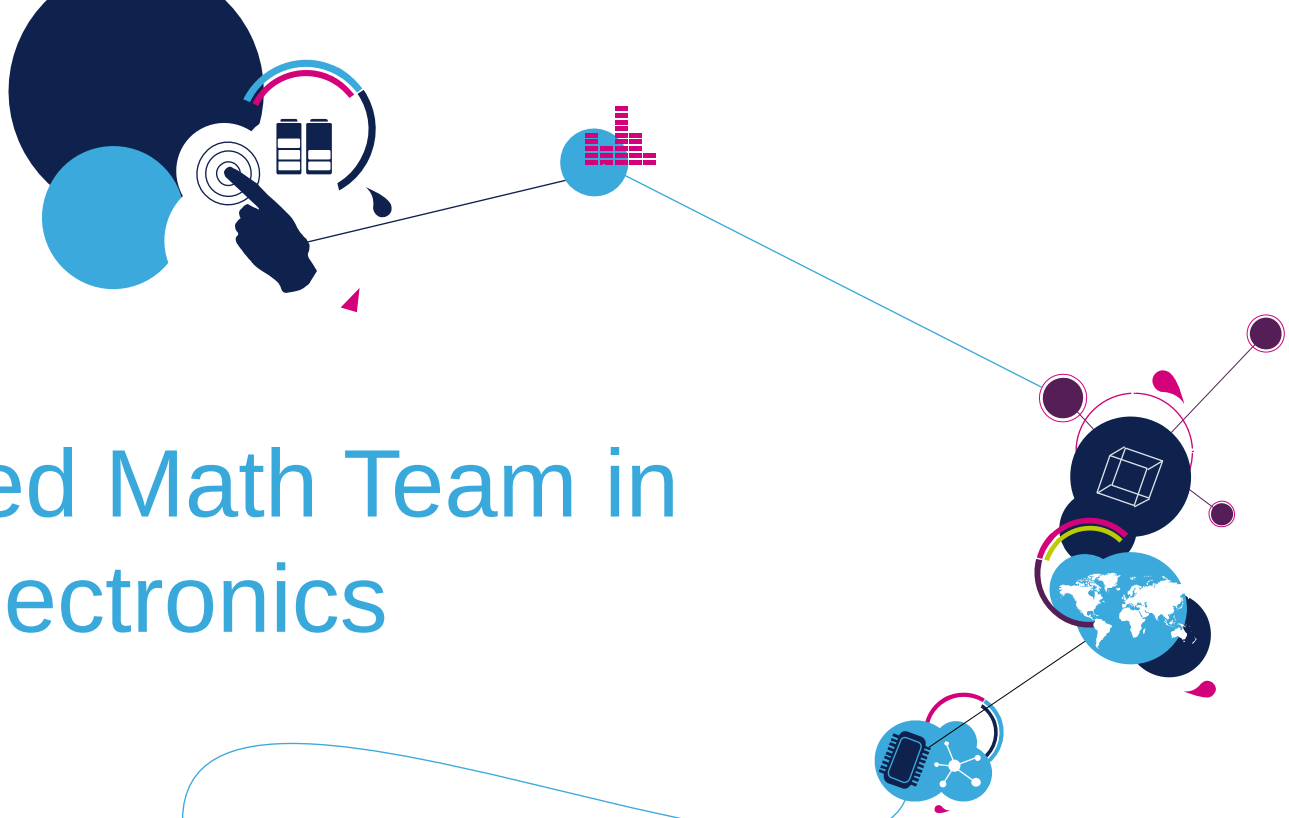

The Applied Math Team in STMicroelectronics

Beatrice Rossi

18/05/2017

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Who I Am ☺

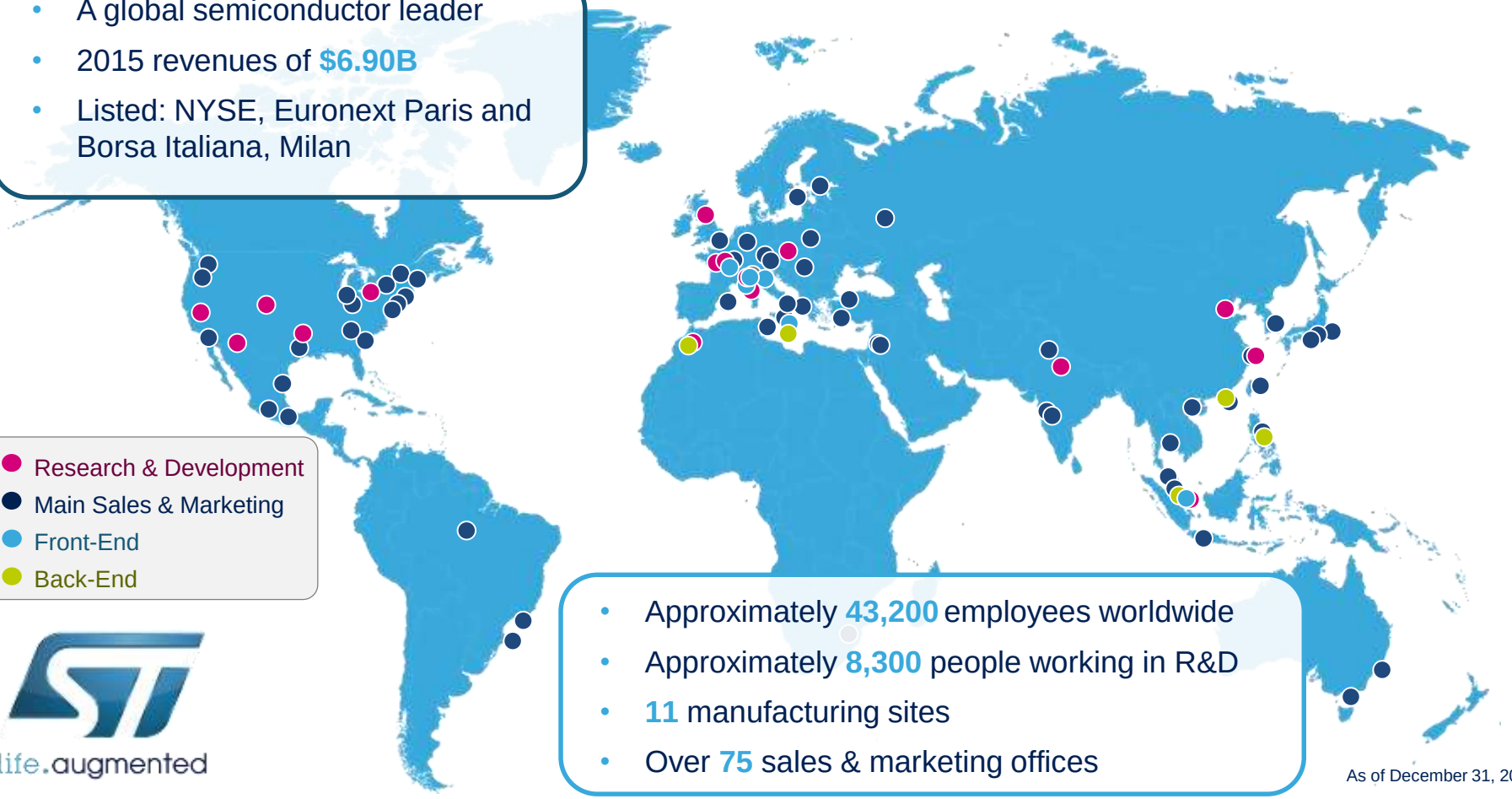
- Attended both “Triennale” and “Magistrale” courses at Milano Bicocca University
- Internship in STMicroelectronics in 2007 (Elliptic Curves Cryptography)
- Graduated in Mathematics in 2007
- Employed in STMicroelectronics (Applied Math Group) since 2008

…I love hiking, playing violin and I attend Jazz singing lessons!

