Thesis Summary

Title: Analysis and Design of Efficient Passive Components for the Millimeter-Wave and THz Bands

Author: Antonio José Berenguer Verdú

Abstract

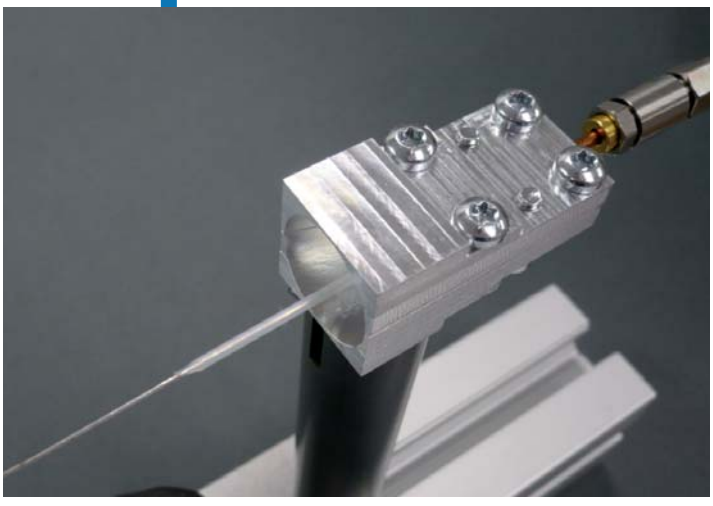
This thesis tackles issues of particular interest regarding analysis and design of passive components at the mm-wave and Terahertz (THz) bands. Innovative analysis techniques and modeling of complex structures, design procedures, and practical implementation of advanced passive devices are presented.

The first part of the thesis is dedicated to THz passive components. These days, THz technology suffers from the lack of suitable waveguiding structures since both, metals and dielectrics, are lossy at THz frequencies. This implies that neither conventional closed metallic structures used at microwave frequencies, nor dielectric waveguides used in the optical regime, are adequate solutions. Among a variety of new proposals, the Single Wire Waveguide (SWW) stands out due to its low attenuation and dispersion. However, this surface waveguide presents difficult excitation and strong radiation on bends. A Dielectric-Coated Single Wire Waveguide (DCSWW) can be used to alleviate these problems, but advantages of the SWW are lost and new problems arise.

Until now, literature has not given a proper solution to radiation on bends and rigorous characterization of these waveguides lacks these days. This thesis provides, for the first time, a complete modal analysis of both waveguides, appropriated for THz frequencies. This analysis is later applied to solve the problem of radiation on bends. Several structures and design procedures to alleviate radiation losses are presented and experimentally validated.

The second part of the thesis is dedicated to mm-wave passive components. When implementing passive components to operate at such small, millimetric wavelengths, ensuring proper metallic contact and alignment between parts can be challenging. In addition, dielectric absorption becomes significant at mm-wave frequencies. Consequently, conventional hollow metallic waveguides and planar transmission lines present high attenuation so that new topologies are being considered. Gap Waveguides (GWs), based on a periodic structure introducing an Electromagnetic Bandgap effect, provide suitable results since they do not require metallic contacts and avoid dielectric losses.

However, although GWs have great potential, several issues prevent GW technology from becoming consolidated and universally used. On the one hand, the topological complexity of GWs complicates the design process since full-wave simulations are time-costly and there is a lack of appropriate analysis methods and suitable synthesis procedures. On the other hand, benefits of using GWs instead of conventional structures are required to be more clearly evidenced with high-performance GW components and proper comparatives with conventional structures. This thesis introduces several efficient analysis methods, models, and synthesis techniques that will allow engineers without significant background in GWs to straightforwardly implement GW devices. In addition, several high performance narrow-band filters operating at Ka-band and V-band, as well as a rigorous comparative with rectangular waveguide topology, are presented.



Thesis Summary

Title: Integrated Optical Filters for Microwave Photonic Applications

Author: Javier Sánchez Fandiño

Supervisors:
Dr. Pascual Muñoz Muñoz
Prof. José Capmany Francoy

Summary

Microwave photonics (MWP) is a well-established research field that investigates the use of photonic technologies to generate, distribute, process and analyze RF waveforms in the optical domain. Despite its great potential to solve long-standing problems faced by both the microwave and electronics industries, MWP systems are bulky, expensive and consume a lot of power. Integrated microwave photonics (IMWP) is an emerging area of research that promises to alleviate most of these drawbacks through the use of photonic integrated circuits (PIC).

In this work, we have aimed at further closing the gap between the worlds of MWP and integrated optics. In particular, we have focused on the design and experimental characterization of PICs with reconfigurable, ring-assisted Mach-Zehnder interferometer filters (RAMZI), and demonstrated its potential use indifferent IMWP applications. These filters consist of a symmetric MZI loadedwith ring resonators, which are coupled to the MZI branches by different optical-couplers.

The contributions of this thesis can be split into two sections. In the first one, we demonstrate integrated optical couplers and reflectors with variable power splitting and reflections ratios. These exploit the well-known properties of tapered multimode interference couplers (MMI), and their inherent robustness makes them highly suitable for the implementation of both RAMZI and reflective filters. Besides, we study in detail the impact of manufacturing deviations in the performance of a 4x4 MMI-based 90 o hybrid, which is a fundamental building block in coherent optical communication systems.

In the second section, we demonstrate the use of integrated RAMZI filters for three different IMWP applications, including instantaneous frequency measurement (IFM), direct detection of frequency-modulated signals in a MWP link, as well as in tunable, coherent MWP filters. A theoretical analysis of the limits and trade-offs that exist in photonics-based IFM systems is also provided. Even though these are early proof-of-concept experiments, we hope that further technological developments in the field will finally turn MWP into a commercial reality.

Thesis Summary

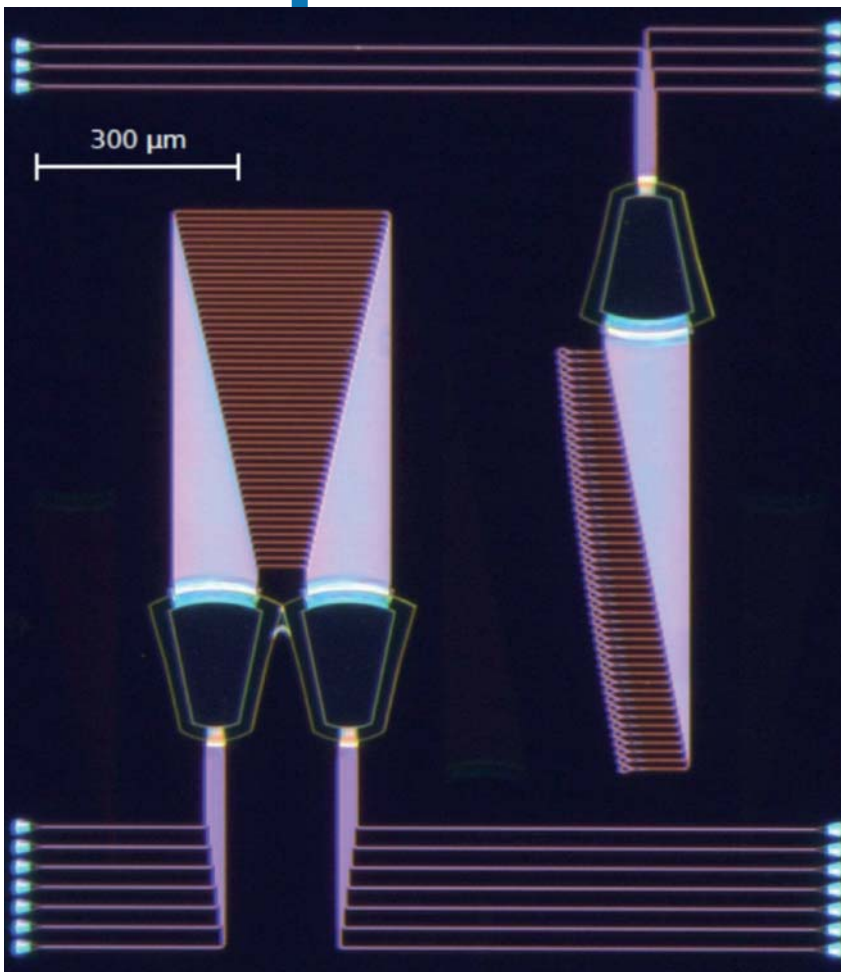
Title: Advanced Arrayed Waveguide Gratings: Models, design strategies and experimental Demonstration

Author: Bernardo Andrés Gargallo Jaquotot

Supervisor:
Dr. Pascual Muñoz Muñoz

Summary

The present PhD thesis deals on the model, design and experimental demonstration of ArrayedWaveguide Grating (AWG) with advanced features. Firstly, building upon existing AWG formulations, design equations are provided, libraries developed and all this is experimentally validated with devices in Indium Phosphide (InP) and Silicon-on-insulator (SOI) technologies. Next, a model and experimental validation is reported for an Interleave-Chirped Arrayed Waveguide Grating (IC-AWG), which is able to process optical signals as WDM demultiplexer, polarization splitter and phase diversity component all in a single device. This device was fabricated and tested in InP technology. The second innovative AWG demonstrated in this thesis, a Reflective type (R-AWG), whose layout allows for tailoring the pass-band shape and to change the spectral resolution. A demonstration of design and fabrication for this device is provided in SOI technology. The last AWG with innovative concepts is one driven by Surface Acoustic Waves (AWG-SAW), where the spectral channels can be tuned by means of acousto-optic effect. The device was fabricated in Aluminium Gallium Arsenide (AlGaAs) technology, and measurements are provided to validate the concept and design flow. In parallel this thesis has resulted in the development of different AWG layouts for a wide number of (generic) technologies and foundries, coded into design libraries, of use in a de-facto standard software employed for the design of photonic integrated circuits. These design libraries have been licensed to the UPV spin-off company VLC Photonics S.L.



Thesis Summary

Title: Design and fabrication of customized fiber gratings to improve the interrogation of optical fiber sensors

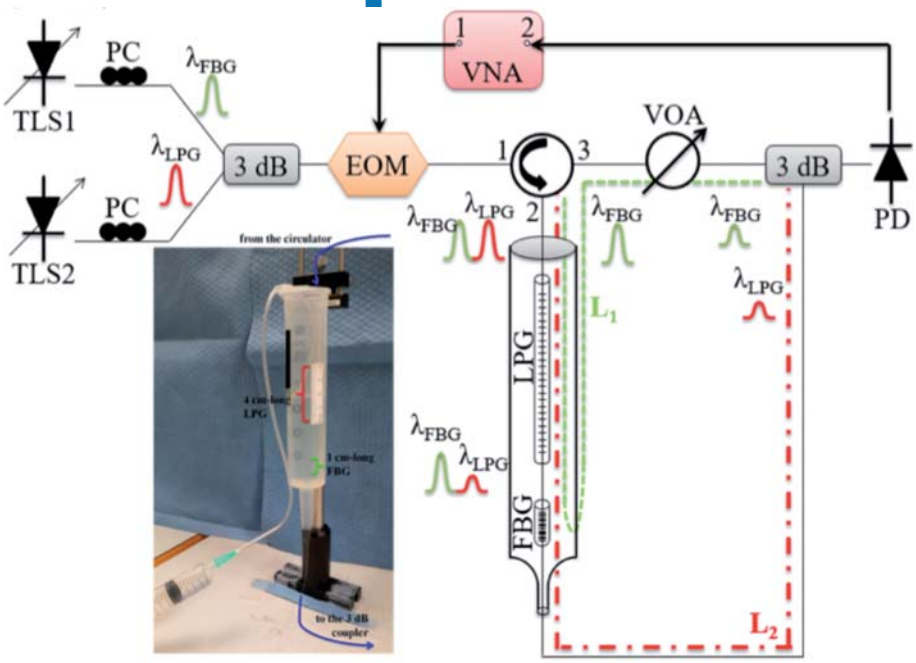
Author: Amelia Lavinia Ricchiuti

Supervisor:
Salvador Sales Maicas

Summary

Fiber grating sensors and devices have demonstrated outstanding capabilities in both telecommunications and sensing areas, due to their well-known advantageous characteristics. Therefore, one of the most important motivations lies in the potential of customized fiber gratings to be suitably employed for improving the interrogation process of optical fiber sensors and systems.

