ANNEX 9: ERC grant holders – more detailed info

Advanced Grants:

Johan Schoukens, *Data Driven Structured Modelling of Nonlinear Dynamic Systems (SNLSID)*

ABSTRACT - Today's state-of-the art methods for system and control design are model based. The ever increasing demand for higher performance and efficiency pushes the systems in a nonlinear operation mode so that nonlinear models are required for their design and control. The model quality and the model building cost are becoming limiting factors for further technological developments. To close the gap between the designers and the modellers we propose a fundamentally new approach to deliver highly structured nonlinear models meeting the designer's needs. From a theoretical point of view, the major contribution is the development of a new nonlinear structured system identification framework. From practical point of view, the new nonlinear modelling paradigm will become an enabling technology to further push the performance and efficiency of system and control design. We follow a three step strategy to identify structured nonlinear models: - A top down approach in which we develop data driven structure revealing methods starting from initial unstructured nonlinear state space models. - A bottom up approach that identifies complex block oriented models, including parallel and feedback structures starting from the best linear approximation of the nonlinear system. These models are highly structured from the start. - A new dedicated experiment design strategy will be developed to retrieve the "best" models with the least experimental cost. Solving these problems is far beyond the actual abilities of the system identification community. However, our long standing recognized experience in frequency domain system identification in the presence of nonlinear distortions, and recent work by the PI guarantee the feasibility of the project. Structured nonlinear model building has applications in traditional industrial and emerging new high technological applications, including biomechanical and biomedical applications.

Consolidator Grants:

Peter Schelkens, *Sparse Signal Coding for Interference-based Imaging Modalities (INTERFERE)*

ABSTRACT **-** Since its invention in 1948 by Dennis Gabor holography has held the promise to empower full parallax 3D visualisation. Though the trajectory has been significantly longer than expected, recent developments in photonics, microelectronics and computer engineering have led to the prospective to realize within a decade dynamic full parallax holography with acceptable rendering quality and viewing angle. Unfortunately projections – based on the current state-of-the-art and expected evolution in the underlying "hardware" technologies – still predict exascale computing power and terabytes-per-second data rates. Since dynamic digital holography requires huge amounts of pixels to be sensed, transmitted and represented, sparse signal representations hold a great promise reducing the computational complexity and bandwidth usage. INTERFERE will design a generic source coding methodology and architecture to facilitate the exploitation of sparse signal representations for dynamic, full parallax, large viewing angle digital holography and more generic, interference-based modalities, with the ambition to reduce the signal processing tailbacks while exploiting simultaneously human visual system characteristics. Realizing these research objectives – with a strong focus on advanced signal representations, associated source coding methodologies and visual quality modelling – will provide a breakthrough with respect to the complexity reduction and thus realisation of full-parallax, wide viewing angle dynamic digital holography and benefit the earlier mentioned adjacent scientific fields. Intermediate results or components will have serendipic effects on other scientific disciplines and open new horizons for markets such as – but not limited to – medical imaging, biophotonics, life sciences, public safety, digital holographic microscopy, holographic biomedical sensors, data storage and metrology, illustrating the high-gain potential of INTERFERE.

Starting Grants

Mathieu Vinken, *Connexin and pannexin channels as drug targets and biomarkers in acute and chronic liver disease (CONNECT)*

ABSTRACT - The CONNECT project intends to contribute to the substantiation of the controversial scientific concept stating that hemichannels consisting of connexin32 and connexin43 as well as pannexin1 channels act as pathological pores. This hypothesis will be verified in the specific context of cell death and inflammation, both which are key features of acute liver failure and liver fibrosis. As such, the project is organised in 3 workpackages. In the first workpackage, connexin32, connexin43 and pannexin1 expression and activity will be studied in human and animal diseased liver tissue. The second workpackage is targeted towards the in vitro characterisation of recently generated inhibitors of hemichannels consisting of connexin32 and connexin43 as well as pannexin1 channels, namely Gap24, Gap19 and 10Panx1, respectively. Particular

attention will be paid to their target selectivity and potential to reduce cell death and inflammation in liver-based in vitro models. The goal of the third workpackage is to test the in vivo extrapolation of the established in vitro findings. To this end, Gap24, Gap19 and 10Panx1 will be administered to animal models of acute liver failure or liver fibrosis, followed by evaluation of their outcome on cell death, inflammation and clinically relevant read-outs. The CONNECT project is anticipated to significantly impact the connexin and pannexin research area, as it foresees the development and optimisation of new tools and technology to study connexin hemichannels and pannexin channels. The clinical utility of this high risk/high gain project is dual, as it aspires the establishment of novel drug targets and tissue biomarkers for, respectively, the treatment and diagnosis of liver disease. However, given the generic nature of the driving concept, the outcome of the CONNECT project is equally of clinical relevance for a plethora of other pathologies.

