Sensing with RF Signals by Exploiting Diffraction

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OTHER INFORMATION

KEYWORDS

RF Signals, Geometrical Theory of Diffraction, WiFi, Sensing, Wireless, mmWaves, Imaging Sensors, Imaging

CATEGORIZED AS

- **Communications**
  - Other
  - Wireless

RELATED CASES

2024-861-0

BACKGROUND

The number of wirelessly connected devices has grown rapidly in recent years, making wireless signals such as WiFi ubiquitous. This has resulted in considerable interest in applying communication signals for sensing and learning about the environment. Examples include sensing with WiFi signals, with Millimeter Waves (mmWaves), or as part of next generation cellular systems. Imaging objects, on the other hand, can be used for applications including smart homes, structural health monitoring, search and rescue, surveillance, excavation, autonomous driving and more. If details of objects and spaces can be sensed with cheap, omnipresent WiFi devices, or with the mmWave signals of the next generation cellular systems, it will create new possibilities for many applications, and it can be used to complement existing imaging sensors. While radio frequency (RF) signals have shown promise in applications where there is motion (e.g., body motion), imaging details of still objects with RF signals has remained a challenge, due to lack of motion. The traditional method of using cameras for imaging, on the other hand, is limited by cameras' inability to look through occlusions and walls and their unreliability in low-light conditions.

DESCRIPTION

Researchers at the University of California, Santa Barbara have created a novel method for imaging with RF signals, by exploiting the phenomenon of diffraction More specifically, the invention uses the interaction of edges of the objects with the incoming waves. In this application, edges are not limited to visibly sharp edges but include any surface whose radius is relatively small. This innovative method images the edges of objects, scenery, or entities, utilizing the interaction between one or more transmitted signals and the edges (or surfaces with small enough curvatures) in the imaging area of interest by exploiting the Geometrical Theory of Diffraction (GTD) and the corresponding Keller cones. The method results in much better imaging results than state of the art.

This method does not require specialized or expensive equipment to produce high quality images of objects. Further, the method is not machine-learning based, which means it does not rely on collecting RF training data, which is often cumbersome and limited in generalizability to new areas.

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ADVANTAGES

- Allows for imaging through occlusions and in low-light conditions
- Uses existing technology, reducing costs
- Can be used to visualize still objects
- Does not require a deep neural network

APPLICATIONS

- Smart homes
- Smart city
- Autonomous driving
- Structural health monitoring
- Context inference
- Search and rescue
- Surveillance
- Excavation

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Published Application	20250123391	04/17/2025	2024-861

Additional Patent Pending

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- RF Signal-Based Human Context Inference for Health and Safety Monitoring
- Generating Massive Synthetic RF Data for RF Sensing Applications

- RF Signals for Crowd Analytics and Collective Behavior
- A Novel Method for RF Field Programming and Intelligent Surface Design Using Diffraction-Inducing Elements

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