This Ph.D. dissertation is focused on the study, design, fabrication and performance evaluation of customized fiber Bragg gratings (FBGs) and long period gratings (LPGs) with the double aim to present novel sensing technologies and to enhance the response of existing sensing systems. In this context, a technique based on time-frequency domain analysis has been studied and applied to interrogate different kind of FBGs-based sensors. The distribution of the central wavelength along the sensing structures has been demonstrated, based on a combination of frequency scanning of the interrogating optical pulse and optical time-domain reflectometry (OTDR), allowing the detection of spot events with good performance in terms of measurand resolution. Moreover, different customized FBGs have been interrogated using a technology inspired on the operation principle of microwave photonics (MWP) filters, enabling the detection of spot events using radio-frequency (RF) devices with modest bandwidth. The sensing capability of these technological platforms has been fruitfully employed for implementing a large scale quasi-distributed sensor, based on an array of cascaded FBGs. The potentiality of LPGs as fiber optic sensors has also been investigated in a new fashion, exploiting the potentials of MWP filtering techniques. Besides, a novel approach for simultaneous measurements based on a half-coated LPG has been proposed and demonstrated. Finally, the feasibility of FBGs as selective wavelength filters has been exploited in sensing applications; an alternative approach to improve the response and performance of Brillouin distributed fiber sensors has been studied and validated via experiments. The performance of the reported sensing platforms have been analyzed and evaluated so as to characterize their impact on the fiber sensing field and to ultimately identify the use of the most suitable technology depending on the processing task to be carried out and on the final goal to reach.



Thesis Summary

Title: Design of a Cross-Layer Scheme for the Balance between Energy Efficiency and Quality of Service in the Transmission of Multimedia Traffic in Ad-Hoc Networks

Author: González Martínez, Santiago Renán

Supervisors: Arce Vila, Pau, Guerri Cebollada, Juan Carlos
Defended on May 30th, 2017.

Summary

This thesis dissertation addresses the problem of energy constraints in ad hoc wireless networks. In this sort of networks nodes are generally powered by means of batteries, which involves significant limitations regarding the time of operation of devices. The nodes whose battery level describes important energy depletion represent potential elements for loss of connectivity, which results in an increase of packet loss rate. Therefore, the management of energy expenditure is one of the main research challenges to face in ad hoc networks, especially when developing applications in real scenarios. However, energy management is not a trivial task due to the inherent features of this kind of networks, such as the distributed operation as well as the access medium mechanism. In that sense, traditional solutions of energy optimization based on the definition of power-saving intervals (sleep mode) are not suitable considering the operational characteristics of an ad hoc network, due to the substantial deterioration of network connectivity. In addition, the exponential growth of applications focused on the transmission of multimedia contents (especially video) available on mobile devices involves specific quality of service levels. Consequently, the design of solutions for the optimization of energy resources should be carried out without degrading the Quality of Experience perceived by the users. The contributions of this thesis are focused, in the first place, on the analysis of those factors which generate an increase of the energy consumption in the wireless medium and are related to the principle of operation of the radio interface. In particular, the intense operation in reception mode on the interference areas, as a result of the overhearing effect, as well as the high number of transmission retries due to channel access contention, are defined as the main aspects that increase energy demand in the network. On the other hand, with the aim of optimizing energy resources in the nodes without causing damage on the Quality of Service, this thesis proposes meaningful improvements to the routing protocol by means of a cross-layer scheme. Specifically, the designed mechanism carries out an evaluation of both the energy capacity available in the nodes and the distribution of devices along the wireless medium. To that end, this proposal introduces a new metric in the routing computation process, called strategic value, which reports the importance of a node in the network in terms of connectivity (i.e. number of neighbor nodes). This scheme aims to reduce the energy expenditure caused by the overhearing effect along the areas with higher node density as well as to extend the lifetime for those nodes with higher number of neighbors which are strategic to preserve network connectivity. Additionally, considering the current pragmatic approach in ad hoc networks focused on the design of specific applications, the evaluation hereby presented has been performed by means of a simulation environment and also through the implementation of a testbed. Specifi-

cally, the operation of the proposed scheme has been analyzed on a set of ad hoc nodes which has been implemented through development platforms. Also, a software tool has been developed in order to control and configure the experiments. Results prove that the proposal allows to extend the lifetime of the network as well as to increase packet reception rate as a consequence of the prevention in the route breakages due to energy depletion. Finally, it is worth mentioning that the knowledge acquired by the design, configuration and analysis of experiments by means of hardware devices, has motivated the development of proposals and application studies of ad hoc networks in real environments, which represent an additional contribution of this thesis dissertation.

Thesis Summary

Title: Full-wave characterization of bi-dimensional cavities and its application to the design of waveguide filters and multiplexers

Author: Carceller Candau, Carlos

Supervisors: Boria Esbert, Vicente Enrique; Soto Pacheco, Pablo; Gil Raga, Jordi
Defended on March 14th, 2016.

Summary

Modern communications systems impose stringent requirements on the equipment that operates at microwave frequency, especially in the case of wireless communications. The design of passive components for these applications is contingent upon the availability of accurate electromagnetic (EM) modeling tools that can efficiently handle the complex geometry of such components.

Despite the widespread use of mesh-based general-purpose computer-aided engineering (CAE) tools to perform final design verifications, their application during the optimization process is limited. Optimum designs require a large number of simulations, which are computationally expensive when performed by general purpose tools. Instead, microwave designers prefer to employ faster software tools tailored to specific geometries, such as waveguide components, multilayered structures, etc. Therefore, the development of faster and more efficient specialized EM tools has a direct impact on the design of microwave components, both quantitatively and qualitatively. Increasingly complex geometries are modeled more accurately, and may be incorporated into novel designs without penalizing development time and its associated costs. By doing so, passive components become more advanced and are able to fulfill stricter requirements. At the same time, new research and development opportunities arise in order to address the challenges posed by these advanced structures.

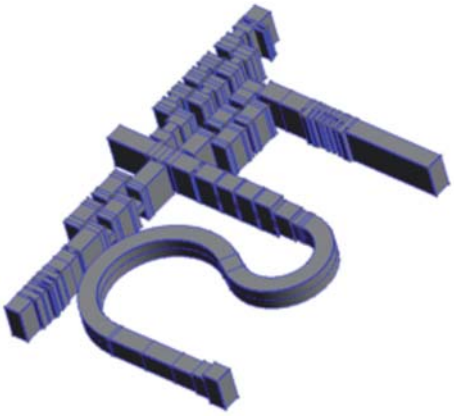
The present thesis is focused on a specific type of waveguide cavity geometry: bi-dimensional structures of arbitrary shape. Most microwave components based on rectangular waveguides include these elements (bends, T-junctions, tapers, power-dividers, etc.), thus the scope of this work is wide. To characterize these structures, an efficient full-wave modal formulation is developed. Taking into account common properties of bi-dimensional structures, such as its electromagnetic symmetry, the resulting technique is very efficient and accurate. Thanks to the integration of this formulation into a CAE tool, a designer is able to solve complex systems that combine this type of element with components of vastly different shapes.

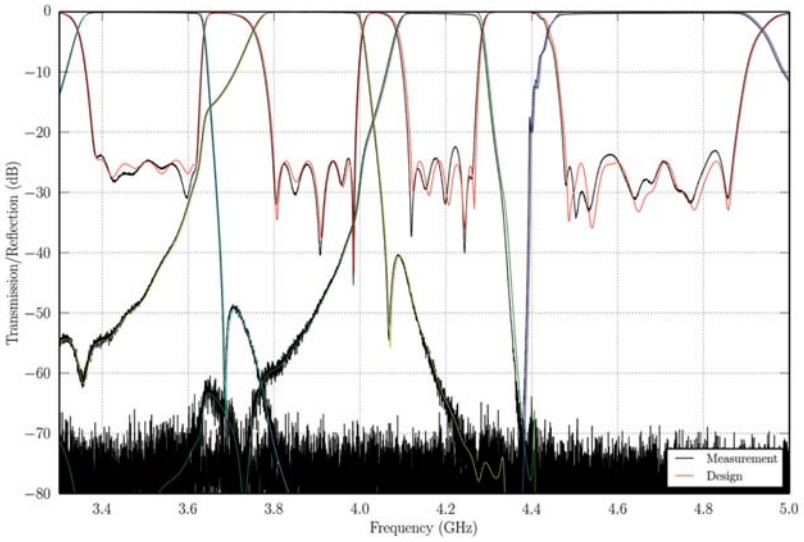
The developed formulation is first applied to the analysis and design of passive components, such as filters, multiplexers and orthomode transducers. These examples are employed to validate the results, as well as to demonstrate the improvement that the proposed analysis technique represents over well-known commercial EM packages. Likewise, this formulation is combined with the tool SPARK3D to predict RF breakdown (multipactor and corona) in selected bi-dimensional structures.

Novel implementations of waveguide quasi-elliptic filters, based on the interconnection of bi-dimensional cavities, are also proposed. Special attention is paid to the realization of multiple transmission zeros (TZs) with tuning-less compact structures. First, a novel family of filters, known as hybrid-folded rectangular waveguide structures, is studied. Simple and

flexible methods to prescribe the location of the transmission zeros realized by these structures are presented. Practical aspects related to their physical implementation are also discussed. Secondly, a compact and purely capacitive obstacle, capable of realizing multiple TZs, is presented and discussed. In both cases, multiple examples are given to illustrate the step-by-step process involved in the design of these structures.

Finally, a systematic procedure for the design of wideband manifold-coupled multiplexers is proposed. To prevent the generation of undesired resonances, stubs that connect the filters to the manifold are removed. Likewise, the manifold length is kept as short as possible. Following a simple procedure, based on analytical formulas and EM simulations, a good starting point for the final optimization of these structures is obtained. It has been applied to a wideband quadruplexer for passive intermodulation measurements at C-band.





Thesis Summary

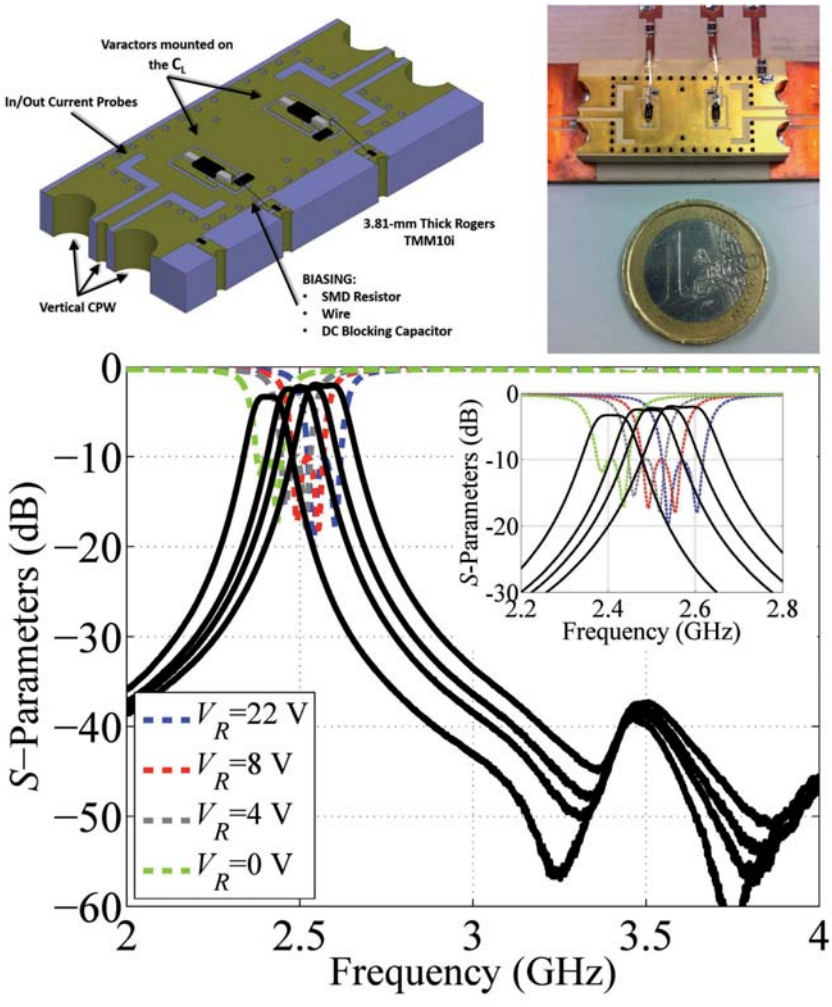
Title: Substrate Integrated Coaxial Filters with Fixed and Tunable Responses

Author: Sirci, Stefano

Supervisors: Boria Esbert, Vicente Enrique; Martínez Pérez, Jorge Daniel
Defended on February 16th, 2017.

