Could new technique for 'curving' light be the secret to improved wireless communication?

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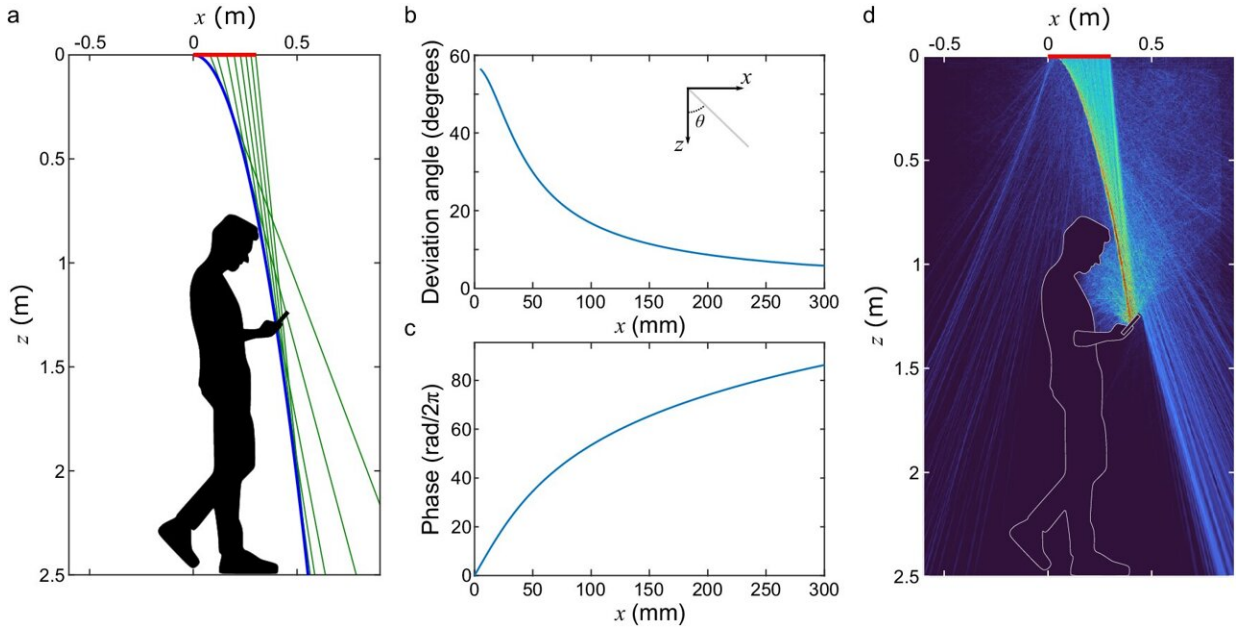


Trajectory engineering. Credit: *Communications Engineering* (2024). DOI: 10.1038/s44172-024-00206-3

While cellular networks and Wi-Fi systems are more advanced than ever, they are also quickly reaching their bandwidth limits. Scientists know that in the near future they'll need to transition to much higher communication frequencies than what current systems rely on, but before that can happen there are a number of—quite literal—obstacles

standing in the way.

Researchers from Brown University and Rice University say they've advanced one step closer to getting around these solid obstacles, like walls, furniture and even people—and they do it by curving light.

In a new study published in *Communications Engineering*, the researchers describe how they are helping address one of the biggest logjams emerging in wireless communication.

Current systems rely on microwave radiation to carry data, but it's become clear that the future standard for transmitting data will make use of terahertz waves, which have as much as 100 times the data-carrying capacity of microwaves. One longstanding issue has been that, unlike microwaves, terahertz signals can be blocked by most solid objects, making a direct line of sight between transmitter and receiver a logistical requirement.

