UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

"Time-Variant and Non-Linear Transponders: from Theory to Practice"

Assistant Prof. Nicolas Barbot

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Short Abstract: This course aims to provide a summary of the different techniques used to detect and identify a transponder in real environment using radio frequency waves. The first approach allows the transponders to modulate its backscattered field. These transponders are able to generate new frequency components around the carrier frequency sent by the reader. Different examples include NFC, UHF RFID, barcodes… The second approach is based on the non-linearity of the transponders. These transponders can create new frequency components located at multiple of the fundamental frequency used by the reader. These two approaches allow to detect and identify a transponders in complex environment and offer significant advantages in term of read range and coding capacity compared to traditional techniques.

After describing the principle of operation of these two approches, RF instumentation will be used to detect, characterize and identify the previously presented transponders. Measurements will be done in both time and frequency domain using the available instrumentation in the University of Pisa, and instrumentation from the LCIS laboratory. Software defined radio will be used to implement a fully functional reader.

Course Contents in brief:

- Introduction to Linear Time Invariant Transponders.
- Modulated Transponders
  - UHF RFID
  - Rotating Scatterers
  - Translated Scatterers
- Non Linear Transponders
  - Harmonic Transponders
  - Non-Linear Modulation
- Measurement and Characterization of LTV and NL transponders
  - Reader Architecture
  - Time domain analysis (VNA)
  - Frequency domain analysis (Spectrum analyzer)

Total # of hours of lecture: 16 hours

References:

[1] N. Barbot, O. Rance and E. Perret, "Classical RFID Versus Chipless RFID Read Range: Is Linearity a Friend or a Foe?," in *IEEE Transactions on Microwave Theory and Techniques*, vol. 69, no. 9, pp. 4199-4208, Sept. 2021, doi: 10.1109/TMTT.2021.3077019.

[2] N. Barbot, R. de Amorim and P. Nikitin, "Simple Low Cost Open Source UHF RFID Reader," in *IEEE Journal of Radio Frequency Identification*, vol. 7, pp. 20-26, 2023, doi: 10.1109/JRFID.2022.3227533.

[3] N. Barbot and E. Perret, "Linear Time-Variant Chipless RFID Sensor," in *IEEE Journal of Radio Frequency Identification*, vol. 6, pp. 104-111, 2022, doi: 10.1109/JRFID.2021.3120666.

CV of the Teachers

Assistant Prof. Nicolas Barbot

Nicolas Barbot received the M.Sc. degree and Ph.D. degree from the University de Limoges, France in 2010 and 2013 respectively. His Ph.D. work in Xlim Laboratory was focused on error-correcting codes for the optical wireless channel. He also realized a post-doctoral work in joint source-channel decoding at L2S Laboratory, in Gif-sur-Yvette, France. Since September 2014, he has been an Assistant Professor at the Université Grenoble Alpes - Grenoble Institute of Technology, in Valence, France. His scientific background at LCIS Laboratory covers wireless communications systems based on backscattering principle which include classical RFID and chipless RFID.
His research interest include transponders which can not be described by linear time-invariant systems. This gathers harmonic transponders which are based on the use of a non-linear component (Schottky diode) or linear time-variant transponders which are based on the modification of their response in the time domain. He also places special interests on antenna design and instrumentation based on these phenomena. Since 2013, he published more than 20 international journals and more than 40 conference papers.

Room and Schedule

Room: Meeting room at the Dept. of Information Engineering, Via G. Caruso, 16, Pisa.

Schedule:

18/06/2024: 14:00 - 18:00
19/06/2024: **13:30 - 18:30**
20/06/2024: **13:30 - 18:30**
21/06/2024: 14:00 - 18:00