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Deep unfolding based channel estimation for wideband terahertz near-field massive MIMO systems

Key words: Terahertz; Massive MIMO; Channel estimation; Deep learning

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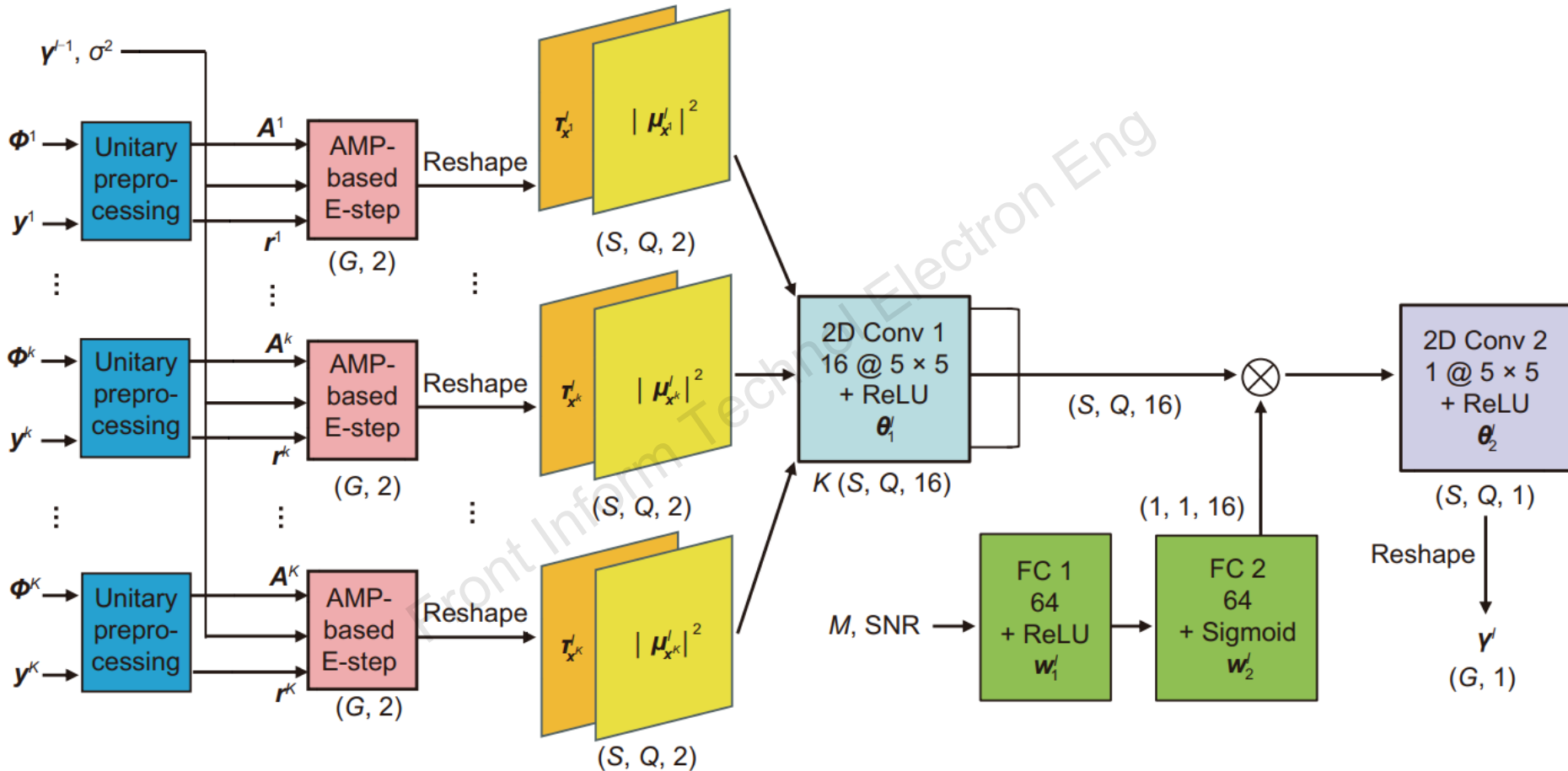
Motivations

- In terahertz massive MIMO channel estimation, the near-field beam split effect caused by large bandwidth and array aperture will decrease the channel sparsity and destroy the channel sparsity structure in the angular–frequency domain.
- Existing compressive sensing algorithms suffer from either bad performance or high complexity. A good tradeoff is desired.
- Current deep learning approaches are trained separately under different system configurations, which increases the training and storage overhead and decreases the robustness.