Summary

Wireless and mobile communications are already playing an important role in our lives, and this will can only grow more and more due to the predominant importance and use of modern smartphones, tablets and any kind of connected devices. With this is mind, the spectrum for wireless and mobile communications is becoming incredibly overcrowded, leading to increasing requirements for RF front-end filters. This progress has encouraged an impressive need for developing low-cost, high performance, mass-producible, small footprint, and highly integrated front-end solutions for microwave and millimeter-wave systems and applications including emerging 5G and future wireless platforms. In this context, high quality factor resonators are usually typical basic building blocks of many high performance passive and active circuits, and its design has become even more challenging in the last decade. As a result, Substrate Integrated Waveguide (SIW) technology has attracted scientific community and industry attention as a very good candidate for developing such desired high-Q planar microwave devices. Recently, SIW is demonstrating to be a successful approach for implementing microwave and mm-wave filters with high Q-factor, easy integration with other planar circuits, and for mass-production manufacturing processes in many technologies (i.e. Printed Circuit Board (PCB) and Low Temperature Co-fired Ceramics (LTCC) technologies among them). Its enormous similarity with waveguides is probably one of the main reasons why the development of SIW-based components and circuits is rapidly growing among the research community. Other potential features that, combined with the former advantages, could be of huge interest in a wide range of wireless and mobile applications are a lively set of research subjects, such as compactness, advanced filtering responses, and recently frequency-agility capabilities. These key features have been recently introduced in the design of microwave filters for the



next-generation wireless systems. Taking into account the above-mentioned background, the work carried out during the course of this PhD Thesis has been directed towards a further study of SIW technology to propose, analyze and develop an innovative and original resonator topology. The proposed topology is based on the extension of the classical coaxial waveguide resonator to SIW technology, and must take advantage of the characteristics of SIW devices to allow the design of improved and innovative microwave resonator filters for advanced wireless systems. This PhD Thesis includes the latest improvements made on this topic, from the working principles of the basic coaxial SIW block to different applications for the design of compact quasi-elliptic and reconfigurable microwave filters. The results are promising and demonstrate the validity of the proposed topology for the design of high-Q microwave filters, as well as its potential application to implement complex designs. The general knowledge gained from these cases of study can be considered a good base for further developing this technology, which can help to improve its EM performance, and also contribute to a more general use in the market.

Thesis Summary

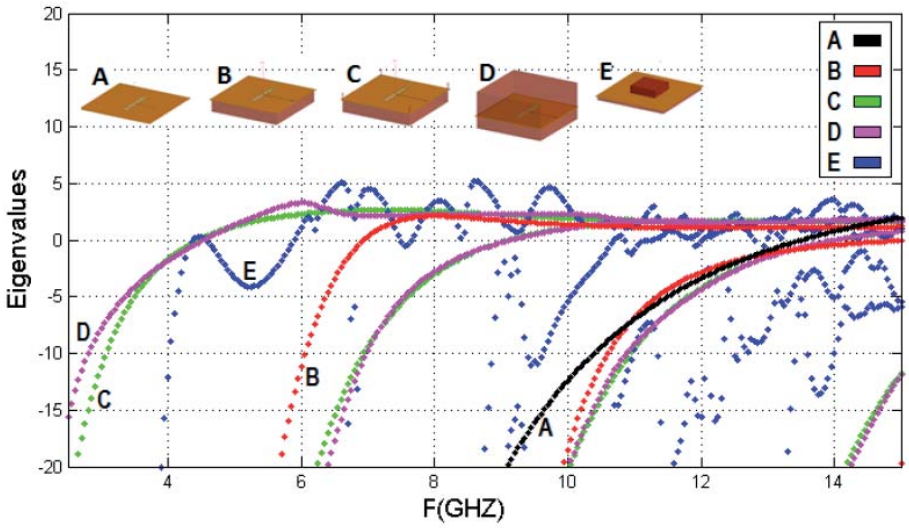
Title: Contribution to the physical interpretation of characteristic mode resonances. Application to dielectric resonator antennas

Author: Bernabeu Jiménez, Tomás

Supervisors: Valero-Nogueira, Alejandro; Vico Bondía, Felipe
Defended on July 19th, 2017.

Summary

The Theory of Characteristic Modes is being adopted by many research groups around the world in the last decade. This topic and their use in different metallic antenna design is growing very fast. However, most of the applications has been only concentrated on conducting surfaces without any physical knowledge about its limitations and its physical interpretation. As far as dielectric bodies are concerned, there have not been so many published articles. The reason is that there are different integro-differential formulations and the interpretation of their solutions is not as obvious as in conducting bodies. Here, a theoretical interpretation considering loss-less conducting and dielectric bodies is presented. The conclusions drawn in this thesis will allow us to better understand the solutions of the Theory of Characteristic Modes and their limitations. This is important for antenna engineering. In addition, this analysis will allow to develop a novel method for the design of antennas based on dielectric resonators, DRA. This method is called Substructure based-PMCHWT method, and is based on the implementation of the Schur complements of the method of moments matrix operator. This study permits to optimize the radiation bandwidth in the same analysis process for both, the dielectric and the feed, e.g. slot. Moreover, it allows to understand how the slot behaves in the presence of the dielectric resonator and vice versa. This method can also be used to design DRA using low permittivities. This is important in the design of DRA because the feed perturbs the system and produces a shift in the resonances of the characteristic modes. So, therefore, by considering the feed system in the characteristic modes analysis a more realistic results than a conventional analysis is obtained. On the other hand, the resonances of the characteristic modes at low permittivities are displaced from what are the natural resonances of the dielectric resonator and also the corresponding S11 resonance. Thus, designing with this new method it can draw new conclusions about the design of DRA using the Theory of Characteristic Modes.



Thesis Summary

Title: Contributions to Deep Learning Models

Author: Mansanet Sandín, Jorge

Supervisors: Albiol Colomer, Alberto; Paredes Palacios, Roberto
Defended on January 12th, 2016.

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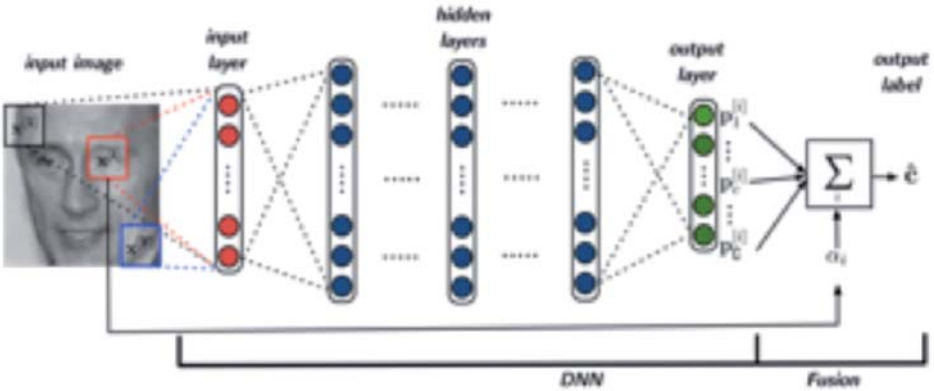
Summary

Deep Learning is a new area of Machine Learning research which aims to create computational models that learn several representations of the data using deep architectures. These methods have become very popular over the last few years due to the remarkable results obtained in speech recognition, visual object recognition, object detection, natural language processing, etc.

The goal of this thesis is to present some contributions to the Deep Learning framework, particularly focused on computer vision problems dealing with images. These contributions can be summarized in two novel methods proposed: a new regularization technique for Restricted Boltzmann Machines called Mask Selective Regularization (MSR), and a powerful discriminative network called Local Deep Neural Network (Local-DNN). On the one hand, the MSR method is based on taking advantage of the benefits of the L2 and the L1 regularizations techniques. Both regularizations are applied dynamically on the parameters of the RBM according to the state of the model during training and the topology of the input space. On the other hand, the Local-DNN model is based on two key concepts: local features and deep architectures. Similar to the convolutional networks, the Local-DNN model learns from local regions in the input image using a deep neural network. The network aims to classify each local feature according to the label of the sample to which it belongs, and all of these local contributions are taken into account during testing using a simple voting scheme.

The methods proposed throughout the thesis have been evaluated in several experiments using several image datasets. The results obtained show the great performance of these approaches, particularly on gender recognition using face images, where the Local-DNN improves other state-of-the-art results.



Thesis Summary

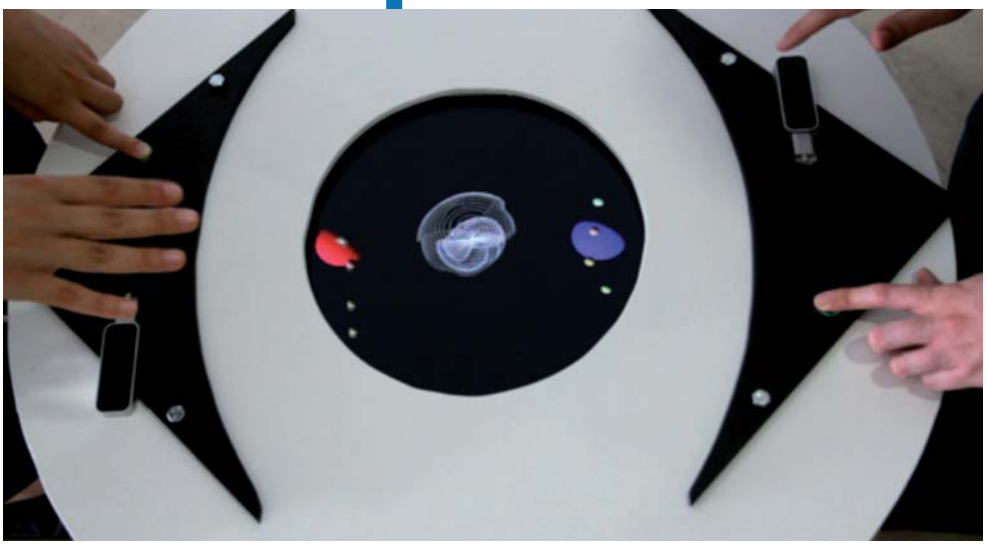
Title: Interactivity as an extension of the individual through the creation of Homeostasis: Interactive installation for two hearts and hands

Author: Scarani, Stefano

Supervisor: Sastre, Jorge
Defended on December 21st, 2016.

Summary

The main object of this thesis is the proposal, development and verification of hypothetical relationships that are established from the creation of an interactive installation between its components, be they the public, the device and the interaction between these components and their particularities in the relational behavior created in the interactivity environment. This research aims to compare the theoretical aspects with the practical experience in attempting to define the framework in which the performative project develops. In this theoretical framework we highlight certain aspects of particular relevance, related to the different types of relationships that are established between individual, device and community. These aspects constitute, at the same time, the theoretical framework and guidelines that structure the performative project, consisting of the creation of the interactive installation Homeostasis. The practical realization of an interactive work as a central element in the development of the research, links the conclusions of the investigation to the specific reactions of the public, leading to a forced confrontation of theoretical aspects with practical evidence, thereby maintaining a substantially empirical analysis of the research results.



Thesis Summary

Title: Enhanced fluid characterization in the millimeter-wave band using Gap Waveguide Technology

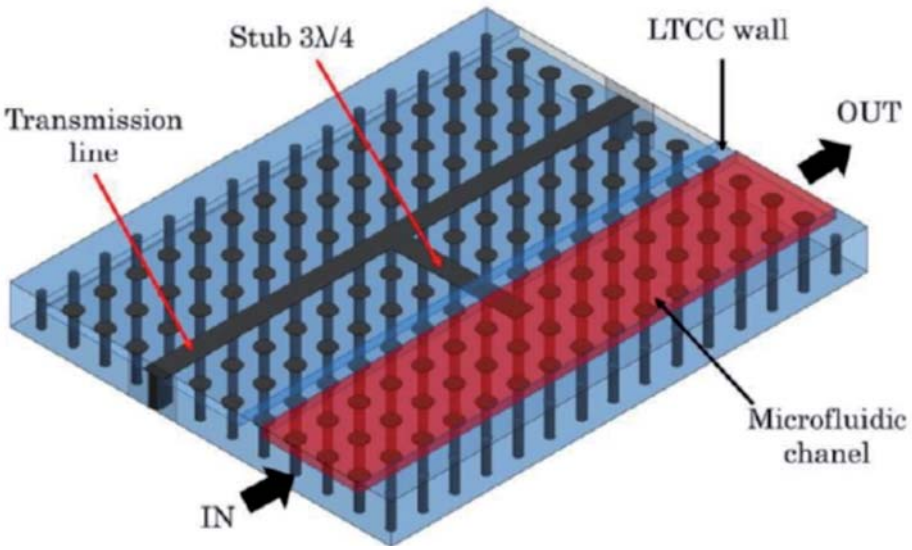
Author: Arenas Buendia, Cristina

Supervisor: Person, Christian; Valero Nogueira, Alejandro; Gallée, François

Defended on February 2nd, 2016.