Bram Vanderborght, *Series-Parallel Elastic Actuators for Robotics (SPEAR)*

ABSTRACT – Actuators are key components for moving and controlling a mechanism or system. However, the torque and efficiency of the current state-of-the-art actuators are insufficient and much lower than in humans. There are several applications (including prostheses, exoskeletons and running robots) where the unavailability of suitable actuators hinders the development of well-performing machines with capabilities comparable to a human. Remarkable, the power density and efficiency of electric motors are higher than a human muscle, so the problems of insufficient torque and efficiency resides in the transmission of the power and that the motors are not used at their highest efficiency. The first innovation of SPEAR is to solve the torque and efficiency problems, by investigating in depth a novel actuation paradigm, which I call Series-Parallel Elastic Actuation (SPEA) and that goes beyond variable impedance actuators. This new actuation paradigm is inspired by the series-parallel organisation of the muscle fibres. Modularity in actuation is currently introduced by placing in all joints the same motor, leading to over- or underactuated joints. In our body however, all the skeletal muscles are built of the same basic actuation unit: a muscle fibre. Modularity in actuation in a biological system is not at muscle level, but on a sublevel: the muscle fibre. SPEAR will introduce a second major innovation: the SPEA will introduce a basic actuation unit, a "transistor for actuation". Such a SPEA-element is a missing link in robotics and will innovate the way robots are designed and built. The project will study the theoretical framework, the design principles, the control algorithms and the validation of demonstrators. SPEAR will fully answer all the research challenges and explore the frontiers of this novel actuation paradigm, leading to a tremendous impact on all engineered, actuated systems, especially in robotics.

Nathalie Vermeulen, Next-generation on-chip supercontinuum light sources based on graphene-enabled extreme nonlinear optics *(NEXCENTRIC)*

ABSTRACT - With this ERC project I want to induce a paradigm shift in the development of integrated nonlinear optical devices. Nonlinear optics, the scientific discipline in which nonlinear light-matter interactions are studied, has been a very active area of research ever since the invention of the laser in 1960. Although this scientific branch has great application potential when implemented in on-chip optical waveguides, its promise for the development of widely usable integrated optical devices has not yet been fulfilled. The state-of-the-art of integrated nonlinear optical devices indeed does not comply with the requirements for widespread deployment as these devices rely on non-standard waveguide designs, large on-chip foot prints and/or impractical pump lasers. Therefore, I propose in this project to eliminate the issues of the state-of-the-art devices by introducing novel material and device physics. More specifically, my goal is to exploit extreme, but practically unexplored, nonlinear optical properties of graphene-covered silicon waveguides to develop next-generation near-infrared-pumped nonlinear supercontinuum light sources. These will truly be "next-generation" sources as they will rely on standard waveguide design, ultra-compact foot prints and practical near-infrared pump lasers, while exhibiting unprecedented performances. The concrete objectives of my project are to theoretically study, model, fabricate and experimentally demonstrate three novel graphene-on-silicon-based nonlinear optical devices that rely on three different nonlinear optical effects, and the on-chip cascading of these novel devices to create the targeted "next-generation" near-infrared-pumped supercontinuum sources with up to four emission bands. Based on my theoretical and experimental research experience with nonlinearities in waveguides and my preliminary modelling results supporting the feasibility of these objectives, I believe that, with this ERC starting grant, I will be able to carry out this original "high-gain/high-risk" project. By doing so, I will introduce a paradigm shift in the development of integrated nonlinear optical devices enabling them to fulfil their long-awaited promise, and at the same time initiate a new era in the research on graphene and its nonlinear optical applications.

Bart de Boer, *Advancing behavioral and cognitive understanding of speech (ABACUS)*

ABSTRACT - I intend to investigate what cognitive mechanisms give us combinatorial speech. Combinatorial speech is the ability to make new words using pre-existing speech sounds. Humans are the only apes that can do this, yet we do not know how our brains do it, nor how exactly we differ from other apes. Using new experimental techniques to study human behavior and new computational techniques to model human cognition, I will find out how we deal with combinatorial speech. The experimental part will study individual and cultural learning. Experimental cultural learning is a new technique that simulates cultural evolution in the laboratory. Two types of cultural learning will be used: iterated learning, which simulates language transfer across generations, and social coordination, which simulates emergence of norms in a language

community. Using the two types of cultural learning together with individual learning experiments will help to zero in, from three angles, on how humans deal with combinatorial speech. In addition it will make a methodological contribution by comparing the strengths and weaknesses of the three methods. The computer modeling part will formalize hypotheses about how our brains deal with combinatorial speech. Two models will be built: a high-level model that will establish the basic algorithms with which combinatorial speech is learned and reproduced, and a neural model that will establish in more detail how the algorithms are implemented in the brain. In addition, the models, through increasing understanding of how humans deal with speech, will help bridge the performance gap between human and computer speech recognition. The project will advance science in four ways: it will provide insight into how our unique ability for using combinatorial speech works, it will tell us how this is implemented in the brain, it will extend the novel methodology of experimental cultural learning and it will create new computer models for dealing with human speech.

