Radar Systems Prototyping

Instructor:

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Abstract:

Whether you are a student seeking real data to prove your Ph.D. thesis, or a researcher planning for experimentation in your grant proposal, or a system engineer in need of a radar prototype to demonstrate your innovative idea to a customer, you will be faced with prototyping a radar system with limited time and budget. There exist many books and tutorials on radar signal processing, but little is found on how to build your radar prototype that can support and run these algorithms.

This tutorial will provide you with practical skills and techniques needed to build your advanced radar prototype. The focus is not on how devices/algorithms work, but on how to *relate* the choice of microwave devices and signal processing algorithms to the desired radar specifications. You will learn how to interpret datasheets, how components/algorithms affect each other, and how signal processing dictates RF constraints, and how signal processing can fix your RF limitations.

The course will end with a step-by-step MIMO radar design example, starting from the requirements and ending with a schematic and bill of material. All participants will also receive a *free* consultation to their current radar system design until their project is completed.

Intended Audience:

- Students seeking to develop basic radar systems for academic and research purposes
- Engineers / scientists seeking practical skills to develop prototype hardware
- Young engineers facing their first radar systems design
- Specialists, theoreticians and academicians who are interested in the “big picture” in Radar
- Project and program managers of radar systems who wish to learn how to interpret and evaluate technical content and documents
- Designers new to the radar field or those needing a refresher on the basics of Radar systems design and an overview of state-of-the-art Radar sub-systems technology

Learning Outcomes:

Learn how to write schematics, bill of materials and algorithm flowcharts from e desired radar systems requirements using commercial-off-the-shelf components and basic algorithms. Emphasis is given to radar prototyping under time, budget and manpower constraints.

Detailed Description:

The proposed syllabus includes, but is not limited to:

1. Principles of system analysis, requirement engineering, SWAP analysis, and trade studies
2. Explore RF chain design techniques applicable from 1 MHz to 300 GHz. This includes:
   a. Translate radar performance requirements to RF requirements
   b. Design the RF chain to meet linear dynamic range requirements
   c. Design the RF chain to meet noise requirements
   d. Impedance matching to meet gain and gain flatness requirements
3. Front-end components and subsystems. This includes:
   a. The right antenna and cabling for the right mission

b. Understanding how the selection of one component may affect the selection of others
c. Amplifier selection and proper location in the RF chain
d. How to select oscillators and frequency references that meet the Doppler constraints

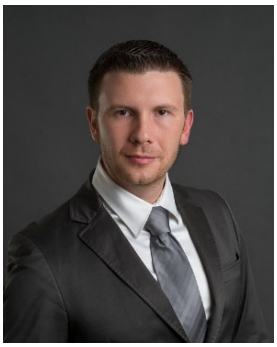
4. Back-end Design
   a. Understand ADC and DAC system parameters.
   b. Design the direct digital up/down conversion algorithms that preserve the signal quality obtained by the RF chain. Understand how RF chains directly affect the DSP design, and vice-versa
5. **Radar system designs example: Step-by-step design of an X-band pulse-Doppler radar (45 min)**

Prior Presentations:

This tutorial, introduced in 2015, remains one of the most attended classes, with consistently high remarks. This is because it is suited to all the newcomers to RadarConf. Specifically, the course has been successfully presented in the following events:

- IEEE Radar Conference 2019, half-day, 16 participants (3rd most attended tutorial)
- Telephonics University, 2018, full-day, 45 participants.
- IEEE Radar Conference 2018, half-day, 24 participants (2nd most attended tutorial)
- IEEE Radar Conference 2017, half-day, 33 participants (1st most attended tutorial)
- IEEE Radar Conference 2016, half-day, 20 participants (2nd most attended tutorial)
- The University of Dayton, full-day, presented three times. About 40 participants
- The University of Algiers, full day. About 40 participants
- National Air Space Intelligence Center, three days. About 20 participants
- Air Force Research Laboratory, full day. About 30 participants.
- IEEE NAECON Conference, Dayton OH, half-day, presented three times. About 30 participants
- PSATRI defense center, Riyadh, Saudi Arabia. About 40 participants
- IEEE Signal Processing Symposium, Debe, Poland (half-day). About 20 participants

Bio-sketches:



Dr. Lo Monte has more than ten years of applied radar, RF, DSP, EW system design and prototyping experience, from small companies, consulting, academia, research institutions, to large defense contractors and government agencies worldwide. He serves as Chief Scientist at Telephonics Corporation, with the role of translating research innovations into commercial products. Prior to that, he was a Professor at the University of Dayton, where he created the courses “Intro to Radar,” “Radar/RF Systems Design,” and “Intro to Electronic Warfare.” He was also the Director of the Mumma Radar Laboratory and served as an engineering contractor for the Air Force Research Laboratory. Dr. Lo Monte has published over 70 peer-reviewed journals, conference papers, book chapters, and patents.

Dr. Lo Monte is very active in the IEEE community, serving in the AESS Board of Governor as the Vice President for Education, and the representative to the Sensors Council. Dr. Lo Monte is also an AESS Distinguished Lecturer and an approved AESS Short Course Instructor. In this role, he taught more than 20 short courses worldwide, with a focus to underserved areas. Dr. Lo Monte is also the Topical Editor of the IEEE Sensors Journal for “Radiation Sensors.” Dr. Lo Monte also served as a technical panel member, steering committee member, judge, tutorial instructor, special session organizer, and session chair in many international IEEE conferences.

Supporting Material






Lorenzo, it was great meeting you at the conference. I have had a chance to review your tutorial. A colleague of mine, Elizabeth Kowalski, was quite pleased with what sh got out of it. I was equally impressed. David

Hi Lorenzo,

You did a fantastic job with the Radar Systems Engineering tutorial, thank you!

Dear Professor/Dr. Lorenzo Lo Monte,

Thank you for your excellent and most useful tutorial yesterday on "radar system engineering". I've learned much from you.

Lassie,
Professor LoMonte taught a 2-hour radar design tutorial at the IEEE conference I attended a few months ago. It was excellent, and I really think my team (and probably ACLR) could benefit from the extended course. The radar reverse-