INNOVATION PARTNERSHIPS
UNIVERSITY OF MICHIGAN

Parametric Time Modulated Electrically Small Antenna

TECHNOLOGY NUMBER: 2024-494

OVERVIEW

Enhancing bandwidth and efficiency of electrically small antennas (ESAs).

- Uses parametric space- and time-variation to boost antenna performance significantly
- Communications, wireless sensing, IoT devices, and remote monitoring systems

BACKGROUND

Electrically small antennas (ESAs) are vital for many communications and sensing applications requiring a compact design relative to the operating wavelength. Historically, achieving a balance between size, quality factor (Q), bandwidth, and efficiency in ESAs has posed significant challenges. There are fundamental limits on the Q of passive, linear, time-invariant (LTI) small antennas, influencing subsequent research. Several methods, such as internal matching networks and multimode resonance, have been developed to address these constraints but still fall short due to inherent limits like the Bode-Fano criterion. Non-LTI methods involving parametric modulation have also been explored but introduce issues like spurious harmonic radiation and large input reflections. Thus, there exists a pressing need for an innovative approach that can enhance the bandwidth and efficiency of ESAs without these drawbacks.

INNOVATION

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Category
Hardware
Engineering & Physical Sciences
Semiconductors, MEMS, and Electronics

Inventor
Anthony Grbic

Further information
Joohee Kim
jooheek@umich.edu

Innovation Partnerships Tech Marketing Team
IPInventions@umich.edu

View online

Researchers at the University of Michigan have developed an efficient rotationally symmetric ESA leverages parametric space- and time-variation to couple energy between radiative and non-radiative modes. This technique extends the radiation and matching bandwidths by more than 6.9 dB while inherently suppressing spurious harmonics, eliminating the need for external idler resonators. Analogous to a negative-resistance parametric amplifier, yet detuned for frequency to avoid maximum parametric gain, this approach reduces spurious coupling to higher-order resonances. It achieves an efficiency-bandwidth product improvement of more than 7.6 dB over traditional LTI antennas without the trade-off of increased losses. Potential real-world applications include enhanced performance in telecommunications, wireless sensing, Internet of Things (IoT) devices, and remote monitoring systems, providing significant benefits in bandwidth and efficiency for compact antenna designs.

ADDITIONAL INFORMATION

REFERENCES:

- "Increasing the Efficiency-Bandwidth of Small Antennas by Coupling Radiative and Non-Radiative Modes Using Time-Variation"
- "Increasing the Efficiency-Bandwidth Product and Impedance Bandwidth of Electrically-Small Antennas Through Parametric Space-Time Variation"
- "Space–Time Modulation of a Multimode Electrically Small Antenna for Increased Matching and Efficiency Bandwidths"

INTELLECTUAL PROPERTY:

Patent application pending.

KEYWORDS:

Communication, Sensing, Antenna, ESA