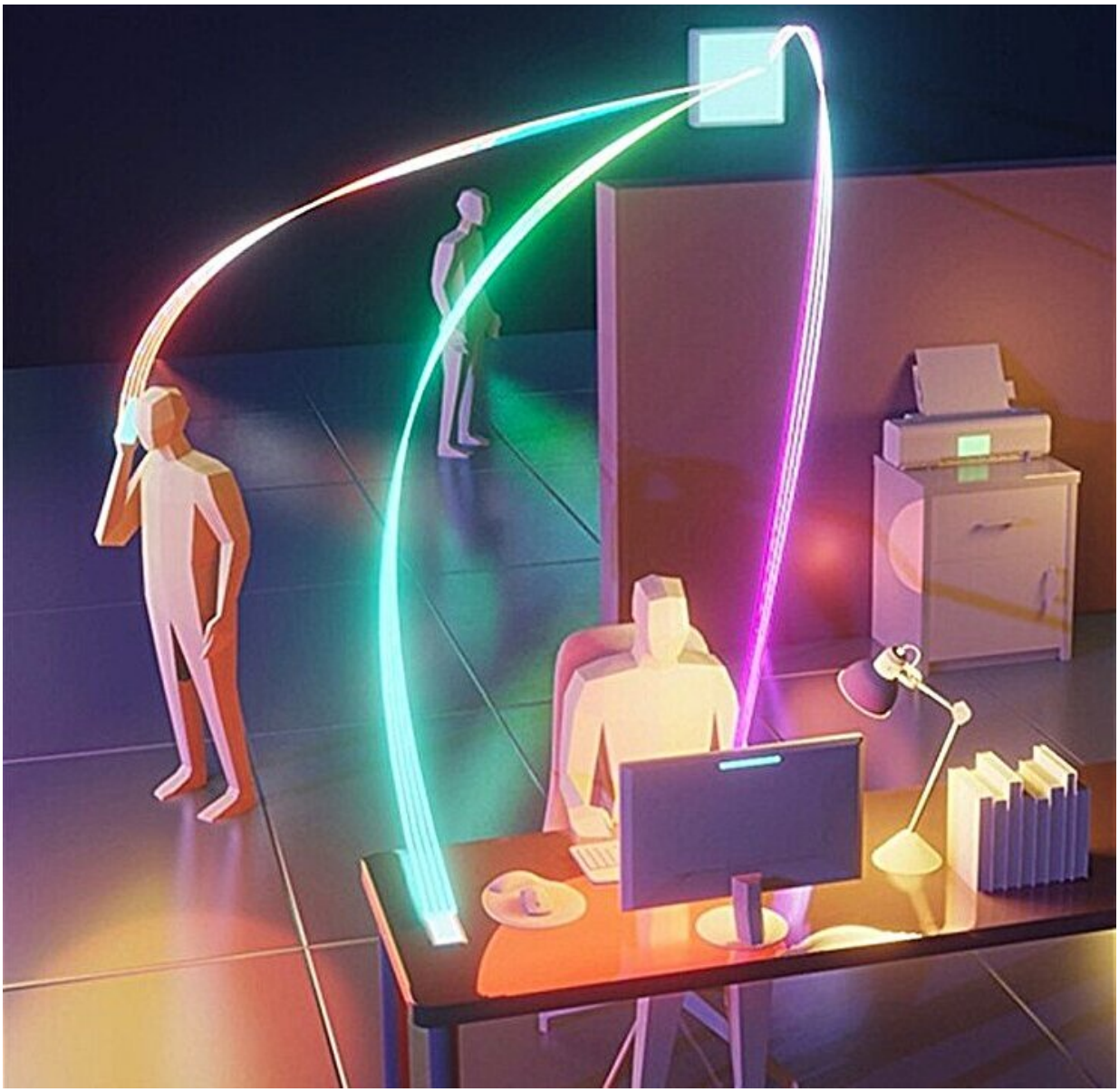
"Most people probably use a Wi-Fi base station that fills the room with wireless signals," said Daniel Mittleman, a professor in Brown's School of Engineering and senior author of the study.

"No matter where they move, they maintain the link. At the higher frequencies that we're talking about here, you won't be able to do that anymore. Instead, it's going to be a directional beam. If you move around, that beam is going to have to follow you in order to maintain the link, and if you move outside of the beam or something blocks that link, then you're not getting any signal."

The researchers circumvented this by creating a terahertz signal that follows a curved trajectory around an obstacle, instead of being blocked by it. The novel method unveiled in the study could help revolutionize wireless communication and highlights the future feasibility of wireless

data networks that run on terahertz frequencies, according to the researchers.

"We want more data per second," Mittleman said. "If you want to do that, you need more bandwidth, and that bandwidth simply doesn't exist using conventional frequency bands."



A study that could revolutionize wireless communication introduces a novel method to curve terahertz signals around an obstacle. Credit: Mittleman Group

In the study, Mittleman and his colleagues introduce the concept of self-accelerating beams. The beams are special configurations of electromagnetic waves that naturally bend or curve to one side as they move through space. The beams have been studied at optical frequencies but are now explored for terahertz communication.

The researchers used this idea as a jumping off point. They engineered transmitters with carefully designed patterns so that the system can manipulate the strength, intensity and timing of the electromagnetic waves that are produced. With this ability to manipulate the light, the researchers make the waves work together more effectively to maintain the signal when a solid object blocks a portion of the beam.

Essentially, the light beam adjusts to the blockage by shuffling data along the patterns the researchers engineered into the transmitter. When one pattern is blocked, the data transfers to the next one, and then the next one if that is blocked. This keeps the signal link fully intact. Without this level of control, when the beam is blocked, the system can't make any adjustments, so no signal gets through.

This effectively makes the signal bend around objects as long as the transmitter is not completely blocked. If it is completely blocked, another way of getting the data to the receiver will be needed.

"Curving a beam doesn't solve all possible blockage problems, but what it does is solve some of them and it solves them in a way that's better than what others have tried," said Hichem Guerboukha, who led the study as a postdoctoral researcher at Brown and is now an assistant

professor at the University of Missouri—Kansas City.

The researchers validated their findings through extensive simulations and experiments navigating around obstacles to maintain communication links with high reliability and integrity. The work builds on a previous study from the team that showed terahertz data links can be bounced off walls in a room without dropping too much data.

By using these curved beams, the researchers hope to one day make wireless networks more reliable, even in crowded or obstructed environments. This could lead to faster and more stable internet connections in places like offices or cities where obstacles are common. Before getting to that point, however, there's much more basic research to be done and plenty of challenges to overcome as terahertz communication technology is still in its infancy.

"One of the key questions that everybody asks us is how much can you curve and how far away," Mittleman said. "We've done rough estimations of these things, but we haven't really quantified it yet, so we hope to map it out."

More information: Hichem Guerboukha et al, Curving THz wireless data links around obstacles, *Communications Engineering* (2024). DOI: 10.1038/s44172-024-00206-3

Provided by Brown University

https://techxplore.com/news/2024-04-technique-secret-wireless-communication.html