Where I Work

Who We Are

- A global semiconductor leader
- 2015 revenues of **$6.90B**
- Listed: NYSE, Euronext Paris and Borsa Italiana, Milan



- Research & Development
- Main Sales & Marketing
- Front-End
- Back-End

- Approximately **43,200** employees worldwide
- Approximately **8,300** people working in R&D
- **11** manufacturing sites
- Over **75** sales & marketing offices

As of December 31, 2015

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Where You Find Us

Making **driving** safer, greener and more connected

Making **homes** smarter, for better living, higher security, and less waste

Making everyday **things** smarter, connected and more aware of their surroundings

Enabling the evolution of **industry** towards smarter, safer and more efficient factories and workplaces

Enabling **cities** to make more of available resources

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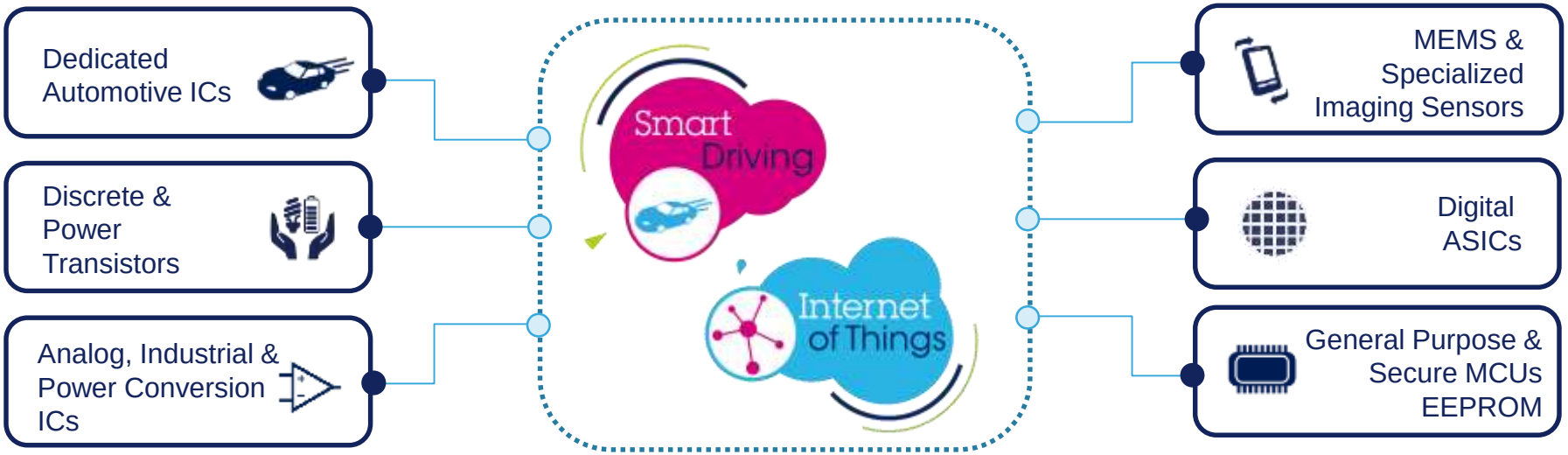
Product Family Focus

The leading provider of products and solutions
for Smart Driving and the Internet of Things



Portfolio delivering complementarity for target end markets, and synergies in R&D and manufacturing

