

Opening new doors in the VR world—literally

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RedirectedDoors+ in action. Credit: Kazuyuki Fujita et al

Room-scale virtual reality (VR) is one where users explore a VR environment by physically walking through it. The technology provides many benefits, given its highly immersive experience. Yet the drawback is that it requires large physical spaces. It can also lack haptic feedback when touching objects.

Take, for example, opening a door. Implementing this seemingly menial

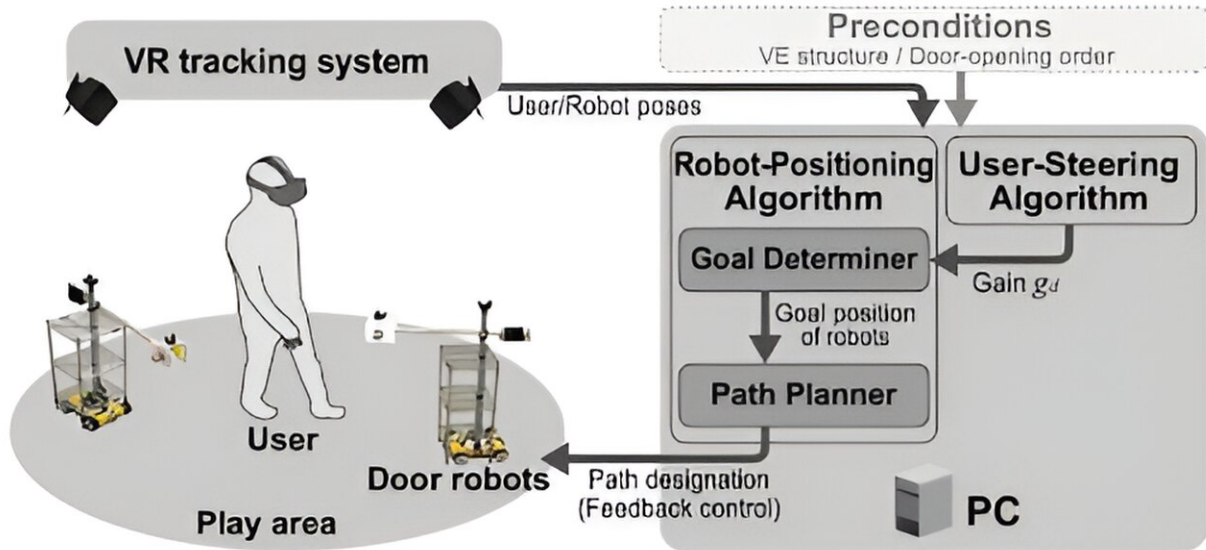
task in the virtual world means recreating the haptics of grasping a doorknob while simultaneously preventing users from walking into actual walls in their surrounding areas.

Now, a research group has developed a new system to overcome this problem: RedirectedDoors+.

The group was led by Kazuyuki Fujita, Kazuki Takashima, and Yoshifumi Kitamura from Tohoku University and Morten Fjeld from Chalmers University of Technology and the University of Bergen.

"Our system, which is built upon an existing visuo-haptic door-opening redirection technique, allows participants to subtly manipulate the walking direction while opening doors in VR, guiding them away from real walls," points out Professor Fujita, who is based at Tohoku University's Research Institute of Electrical Communication (RIEC). "At the same time, our system reproduces the realistic haptics of touching a doorknob, enhancing the quality of the experience."

To provide users with that experience, RedirectedDoors+ employs a small number of 'door robots.' The robots have a doorknob-shaped attachment and can move in any direction, giving immediate touch feedback when the user interacts with the doorknob. In addition, the VR environment rotates in sync with the door movement, ensuring the user stays within the physical space limits.



A system overview of RedirectedDoors+. Credit: Kazuyuki Fujita et al

A simulation study conducted to evaluate the performance of the system demonstrated the physical space size could be significantly reduced in six different VR environments. A validation study with 12 users walking with the system likewise demonstrated that this system works safely in real-world environments.

"RedirectDoors+ has redefined the boundaries of VR exploration, offering unprecedented freedom and realism in virtual environments," adds Fujita. "It has a wide range of applicability, such as in VR [vocational training](#), [architectural design](#), and urban planning."

The study is [published](#) in the journal *IEEE Transactions on Visualization and Computer Graphics*.

More information: Yukai Hoshikawa et al, RedirectedDoors+: Door-Opening Redirection with Dynamic Haptics in Room-Scale VR, *IEEE Transactions on Visualization and Computer Graphics* (2024). [DOI: 10.1109/TVCG.2024.3372105](https://doi.org/10.1109/TVCG.2024.3372105)

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