Summary

Microfluidic systems have emerged as a promising technology for molecular analysis, biodefence and microelectronics. The properties of the microfluidic devices, such as rapid sample processing and the precise control of fluids, have made them attractive candidates to replace traditional experimental approaches. Microfluidic devices are characterized by fluidic channels with dimensions on the order of tens to hundreds of micrometers. Structures with this size enable the integration of lab-on-chip technology, which allows processing miniaturized devices for fluid control and manipulation. Fluid sensing by microwave sensors based on the RF analysis offers new possibilities for the characterization of media by non-invasive methods. Dielectric measurement of fluids is important because it can provide the electric or magnetic characteristics of the materials, which proved useful in many research and development fields, such as molecular biology and medical diagnosis. Several techniques are available in the frequency domain for analyzing the dielectric properties of liquids and their composition. We are focused in resonant cavity techniques for fluid characterization in the millimeter-wave range. However, these techniques are incompatible with lab-on-chip process due its dimensions in this frequency range. In this context, a new structure called gap waveguide appears as a good candidate to overcome the principal drawbacks of the classical resonant cavities. This thesis presents the development of the gap waveguide technology in the millimeter-wave band. Other conventional technologies are discussed as well, to compare them with the performance in terms of losses of the gap waveguide. We also present the resonator design based on gap waveguide with the purpose of making the gap waveguide a technology capable of working in the microfluidic sensing domain. In this context, we propose a comparative study between gap waveguide and Substrate Integrated Cavity (SIC) with the aim to characterize the fluid permittivity at 60 GHz. With this purpose, several prototypes have been manufactured with PCB ("Printed Circuit Board") and Low Temperature Co-fired Ceramic (LTCC) technologies. A work in the LTCC laboratory has been done with the purpose of validating some steps in the LTCC process which are key in the gap waveguide manufacturing, especially those related with the creation of cavities (external and internal) using LTCC materials.



Thesis Summary

Title: Beam Position Monitoring In The CLIC Drive Beam Decelerator Using Stripline Technology

Author: Benot Morell, Alfonso

Supervisor: Boria Esbert, Vicente Enrique
Defended on February 22nd, 2016.

Summary

The Compact Linear Collider (CLIC) is an electron-positron collider conceived for the study of High-Energy Physics in the TeV center of mass energy region, and is based on a two-beam operation principle: instead of using active elements (klystrons), the necessary RF power to accelerate the Main Beam (MB) is obtained from the deceleration of a high-current, moderate energy Drive Beam (DB) in the so-called Power Extraction and Transfer Structures (PETS). These structures emit an RF signal of about 130 MW power at 12 GHz. As this frequency is above the cut-off frequency of the fundamental mode for the specified beam pipe dimensions (7.6 GHz), the inference propagates from the PETS to the neighboring devices, including the Beam Position Monitors (BPM). According to the CLIC Conceptual Design Report (CDR), an efficient beam position monitoring system for the CLIC DB decelerator needs to meet the following requirements:

- It should be as simple and economic as possible, as 41580 units are required, amounting to 75% of all CLIC BPMs.

- The signal processing scheme should not be affected by the PETS interference. This rules out processing the signals at the beam bunching frequency (12 GHz).

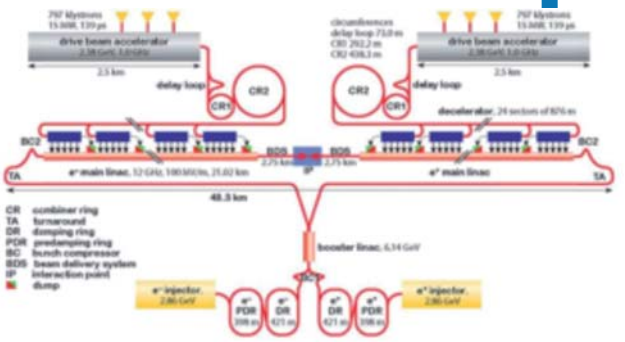
- The resulting position signal should detect changes in the beam position whose duration is 10 ns or longer.

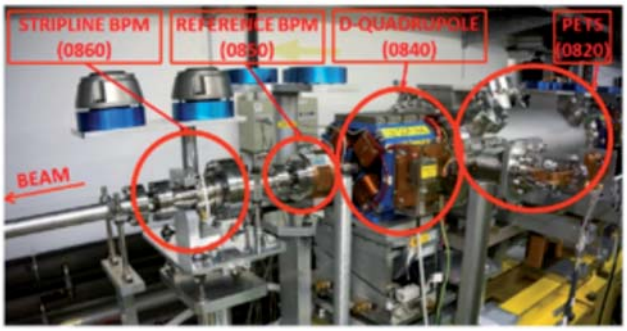
- The required spatial resolution is 2 um for a 23 mm diameter vacuum pipe.

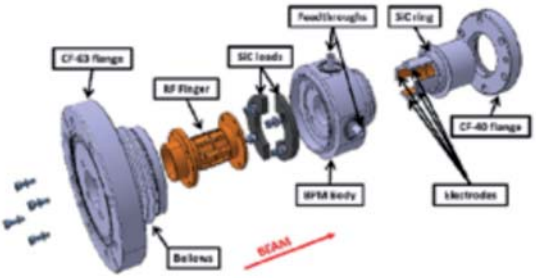
- Wide dynamic range: the electronic acquisition system must be able to process signals with extreme levels, induced by either very high (100 A) or very low (3 A) current beams.

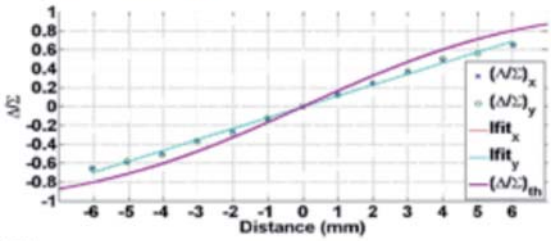
This PhD thesis describes the electromagnetic and mechanical design of the first prototype BPM developed for the CLIC Drive Beam, and its characterization tests in laboratory and with beam. The first two chapters introduce the CLIC project and review the state-of-the-art beam position monitoring techniques. Chapter 3 presents the design of the BPM. The stripline technology has been selected, as it is the only one among the most commonly used BPM techniques to present a suitable frequency response to filter out the RF interference caused by the PETS. Choosing an appropriate length for the electrodes, it is possible to tune one of periodic notches in the stripline frequency response to 12 GHz. The influence of different electromagnetic and geometrical aspects is also studied, such as beam coupling impedance or the ratio between longitudinal and transverse dimensions. The design of the electronic acquisition system is presented in Chapter 4, considering the project requirements in terms of resolution (2 um), accuracy (20 um) and time resolution (10 ns). Due to the high amount of units required, the number of electronics components has been minimized. As the designed signal processing scheme is based on charge integration, it can be adapted to different stripline pick-

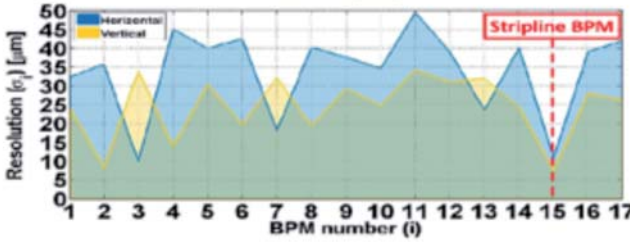
ups by simply modifying the attenuator settings according to the required output signal levels. The laboratory characterization tests of the prototype stripline BPM, in the low and the high frequency ranges, performed with a thin wire and a coaxial waveguide, respectively, are described in Chapter 5. The measurement results are compared with the theoretical estimation and the electromagnetic field simulations. In addition, the high-frequency test reveals that the first prototype stripline BPM does not provide sufficient suppression of the 12 GHz PETS RF interference. An additional study proposes several modifications and guidelines for a second prototype stripline BPM. Finally, Chapter 6 presents the beam tests of the prototype stripline BPM at the CLIC Test Facility 3 (CTF3) in the Test Beam Line (TBL), a scaled version of the CLIC Drive Beam decelerator. Two types of tests were performed: linearity/sensitivity and resolution. These results are compared to the ones in the laboratory characterization tests. An upper bound of the resolution is estimated performing a Singular Value Decomposition (SVD) analysis.











Thesis Summary

Title: VLSI implementation of successive projection algorithm for detection of MIMO systems

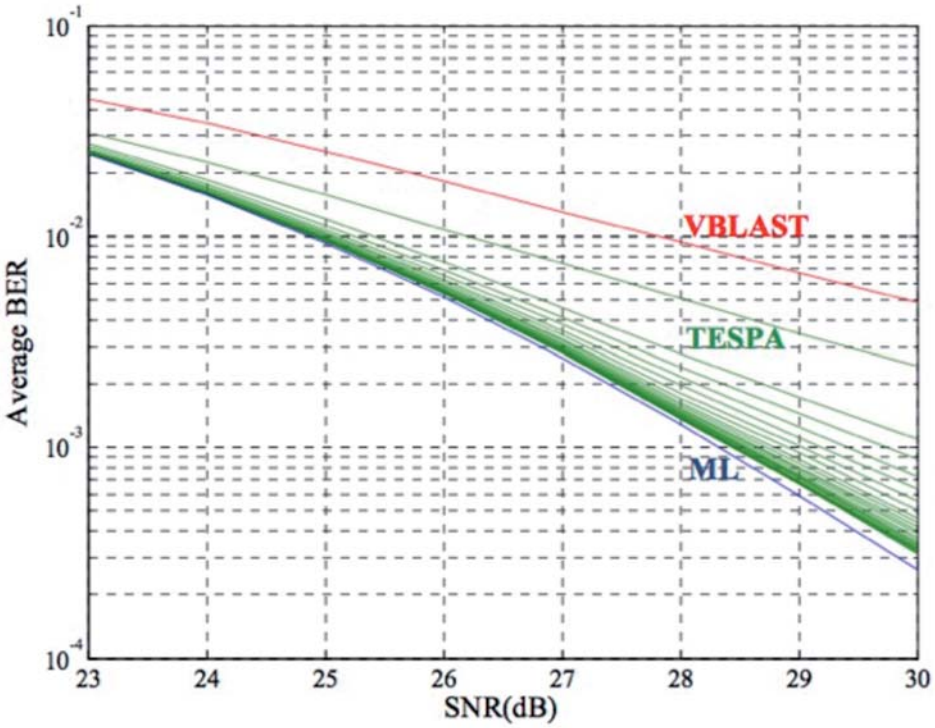
Author: Marín-Roig Ramón, José

Supervisors: Almenar Terre, Vicenç; Valls Coquillat, Javier
Defended on January 22nd, 2016.

