Creating Diversity in 5G via Beam Pattern Jittering

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Goals:

• Enhance capacity (numbers of users or throughput),
• Increase QoS (probability-of-error performance),
• Reduced Cost

A merger of Directionality AND Transmit Diversity

HOW? Adaptive Antenna Arrays at the BS:
(1) Proper Phase shifts → Directionality (Spatial Multiplexing)
(2) Moving beam pattern → Transmit Diversity (Induced Time Diversity)
(3) Low Cost: Complexity remains at the BS, Low MS Complexity

Examples of Beam Pattern Movement:
Beam Pattern Oscillation; Beam Pattern Beating

Antenna Pattern movement between 0.05% and 5% of its HPBW.

Circular Channel Model for High Altitude BS

Semi-Elliptical Channel Model for Low Altitude BS

The control parameter $\xi \in [0.0005, 0.05]$: Antenna pattern movement between 0.05% and 5% of its HPBW.

Real-time root-MUSIC DOA estimation via Parallel Polynomial Rooting

Newton map:

Critical points:

Properties:
1. Symmetry of Roots across Unit Circle;
2. Access to infinity - M+3
M Poly. Degree

Newton Map of Root-MUSIC Polynomial in Various Antenna Array Conditions

Rician channel with one non-line-of-sight (NLOS) path

Real-time implementation of root-MUSIC

Finding the closest root magnitude

DOA estimation

Composing the polynomial coefficients

Finding the roots of the polynomial

SVD

• Iterative algorithms that take large number of iterations
• Only offline processing possible for large matrices sizes
• Lack of modular, extendable design for SVD

• Computationally complex
• Absence of simple parallel algorithms
• Lack of modular, extendable design for polynomial rooting

Brent-Luk-Van (BLV) SVD:

Special purpose CORDIC algorithm → computation reduction → FPGA Implementation Not suitable for Large Matrices

Proposed SVD:

In each iteration target the biggest element and few other big elements
These set of four big elements need to be row and column exclusive
No exchange of data between iterations is required.
We term this as “dynamic ordering” unlike Jacobi methods which follow predefined “fixed ordering”

Reduction more Evident as Matrix Size Increases;

Improvement more Evident as Matrix Size Increases;


Real Time Signal Processing Challenges for Massive MIMO SDR

Real-time root-MUSIC DOA estimation via Parallel Polynomial Rooting

Method

Computational Complexity

Parallel Implementation

Comments

Eigenvalue decomposition using QR

O(N^2)

Not a QR decomposition; iterates stochastically

Roots by balanced factorization of polynomial

O(N log(N) loglog(N))

Roots by balanced factorization of polynomial

O(N log^2(N))

Roots by balanced factorization of polynomial

O(N log(N) loglog(N))

Newton's method for general polynomials

O(N log(N) loglog(N))

Newton's method for general polynomials

O(N log(N) loglog(N))

Large set of root pairs

Proposed method

O(N log(N) loglog(N))

Large set of root pairs

Method suited to FPGA

Poly. Size