Introduction to Millimeter Wave Imaging

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Abstract:

When I started to study Electrical Engineering, I had no idea which peculiar topic I would choose; I was just keen to be involved in a field that would shape our future lives! Then, I took my first class in Electromagnetism (EM). I discovered Maxwell's equations and have been immediately amazed by the corpus of physical problems they can solve. But above all, I have been fascinated by what we then called the Radio frequencies (RF). It was the first time that I heard about waves that we cannot hear or see, but that can interact with matter and sense it! Moving on in my studies, I heard about microwave imaging and inverse problems: It was even more spectacular! Teachers explained to us that if we send these invisible waves to an object, we might be able to reconstruct it, which means to find its shape and the material it is made of. Starting research, I discovered that it was not so simple, but I also got a chance to conduct my own experiments and make my own images. This is what I would like to share in this introduction to Millimeter Wave imaging. The class will be mainly a lab course. I will very briefly introduce microwave imaging and two well-established methods for making an image starting from measurements. We will investigate the millimeter-wave band and more specifically the W-band (75-110GHz) as the short wavelength provides fine cross-range resolution, hence should provide images close to optical ones.

Practical organization: Every participant will get a file (.mat) including the measurements of an unknown object or set of objects. The goal is to develop codes under the teacher's guidance in order to create an image of the object. This will take two sessions.

Session 1 (2 hours): slides of introduction, description of the measurement system and analysis of the (. mat) file. Development of a program that uses the 2DFFT and the obtention of a first image of the object.

Session 2 (2 hours): Development of a program that uses the Back propagation Algorithm and the obtention of a second image of the object. Comparison of both methods. Every student will show the image to the group of students, and we will discuss the results. Are the objects recognizable and why?

Bio:

Professor Claire Migliaccio obtained an Engineering degree in 1993 and a PhD degree from INP Grenoble, France, in 1996. She was appointed as Assistant Professor at Université Côte d'Azur where she became Full Professor in 2007. Her research interests range from microwave to millimeter-wave systems for radar and imaging applications, including antenna design, measurements, and imaging techniques. She has conducted or participated in more than 30 collaborative research projects involving academic and industrial partners at national and international levels. She has co-authored more than 100 scientific contributions. Her main achievements deal with mm-wave radar for rescue helicopters or FOD detection and mm-wave scanners for security, food safety, and archaeological applications. Since 2012, she has held several leadership positions at university and national and international level, including the Direction of the IT Doctoral School (2017-2022), election at the University Academic Council (since 2020), the vice-presidency of the ASTRID committee of the French National Agency (2023-2025), elected member of the National Council of French Universities (2023-2027), elected AdCom member (2020-2022), founder and chair of the IEEE AP-S ECE committee (Expanding, Collaboration and Engagement), founder and Chair of the IEEE A-PS Mojgan Daneshmand Grant for women, Track Editor of IEEE TAP (2017-2022), Associated Editor of IEEE TAP (2016-2017), of IEEE TRS since 2022 and AP- Magazine starting on January 1st 2025.