

MIREIA CALVO GONZALEZ

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EDUCATION

- 2014 - 2017** **European PhD in “Signal processing and Telecommunications” and in “Biomedical engineering”.**
Joint PhD program: LTSI – INSERM U1099 (Université de Rennes 1); ESAIL – CREB (Universitat Politècnica de Catalunya)
Qualification: Excellent, « Cum Laude » mention
- 2014** **Master’s thesis**
Universitat de Barcelona – Universitat Politècnica de Catalunya; Barcelona
Qualification: 10/10, **Honors**
- 2012 - 2014** **MSc in Biomedical engineering**
Universitat de Barcelona – Universitat Politècnica de Catalunya; Barcelona
Qualification: 9.5/10
- 2011** **Master’s thesis**
Illinois Institute of Technology; Chicago, USA
Qualification: 10/10, **Honors**
- 2006 - 2011** **MSc and BSc in Telecommunications engineering**
Universitat Politècnica de Catalunya; Barcelona

RESEARCH AND WORK EXPERIENCE

		2017
PhD thesis		2014
Biomedical engineer	Master’s thesis	2013
Researcher	MSc in Biomedical engineering	2012
Engineer		2011
Master’s thesis		
MSc and BSc in Telecommunications engineering		2006

After graduating as a telecommunications engineer in Spain with an internship in image processing in the United States in 2011, I worked as an engineer until 2012. Then, between 2012 and 2014, I completed my master's degree in biomedical engineering, in parallel with a salaried activity, in order to gain experience in the field of research; first as a part-time eHealth researcher at the Barcelona Digital Technology Center, then as a full-time research engineer at the Hospital Clínic de Barcelona. After my Master's thesis in signal processing, I completed a European PhD thesis

between the Université de Rennes 1 and the Universitat Politècnica de Catalunya (2014-2017). Currently, I am a postdoctoral researcher at the Laboratoire de Traitement du Signal et de l'Image (Université de Rennes 1), in partnership with CAIRDAC, a company specialized in medical devices.

- **Postdoctoral Researcher** in Signal processing. *November 2017- nowadays.*

LTSI – INSERM 1099 (Université de Rennes 1).

Research topic: Application of advanced signal-processing approaches for the analysis of cardiac 3D-accelerometry signals acquired from different populations of pigs, under different physiological conditions. The main objective of the study was the local characterization of the time-varying frequency components involved in the mechanical cardiac activity at baseline and under the effect of different pharmacological agents.

- **PhD Thesis** in Signal processing. *October 2014 – November 2017.*

LTSI – INSERM 1099 (Université de Rennes 1); ESAIL – CREB (Universitat Politècnica de Catalunya).

Title: Analysis of the cardiovascular response to autonomic nervous system modulation in Brugada syndrome patients.

Supervisors: Alfredo Hernández and Virginie Le Rolle (Université de Rennes 1); Pedro Gomis (Universitat Politècnica de Catalunya).

Jury members: Luca Mainardi (PU, Politecnico di Milano), Ron Summers (PU, Loughborough University), Catherine Marque (PU - CNU :61, Université de Technologie de Compiègne), Virginie Le Rolle (MC – CNU : 61, Université de Rennes 1), Alfredo Hernández (DR, INSERM), Pedro Gomis (MC, Université Polytechnique de Catalogne).

Research topic and contribution: Brugada syndrome (BS) is a genetic arrhythmogenic disease characterized by a distinctive electrocardiographic pattern, associated with a high risk for sudden cardiac death. Its complex and multifactorial nature turns risk stratification into a major challenge. Although variations in autonomic modulation are commonly related to arrhythmic events in this population, novel markers with higher predictive values are still needed so as to identify those patients at high risk. Since the autonomic function can be better characterized through the application of standardized maneuvers stimulating the autonomic nervous system (ANS), the main objective of this thesis is to evaluate and compare the cardiovascular response to ANS modulations overnight, as well as in response to exercise and HUT testing, on a series of BS patients with different levels of risk (symptomatic and asymptomatic subjects).

- In a first part of this work, we apply previously described methods for the analysis of heart rate complexity, baroreflex sensitivity, and non-stationary heart rate variability, never before studied in the context of BS patients [J1, J3, C2, C5, C7-8, Ch1].
- In a second part, in order to address the multifactorial nature of the disease, a multivariate approach based on a step-based machine learning method is introduced. By employing markers extracted at signal-processing analysis, robust classifiers capable of distinguishing patients at different levels of risk are proposed [J2, C3].
- The third part of this work has been focused on the proposal of novel mathematical models and the associated model analysis methods, so as to study the autonomic and hemodynamic responses to exercise and HUT testing. Finally, a prospective application of a multivariate approach integrating parameters extracted at the model-based stage is also presented [C1, C4, C6, C15].