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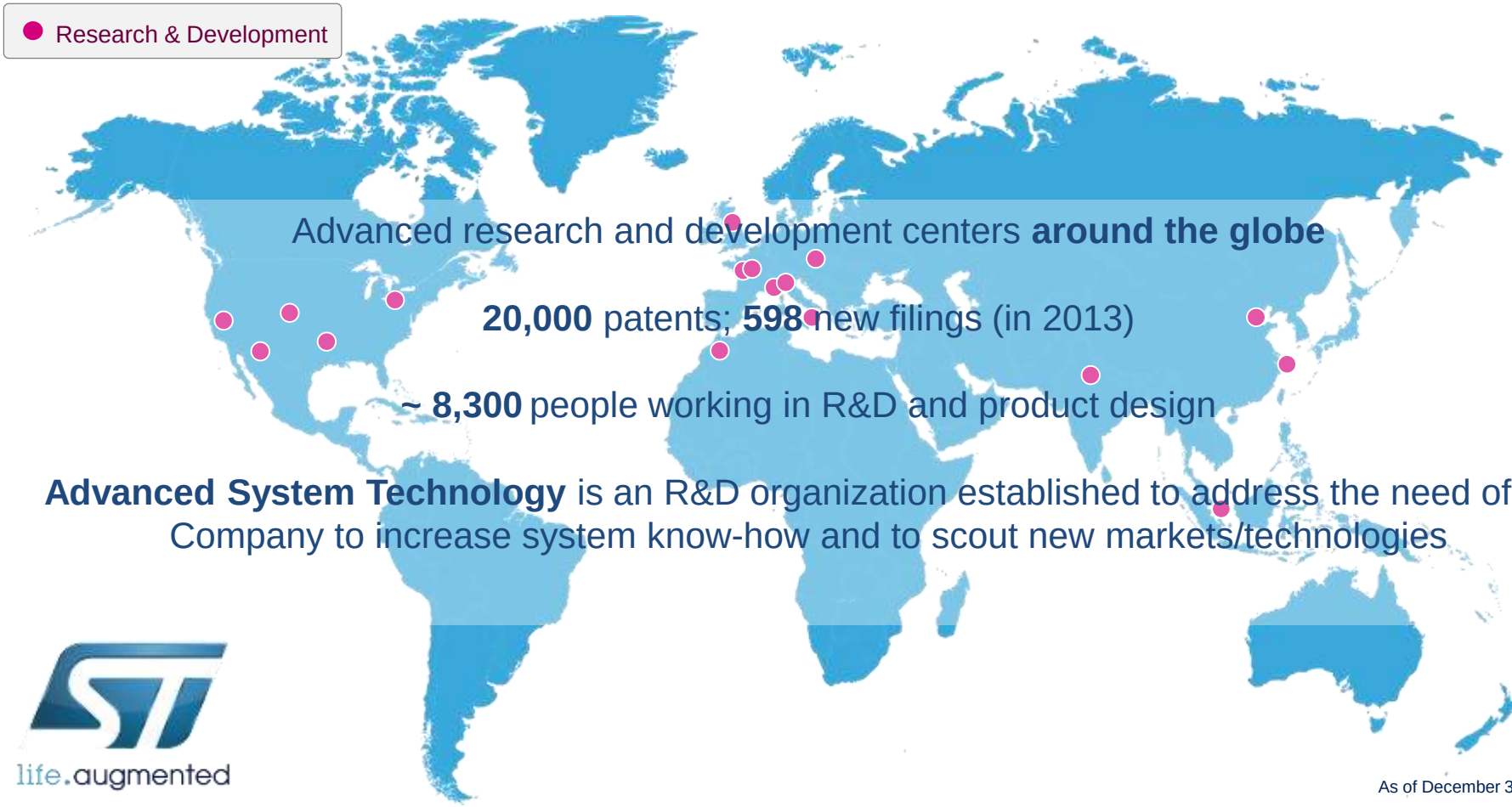
An Unwavering Commitment to R&D



Advanced research and development centers **around the globe**

20,000 patents; **598** new filings (in 2013)

~ 8,300 people working in R&D and product design

Advanced System Technology is an R&D organization established to address the need of the Company to increase system know-how and to scout new markets/technologies

As of December 31, 2015

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Applied Math Team

AST centre of Applied Math:

- Study new mathematical tools to analyse/process data arising in application problems coming from AST groups
- Share knowledge/expertise
- Cooperate in projects where the exploitation of mathematical tools is of crucial importance in order to find innovative solutions
- Give daily support to AST groups
- Establish links between AST and academic institutes of applied math research

