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:M23-024P
Published: 6/2/2023

Inventors

Sule Ozev
Ferhat Ataman
Chethan Kumar
Sandeep Rao

Contact

Physical Sciences Team

Improving Angle Estimation Accuracy for Millimeter-Wave Radars

Radar systems transmit electromagnetic waves through the air and the objects in the aperture reflect the signal. The reflected signal is captured by the radar to find the position, angle, and velocity of each object. Millimeter-wave (mmWave) radar is a subclass of radar systems that uses millimeter waves to operate. The main advantage of mmWave radars is the wavelength of the signal is relatively small compared to the electromagnetic spectrum, which enables the use of smaller antennas.

Millimeter-wave radars are used to estimate the position of an object relative to the radar position. To specify the position of the object relative to the radar, the object's range, azimuth angle, and elevation angle are determined. However, the estimation accuracy decreases as the objects' angle increases relative to the system. Thus, angle estimation becomes much more challenging when the object is positioned at higher angles with respect to the radar. To estimate the object position, a mm-wave signal with changing frequency is emitted. The signal is reflected from the object and is received by the same device. The difference in frequency between the currently emitted wave and the return wave depends on the time it takes for the signal to reflect back. Thus, by measuring this frequency difference, the range of the object can be determined. To do so, the return signal is mixed with the currently transmitted signal and Fast Fourier Transform (FFT) of the resulting signal is calculated. This process is called "range FFT". For multiple antenna systems, the range FFT can be taken for each transmit and receive antenna, yielding multiple range FFT results. To increase the accuracy, these results are averaged. Angle estimation makes use of the slight phase differences between different antenna paths. The systematic error in the calculation steps is accumulated through angle estimation. There is a need to correct these systemic errors in the angle estimation process.

Researchers at Arizona State University and Texas Instruments have developed an accurate angle estimation/correction method for millimeter-wave (mmWave) radar. The method employs one or more of the following techniques to overcome the systemic error(s) causing angle estimation errors: mathematical correction, non-iterative refinement, and/or iterative refinement.

Potential Applications:

- Subroutine for any radar application (specifically any millimeter-wave radar application)

Benefits and Advantages:

- Angle estimation method:

- Determines systemic sources of error in angle estimation
- Determines conditions on object distance, radar settings, and/or object angle causing systemic sources of error
- Removes/corrects systemic errors in angle estimation

- Little computational overhead required for angle estimation method