Overall, the obtained results provide new insights into the underlying autonomic mechanisms regulating the cardiovascular system in BS, improving physiopathology and prognosis interpretation. The proposed approach may be used as an instrument for the identification of those asymptomatic patients at high risk who may benefit from a cardioverter defibrillator implantation.

Associated publications: 3 articles in JCR indexed international peer-reviewed journal, 1 book chapter, 5 international conferences with proceedings, 3 international and 1 national conferences. 2 articles have been submitted to international journals, and 3 articles are in preparation.

– **Master's Thesis** in Signal Processing. *February – July 2014.*

ESAII – CREB (Universitat Politècnica de Catalunya).

Title: ECG analysis for the automatic detection of Brugada pattern.

Supervisor: Pedro Gomis.

Research topic: Brugada syndrome is characterized by a distinctive electrocardiographic pattern, as well as an increased risk of cardiac arrhythmias and sudden death. Since there are currently no indicators to determine the individual risk, the goal of this project is to design an automatic algorithm for the detection of relevant electrocardiographic parameters in order to determine their prognostic value in future studies. The algorithm was tested in two patients with different degrees of severity and a control case, obtaining relevant trends in heart rate variability and in the burden of beats presenting type-1 Brugada pattern.

Associated publications: 1 national conferences [C16].

– **Biomedical engineer and researcher** in signal and image processing. *July 2013 – September 2014.*

Fundació Clínic per la Recerca Biomèdica, Hospital Clínic de Barcelona.

Developed activity: Technical support in the operation room during procedures of radiofrequency ablation, cryoablation and conventional electrophysiological studies, by using X-rays, polygraphs, stimulators and 3D navigators (CARTO and NAVx systems). At the same time, I developed signals and image processing methods for the characterization of cardiac tissue, in order to predict arrhythmias and their associated complications I have also participated in the collection of data acquired during different procedures so as to perform statistical analysis *a posteriori*. I collaborated in the following research projects:

- Atrial fibrillation re-ablation, assisted by magnetic resonance imaging (MRI).
- Tissue characterization in persistent atrial fibrillation, based on MRI.
- Sympatho-vagal balance evaluation in relation to height in the general population.
- Participation in the European Heart Society program *European Heart Survey*.

Associated publications: 4 articles in a JCR indexed international peer-reviewed journals [J4-7], 6 international [C9-14] and 2 national conferences [C17-18].

– **Researcher** in R&D eHealth. *September 2012- June 2013.*

Barcelona Digital Technology Center.

Developed activity: Development of the ontology created for the national project "Rehabilita –Disruptive technologies for the rehabilitation of the future".

Associated publications: 1 article in a JCR indexed international peer-reviewed journal [J8].

- **Head** of digital media and CSR. *December 2011- September 2012.* Comgrafic SA.
Developed activity: Development of the corporate website, introduction and maintenance of social networks and digital publicity and development of the social work “Everybody deserves a book”.
- **Master’s Thesis** in Image Processing. *February – July 2011.*
MIRC (Illinois Institute of Technology).
Title: Channelized Hotelling observer optimization for medial image quality assessment in lesion detection tasks.
Supervisor: Jovan G. Brankov.
Research topic: An alternative increasingly used in the evaluation of medical image quality are the Numerical Observers, mathematical methods that estimate the human behavior in the detection of lesions in medical images. In this manuscript the Channelized Hotelling Observer was studied, using different channels and internal noise models, optimizing its estimation of the human decisions.

TEACHING EXPERIENCE

- **Informatics**
MSc in Electronics and Telecommunications. ISTIC – Université de Rennes 1.
- **Signal processing**
MSc in Electronics and Telecommunications. ISTIC – Université de Rennes 1.
- **Informatics**
BSc in Electronics, Electrical engineering and Automatics. ISTIC – Université de Rennes 1.
- **Dynamic web programming**
DUT in Telecommunications. IUT de Saint-Malo – Université de Rennes 1.
- **Embedded programming**
DUT in Electrical engineering. IUT de Rennes – Université de Rennes 1.
- **Industrial computing**
DUT in Electrical engineering. IUT de Rennes – Université de Rennes 1.
- **Other:**
 - **Associate professor.** Master of Data Science. Universitat Oberta de Catalunya (UOC). *September 2017 – nowadays.*
 - **Academy teacher** of Mathematics for university students in Telecommunications engineering. Epsilon Formation. *February - June 2010.*
 - **Private tutor** in Mathematics, Physics, Science and English for high school students. *September 2004 - December 2010.*
 - **Artistic roller skating trainer.** *September 2006 - December 2010.*