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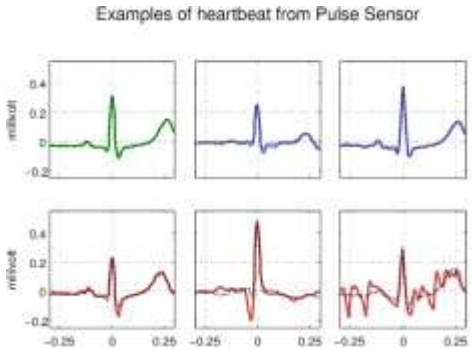
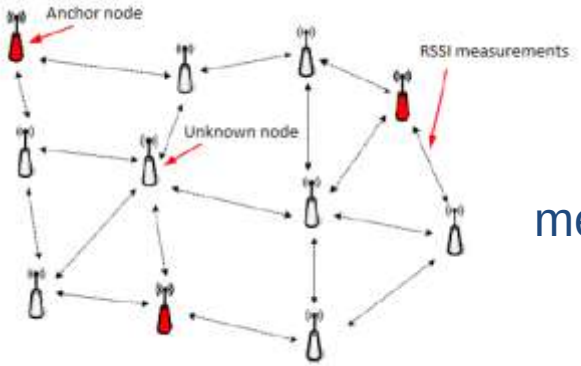
Data Types

signals



images

3D point clouds

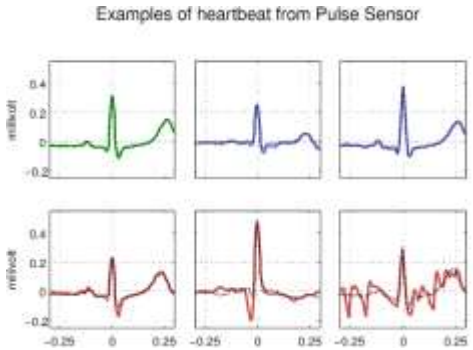


physical measurements

Challenges: complexity, lack of formal structure, multimodality, noise, outliers, missing data, dynamicity…

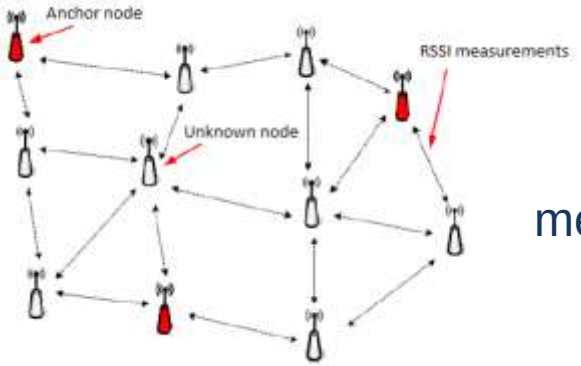
Applications

signals
monitoring/
AD



Images
face identification

3D point clouds
registration



physical
measurements
…

Strategy: exploit meaningful representations which capture the useful characteristics of the data

Mathematical Tools (1)

- **Reducing Dimensionality**: aims to identify hidden a structure within the data that is often of lower dimension
  - ✓PCA, RPCA
  - ✓Low-rank approximations (SVD, BRP), Matrix Completion
  - ✓Spectral ebbendings (MDS): Development of feasible solutions for the SNLP

- **Sparsity and Regularization**: looks for parsimonious model for the data, requiring a number of parameters much smaller than its dimension
  - ✓Sparsity-enforcing techniques: Block-sparsity based Indoor Localization, Sparsity-based DOA estimation using MEMS microphones array
  - ✓Compressed Sensing: Face Identification via sparsity models and CS
  - ✓LowRank&Sparse matrix decompositions: R-Godec for Robust Rotation Synchronization

Mathematical Tools (2)

- **Supervised Learning**: aims to infer a function to describe hidden structures in the data using a training set of labelled examples (eventually combining dimensionality reduction and sparsity-enforcing techniques)
  - ✓Supervised NN and CNN: Approximate Computation for Convolutional Neural Networks

