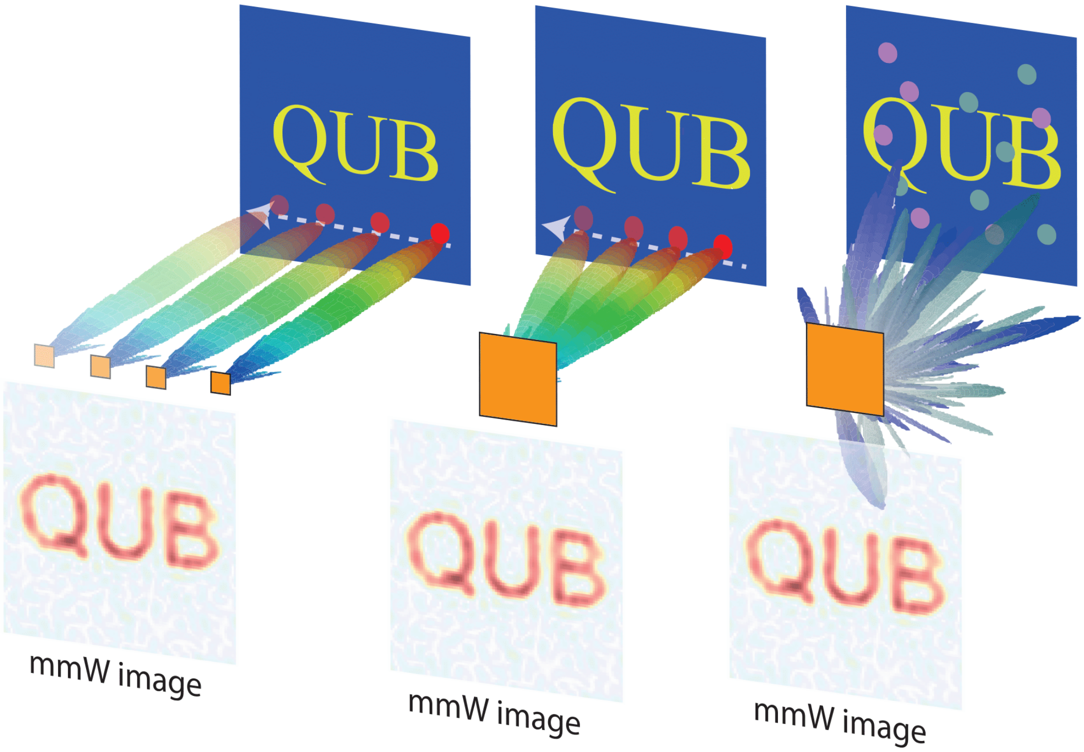


Coded-Aperture Compressive Imaging for Computational mmWave Radar Imaging, Sensing and Localization

The millimetre-wave (mmWave) part of the electromagnetic spectrum offers unique advantages, including, but not limited to, the ability to work in all-weather conditions, penetrate through most optically opaque materials while offering non-ionizing radiation. As a result, mmWave radar imaging and sensing technologies are widely used in a variety of applications: security-screening, non-destructive testing, sensing of vital respiration data, etc.

In radar imaging and sensing systems, the physical layer architecture plays a crucial role. The state-of-the-art technology relies on variants of synthetic aperture radar and phased array based solutions.

These techniques conventionally leverage a raster scan, either mechanical, electronic or both, and as a result, the current radar technology suffers from challenges such as:

