Near-field wideband channel estimation for extremely large-scale MIMO

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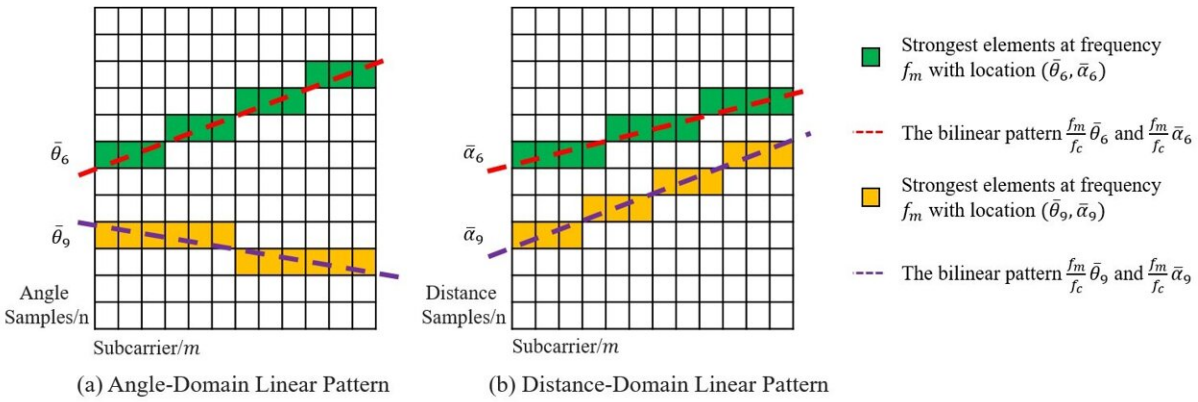

Bilinear pattern of near-field beam split. Credit: Science China Press

Extremely large-scale multiple-input-multiple-output (XL-MIMO) at millimeter-wave (mmWave) and terahertz (THz) bands plays an important role in 6G networks for its extreme high beamforming gain and abundant spectrum resources.

To unleash the superiority of XL-MIMO, accurate channel estimation is of great importance to perform efficient precoding. Unfortunately, as opposed to classical 5G massive MIMO, channel estimation for high-frequency XL-MIMO in 6G faces a serious challenge of "near-field beam split."

To elaborate, high-frequency XL-MIMO brings the qualitative paradigm shift from conventional far-field planar-wave communications to its near-field spherical-wave counterpart. In addition, the ultra-large bandwidth at mmWave and THz make the electromagnetic wavefront of different frequency components differ from each other, leading to the undesired beam split effect. The coupling of near-field and beam split effects gives rise to a complex structure of wireless channels, whose estimation is intractable for existing methods.

New research, titled "Near-Field Wideband Channel Estimation for Extremely Large-Scale MIMO," was published in *Science China Information Sciences*. It is co-authored by Mr. Mingyao Cui (first author) and Prof. Linglong Dai (corresponding author) from Tsinghua University, China.

In this article, a bilinear pattern detection (BPD) based approach was proposed to accurately recover the high-frequency XL-MIMO channel. First, the bilinear pattern of the near-field beam split effect is revealed, which implies that the sparse support set of near-field channels in both the angle and distance domains can be regarded as a linear function against frequency.

Then, this bilinear pattern is used to estimate the angle-of-arrival (AoA) and distance parameters of each near-field path component via a modified simultaneously orthogonal matching pursuit algorithm. Finally, simulation results demonstrated their scheme is capable of achieving high channel estimation accuracy in all far-field/near-field/narrowband/wideband conditions.

This paper provides a solution to channel estimation in the presence of near-field beam split. It is expected that the bilinear pattern could be extended to various near-field wideband communication scenarios for addressing near-field beam split issues, such as reconfigurable intelligent

surface communications and cell-free massive MIMO communications.

More information: Mingyao Cui et al, Near-field wideband channel estimation for extremely large-scale MIMO, *Science China Information Sciences* (2023). DOI: 10.1007/s11432-022-3654-y