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Relay-Aided Intelligent Reconfigurable Surfaces for Robust Performance with Fewer Elements

Background

Wireless communications systems in 5G and beyond are using high-frequency signals (in the mmWave band in 5G and sub-terahertz bands in 6G and beyond). The large bandwidth available at these high frequencies enable the communication systems to send data at very high rates. However, increasing frequency comes at the expense of lower penetration through obstacles. This is concerning for network coverage, as objects in the environmental can more readily interrupt wireless communication links. As a promising solution to this challenge, the concept of intelligent reconfigurable surfaces (IRSs) has been attracting massive interest from academia, industry, and defense. IRSs are devices that comprise large numbers of controllable nearly-passive reflecting elements. These low-cost devices reflect the incident signals towards intended receivers which enhances the network coverage and provides a way to bypass potential blockages. The major challenge for the current IRS systems is the massive number of elements required to meet power gain expectations. Controlling an array of this size incurs an extremely large overhead from channel estimation and beam training (to find the best direction to point the very narrow beam). Further, since the beams of these systems are extremely narrow, the users may easily compromise coverage with any small movements. Hence, for real deployment to be successful, innovations must address these core issues.

Invention Description

Researchers at Arizona State University have developed an efficient architecture for IRS systems. The proposed architecture consists of two side-by-side surfaces connected via a full-duplex relay. This architecture divides the required power gain between the nearly-passive intelligent surfaces and the active relay, which keeps these systems low-cost while requiring significantly fewer elements compared to the current IRS approaches.

Potential Applications

- 5G and 6G wireless communication

- Intelligent reconfigurable surfaces (IRSs)

Benefits and Advantages

- Significantly reduces the required number of elements
- Minimizes channel estimation and beam training overhead, allowing support for mobile users
- Uses wider beams for enhanced system robustness
- High flexibility in deployment—the two surfaces can be installed back-to-back or on different faces of a building

Related Publication: [Relay Aided Intelligent Reconfigurable Surfaces: Achieving the Potential Without So Many Antennas](#)

[Homepage of Professor Ahmed Alkhateeb](#)