- **Unsupervised Learning**: aims to infer a function to describe hidden structure from unlabeled data (eventually combining dimensionality reduction and sparsity-enforcing techniques)
  - ✓Clustering: J-DFA
  - ✓Learning sparsifying dictionaries: ECG Monitoring in Wearable Devices by Sparse Models

Applied Math Team

AST centre of Applied Math:

- Study new mathematical tools to analyse/process data arising in application problems coming from AST groups
- Share knowledge/expertise
  - Organize periodical meetings for deepening the knowledge on specific tools and sharing knowledge with other teams
- Cooperate in projects where the exploitation of mathematical tools is of crucial importance in order to find innovative solutions
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2016/17 Projects

Development of feasible solutions for the SNLP
[uniMI, uniUD]

2016:
- Spectral Motion Synchronization in SE(3)
- Global Registration of 3D Point Sets via LRS decomposition

2015:
- Camera Motion Synchronization via Matrix Decomposition
- J-DFA
- Depth Estimation for fisheye cameras

2014:
- R-Godec: Robust Absolute Rotation Estimation via LRS decomposition

ECG Monitoring in Wearable Devices by Sparse Models
[Remote Monitoring Team, uniMI, PoliMI]

Approximate Computation for Convolutional Neural Networks
[EST Team, uniMI]

2015:
- Block-Sparsity based Indoor Localization

2014:
- Deterministic Recovery via l1 min
- FI via sparsity models and CS

2013:
- DoA Estimation using MEMS michrophones arrray

Mathematical Tools

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Innovative Solutions

PATENTS

1. A Semiconductor Device and Corrisponding Debugging Method – N.Grossier, L.Guerrieri, G.Gobbato, D.Zerbini, M. Cordoni, P. Fragneto – 15-AG-0800IT01 – **filled**

2. Anomaly detection in ECG via Sparse Representation – B.Rossi, D.Zambon, P.Fragneto, D.Carrera, G.Boracchi – 16-AG-0030 – **submitted**

CONFERENCE PAPERS

1. On Computing the Translations Norm in the Epipolar Graph – F.Arrigoni, B.Rossi, A.Fusiello – **accepted** at 3DV2015
2. Robust and Efficient Camera Motion Synchronization via Matrix Decomposition – F.Arrigoni, B.Rossi, A.Fusiello – **accepted** at ICIAP2015
3. Novel View-Synthesis from Multiple Sources for Conversion to 3DS – F.Malapelle, A.Fusiello, B.Rossi, P.Fragneto – **accepted** at ICIAP2015
4. Automatic 3DS Conversion of Historical Aerial Photographs – F.Malapelle, A.Fusiello, B.Rossi, P.Fragneto, A.Hast – **accepted** at IC3D 2015
5. J-DFA: a Novel Approach for Robust Differential Fault Analysis – L.Magri, S.Mella, P.Fragneto, F.Melzani, B.Rossi – **accepted** at FDTC2015
6. Dictionary design for sensor network localization via block-sparsity – A.Bay, D.Carrera, S. Fosson, P.Fragneto, M.Grella, C.Ravazzi, E.Magli – **accepted** at MMSP2015

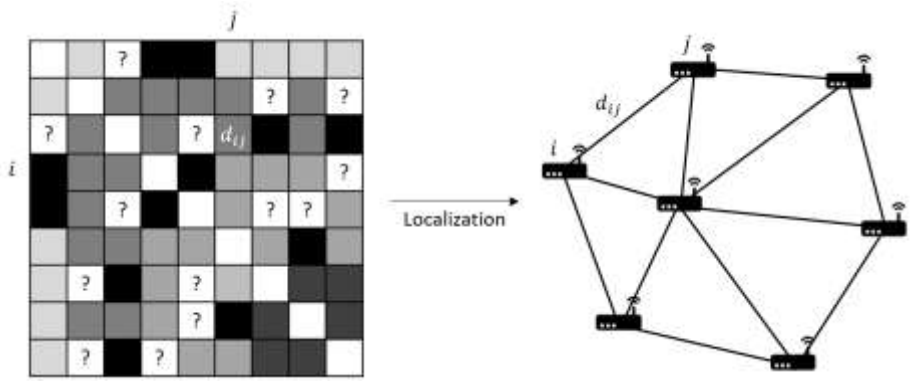
1. ECG Monitoring in Wearable Devices by Sparse Models – D. Carrera, B.Rossi, D.Zambon, P.Fragneto, and G.Boracchi – **accepted** to ECML-PKDD2016
2. Global Registration of 3D Point Sets via LRS decomposition – F.Arrigoni, B.Rossi, and A.Fusiello – **accepted** to ECCV2016
3. Camera Motion from Group Synchronization – F.Arrigoni, B.Rossi, and A.Fusiello – **accepted** to 3DV2016

