Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

Case ID:M23-146P^
Published: 1/17/2024

Inventors

Abu Huraira Muhammad Idban
Seyedmohammadreza Faghih Imani

Contact

Physical Sciences Team

Angle of Arrival Detection using Intensity-Only Data

Many navigation systems rely on detecting the angle of arrival (AoA) of waves to determine desired coordinates. For example, a variety of radar systems deploy AoA detection to deliver desired information about the surrounding area or target of interest. Modern radio environments rely on adaptive beamforming techniques to direct electromagnetic waves toward intended directions. Therefore, the knowledge of the direction of desired transmitters/receivers is a crucial aspect in such adaptive beamforming applications.

Conventional AoA estimation utilizes the phase or time delay of a received signal. In essence, these AoA estimation protocols are based on the reception of amplitude and phase (or time delay) of return signals. However, the detection of complex signals requires complicated circuitry making the radio device bulky and expensive. The complexity of AoA detection can be significantly reduced if the AoA can be estimated using only the intensity (or strength) of the incoming signal. In other words, replacing traditional AoA detection mechanisms with an intensity only AoA detection approach will reduce the implementation cost and computational complexity. Moreover, the spatial/angular resolution of detecting AoA is linearly proportional to the aperture size. In conventional implementations, increasing the aperture size may necessitate using more receivers to obtain the required spatial resolution. It is desirable to achieve high spatial/angular resolution while keeping the number of receivers at a minimum.

Researchers at Arizona State University have developed a device that captures the intensity of incident waves and a method (an algorithm) to deduce the corresponding angle of arrival (AoA) of the waves. The device offers high resolution for the detection of AoA using only a single receiver that operates over a narrowband and can be implemented in a simple manner where only measuring the intensity or voltage is required.

Related publication: Detecting Angle of Arrival on a Hybrid RIS Using Intensity-Only Data

Potential Applications:

- Wireless communication networks
- Radar
- Navigation systems

Benefits and Advantages:

- A single receiver can be used
- Can operate over a narrowband (down to a single frequency) without any degradation in operation

- Does not need/require iterative long impedance matching, syncing with the transmitters, or switching to absorption mode
- When device is used as a reconfigurable intelligent surface (RIS):
  - integrated sensing feature eliminates the necessity of computationally complex joint channel estimation
  - simultaneous sensing and reflection features allow for seamless and full-autonomous operation of the RIS without the requirement of switching between reflection and absorption modes
  - sensing from all the elements doesn’t require dedicated receiver elements and retains information from the full spatial capacity of the RIS in the sparsely sensed data