Summary

The insatiable demand for bandwidth linked to the lowering price of terminals and telecommunication services, have led to a spectacular growth of the wireless communications market in recent years. Those entities responsible of the technological standardization have guided this growth aproving standards as LTE (Long Term Evolution), IEEE 802.11 (WiFi) and IEEE 802.16 (WiMax) or 3G networks or 4GPP. They all share a common denominator to improve the spectral efficiency, they make use of MIMO technologies, that is multiple antennas on transmitter and receiver, and high modulation schemes as 256QAM. Under this perspective of great gains in the spectral efficiency, it is not surprising that MIMO technology has been incorporated into the standards mentioned above. However, achieving these gains is not trivial, to the extent that the VLSI implementation of this technology has become a challenge. In this thesis it has been undertaken a comprehensive study of different MIMO detectors, studying those belonging to the two families that show best features for being implemented in VLSI technology: successive interference cancellation (VBLAST detector) and based on a search in tree (KBest detector). Although initially the benefits achieved by the second group (KBest) are far superior to those of the first (VBLAST), the recent appearance in the specialized literature of the Successive Projections Algorithm (SPA) opens the door to the development of a new detector, belonging to the family of the detectors of Successive Interference Cancellations (SIC), which will be able to compete in performance with the KBest detectors. This work provides the necessary algorithmic keys that make viable and competitive the hardware implementation of the SPA algorithm. In particular, two mechanisms of control of repetitions have been developed: Simplified-ESPA (SESPA) and Table-ESPA (TESPA), and the mechanisms for obtaining hard and soft output, existing in the literature, have been adapted to this algorithm. It has been designed the first VLSI architecture for the SPA algorithm, being highly flexible, in the sense that it adapts to different conditions of transmission and complies with the latest published specifications in the WiMAX and LTE standards. The flexibility of the architecture allows selecting different configurations of antennas in transmission and reception, from 2x2 to 4x4, different modulation schemes from QPSK until 256QAM, controls the balance between transmission rate and the benefits BER/FER and offers the soft output and hard output decisions. Finally, with this architecture has been implemented the SESPA and TESPA detectors, with soft output and hard output, in FPGA and ASIC technology. These detectors have been evaluated and compared to the best published in the specialized literature,

achieving a peak rate of 465 Mbps for the detector SESPA 4x4 256QAM, with an area of 3.83 mm^2 with a 90 nm technology. The detectors implemented offer as added value, in addition to the high configurability, the ability to decode 256-QAM without increasing the area. This feature is highly competitive with the non-linear detectors based on KBest, which are very sensitive, in regard to decoding rate and area, with the selected modulation scheme. In addition, the detectors based on ESPA reach a FER performance (soft output) clearly competitive with KBest detectors, due to a higher quality of the LLR generated by the ESPA. The comparison with other flexible architectures selected shows that the SESPA and TESPA detectors offer a greater configurability of transmission parameters and the best balance between area, BER performance and detection rate.



Thesis Summary

Title: Architecture and algorithms for the implementation of digital wireless receivers in FPGA and ASIC: ISDB-T and DVB-S2 cases

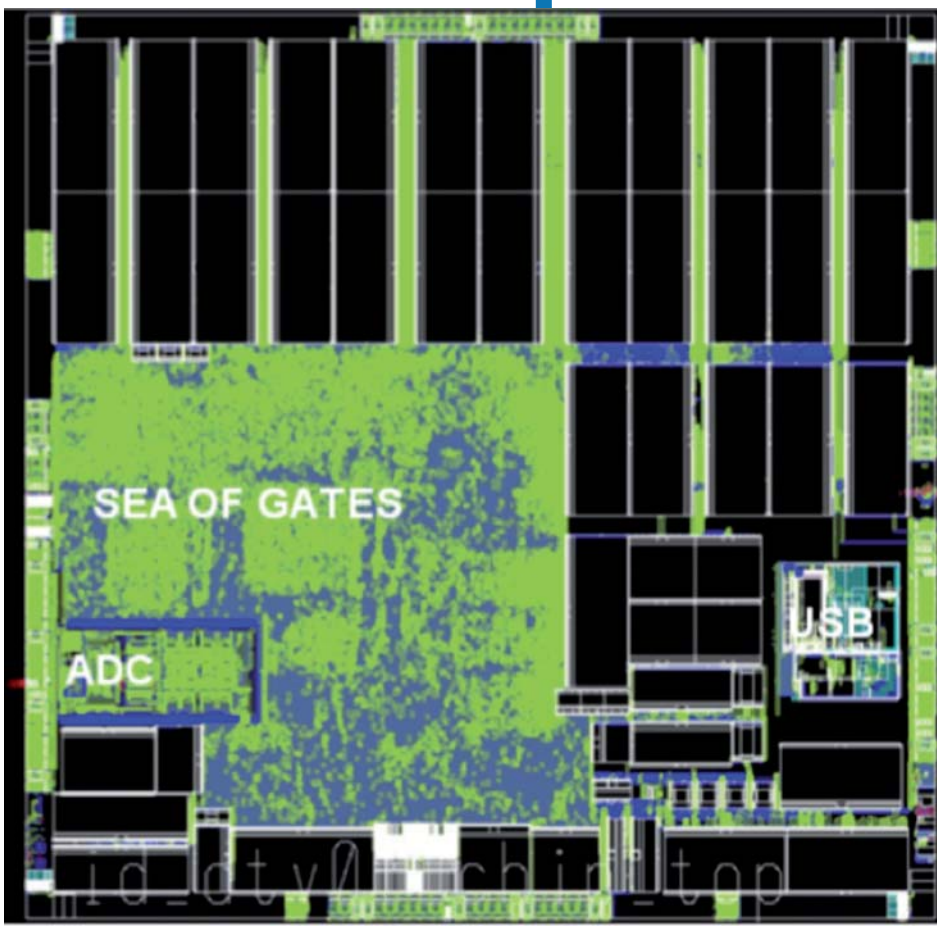
Author: Rodrigues de Lima, Eduardo

Supervisors: Almenar Terre, Vicenç; Flores Asenjo, Santiago J.
Defended on January 21st, 2016.

Summary

The first generation of Terrestrial Digital Television(DTV) has been in service for over a decade. In 2013, several countries have already completed the transition from Analog to Digital TV Broadcasting, most of which in Europe. In South America, after several studies and trials, Brazil adopted the Japanese standard with some innovations. Japan and Brazil started Digital Terrestrial Television Broadcasting (DTTB) services in December 2003 and December 2007 respectively, using Integrated Services Digital Broadcasting - Terrestrial (ISDB-T), also known as ARIB STD-B31. In June 2005 the Committee for the Information Technology Area (CATI) of Brazilian Ministry of Science and Technology and Innovation MCTI approved the incorporation of the IC-Brazil Program, in the National Program for Microelectronics (PNM) . The main goals of IC-Brazil are the formal qualification of IC designers, support to the creation of semiconductors companies focused on projects of ICs within Brazil, and the attraction of semiconductors companies focused on the design and development of ICs in Brazil. The work presented in this thesis originated from the unique momentum created by the combination of the birth of Digital Television in Brazil and the creation of the IC-Brazil Program by the Brazilian government. Without this combination it would not have been possible to make these kind of projects in Brazil. These projects have been a long and costly journey, albeit scientifically and technologically worthy, towards a Brazilian DTV state-of-the-art low complexity Integrated Circuit, with good economy scale perspectives, due to the fact that at the beginning of this project ISDB-T standard was not adopted by several countries like DVB-T. During the development of the ISDB-T receiver proposed in this thesis, it was realized that due to the continental dimensions of Brazil, the DTTB would not be enough to cover the entire country with open DTV signal, specially for the case of remote localizations far from the high urban density regions. Then, Eldorado Research Institute and Idea! Electronic Systems, foresaw that, in a near future, there would be an open distribution system for high definition DTV over satellite, in Brazil. Based on that, it was decided by Eldorado Research Institute, that would be necessary to create a new ASIC for broadcast satellite reception. At that time DVB-S2 standard was the strongest candidate for that, and this assumption still stands nowadays. Therefore, it was decided to apply to a new round of resources funding from the MCTI - that was granted - in order to start the new project. This thesis discusses in details the Architecture and Algorithms proposed for the implementation of a low complexity Intermediate Frequency(IF) ISDB-T Receiver on Application Specific Integrated Circuit

(ASIC) CMOS. The Architecture proposed here is highly based on the COordinate Rotation Digital Computer (CORDIC) Algorithm, that is a simple and efficient algorithm suitable for VLSI implementations. The receiver copes with the impairments inherent to wireless channels transmission and the receiver crystals. The thesis also discusses the Methodology adopted and presents the implementation results. The receiver performance is presented and compared to those obtained by means of simulations. Furthermore, the thesis also presents the Architecture and Algorithms for a DVB-S2 receiver targeting its ASIC implementation. However, unlike the ISDB-T receiver, only preliminary ASIC implementation results are introduced. This was mainly done in order to have an early estimation of die area to prove that the project in ASIC is economically viable, as well as to verify possible bugs in early stage. As in the case of ISDB-T receiver, this receiver is highly based on CORDIC algorithm and it was prototyped in FPGA. The Methodology used for the second receiver is derived from that used for the ISDB-T receiver, with minor additions given the project characteristics.



Thesis Summary

Title: Efficient algorithms for iterative detection and decoding in Multiple-Input and Multiple-Output Communication Systems

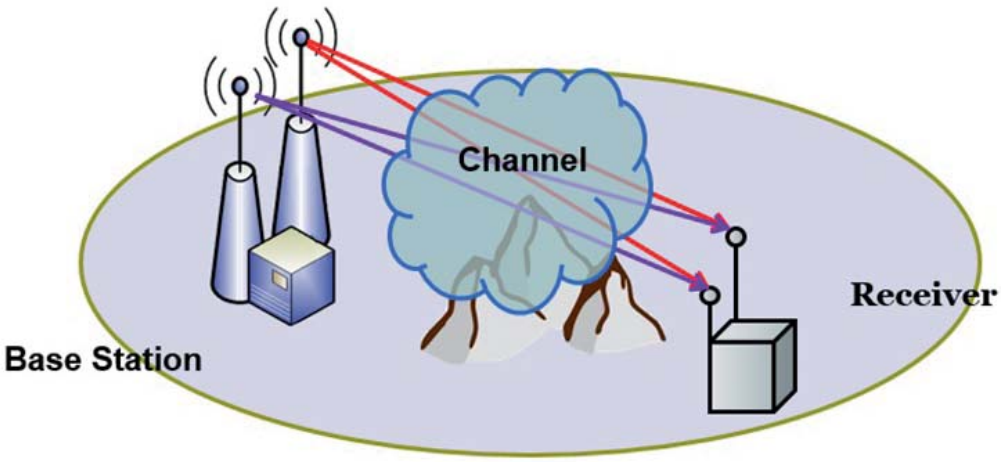
Author: Simarro Haro, Mª Ángeles

Supervisors: Gonzalez, Alberto; Martínez Zaldívar, Francisco José
Defended on July 17th, 2017.

Summary

This thesis fits into the Multiple-Input Multiple-Output (MIMO) communication systems. Nowadays, these schemes are the most promising technology in the field of wireless communications. The use of this technology allows to increase the rate and the quality of the transmission through the use of multiple antennas at the transmitter and receiver sides. Furthermore, the MIMO technology can also be used in a multiuser scenario, where a Base Station (BS) equipped with several antennas serves several users that share the spatial dimension causing interference. However, employing precoding algorithms the signal of the multiuser interference can be mitigated. For these reasons, the MIMO technology has become an essential key in many new generation communications standards. On the other hand, Massive MIMO technology or Large MIMO, where the BS is equipped with very large number of antennas (hundreds or thousands) serves many users in the same time-frequency resource. Nevertheless, the advantages provided by the MIMO technology entail a substantial increase in the computational cost. Therefore the design of low-complexity receivers is an important issue which is tackled throughout this thesis. To this end, one of the main contributions of this dissertation is the implementation of efficient soft-output detectors and precoding schemes. First, the problem of efficient soft detection with no iteration at the receiver has been addressed. A detailed overview of the most employed soft detectors is provided. Furthermore, the complexity and performance of these methods are evaluated and compared. Additionally, two low-complexity algorithms have been proposed. The first algorithm is based on the efficient Box Optimization Hard Detector (BOHD) algorithm and provides a low-complexity implementation achieving a suitable performance. The second algorithm tries to reduce the computational cost of the Subspace Marginalization with Interference Suppression (SUMIS) algorithm. Second, soft-input soft-output (SISO) detectors, which are included in an iterative receiver structure, have been investigated. An iterative receiver improves the performance with respect to no iteration, achieving a performance close to the channel capacity. In contrast, its computational cost becomes prohibitive. In this context, three algorithms are presented. Two of them achieve max-log performance reducing the complexity of standard SISO detectors. The last one achieves near max-log performance with low complexity. The precoding problem has been addressed in the third part of this thesis. An analysis of some of the most employed precoding techniques has been carried out. The algorithms have been compared in terms of performance and complexity. In this con-

text, the impact of the channel matrix condition number on the performance of the precoders has been analyzed. This impact has been exploited to propose an hybrid precoding scheme that reduces the complexity of the previously proposed precoders. In addition, in Large MIMO systems, an alternative precoder scheme is proposed. In the last part of the thesis, parallel implementations of the SUMIS algorithm are presented. Several strategies for the parallelization of the algorithm are proposed and evaluated on two different platforms: multicore central processing unit (CPU) and graphics processing unit (GPU). The parallel implementations achieve a significant speedup compared to the CPU version. Therefore, these implementations allow to simulate a scalable quasi optimal soft detector in a Large MIMO system much faster than by conventional simulations.



