Multi-Function RF Systems for Radar and Communications

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Description

In this tutorial we will discuss multi-function RF systems that provide agile radar and communications performance. These address the rising demand for RF systems to provide adaptivity and serve multiple tasks in an energy-, hardware-, space-, spectrum- efficient way, and the recent interest in Dual-Functional Radar-Communication (DFRC) systems. The tutorial will cover three parts:

1. Multi-function RF sensing systems: Concept, Development, and Implementation – M. Ritchie - 60min.

This part focuses on describing the core concepts behind mult-function RF systems. A focus of this will be on enabling hardware such as the Xilinx RFSoC, how it is possible to construct flexible multi-function RF solutions based on this, as well as what challenges there are faced. The tutorial will cover design considerations when developing on a RFSoC device and a review of what methods are needed when developing on the hardware; A description of the range of RF functions (Active/Passive Radar Modes, Surveillance Mode) that a single unit could undertake as well as how these could be configured, operating in series, parallel or enabling hot-swappable modes; How can multistatic operation be achieved and what are the requirements for Position Navigation Timing solutions that need to interface with the RFSoC.

2. Dual-Functional Radar and Communication (DFRC) systems: Signal processing and prototyping – C. Masouros – 60min.

This part focuses on the new research stream of integrated sensing and communications (ISAC). This aims to enable the rescue of radio hardware for both communications and radar, to support a multifunctional wireless network. This part will cover the benefits of dual functionality; signaling design for DFRC; Security challenges and opportunities for ISAC; ISAC design on a network level;

3. Radar-Centric DFRC: Experiments and Field Trials – M. Ritchie – 30min

This part of the tutorial will review real world experimental results and field trials performed using a RFSoC for DFRC methods. The results from the experimental campaign and field trials will be analysed and trade-offs between radar performance and communications performance will be further discussed.

Summary and Q&A - 30min

Potential Audience.

The Tutorial is targeted towards researchers from academia, industry, defense and government stakeholders, early stage researchers; those interested in developing wireless technologies for radar and communications, and those who are interested in system multifunctionality through radar and communications techniques, e.g., vehicular network, drone network and WiFi based indoor positioning. The links and references of the material to **Radar, Wireless Communications, Physical-Layer Security, Dual Function Radar/Communications Systems, Hardware-Efficient MIMO** and **Optimization** define its primary audience as researchers in these areas. In addition to the researchers from IEEE AESS, this tutorial is intended for audiences from the communities of **Information Theory**, S**ignal Processing**, **Mobile Computing, Intelligent Transportation.**

Bios

Christos Masouros (FIEEE, MIET) received the PhD in Electrical and Electronic Engineering from the University of Manchester, UK in 2009. In 2008 he was a research intern at Philips Research Labs, UK. Between 2009-2012 he held research positions in the University of Manchester and Queen's University Belfast. In 2012 he joined University College London (UCL) as a Lecturer. He has held a Royal Academy of Engineering Research Fellowship between 2011-2016. Since 2019 he is a Full Professor of Signal Processing and Wireless Communications in the Dept. Electrical and Electronic Engineering, UCL. He was the co-recipient of the 2021 IEEE SPS Young Author Best Paper Award, and the 2023 IEEE ComSoc Stephen O. Rice Prize, and the Best Paper Awards in the IEEE GlobeCom 2015 and IEEE WCNC 2019 conferences. He is an Editor for the IEEE Open Journal of Signal Processing, and Editor-at-Large for IEEE Open Journal of the Communications Society. He is a founding member and Vice-Chair of the IEEE Emerging Technology Initiative on Integrated Sensing and Communications (ISAC), Chair of the IEEE Wireless Communications Technical Committee Special Interest Group on ISAC.

Matthew Ritchie (SMIEEE) received an MSci degree in physics from The University of Nottingham, in 2008. Following this he completed an Eng.D degree at University College London (UCL), in association with Thales U.K., in 2013. He continued at UCL as a postdoctoral research associate focusing on machine learning applied to multi-static radar for micro-Doppler classification. In 2017 Dr. Ritchie took a Senior Radar Scientist position at the Defence Science and Technology Laboratories (Dstl) which also involved working as the Team Leader for the Radar Sensing group in the Cyber and Information Systems Division. During his time at Dstl he worked on a broad range of cutting-edge RF sensing challenges collaborating with both industry and academia. As of 2018 he returned to UCL and is currently an Associate Professor within the Radar Sensing group.

Murat Temiz is a research fellow at the University College London, focusing on integrated sensing and communication (ISAC) systems. He graduated with a PhD from the Electrical and Electronics Department at the University of Manchester in 2020. Since then, he has worked on multiple research projects funded by prestigious entities such as the EU, UK EPSRC and DASA. His research includes theoretical and experimental studies on ISAC systems, including system design and experimental measurements, machine learning and algorithm design and signal processing ISAC.