AWARDS AND GRANTS

- **EAE Business School – Entrepreneur woman.** Scholarship covering 42% of MBA tuition fees, to promote the presence of women in management positions. *February 2018.*

- **Woman ICT revelation.** Award granted by the Government of Catalonia to highlight the work of women with short but relevant professional careers in the field of ICT. *December 2017.*
- **Instituto de Salud Carlos III.** FIS grant as associate researcher in the project “Estudio ANVERSO : Análisis Continuo y Automático de Variables Electrocardiográficas en relación al Riesgo de muerte Súbita en pacientes con síndrome de Brugada”. Main investigator: Elena Arbelo Lainez. *September 2016.*
- **Obra social La Caixa.** Postgraduate grant in order to perform doctoral studies in signal processing at Université de Rennes 1 for two years. Thesis title: “Analysis of the electrocardiographic response to the modulation of the autonomic nervous system in patients with Brugada syndrome”. *October 2014.*
- **Societat Catalana de Cardiologia.** Grant as associate researcher in the Project “RESTORE-SR. Estudi pilot d’ablació de substrat auricular patològic identificat amb mapa electroanatòmic en ritme sinusal i ressonància magnètica per al tractament de la fibril·lació auricular persistent”. Main investigator: Lluís Mont Girbau. Funding entity: Medtronic. *May 2014.*
- **Instituto de Salud Carlos III.** FIS grant as associate researcher in the project “Ablación de fibrilación auricular asistida por resonancia magnética: personalizando el tratamiento mediante la identificación del sustrato arrítmico”. Main investigator: Josep Brugada Terradellas. *September 2013.*

LANGUAGES

- **Spanish and Catalan:** Native speaker.
- **English:** Level C2.
Kaplan International and Lakeview Learning Center, **Chicago**, *March - July 2011.*
Certificate of Proficiency in English – Cambridge. *June 2012.*
- **French:** Level C2.
Acadèmia Te-Sis, **Barcelona**, *July 2014 – September 2014.*
CIREFE (Université Rennes 2), **Rennes**, *February 2015 – May 2016.*
- **German:** Level A1.
Acadèmia Avanç, **Barcelona**, *October 2012 – July 2013.*

OTHER INFORMATION

- Master in Business Administration (MBA) Online. EAE Business School. *April 2018 – nowadays.*
- Jury member for the Equit@t award 2018. Universitat Oberta de Catalunya. *April 2018.*
- Participation in the organizing committee of the international conference *Computing in Cardiology 2017.*
- Oral presentation at the workshop *STAFF meeting*. Saint-Malo, France. *September 2017.*
- **Supervisor** of BSc thesis in Biomedical engineering. Universitat de Barcelona. *January – June 2014.*
- Students representative at the MSc in Biomedical engineering. *October 2012 – July 2014.*

- **Elite athlete in artistic roller skating.** Seven gold medals in the Spanish Championship, winner of the European Cup and third position in the World Championship. *September 1994 – December 2011.*
- **Volunteering.**
 - Program for the prevention of the paludisme through the distribution of mosquito nets in the Gambia and Senegal. Africa, Stop Malaria. *November 2016.*
 - Collaboration in food distribution in order to meet the basic human needs of individuals and families whose lives have been disrupted by unplanned events such as a domestic crisis, fire, unemployment, relocation or who for any reason are in need of emergency provisions. Secours Populaire Français. *June - July 2015.*
 - Program for the social promotion of the woman through the learning of Spanish and Catalan and seminars about work orientation and healthy habits. YMCA Barcelona. *October 2011-December 2011.*
 - Currently, I manage the social work “Everyone deserves a book”, consisting in the collection and distribution of used books to different NGOs with the aim of making them reach those who need them.

PUBLICATIONS

International peer-reviewed journals

[J1] M Calvo, V Le Rolle, D Romero, N Béhar, P Gomis, P Mabo, A Hernández. Heart rate differences between symptomatic and asymptomatic Brugada syndrome patients at night. *Physiological measurement* **2018** (accepted).

[J2] M Calvo, D Romero, V Le Rolle, N Béhar, P Gomis, P Mabo, A Hernández. Multivariate classification of Brugada syndrome patients based on autonomic response to exercise testing. *PLOS ONE* **2018**, 13 (5), e0197367.