JOURNALS

1. A data-fusion approach to motion-stereo- F.Malapelle, A.Fusiello, B.Rossi, P.Fragneto, **published** by Signal Processing: Image Communication
2. Block-sparsity based localization in wireless sensor networks – A.Bay, D.Carrera, S. Fosson, P. Fragneto, M. Grella, C. Ravazzi, E. Magli **published** by EURASIP Journal on Wireless Communications and Networking 2015
3. Spectral Motion Synchronization in SE(3) – F. Arrigoni, B.Rossi, and A.Fusiello – **published** to SIAM Journal on Imaging Sciences
4. Robust Rotation Synchronization via Low-rank and Sparse Matrix Decomposition – F.Arrigoni, A.Fusiello, B.Rossi, P. Fragneto – **submitted** to International Journal of Computer Vision (IJCV)

Development of feasible solutions for the SNLP
(Internship Marco Patane - UniMI)

Goal: localize a sensor network using distance measurements between pairs of nodes



- Mathematical study of theoretical conditions under which the problem can be solved
- Comparison of state-of-the-art approaches and development of new feasible solutions
- Novel proposal (ER-GoDec) based on low-rank and sparse matrix decompositions and robust matrix completion
- Evaluation through simulated data: ER-GoDec vs state-of-the-art approaches (SDP, SMACOF)
- Development of a demo using real data coming from a network of STM32 Nucleo boards equipped with Spirit1 module for point-to-point connection

Approximate Computations for Convolutional Neural Networks (Internship Valentina Arrigoni - UniMI)

Goal: accelerate/approximate the forward propagation step of CNNs using unconventional numerical representations for weights and activations

- Mathematical study of CNNs, conventional and unconventional number systems that simplify the dot product operator
- Development of schemes for the forward propagation in alternative domains together with algorithmic procedures finalized at tuning the additional parameters that are introduced. The main objective of the tuning procedures consists in maintaining the network accuracy
- Formal investigations have been supported by experimental analysis conducted on a widely used CNN, AlexNet
- ST is interested in developing an hardware implementation of one of the proposed solution. This work falls into a wider project for the development of an ultra low power CNN accelerator finalized at making this technology pervasive in embedded systems

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Internships' Info

- Duration: 6 to 9 months Internships / Master's Thesis Internships
- Master dissertations: you will have a mentor for your dissertation within the company. You should approach a professor at your university to supervise the dissertation, with whom the subject matter will be coordinated
- Remuneration: 600-750 Euro per month (full time)
- Site: Agrate Brianza
- Requirements: good study record, team spirit, initiative and communication skills, fluent English (preferred)
- Technical Requirements: numerical analysis, optimization, applied linear algebra, Matlab programming, C programming (basics)

My Experience in AMT

- We can use mathematics to solve real-world problems
- In an industrial research context mathematics can trigger a process of innovation or a technological change
- As technological problems become more complex, even mathematical techniques that address them need to be at the cutting edge. This requires a rigorous theoretical preparation
- Even out of University I’ve found beautiful mathematical problems to be studied and (hopefully) solved

Thanks!

Contacts

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pasqualina.fragneto@st.com

valeria.riva@st.com