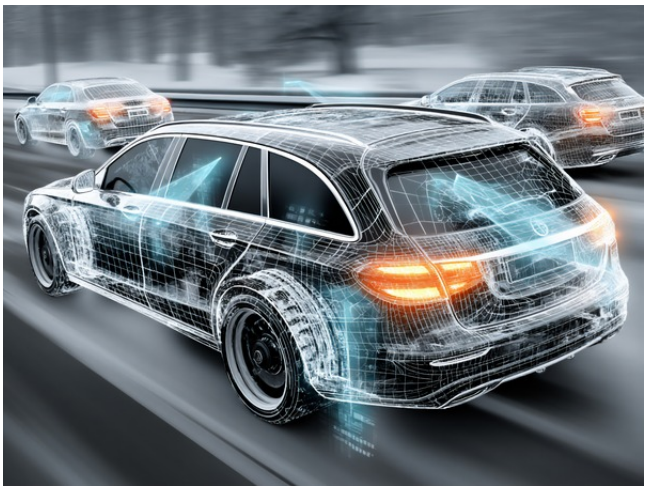
INNOVATION PARTNERSHIPS
UNIVERSITY OF MICHIGAN

mmID Localization and Orientation Sensing via Frequency-Divided Beam Multiplexing

TECHNOLOGY NUMBER: 2024-561



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Category
Engineering & Physical Sciences
Semiconductors, MEMS, and Electronics

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OVERVIEW

Long-range, low-power mm-wave tag system for precise localization and orientation sensing

- Enables accurate 2D localization and orientation tracking at >10m range and high clutter, surpassing RFID
- Augmented reality, robotics, autonomous vehicles, inventory tracking, industrial automation, motion capture

BACKGROUND

Accurate localization and orientation detection of objects are critical for numerous applications, including augmented reality, robotics, and inventory management. Traditional RFID systems leverage low cost and non-line-of-sight operation but face severe limitations in range, accuracy, and reliability, particularly in dense, dynamic, or cluttered environments. Earlier improvements using millimeter-wave tags (mmIDs) extended range and directional capacity, but orientation sensing either required multiple antennas or suffered from short detection ranges and low precision. Most existing solutions also struggle with interference, limited bandwidth, and unreliable performance amidst environmental clutter. As applications increasingly demand precise spatial awareness at greater distances and under challenging conditions, there is a significant need for a low-power, scalable, and robust solution offering both fine-grained localization and orientation measurement for tagged objects.

INNOVATION

Researchers at the University of Michigan have developed a novel mm-wave tag and reader system leveraging frequency-divided beam multiplexing and cross-polarized Rotman lens technology to provide both precise localization and orientation sensing. The passive or ultra-low-power tag generates multiple uniquely modulated backscatter beams, each corresponding to a distinct spatial direction. A radar reader system, using advanced FMCW signal processing and machine learning, can unambiguously determine the tag's 2D position with a median error of 6.4 cm and its orientation with a mean absolute error of 3.6°, all at distances beyond 10 meters and in highly cluttered settings. The solution outperforms prior RFID and mmID approaches in both range and robustness, enabling applications in dynamic, complex environments and laying a foundation for future long-range, multi-degree-of-freedom sensing technologies such as AR headsets, autonomous robots, or industrial logistics.

ADDITIONAL INFORMATION

REFERENCES:

- "Long-Range mmID Localization and Orientation Sensing via Frequency-Divided Beam Multiplexing"

INTELLECTUAL PROPERTY:

Patent application pending.

KEYWORDS:

mmID, Millimeter Wave, Localization, Orientation Sensing, Tracking, Robotics