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Codebook-Based User Tracking in IRS-Assisted mmWave Communication Networks

MORITZ GARKISCH (Friedrich-Alexander-Universität Erlangen-Nürnberg), VAHID JAMALI (Technische Universität Darmstadt), AND ROBERT SCHOBER (Friedrich-Alexander-Universität Erlangen-Nürnberg)

How can a mobile user be tracked in an IRS-assisted system?
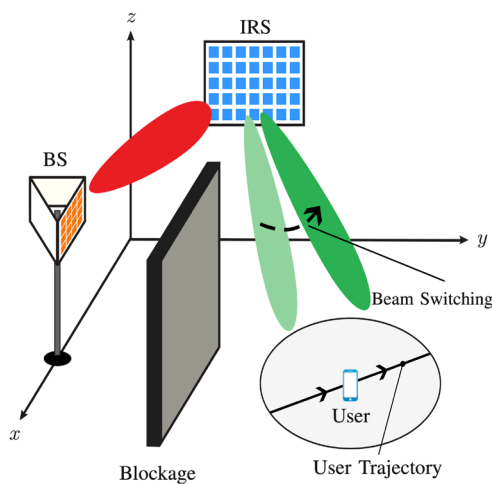
(a)

The system consists of a base station (BS), an intelligent reflecting surface (IRS), and a user that moves within an obstructed area. The IRS configures its reflection properties by selecting a phase-shift configuration from a pre-defined codebook.
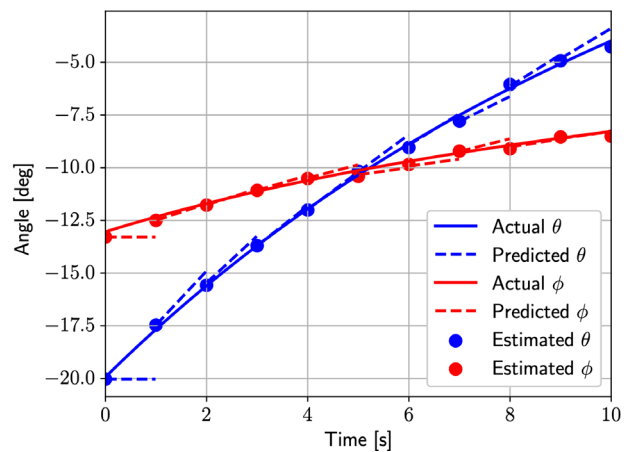
(b)

Visualization of the user tracking algorithm, showing the periodic direction estimations (dots), the continuous trajectory extrapolation (dashed lines), and the true direction (solid lines).

KEY FINDINGS

We present a novel mobile user tracking (UT) scheme for codebook-based IRS-aided mmWave systems. The proposed (UT) scheme exploits the temporal correlation of the direction from the IRS to the mobile user for selecting IRS phase shifts that provide reflection towards the user. We assume that the IRS is fully passive and cannot perform sensing. Therefore, we estimate the direction from the IRS to the user at the user and then feed it back to the BS via a control channel. The IRS cycles through several candidate codewords, while the BS sends a pilot sequence for each candidate codeword. To this end, the user's direction is periodically estimated based on a generalized likelihood ratio test (GLRT). Furthermore, the user's trajectory is extrapolated from past direction estimates by fitting an arbitrary number of past estimates to a polynomial with a minimum mean square error approach. During data transmission, the IRS codeword selection is done based on proximity to the extrapolated trajectory.

CONCLUSION: The proposed UT scheme enables effective codeword selection with low estimation overhead overcoming the lack of sensing capabilities of the IRS and the limitation to codebook-based reflection configuration.

M. Garkisch, V. Jamali and R. Schober, "Codebook-Based User Tracking in IRS-Assisted mmWave Communication Networks", in Proc. IEEE Int. Conf. Acoust. Speech Signal Process. (ICASSP), Rhodes Island, Greece, 2023, pp.~1-5, doi:~10.1109/ICASSP49357.2023.10097027.