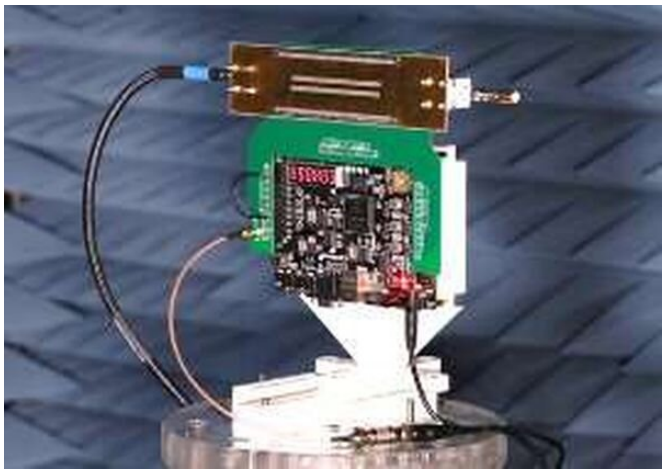
A space-time coding metasurface antenna for efficient and secure communications

22 November 2022, by Ingrid Fadelli



Photograph of the space-time-coding metasurface antenna. Credit: Wu et al.

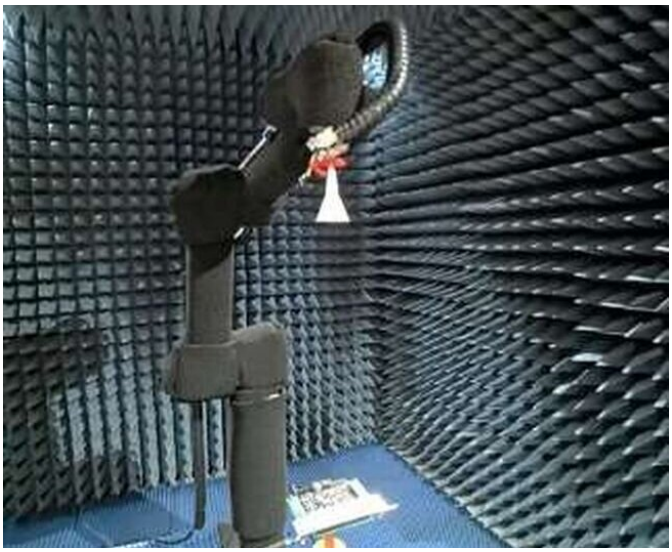
Antennas that can couple guided waves emitted from different sources in free space and manipulate these waves are crucial to the development of numerous technologies, including wireless communication, optical communication and ranging systems. Metasurfaces, thin films made up of several elements, have shown promise for developing these types of antennas.

Researchers at City University of Hong Kong and Southeast University have recently created a new metasurface antenna that can extract and manipulate guided waves to create desired free-space waves in both the spatial and frequency domains. This antenna, introduced in a paper published in *Nature Electronics*, combines two different research advancements, namely amplitude-modulated (AM) leaky-wave antennas and space-time coding techniques.

"Our paper is based on the invention of the amplitude-modulated leaky-wave antenna reported in the Ph.D. thesis of Dr. Gengbo WU at the City University of Hong Kong (CityU) and the groundbreaking research on space-time-coding metasurface led by Academician Tie Jun Cui at Southeast University," Prof. Chi Hou Chan, one of the researchers who carried out the study, told TechXplore. "The AM leaky-wave antennas are inspired by the amplitude modulation in classical communications theory. "

A key advantage of AM leaky-wave antennas is that their radiation pattern can easily be synthesized or tailored for specific uses, by changing the antenna's shape and structure. Once an antenna is fabricated, however, its radiation characteristics will typically remain fixed.

"Around the same time when the AM leaky-wave antennas were presented in 2020, Dr. Jun Yan Dai joined the CityU research group from Southeast University for a postdoctoral research fellow appointment," Prof. Chan said. "He came from the research group led by Academician Tie Jun Cui and Professor Qiang Cheng and brought us the use of space-time coding, or software control, to dynamically reconfigure the antenna performance."



Measurement setup of the space-time-coding metasurface antenna in a microwave anechoic chamber. Credit: Wu et al.

Space-time coding, or space-time block coding, is a technique that allows engineers to transmit multiple copies of a data stream across several antennas, using the different versions of the original data to transfer data more reliably. Prof. Chan and his colleagues combined space-time coding techniques with AM leaky-wave antenna design to enable the modulation of emitted radiation patterns.

"By combining the two approaches, we achieve a designated radiation characteristic by controlling the on-off sequences and durations of the switches on the leaky-wave antenna through a space-time matrix that can be generated via analytical means," Prof. Chan explained. "Due to the guided-wave nature of the leaky-wave antenna, unwanted harmonics generated by the switches can be filtered out by the waveguide, leading to sideband suppression. The reported research results are generated with synergistic efforts and complementary expertise by the two research teams at City University of Hong Kong and Southeast University."

The new sideband-free and space-time coding metasurface antennas introduced by the researchers ultimately allow users to attain different radiation characteristics through software control, without requiring physical alterations to the antenna's structure. This means that the unwanted sidebands or harmonics that hinder the performance of conventional antennas based on reconfigurable metasurfaces can be eradicated.

"For example, the same frequency beam steering is achievable with our antenna," Prof. Chan said. "As the space-time matrix is linear, different beams radiating at different frequencies can be generated simultaneously by the superposition of different space-time matrices. As the space-time matrix is linear, different beams radiating at different frequencies can be generated simultaneously by the superposition of different space-time matrices."

Prof. Chan and his colleagues assessed the effectiveness of their antenna design in a series of tests and found that it enabled high-efficiency frequency conversion, fundamental-frequency continuous beam scanning and the independent control of multiple harmonics. In the future, their antenna could be combined with different base-band modulation schemes to achieve highly efficient and secure communications.

"In our next studies, we plan to modify the antenna's structure to achieve more control over the radiation characteristics, including polarization of the radiated beams," Prof. Chan added. "One unique feature of the antennas is that we can control the amplitude and phase distributions on the antenna aperture. Therefore, we can create all kinds of radiation characteristics, including linear sweeping of a focused spot along the length or perpendicular to the antenna surface."

More information: Geng-Bo Wu et al, Sideband-free space–time-coding metasurface antennas, *Nature Electronics* (2022). DOI: 10.1038/s41928-022-00857-0

© 2022 Science X Network

APA citation: A space-time coding metasurface antenna for efficient and secure communications (2022, November 22) retrieved 29 November 2022 from https://techxplore.com/news/2022-11-space-time-coding-metasurface-antenna-efficient.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.