[J3] M Calvo, P Gomis, D Romero, V Le Rolle, N Béhar, P Mabo, A Hernández. Heart rate complexity analysis in Brugada syndrome during physical stress testing. *Physiological measurement* **2017**, 38 (2), p. 387-396.

[J4] F Bisbal, F Gómez-Pulido, P Cabanas-Grandío, N Akoum, M Calvo, D Andreu, S Prat-González, R J Perea, R Villuendas, A Berruezo, M Sitges, A Bayés-Genís, Josep Brugada, N F Marrouche, L Mont. Left Atrial Geometry Improves Risk Prediction of Thromboembolic Events In Patients with Atrial Fibrillation. *Journal of Cardiovascular Electrophysiology* **2016**, 27(7), p. 804-810.

[J5] D Andreu*, F Gomez-Pulido*, M Calvo, A Carlosena-Remírez, F Bisbal, R Borràs, E Benito, E Guasch, S Prat-Gonzalez, R J Perea, J Brugada, A Berruezo, L Mont. Contact Force Threshold for Permanent Lesion Formation in Atrial Fibrillation Ablation: A Cardiac Magnetic Resonance-based Study to Detect Ablation Gaps. *Heart Rhythm* **2015** 13(1), p. 37-45.

[J6] F Bisbal, M Calvo, E Trucco, E Arbelo. Left Atrial Tachycardia after atrial fibrillation: can MRI

assist the ablation? *Canadian Journal of Cardiology* **2014**, 31(1), p. 104.e1-3.

[J7] A Alcaine, D Soto-Iglesias, **M Calvo**, E Guiu, D Andreu, J Fernández-Armenta, A Berruezo, P Laguna, O Camara, JP Martínez. A Wavelet-Based Electrogram Onset Delineator for Automatic Ventricular Activation Mapping. *IEEE Transactions on Biomedical Engineering* **2014**, 61 (12), p. 2830-2839.

[J8] **M Calvo**, L Subirats, L Ceccaroni, JM Maroto, C de Pablo, F Miralles. Automatic assessment of socioeconomic impact on cardiac rehabilitation. *International Journal of Environmental Research and Public Health* **2013**, 10, p. 5266-5283.

Book chapters

[Ch1] **M Calvo**, V Le Rolle, D Romero, N Béhar, P Gomis, P Mabo, A Hernández. Chapter 7b: Gender differences in the autonomic response to exercise testing in Brugada syndrome. *Sex-specific analysis of the cardiovascular function*. 1st ed. Springer Publishing.

International conferences with proceedings

[C1] **M Calvo**, V Le Rolle, D Romero, N Béhar, P Gomis, P Mabo, A Hernández. Global sensitivity analysis of a cardiovascular model for the study of the autonomic response to head-up tilt testing. July 17th – 21th, Honolulu, USA. *Annual International Conference of the IEEE Engineering in Medicine and Biology Society* **2018** (accepted).

[C2] **M Calvo**, V Le Rolle, D Romero, N Béhar, P Gomis, P Mabo, A Hernández. Time-frequency analysis of the autonomic response to head-up tilt testing in Brugada syndrome. September 24th – 27th, Rennes, France. *Computing in Cardiology Conference* **2017**, p. 1-4.

[C3] D Romero, **M Calvo**, N Béhar, P Mabo, A Hernández. Ensemble classifier based on linear discriminant analysis for distinguishing Brugada syndrome patients according to symptomatology. September 11th – 14th, Vancouver, Canada. *Computing in Cardiology Conference* **2016**, p.205-208.

[C4] **M Calvo**, V Le Rolle, D Romero, N Béhar, P Gomis, P Mabo, A Hernández. Analysis of a cardiovascular model for the study of the autonomic response of Brugada syndrome patients. August 16th – 20th, Orlando, USA. *Annual International Conference of the IEEE Engineering in Medicine and Biology Society* **2016**, p. 5591-5594.

[C5] **M Calvo**, V Le Rolle, D Romero, N Béhar, P Gomis, P Mabo, A Hernández. Comparison of methods to measure baroreflex sensitivity in Brugada syndrome. September 6th – 9th, Nice, France. *Computing in Cardiology Conference* **2015**, p. 245-248.

International conferences

[C6] **M Calvo**, V Le Rolle, D Romero, N Béhar, P Gomis, P Mabo, A Hernández. Recursive model

identification for the evaluation of the autonomic response to exercise in Brugada syndrome. September 6th – 8th, Compiègne, France. *International Conference on Computational Bioengineering 2017*.