Thesis Summary

Title: Distributed cooperative MIMO in beyond 2020 wireless networks

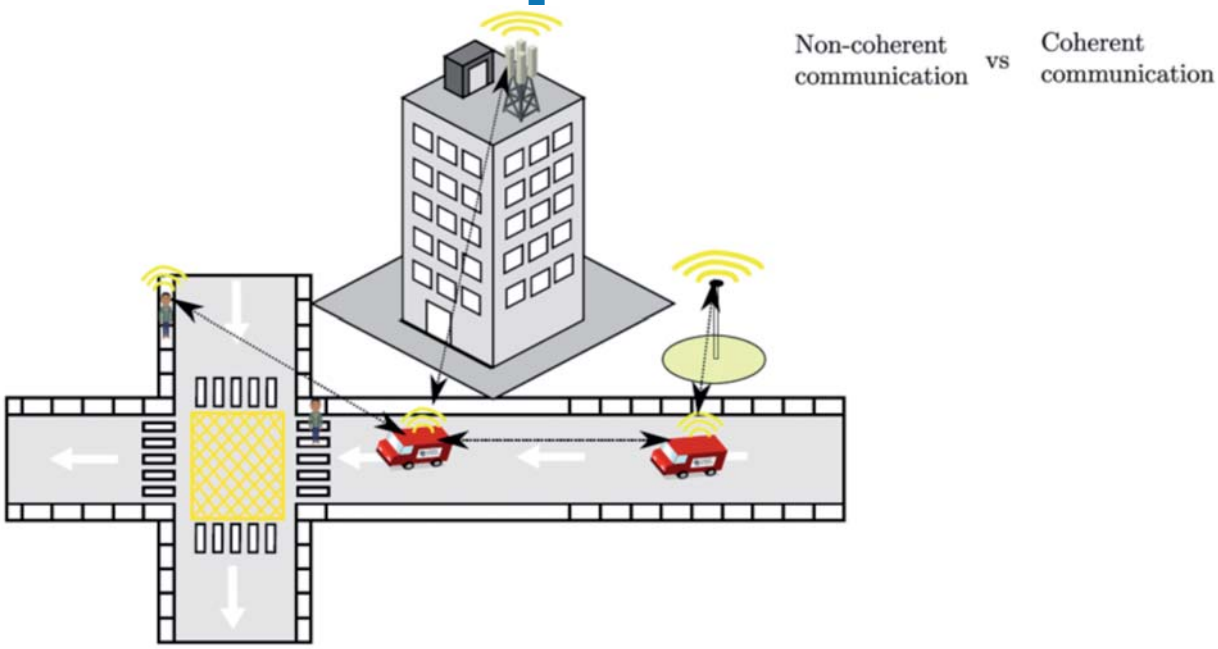
Author: Cabrejas Peñuelas, Jorge

Supervisors: Cardona Marcet, Narciso; Monserrat del Río, Jose Francisco
Defended on February 4th, 2016.

Summary

Mobile communication systems are currently being developed with the aim of providing peak data rates up to 20 times higher to those of LTE-Advanced Rel 10. However, this performance improvement is often far from being the experimented performance by those users who are far from the Base Station (BS). In this sense, there exists a consensus on the fact that the best way to achieve the same quality for all users is with the use of heterogeneous networks composed of macrocells, microcells, femtocells, and relays. This dissertation addresses the use of Mobile Relays (MRs) to provide service to users who are at the cell-edge. MR is a natural extension of the fi xed relay in which users who are in the idle state could retransmit signals received from other transmitters to enhance data rates. This dissertation focuses on proposing and evaluating new techniques that manage the use of the MR in the new generation cellular networks. In particular, the dissertation studies MR from two complementary points of view. The first point of view investigates the MR management at the network level through a signaling protocol known as Media Independent Handover. The central idea of this mechanism is to use this signaling to connect the BS and the user in one of the following two manners. In the former, both entities are connected directly through the xG (x= 2, 3, 4, 5) wireless network. In the latter, there exists an xG connection between the BS and the MR and another one between the MR and the user through an IEEE 802.11 local wireless network. The investigations in this Thesis aim at fi nding a trade-of f between using multiple MRs and reducing signaling overhead. The second point of view deals with MR integration at air interface level. It consists in detecting, proposing, and evaluating new transmission techniques that solve the drawbacks derived from coherent detection. As with point-to-point systems, employing multiple antennas in a cooperative system can signi cantly improve the spectral efficiency of the systems with only one transmit antenna assuming that the channel estate information is available at the receiver. However, performing a coherent detection in a network assisted by relays consumes much more resources than a point-to-point network since the coherent detection requires the channel estimation of source-relay, relay-destination, and source-destination links. In this Thesis, the proposed solution is to use transmission techniques that do not need the channel knowledge to perform the detection. This dissertation evaluates the use of Single-User (SU) open-loop communication methods over temporally-correlated Rayleigh fading MIMO channels. On the other hand, in multi-carrier systems, the Thesis proposes to transmit the Grassmannian signaling (GS) in the virtual block formed by the

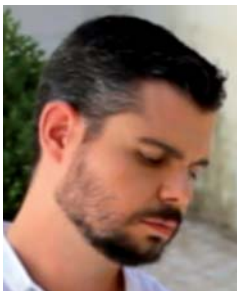
coherence time and the coherence bandwidth. This proposal is due to the fact that GS achieves data rates approaching capacity over block-fading channels. However, this channel type is not common in real systems since channel correlation is often found in frequency, time, and space. For this reason, the next objective is to evaluate the performance of GS compared to the diversity transmission modes of LTE, analyzing the impact of user mobility and antenna correlation. Thanks to these investigations, we point that non-coherent systems are promising techniques in mobility scenarios with a high number of transmit antennas. This result motivates its relevance in the design of new SU open-loop transmission methods with multiple antennas. In downlink multi-user non-coherent scenarios, superposition coding and a suboptimum detection scheme are proposed. This detection system reduces the complexity respect to the maximum likelihood detection. Finally, this dissertation proposes that GS is transmitted in a new carrier type, where any reference signal is transmitted. In this way, the user would change its detection method to non-coherent.



Thesis Summary

This is a fully artistic thesis part of the work in the field of music and technology from ITEAM member Dr. Jorge Sastre

Title: Catalogue d'oiseaux, O. Messiaen: A study on his performing universe through II. Le Loriot and IV. Le Traquet Stapazin



Author: Benítez Suárez, Gregorio

Supervisor: Sastre, Jorge
Defended on July 20th, 2016.

Summary

The main objective pursued in this thesis is that of conducting an enquiry on Catalogue d'oiseaux, observed through the eyes of the performer, using its second and fourth books as the focus of this study when addressing its aesthetic and pianistic approach. The need to gain a closer view of the piece from a performer's perspective arises from the paradox between the importance of this composition in Olivier Messiaen's catalogue of compositions and the real meaning the piano score has among pianists of today. Due to the evolution of the author's composition language, which is expressed in greater conceptual complexity, Catalogue d'oiseaux generates a series of performance-related questions, distancing it from other "traditional" pianistic productions. This factor often leads to apriorism and axioms that generate excessively polarised views on the performance of the piece.

In order to resolve this clash between antagonistic approaches, a methodology has been applied which is based on tracing the "notion of a piece" by studying the timing of the composition, conducting a formal analysis and considering the ornitophonical transcriptions. This theoretical framing acts as a vehicle to uncover the performative nature of Catalogue, where analysing the transcripts, understanding the importance of the time element and assimilating the writing of the two books are tools to relieve a more open musical creation, an aspect confirmed in the study as regards the traditional performance of the work. All of that shows a composition that breaks free from simplistic postulates, offering the pianist a universe of performing possibilities that go beyond any old debate regarding the performance of this extraordinary score of piano literature. The study concludes with a sound recording of the two books and the inclusion of the two pieces in a recital for the Young Performers Cycle of Seville's Maestranza Theatre. Furthermore, part of the research material has been used to write two articles for Melómano Magazine, which are included as annexes, and in some conferences-concerts about the pianism of Olivier Messiaen at different Spanish conservatoires and universities in 2017 on the occasion of the 25th anniversary of Olivier Messiaen's death.

Thesis Summary

Title: Characterization and modeling of the sound production in beluga whales (Delphinapterus Leucas) using speech analysis / synthesis models

Author: Guillermo F. Lara Martínez

Supervisor: Ramón Miralles Ricós
Defended on October 27th. 2016.

Summary

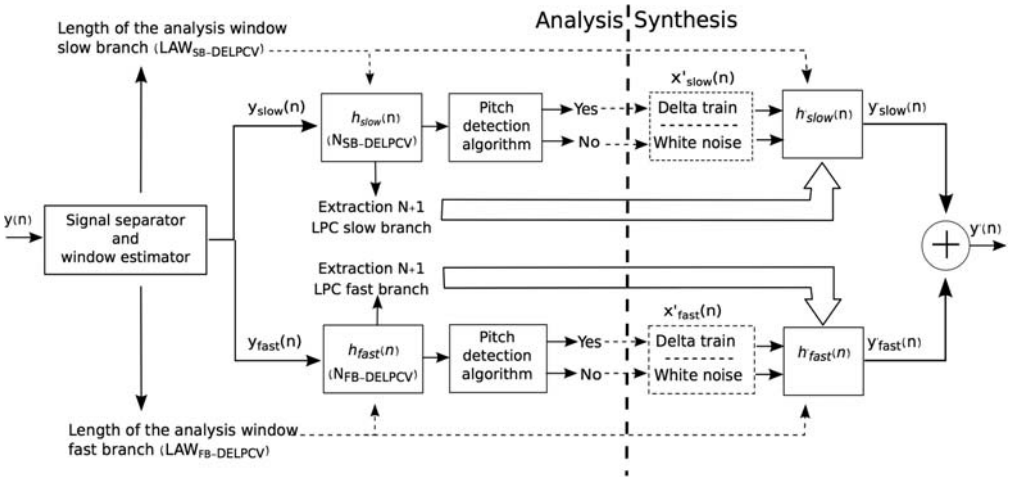
This thesis deals with the study of the sounds produced by beluga whales (Delphinapterus leucas) with a fundamental objective: its characterization and modeling. To this end, analysis / synthesis algorithms of the sounds produced by these animals are proposed. These algorithms are inspired by recent researches on how beluga whales produce the sound and in the physiognomy of the sound production organs.

This is a multidisciplinary work, and to achieve this goal many fields and topics must be studied: the generation of sounds in musical instruments, time-frequency analysis techniques along with pattern recognition methods, feature selection, the potential to include algorithms that work in the cepstral domain and a quantitative analysis of the Recurrence Plots. All this allows to propose a sound production model capable to adapt to the peculiarities of this specie and reproduce with high fidelity its wide repertoire of sounds.

In addition, in order to validate the proposed model, different sounds from a database of beluga whale vocalizations were analyzed. These sounds were compared with those generated with a generic analysis / synthesis model. Furthermore, it is proposed to use the synthesis model parameters for a new sound classification based on how the sounds are produced, achieving better results than those obtained with classifiers based on characteristics of the time-frequency diagram.

All the proposed hypotheses have been validated by doing acoustic measurements of beluga whales from the Oceanografic of Valencia (supervised by park biologists), as well as many audio laboratory recordings under controlled conditions.

Finally, a passive acoustic monitoring device called SAMARUC design in the frame-work of the projects related to this thesis is described. The SAMARUC system has the possibility to include different signal processing algorithms for sound analysis in open water environment and can record high quality sounds. It can also provide the classification of the acoustic events as well as the noise indicators of good environmental status of our seas and oceans. These indicators include underwater noise levels as reflected in the Descriptor 11 of the Marine European Directive. For this reason, we expect that this research will have a significant importance in the future years.