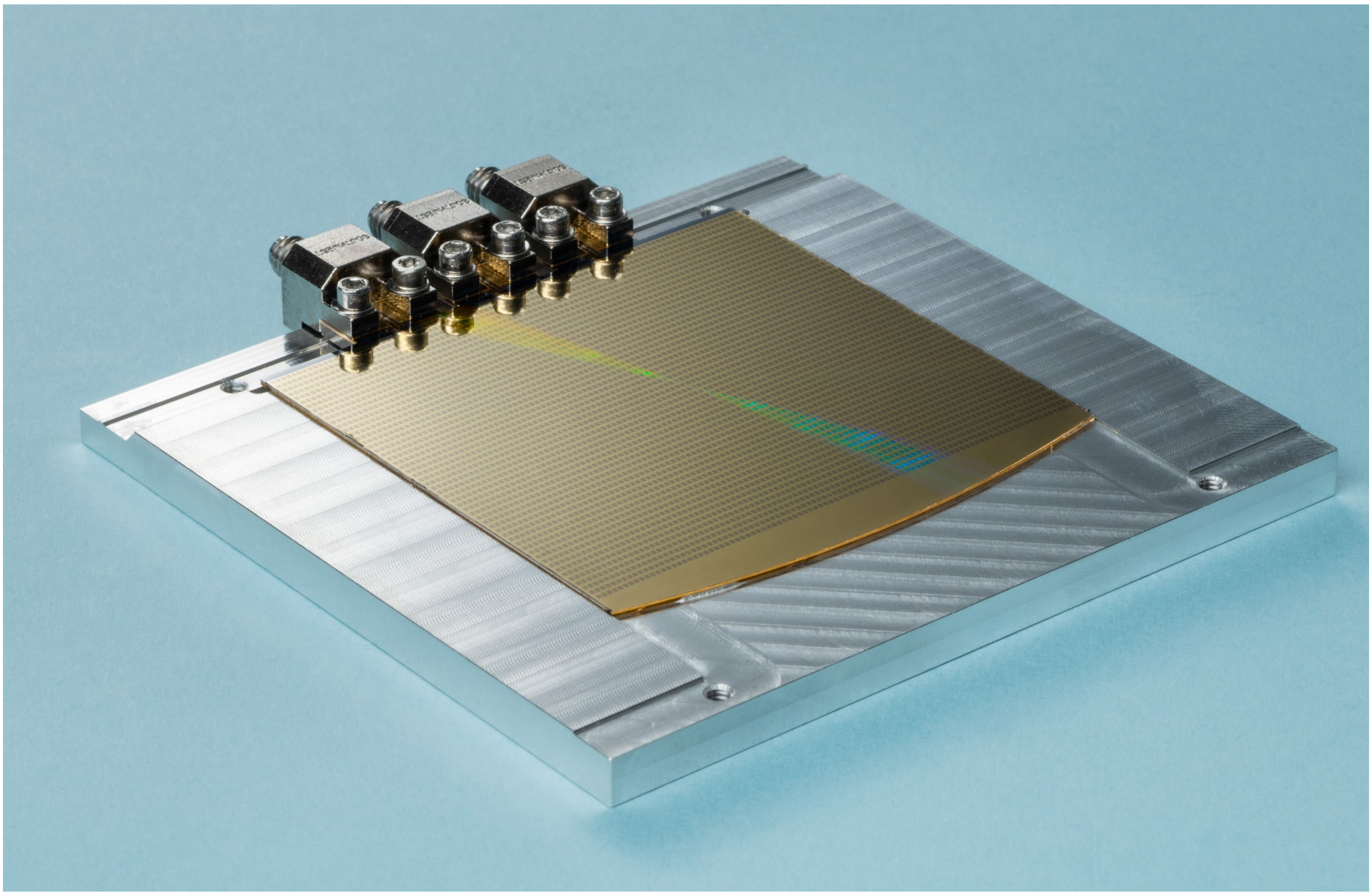
- Radar systems employing mechanical raster scan can exhibit long data acquisition times. This is a significant challenge for real-time operation.
- All-electronic operation realised by phased arrays relies on an excessive number of phase shifters and power amplifiers. These are hardware intense solutions and can consume a significant amount of power. This problem is further amplified as the operating frequency is increased.

We therefore propose a physical layer compression facilitated by coded-apertures. The coded-aperture is realized using cutting-edge metasurface antennas (see overleaf). Unlike the conventional, raster scan-based imaging and sensing modalities, the coded-aperture requires a single channel for data acquisition.

The physical layer compression is achieved thanks to the wave-chaotic radiation patterns of the coded-metasurface aperture, eliminating the raster scan requirement. It eliminates the need for an array-based receiver architecture at the receiver unit, replaced with a single data acquisition channel. This is realized using compressive coded-apertures as the physical layer compression mechanism.

We have invented a compressive channel estimation and direction-of-arrival (DoA) technique, leveraging coded-apertures with a single compressive channel.

We have shown the application of the coded-aperture based radar imaging and sensing systems for a variety of applications, e.g.: security screening, automotive radars.



Holographic Metasurface Antennas

Metasurface antennas are planar surfaces synthesized using sub-wavelength sized meta-atoms. Their significant advantage is that they can manipulate electromagnetic (EM) waves using a holographic principle.

Holography can be considered a modulation technique that, when excited with a reference-wave, can produce the desired image (or the objective function).

Leveraging a similar principle, a holographic metasurface can be used to achieve control of absorption, transmission, reflection and polarization characteristics of EM waves.

In this framework, the role of the holographic metasurface antenna is to modulate the EM waves exciting the metasurface (i.e. reference-wave) into a desired aperture field distribution that generates the radiation pattern of interest (objective function).

A holographic metasurface antenna can achieve this without the need for phase shifting circuits. This brings a significant simplification in the physical layer of metasurface antennas in comparison to their phased array counterparts.

In our research, we have demonstrated holographic metasurface antennas at microwave and mmWave frequency bands. We have not only achieved beam-synthesis using holographic metasurface antennas, but also demonstrated reconfigurable (i.e. software-defined or programmable) metasurface antennas that can radiate electronically switched radiation patterns without using any phase shifters.

Our holographic metasurface antennas (photo) have found applications in wireless communications, remote sensing, and radar imaging up to 100 GHz and above.

For product information or a quote, contact::
Norbert Sagnard, Business Development Manager
Queen’s University Belfast (CWI)
[E] n.sagnard@qub.ac.uk
[W] https://www.qub.ac.uk/ecit/CWI/