Main ideas

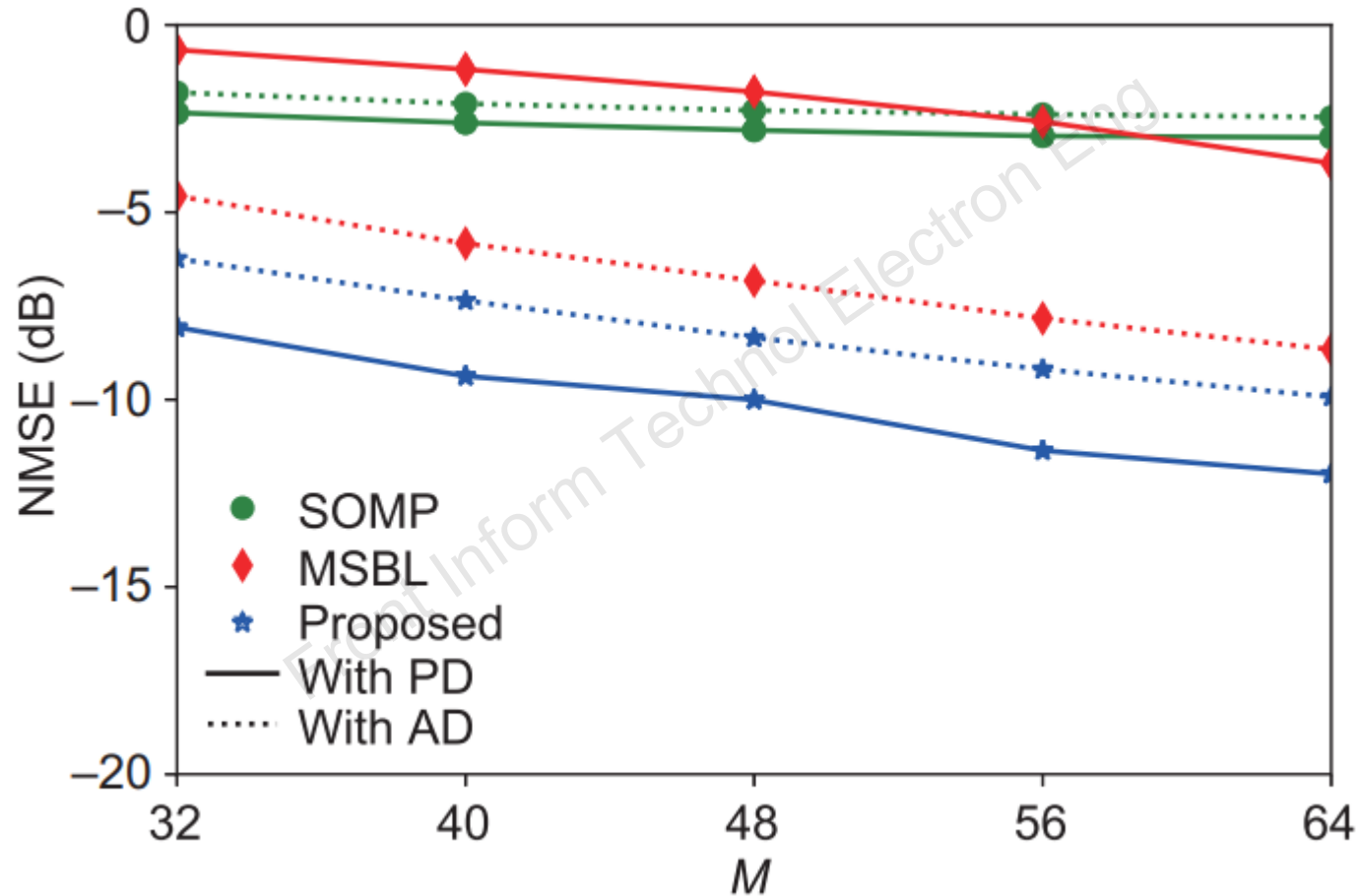
- By using frequency-dependent polar dictionaries, the near-field beam split effect can be properly handled.
- An advanced approximate message passing - sparse Bayesian learning (AMP-SBL) unfolding algorithm is proposed for channel estimation. Specifically, the M-step in each iteration of AMP-SBL is replaced by a deep neural network (DNN), which improves the estimation performance and convergence speed by training a lot of data.
- Under the joint effort of the proposed configuration-related attention mechanism and weighted normalized mean-squared error (NMSE) loss function, effective mixed training is realized to obtain a single universal DNN.

Methods



Architecture of the l^{th} approximate message passing - sparse Bayesian learning layer

Major results



The proposed approach outperforms baselines under various configurations.

Conclusions

To realize robust high-performance low-complexity terahertz massive MIMO channel estimation, we

- alleviate the near-field beam split effect by using frequency-dependent polar dictionaries,
- improve the performance and convergence speed by deeply unfolding the AMP-SBL algorithm, and
- realize effective mixed training through configuration-related loss function and network architecture design.

Simulation results verified the superiority of the proposed approach.



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