Thesis Summary

Title: Non-Uniform Constellations for Next-Generation Digital Terrestrial Broadcast Systems

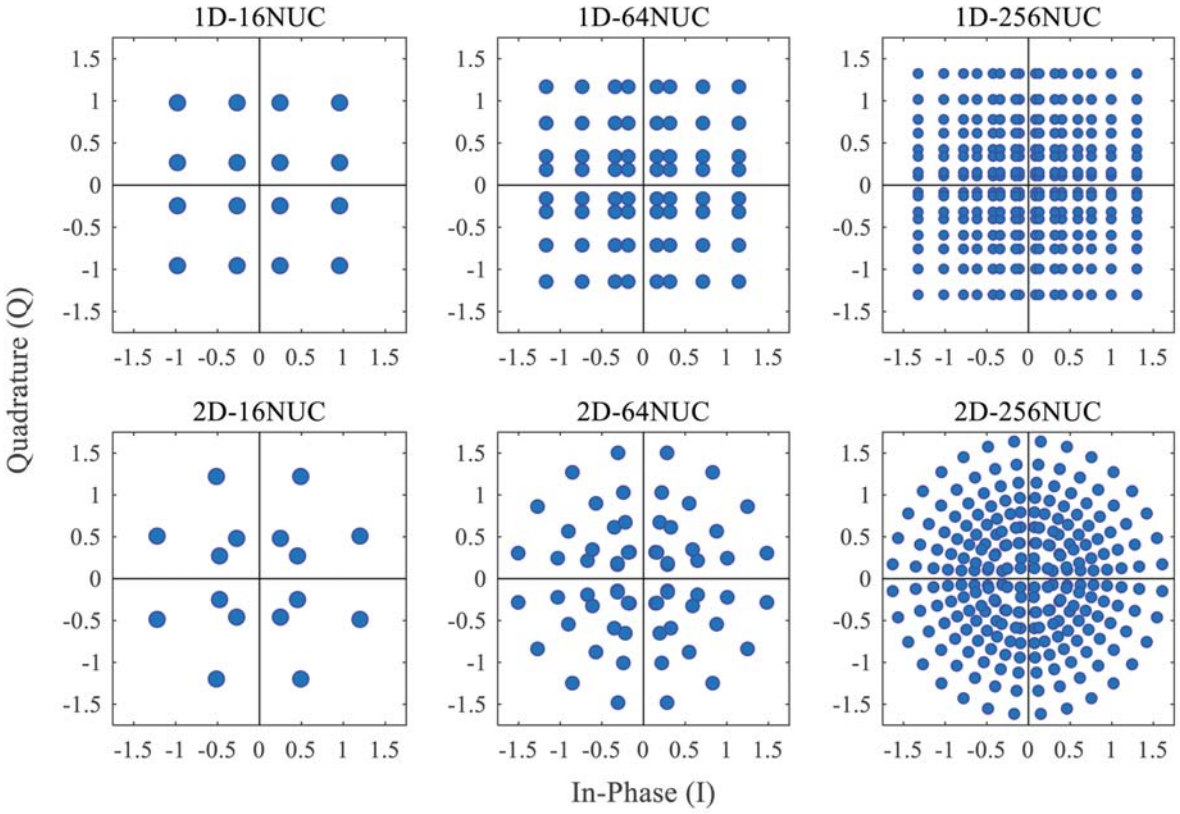
Author: Fuentes Muela, Manuel

Supervisor: David Gomez-Barquero
Defended on June 2nd, 2017.

Summary

Nowadays, the digital terrestrial television (DTT) market is characterized by the high capacity needed for high definition TV services. There is a need for an efficient use of the broadcast spectrum, which requires new technologies to guarantee increased capacities. Non-Uniform Constellations (NUC) arise as one of the most innovative techniques to approach those requirements. NUCs reduce the gap between uniform Gray-labelled Quadrature Amplitude Modulation (QAM) constellations and the theoretical unconstrained Shannon limit. With these constellations, symbols are optimized in both in-phase (I) and quadrature (Q) components by means of signal geometrical shaping, considering a certain signal-to-noise ratio (SNR) and channel model. There are two types of NUC, one-dimensional and two-dimensional NUCs (1D-NUC and 2D-NUC, respectively). 1D-NUCs maintain the squared shape from QAM, but relaxing the distribution between constellation symbols in a single component, with non-uniform distance between them. These constellations provide better SNR performance than QAM, without any demapping complexity increase. 2D-NUCs also relax the square shape constraint, allowing to optimize the symbol positions in both dimensions, thus achieving higher capacity gains and lower SNR requirements. However, the use of 2D-NUCs implies a higher demapping complexity, since a 2D-demapper is needed, i.e. I and Q components cannot be separated. In this dissertation, NUCs are analyzed from both transmit and receive point of views, using either single-input single-output (SISO) or multiple-input multiple-output (MIMO) antenna configurations. In SISO transmissions, 1D-NUCs and 2D-NUCs are optimized for a wide range of SNRs and different constellation orders. The optimization of rotated 2D-NUCs is also investigated. Even though the demapping complexity is not increased, the SNR gain of these constellations is not significant. The highest rotation gain is obtained for low-order constellations and high SNRs. However, with multi-RF techniques, the SNR gain is drastically increased, since I and Q components are transmitted in different RF channels. In this thesis, multi-RF gains of NUCs with and without rotation are provided for some representative scenarios. At the receiver, two different implementation bottlenecks are explored. First, the demapping complexity of all considered constellations is analyzed. Afterwards, two complexity reduction algorithms for 2D-NUCs are proposed. Both algorithms drastically reduce the number of distances to compute. Moreover, both are finally combined in a single demapper. Quantization of NUCs is also explored in this dissertation, since LLR values and I/Q components are modified when using these constellations, compared to traditional QAM constellations. A new algorithm that is based

on the optimization of the quantizer levels for a particular constellation is proposed. The use of NUCs in multi-antenna communications is also investigated. It includes the optimization in one or two antennas, the use of power imbalance, the cross-polar discrimination (XPD) between receive antennas, or the use of different demappers. Assuming different values for the parameters evaluated, new Multi-Antenna Non-Uniform Constellations (MA-NUC) are obtained by means of a particularized re-optimization process, specific for MIMO. At the receiver, an extended demapping complexity analysis is performed, where it is shown that the use of 2D-NUCs in MIMO extremely increases the demapping complexity. As an alternative, an efficient solution for 2D-NUCs and MIMO systems based on Soft-Fixed Sphere Decoding (SFSD) is proposed. The main drawback is that SFSD demappers do not work with 2D-NUCs, since they perform a Successive Interference Cancellation (SIC) step that needs to be performed in separated I and Q components. The proposed method quantifies the closest symbol using Voronoi regions and allows SFSD demappers to work.



Thesis Summary

Title: Ultra Dense Networks Deployment for beyond 2020 Technologies

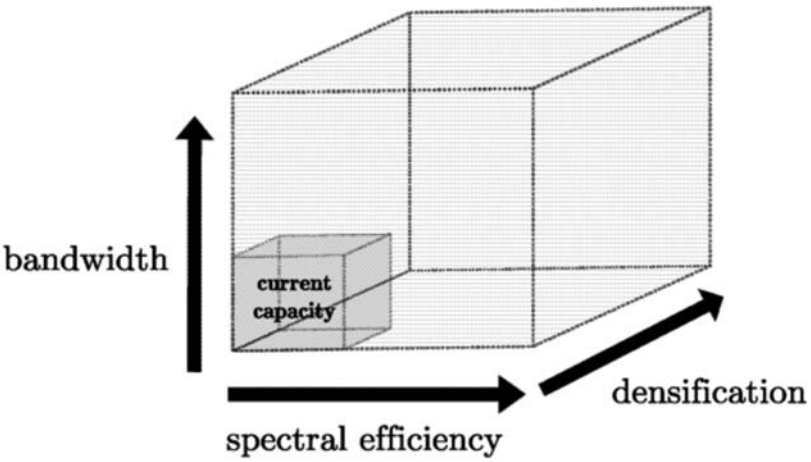
Author: Giménez Colás, Sonia

Supervisors: Cardona Marcet, Narciso; Monserrat del Río, Jose Francisco; Calabuig Soler, Daniel
Defended on July 19th, 2017.

Summary

A new communication paradigm is foreseen for beyond 2020 society, due to the emergence of new broadband services and the Internet of Things era. The set of requirements imposed by these new applications is large and diverse, aiming to provide a ubiquitous broadband connectivity. Research community has been working in the last decade towards the definition of the 5G mobile wireless networks that will provide the proper mechanisms to reach these challenging requirements. In this framework, three key research directions have been identified for the improvement of capacity in 5G: the increase of the spectral efficiency by means of, for example, the use of massive MIMO technology, the use of larger amounts of spectrum by utilizing the millimeter wave band, and the network densification by deploying more base stations per unit area. This dissertation addresses densification as the main enabler for the broadband and massive connectivity required in future 5G networks. To this aim, this Thesis focuses on the study of the UDN. In particular, a set of technology enablers that can lead UDN to achieve their maximum efficiency and performance are investigated, namely, the use of higher frequency bands for the benefit of larger bandwidths, the use of massive MIMO with distributed antenna systems, and the use of distributed radio resource management techniques for the inter-cell interference coordination.
Firstly, this Thesis analyzes whether there exists a fundamental performance limit related with densification in cellular networks. To this end, the UDN performance is evaluated by means of an analytical model consisting of a 1-dimensional network deployment with equally spaced BS. The inter-BS distance is decreased until reaching the limit of densification when this distance approaches 0. The achievable rates in networks with different inter-BS distances are analyzed for several levels of transmission power availability, and for various types of cooperation among cells. Moreover, UDN performance is studied in conjunction with the use of a massive number of antennas and larger amounts of spectrum. In particular, the performance of hybrid beamforming and precoding MIMO schemes are assessed in both indoor and outdoor scenarios with multiple cells and users, working in the mmW frequency band. On the one hand, beamforming schemes using the full-connected hybrid architecture are analyzed in BS with limited number of RF chains, identifying the strengths and weaknesses of these schemes in a dense-urban scenario. On the other hand, the performance of different indoor deployment strategies using HP in the mmW band is evaluated, focusing on the use of DAS. More specifically, a DHP suitable for DAS is proposed, comparing its performance with that of HP in other indoor

deployment strategies. Lastly, the presence of practical limitations and hardware impairments in the use of hybrid architectures is also investigated. Finally, the investigation of UDN is completed with the study of their main limitation, which is the increasing inter-cell interference in the network. In order to tackle this problem, an eICIC scheduling algorithm based on resource partitioning techniques is proposed. Its performance is evaluated and compared to other scheduling algorithms under several degrees of network densification. After the completion of this study, the potential of UDN to reach the capacity requirements of 5G networks is confirmed. Nevertheless, without the use of larger portions of spectrum, a proper interference management and the use of a massive number of antennas, densification could turn into a serious problem for mobile operators. Performance evaluation results show large system capacity gains with the use of massive MIMO techniques in UDN, and even greater when the antennas are distributed. Furthermore, the application of ICIC techniques reveals that, besides the increase in system capacity, it brings significant energy savings to UDNs.



Thesis Summary

Title: 3GPP Long Term Evolution: Performance Analysis and Evolution towards 4G with Coordinated Multi-Point Transmission

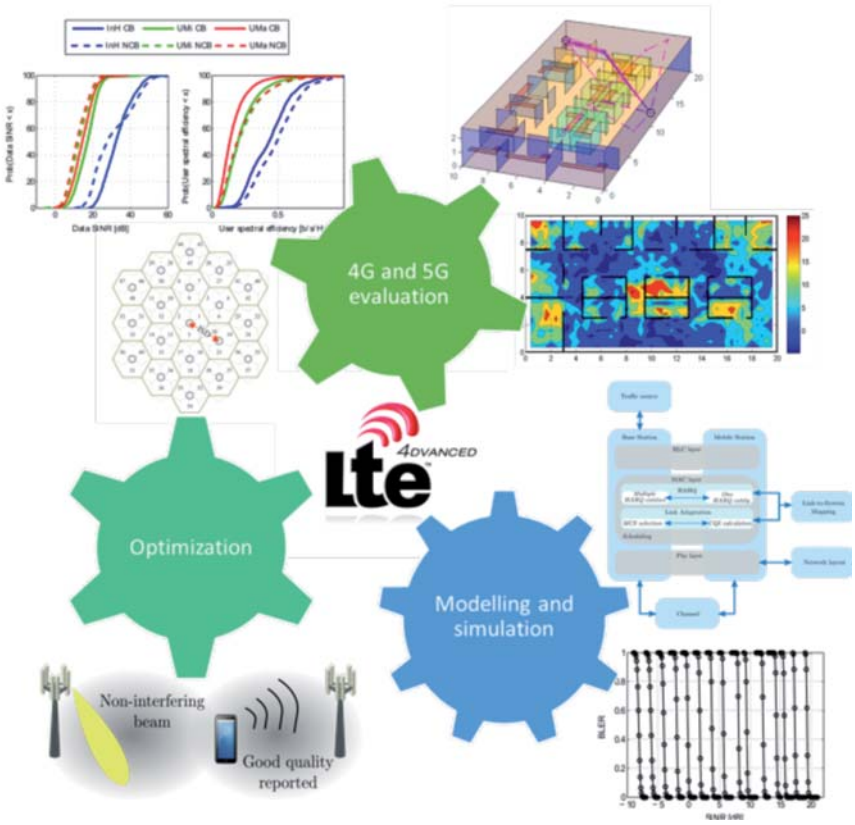
Author: Martín-Sacristán Gandía, David

Supervisors: Cardona Marcet, Narciso; Monserrat del Río, Jose Francisco
Defended on February 5th, 2016.

