16. SOFTWARE DEFINED ELECTRONICS AND VIRTUAL INSTRUMENTATION

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ACTIVITY OF THE SDE-VI LAB, A BRIEF DESCRIPTION

Recent research topics of the Software Defined Electronics (SDE) and Virtual Instrumentation (VI) laboratory:

Reconfigurable physical layers

- Elaboration of CS-GCSK/GCS-DCSK modulation schemes
- Derivation of analytical expression for the BER performance of these new modulation schemes
- Elaboration of a step-by-step method for the derivation of detection algorithms assuring optimum solution for different applications

Application-oriented protocols for PHY layer

- Elaboration of UWB FM-DCSK protocol which improves by an order the coverage of the already published Gaussian UWB Impulse Radio (IR)
- Elaboration of UWB Chirp IR TR protocol which improves by an order the coverage of Gaussian UWB IR but which preserves the channel dispersion suppression capability of Gaussian one

SDE conform BaseBand (BB) WND models

- Elaboration of a step-by-step method for the derivation of equivalent BB models of WLAN and BioMed devices
- By integration of BB simulators into the SDE platform we have elaborated a software defined research platforms for the generation and analysis of real physical signals (see photo below

Detection algorithms on GP-GPU platform suitable for WLAN applications

- We have shown that with appropriate parallel algorithms the GP-GPU platforms can be used to implement detectors
- Elaboration of PSD algorithm which implements the ML detection on GP-GPU platform

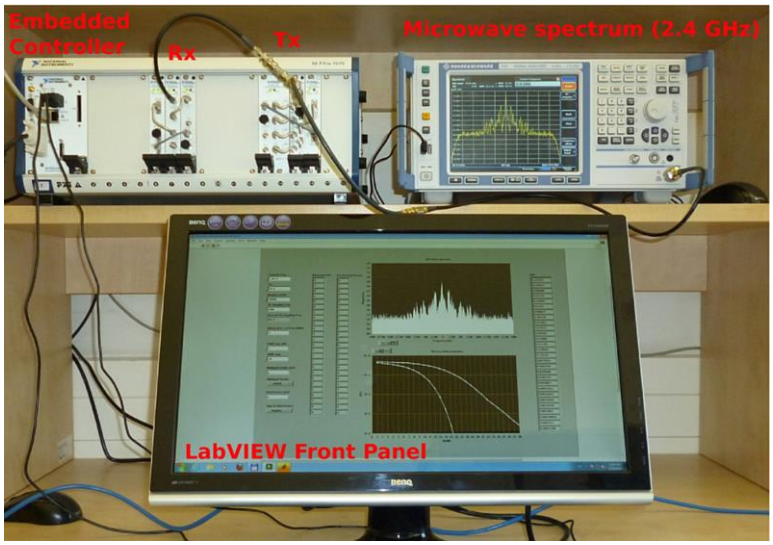

Fig. 1 *Photo of the PXI based SDE research and development platform installed in the SDE-VI lab. The "Embedded Controller" that is responsible for running the application software and controlling the modular units, the "Rx" unit that performs the transformation between the RF and baseband domains, and the "Tx" unit that performs the inverse transformation, are in the same PXI chassis. The "LabVIEW Front Panel" that appears on the PC monitor shows the graphical user interface of the software that is run by the "Embedded Controller". The real physical signals generated by software are measured by a Rohde & Schwarz spectrum analyser.*

INTERNATIONAL RECOGNITION OF OUR LABORATORY

Our SDE-VI Lab has been playing a leading role worldwide in the research of software defined electronics. This leading role had been recognized by IEEE CAS Society and we were asked to write a tutorial on SDE for the IEEE CAS Magazine in 2012. See item [9] in the publications list. Our contribution to this area has attracted the attention of the scientific community even more. As a consequence Prof. Kolumbán has been elected as a speaker in the 2013-2014 Distinguished Lecturer Program (DLP) by the IEEE-CAS.

PUBLICATIONS

[1] Csaba Máté Józsa, Géza Kolumbán, Antonio M Vidal, Francisco J Martínez-Zaldívar, Alberto González: Parallel Sphere Detector algorithm providing optimal MIMO detection on massively parallel architectures, *Elsevier, DSP* 2014 (accepted)

[2] Géza Kolumbán, Tamás Krébesz, Chi K Tse, Francis C M Lau: Turn your baseband Matlab simulator into a fully functional, 2.4-GHz, operating FM-DCSK transceiver using SDE platform, In: *Proceedings of the European Conference on the Circuit Theory and Design* 2013

[3] Géza Kolumbán, Tamás Krébesz, Chi K. Tse, and Francis C.M. Lau: Basics of Communications Using Chaos, Chaotic Signals in Digital Communications -*Electrical Engineering & Applied Signal Processing Series*, October 25, 2013 by CRC Press

[4] Tamás Krébesz, Géza Kolumbán, Francis C M Lau, Chi K Tse: Application of universal software defined PXI platform for the performance evaluation of FM-DCSK communications system, *Proceedings of the European Conference on the Circuit Theory and Design* 2013

[5] Weikai Xu, Lin Wang, Géza Kolumbán: A New Data Rate Adaption Communications Scheme for Code-Shifted Differential Chaos Shift Keying Modulation, *International Journal of Bifurcations and Chaos*,No.7,Vol.22

[6] Géza Kolumbán, Tamás Krébesz, Chi K. Tse, Francis C M Lau: Improving the coverage of ultra wideband impulse radio by pulse compression, In *Proc. 2012 IEEE International Symposium on Circuits and Systems*

[7] Géza Kolumbán, Tamás Krébesz, Chi K. Tse, Francis C M Lau: Implementation of FM-DCSK modulation scheme on USRP platform based on complex envelope, In *Proc. 2012 International Symposium on Nonlinear Theory and its Applications*

[8] Géza Kolumbán, Tamás Krébesz, Francis C M Lau, Chi K. Tse: Performance Comparison of UWB Chirp IR TR and UWB FM-DCSK TR Systems Implemented with Autocorrelation Receiver, In *Proc. 2012 International Symposium on Nonlinear Theory and its Applications*

[9] Géza Kolumbán, Tamás Krébesz, Francis C M Lau: Theory and Application of Software Defined Electronics: Design Concepts for the Next Generation of Telecommunications and Measurement Systems, *IEEE CIRCUITS AND SYSTEMS MAGAZINE* (ISSN: 1531-636X) 12:(2) pp. 8-34.

[10] Tamás Krébesz, Géza Kolumbán, Csaba Máté Józsa: Ultra-Wideband Impulse Radio Based on Pulse Compression Technique, In *Proc. 20th European Conference on Circuit Theory and Design* (ECCTD 2011)

[11] W. K. Xu, L. Wang, Géza Kolumbán: A Novel Differential Chaos Shift Keying Modulation Scheme, *International Journal of Bifurcation and Chaos*

[12] Tamás Krébesz, Géza Kolumbán, Csaba Máté Józsa: Exploiting pulse compression to generate an IEEE 802.15.4a-compliant UWB IR pulse with increased energy per bit, In *Proc. 2011 IEEE International Conference on Ultra-Wideband* (ICUWB)

[13] Tamás Krébesz, Csaba Máté Józsa, Géza Kolumbán: New Carrier Generation Techniques and Their Influence on Bit Energy in UWB Radio, In Proc. *20th European Conference on Circuit Theory and Design* (ECCTD 2011)