PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Ivan Iudice

XXIX Cycle

Training and Research Activities Report – Third Year

Tutor: Giacinto Gelli

1. Information

My name is Ivan Iudice, I was born in Livorno, Italy, in 1986. I received the B.S. degree, in 2008, and the M.S. degree, in 2010, from Università degli Studi di Napoli Federico II, both in Telecommunications Engineering. Since November 2011 I have been working as part of the Communication Systems and Signal Processing group at Italian Aerospace Research Center (CIRA) in Capua, Caserta, Italy. Since March 2014 I have been attending the PhD course in Information Technology and Electrical Engineering (ITEE), XXIX cycle, at Università degli Studi di Napoli Federico II, with Prof. Giacinto Gelli as tutor.

2. Study and training activities

During my second PhD year, I attended the following "ad hoc" course organized by Dipartimento di Ingegneria Elettrica e delle Tecnologie dell'Informazione (DIETI):

- "Analisi funzionale: secondo modulo", taught by Prof. Renato Fiorenza, focused on weak derivatives and Sobolev spaces, projectors on a closed sub-space of an Hilbert space, Fourier series into an Hilbert space, notes on distributions, dual space of a normed vector space and Riesz theorem, Dirichlet's problem in the weak form, reflexive space, weak topology for a normed vector space, space of linear and continuous operators, operator series, hermitian adjoint, self-adjoint operators, notes on the spectral theory, variational inequalities, fixed-point theorem, Gateaux's differentiation and Frechet's differentiation, minimization of functionals.

3. Research activities

The main goal of my research activities is to study and implement advanced technologies for communication systems to be used in the aeronautical environment, specifically for Unmanned Aircraft (UA) applications, and test them on specific test-bed or flight laboratories available at CIRA. To obtain the objectives of my research, I am currently collaborating, under the supervision of my tutor Prof. Giacinto Gelli, with Prof. Francesco Verde of DIETI, and Prof. Donatella Darsena of Dipartimento di Ingegneria of Università Parthenope di Napoli, Italy.

My research activities were mainly focused on receiver synthesis for aeronautical communication data-links employing CPM modulation over doubly (i.e., both in time and frequency) selective wireless communication channels. Since CPM is a non-linear digital modulation method with memory, simple linear equalization techniques cannot be directly used. In many cases, one can leverage on the so-called Laurent representation to obtain a more manageable expression of the CPM signal to be equalized. Most of the techniques already proposed to equalize CPM signals are based on frequency-domain equalization (FDE). However, FDE is not a computationally advantageous strategy when the channel is rapidly time-varying, such as the aeronautical one. Our aim is designing reliable and low-complexity time-varying equalizers, by exploiting all of the CPM signal features, in order to compensate for the effects due to the rapidly time-varying aeronautical channels. In particular:

- the basis expansion model (BEM) has been considered to represent the aeronautical communication channel;
- the second-order statistical characterization of the pseudo-symbols arising from Laurent representation of CPM signals has been studied, showing that some mathematical inconsistencies can be overcome by adopting a one-sided signal model;
- linear time varying (LTV) receiver structures for CPM signal operating over doubly-selective channels have been proposed and implemented by using the BEM model for the channel;

- widely-linear time varying (WLTV) receiver structures for improper CPM signals operating over doubly-selective channels have been proposed and implemented by using the BEM model.

Simulation results reported in the dissertation show that time-varying equalizers significantly outperform the time-invariant ones, and moreover the WLTV implementations provide better performances than the LTV receivers when improper or noncircular features of CPM signals are suitably exploited.

4. Products

- D. Darsena, G. Gelli, F. Verde, and I. Iudice “LTV equalization of CPM signals over doubly-selective aeronautical channels,” 3rd IEEE International Workshop on Metrology for Aerospace, Florence, Italy, 2016.
- D. Darsena, G. Gelli, I. Iudice, and F. Verde “Widely-linear transceiver design for amplify-and-forward MIMO relaying,” 9th IEEE Sensor Array and Multichannel Signal Processing Workshop (SAM), Rio de Janeiro, Brazil, 2016.

In preparation:

- D. Darsena, G. Gelli, I. Iudice, and F. Verde “WLTV equalization of noncircular CPM signals over doubly-selective aeronautical channels,” in IEEE Transactions on Aerospace and Electronic Systems.
- D. Darsena, G. Gelli, I. Iudice, and F. Verde “Conjugate autocorrelation function of pseudo-symbols in Laurent PAM decomposition for one-sided partial-response continuous-phase modulated signals,” in IEEE Signal Processing Letters.

5. Conferences and seminars

None.

6. Activities abroad

None.

7. Tutorship

None.

8. Credits summary

	Credits year 1								Credits year 2								Credits year 3									
		1	2	3	4	5	6			1	2	3	4	5	6			1	2	3	4	5	6			
	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Total	Check
Modules	**20**				6		13	**19**	**10**			7				**7**	**0**		7					**7**	**33**	**30-70**
Seminars	**5**				2,2	3		**5,2**	**5**		0,4			4,2	0,5	**5,1**	**0**							**0**	**10**	**10-30**
Research	**35**	8	8	8	2	6	4	**36**	**45**	10	9		9	9	11	**48**	**60**	10	3	10	10	10	10	**53**	**137**	**80-140**
	60	8	8	8	10	9	17	**60**	**60**	10	9,4	7	9	13	11	**60**	**60**	10	10	10	10	10	10	**60**	**180**	**180**