Summary

In today's information society, there is a growing need to access data communication services ubiquitously, with mobility and increasingly higher data rates. This society's demand has motivated the development of the fourth generation of mobile communications (4G) and its evolution towards the fifth generation (5G). This development has required a revolution on the radio interface of the mobile communications systems, and, consequently, has significantly modified their capabilities and their radio resource management. This is the case of the technology known as Long Term Evolution (LTE) and its 4G version called LTE-Advanced. This Doctoral Thesis addresses the modelling, the radio resource management analysis, and the performance evaluation of the downlink of LTE and LTE-Advanced where, among the different features of LTE-Advanced, the focus is on the Coordinated Multi-Point (CoMP) transmission. The Thesis provides a detailed description of the main characteristics of LTE and LTE-Advanced. The high complexity of these systems has prompted the use of computer simulations as the primary research methodology. The Thesis makes a detailed description of the simulation methodology and the system modelling required, including some contributions of the author in this field. Among them, it is of significant relevance the link-level simulation results used in the European project WINNER + for the LTE evaluation. With regard to the analysis of the radio resource management in LTE, the fundamentals of link adaptation and scheduling are explained in the first place. In relation to the scheduling, the Thesis includes a thorough study of the proportional fairness concept and the suboptimal implementation typically used in LTE to maximize this metric. This study has resulted in a series of ideas embodied in a modification of the typical implementation, which has proved to be capable of increasing the proportional fairness of the resource allocations. Moreover, the link adaptation analysis has revealed the "flashlight" effect problem, which is characterized by a high interference variability due to rapid changes in the scheduling decisions. The Thesis demonstrates that a particular implementation that stabilizes the scheduling decisions can improve the system performance. The radio resource management analysis of this Thesis is completed with the study of CoMP. Specifically, the CoMP scheme studied in this Thesis is a solution with coordinated scheduling and beamforming (CS/CB), that takes into account realistic and robust assumptions concerning the knowledge that the coordinated points have about the channel state. The Thesis proposes this so-

lution for its simplicity and its ability to improve high data rates coverage and capacity even with incomplete channel knowledge. Concerning LTE and LTE-Advanced evaluation, it is performed in two different types of scenarios. On the one hand, the scenarios defined in the process of evaluation of IMT-Advanced. In this framework, it is evaluated the importance of different multi-antenna techniques, including CoMP, considering full-buffer traffic models. The most important conclusions in these scenarios are the significant performance improvement achieved with spatial multiplexing of users and the fact that CoMP mechanisms provide a reduced benefit. The second group of scenarios are those defined by the European project METIS for the evaluation of 5G technologies. Specifically, an indoor office scenario and an outdoor sports stadium have been selected. In these scenarios, a realistic traffic model is used, and it has been demonstrated the utility of CoMP to satisfy the first 5G requirement definitions with feasible frequency bandwidths. In these scenarios with less homogeneous deployments, or with a limited number of transmitters originating the major part of interference, is where this Thesis has found CoMP to be more useful and where the thesis promotes its use.



Thesis Summary

Title: Frequency Planning for Digital Terrestrial Television (DTT) in South America

Author: Ribadeneira Ramírez, Jefferson Alexander

Supervisors: Cardona Marcet, Narciso; David Gomez-Barquero
Defended on February 10th, 2016.

Summary

Digital Terrestrial Television (DTT), offers greater robustness against noise and interference, more efficient use of radio-electric spectrum by the possibility of using single frequency networks (SFN) and the possibility of transmitting several television channels for the same radio channel. In addition, it is possible to provide value-added services such as HDTV and 3D. In the transition from analog to digital television, it must be perform a first stage of simulcast, where both analogue and digital signals should coexist. In this stage, a critical point is the low availability of frequencies. Therefore, first it is necessary to perform a frequency planning at regional level between the countries and internally for each country. Due to the high power that DTT transmitters normally radiate, and the locations of the transmitters at high points, frequency planning at regional level should take into account coordination areas and protection distances inside the border of each country. Finally, DTT network planning should be perform for the assigned frequencies. Additionally, the most efficient usage of the radio electric spectrum involved the introduction of the DTT, have allowed the release of certain frequency bands traditionally allocated for broadcasting. The released bands are known as Digital Dividend (DD), and correspond to the 800 MHz band (790-862 MHz) and 700 MHz (698-806 MHz) in Europe, and 700 MHz band in America. These bands have been allocated for the use of fourth generation mobile communications 4G LTE. The inclusion of LTE in the digital dividend bands, represents an additional problem for the deploy of DTT networks. Because both, DTT and LTE networks must coexist in adjacent frequency channels. Therefore, two coexistence cases must be considered. On the one hand, to the deployment of new DTT networks, must be analyzed the potential interference from LTE networks, as well the possible solutions to mitigate the interference. Moreover, for DTT networks already deployed, interference problems must be solved at the lowest possible cost and impact. This thesis deals with frequency planning for DTT networks in South America, where several DTT standards have been adopted. Most countries in the region have adopted the Japanese-Brazilian standard ISDB-Tb. However, Colombia has adopted the European second generation standard DVB-T2, with the particularity that Colombia is the first country in the world in which DVB-T2 must work with 6 MHz channelization, and must coexist with the analog TV standard NTSC. This along with the late release of the DD band in America, presents a much more complex scenario for DTT planning network in the region. First the frequency planning at the regional level for all countries of South America is studied, later the frequency planning at national level for

Colombia is addressed. For this purpose, is investigated the coexistence of the European second generation standard (DVB-T2), the Japanese-Brazilian first generation standard (ISDB-Tb), the American analog TV standard NTSC and the mobile communications standard LTE working in digital dividend bands, as well as different technical solutions to mitigate interference on DTT networks. Finally, the recommendations of coexistence between analogue television networks NTSC, digital television networks ISDB-T, DVB-T2 and mobile communications networks 4G LTE are presented. These recommendations constitute a useful handbook for DTT network planning in South America.

Thesis Summary

This is a fully artistic thesis part of the work in the field of music and technology from ITEAM member Dr. Jorge Sastre

Title: Stylistic evolution of Leonardo Balada's work

Author: Uribarri Berrojalbiz, Idoia

Supervisor: Sastre, Jorge
Defended on July 7th, 2017.

Summary

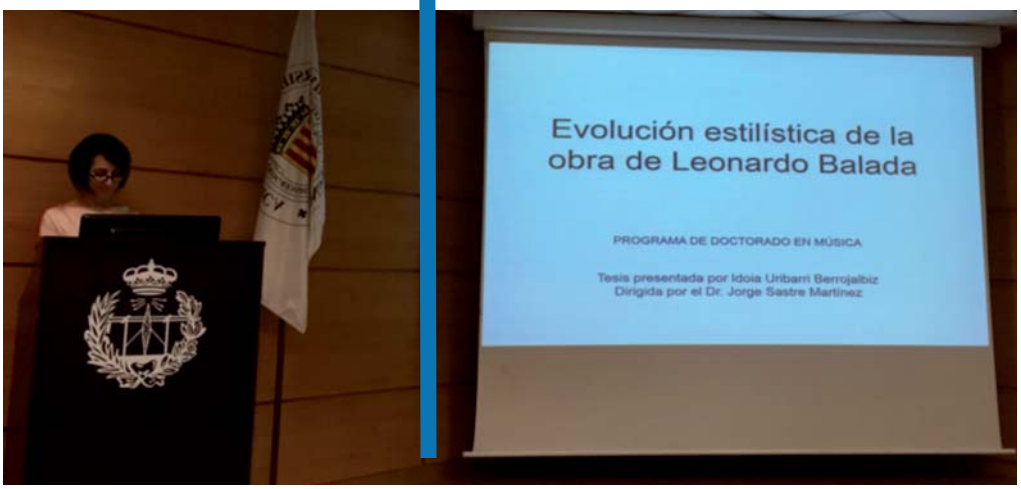
The goal of this investigation is to define Spanish composer Leonardo Balada (Barcelona, 1933) style and evolution through the analysis of four of his compositions.

From the moment he moved to New York in 1956 in order to study with eminent teachers such us Aaron Copland or Vincent Persichetti, Balada has composed more than 120 works of great beauty and personality, ranging all kinds of music genres. Since the early 60s, his music enjoyed international success and he received several commissions from a number of important European and American music institutions. Prestigious orchestras (such as the New York or the Los Angeles Philharmonic), conductors (L. Maazel), soloists (A. de Larrocha and G. Cassadó) have played his compositions, also recorded by labels like Deutsche Grammophon or Naxos.

Notwithstanding the relevance, quality and impact of Balada's work, an overall analysis of his musical language has never been attempted.

Four works are considered in the framework of this investigation: Concert per Violoncello i 9 instrumentistes (1962), María Sabina (1969), Homage to Casals (1975) and Prague Sinfonietta (2003). Each of these works represents a different phase of Balada compositional trajectory and contains those peculiar features that have influenced his music evolution. These features (i.e.: the use or suppression of elements as important as tonal harmony or melody) are common to most of the works composed in the same period and allow us an interpretation of Balada music.

Conversations with the composer as well as his classes (Balada is Composition Professor at the Carnegie Mellon University) were important sources of information. They resulted in greatly helping understanding his music and investigating the features of a very complex musical language that has evolved, with the passing of time and the use of different techniques, to eventually become the peculiar style defining the personality of this exceptional composer.



Other theses

Other PhD dissertations held on iTEAM between January 2016 and July 2017:

Title: Transmit and Receive Signal Processing for MIMO Terrestrial Broadcast Systems

Author: Vargas Paredero, David Eduardo
Supervisor: David Gomez-Barquero
Defended on May 13th, 2016 with highest honours.
http://hdl.handle.net/10251/66081

Title: Radio 3.0 in the municipal environment: values, tools and resources. The case of the municipal radio station Llosa FM

Author: Terol Bolinches, Raúl
Supervisors: Hernandez Franco, Carlos Alberto; Lloret Romero, María Nuria
Defended on June 20th, 2016.
http://hdl.handle.net/10251/67930

Title: VLSI algorithms and architectures for non-binary-LDPC decoding

Author: Lacruz Jucht, Jesús Omar
Supervisors: Valls Coquillat, Javier; García Herrero, Francisco Miguel
Defended on October 3rd, 2016.
http://hdl.handle.net/10251/73266

Title: Design and validation of the second generation of the DTT standard with wireless return channel, to provide Internet connectivity in rural areas in Latin America

Author: Radicelli García, Ciro Diego
Supervisor: Cardona Marcet, Narciso
Defended on March 28th, 2017.
http://hdl.handle.net/10251/80288

Title: Design and implementation of decoders for error correction in high-speed communication systems

Author: Català Pérez, Joan Marc
Supervisors: Valls Coquillat, Javier; García Herrero, Francisco Miguel
Defended on July 7th, 2017.
http://hdl.handle.net/10251/86152

Title: ICTs as a dynamic factor in the teaching-learning process in basic training stages in the Valencian Community, with the support of Learning-Service

Author: Díaz Sáenz, José Ramón
Supervisors: Hernandez Franco, Carlos Alberto; Tolosa Robledo, Luisa María
Defended on July 19th, 2017.
http://hdl.handle.net/10251/86149