Franky Bossuyt, *Tracing antimicrobial peptides and pheromones in the amphibian skin (TAPAS)*

ABSTRACT - Most studies on amphibian skin peptides have an explicit pharmacological focus, and the origin, diversity, and functional diversification of these molecules therefore remain poorly understood. Antimicrobial peptide research in amphibians has been restricted to relatively few closely related genera in a limited number of families. Furthermore, although behavioral tests indicate chemical communication during courtship in many amphibian species, only a single pheromone peptide has been characterized in anurans (frogs and toads), and only two in caudates (salamanders and newts). We propose an integration of transcriptome analyses, peptidome analyses, functional assays, and phylogenetic analyses to: 1. Identify and characterize novel antimicrobial and pheromone skin peptides in a representative of all amphibian families. 2. Study the evolution of these molecules by mapping diversity and function on well-supported phylogenies. 3. Determine the relative contribution of different genetic mechanisms to the rise of antimicrobial and pheromone peptide diversity (e.g. recruitment from genes with other functions, tandem duplications, gene conversion,...). 4. Test the relative contributions of skin peptide evolution (ecological adaptation and/or sexual signal differentiation) in shaping species diversity in amphibian evolutionary radiations. The results of this project are expected to throw a new light on amphibian defense and chemical communication. Since (1) there is a correlation between resistance to lethal infection and synthesis of antimicrobial peptides by the host amphibian, and (2) because systems of chemical communication are especially vulnerable to disruption by anthropogenic change, this project is expected to form an important contribution in the struggle against amphibian decline.

ANNEX 10: Current Senior Research Fellowships

- **Nick van Eijndhoven**, Astroparticle Physics with the IceCube Neutrino Observatory and beyond
- **Sebastiaan Eeltink**, Highly-ordered three-dimensional nanostructures to support post-genomic biotechnology in health and nutrition
- **Franky Bossuyt**, The evolution of courtship behavior in salamandrid newts: from ecology to molecules
- **Han Remaut**, Structural biology of bacterial cell surfaces
- **Kris Boudt**, Multi-regime models to analyze financial risk and their application to the design of investment solutions
- **Kim Roelants**, Tracing the evolution of antimicrobial activity in amphibian peptide families using ancient peptide resurrection
- **Dimitrios Aggelis**, Development of innovative methodology for advanced characterization of damage status of structures based on acoustic methods
- **Ivan Markovsky**, Structured low-rank approximation: theory, algorithms, and applications
- **Karen Celis**, Substantive Representation of Social Groups: Normative Theory, Empirical Research and Methods
- **Steffen Ducheyne**, Revisiting Eighteenth-Century Scientific Methodology: Historical cum Systematic Study of Scientific Methodology after Newton
- **Freya Blekman**, Search for new physics in events with leptons, jets and missing transverse energy at the Large Hadron Collider
- **Marinee Chuah**, Development of novel gene and cell therapy approaches based on induced pluripotent stem cells (iPS) and adult stem cells
- **Erik Franckx**, The transformation of actors in the international law of the sea
- **Guy Verschaffelt**, Characterization, modelling and applications of novel semiconductor lasers
- **Leonardus van Grunsven**, Analysis of HDAC repressor complexes with a function during liver fibrosis
- **Kris Deschouwer**, Political representation in multi-layered systems
- **Marc Elskens**, Flux and fate of organic biogenic material in and through the oceanic water column layers
- **Stefan Magez**, Parasitology: molecular, immunological & biotechnological aspects
- **Sonja Snacken**, Transformations in late modern societies and penality: how to curb exclusionary practices
- **Kristiaan Thielemans**, Cell therapy in Cancer
- **Patrick Vanderheyden**, Experimental models to study angiotensin receptors in the renin-angiotensin system
- **Remy Loris**, Structural biology and biophysics of persistence: Bacterial TA modules
- **Michel Defrise**, Image reconstruction in emission and transmission tomography
- **Diederik Aerts**, Elaboration of a contextual and emergent theory for human thought and decision processes using quantum mathematical structure modeling with applications in the fields of cognition, semantic and decision theories, and economics

(last update 12.12.2014)