[C7] M Calvo, J Hernandez, S Vidorreta, J Brugada, P Gomis, E Arbelo. Automatic Brugada pattern detection on continuous electrocardiographic monitoring. June 18th – 21st, Vienna, Austria. *Cardiostim – EHRA Europace 2017*.

[C8] M Calvo, P Gomis, A Hernández, D Andreu, E Arbelo, P Caminal. Automatic detection of Brugada-like pattern on continuous electrocardiographic monitoring. September 14th – 16th, Barcelona, Spain. *International Conference on Computational Bioengineering 2015*.

[C9] D Andreu, F Gomez-Pulido, M Calvo, E Benito, A Carlosena-Remirez, E Arbelo, JM Tolosana, A Berruezo, J Brugada, L Mont. Usefulness of contact force maps to predict ablation gaps in catheter ablation of atrial fibrillation. *Europace*, 17 (suppl3): ii105. June 21st – 24th June, Milan, Italy. *Cardiostim – EHRA Europace 2015*.

[C10] A Alcaine, D Soto-Iglesias, M Calvo, E Guiu, D Andreu, J Fernández-Armenta, P Laguna, O Cámara, JP Martínez, A Berruezo. Evaluation of an automatic delineation algorithm for activation mapping of focal ventricular tachycardias. August 30th – September 3rd, Barcelona, Spain. *European Society of Cardiology Congress 2014*.

[C11] F Bisbal, F Gómez, N Akoum, M Calvo, P Cabanas, B Vidal, J Brugada, N Marrouche, L Mont. Left Atrial Sphericity improves CHADS2 score stroke prediction in patients with atrial fibrillation. *Europace*, 16 (suppl2): ii89. June 18th – 21st, Nice, France. *Cardiostim – EHRA Europace 2014*.

[C12] P Cabanas, F Bisbal, F Gómez-Pulido, E Guiu, M Calvo, A Berruezo, S Prat, RJ Perea, J Brugada, L Mont. MRI characterization of cryoballoon and radiofrequency ablation lesions after pulmonary vein isolation. *Europace*, 16 (suppl2): ii141. June 18th – 21st, Nice, France. *Cardiostim – EHRA Europace 2014*.

[C13] P Cabanas, F Bisbal, F Gómez-Pulido, E Guiu, M Calvo, A Berruezo, S Prat, RJ Perea, J Brugada, L Mont. MRI characterization of cryoballoon ablation lesions: predicting recurrences after pulmonary vein isolation. *Europace*, 16 (suppl2): ii111. June 18th – 21st, Nice, France. *Cardiostim – EHRA Europace 2014*.

[C14] P Cabanas, F Bisbal, F Gómez-Pulido, E Guiu, M Calvo, A Berruezo, S Prat, RJ Perea, J Brugada, L Mont. MRI characterization of cryoballoon ablation lesions predicting recurrences after pulmonary vein isolation. *Heart Rhythm*, 11 (5). May 7th – 10th, San Francisco, USA. *Heart Rhythm Society Congress 2014*.

National conferences

[C15] M Calvo, V Le Rolle, D Romero, N Béhar, P Gomis, P Mabo, A Hernández. Model-based approach for the study of the autonomic response in Brugada syndrome patients. June 26th – 29th, Poitiers, France. *Colloque de la Société Francophone de Biologie Théorique* **2017**.

[C16] M Calvo, P Gomis, D Andreu, P Caminal, E Arbelo. Análisis del ECG para la detección automática del patrón característico del síndrome de Brugada. November 26-28th, Barcelona, Spain. *Congreso Anual de la Sociedad Española de Ingeniería Biomédica* **2014**.

[C17] E Benito, F Gómez, F Bisbal, M Calvo, S Prat, B Vidal, A Berruezo, JL Mont. Reablación de fibrilación auricular guiada por resonancia magnética: análisis de la eficacia a medio plazo. October 30th - November 1st, Santiago de Compostela, Spain. *Congreso de la Sociedad Española de Cardiología* **2014**.

[C18] F Bisbal, F Gómez-Pulido, N Akoum, M Calvo, P Cabanas, B Vidal, NF Marrouche, L Mont. La esfericidad auricular incrementa el valor predictivo para ictus de la escala CHADS₂ en pacientes con fibrilación auricular. April 23rd – 25th, Girona, Spain. *Congreso de la Sociedad Española de Cardiología, Sección de Electrofisiología y Arritmias* **2014**.