Wireless network controls brain circuits remotely via the internet

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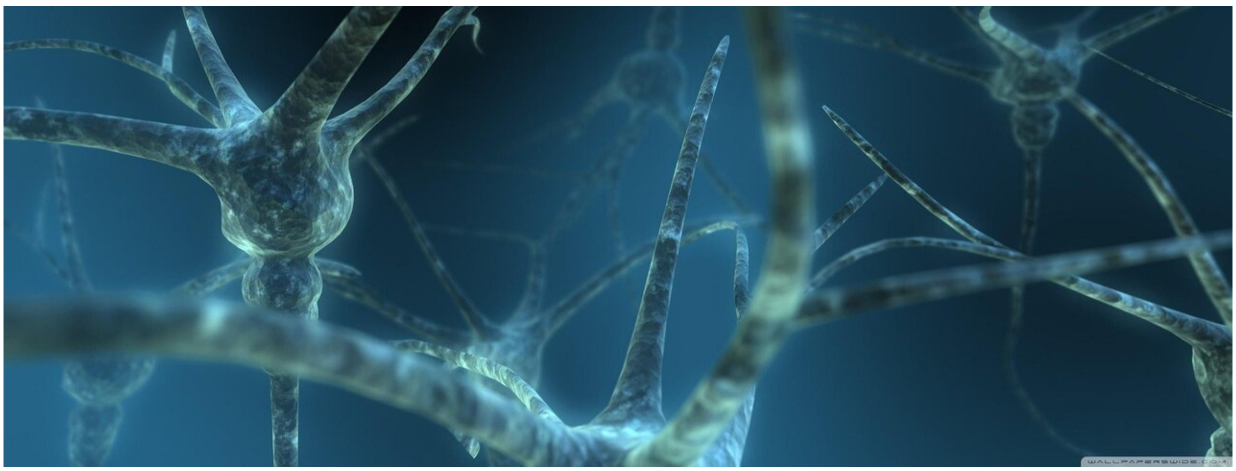

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A new study shows that researchers can remotely control the brain circuits of numerous animals simultaneously and independently through the internet. The scientists believe this newly developed technology can speed up brain research and various neuroscience studies to uncover basic brain functions as well as the underpinnings of various neuropsychiatric and neurological disorders.

A multidisciplinary team of researchers at KAIST, Washington University in St. Louis, and the University of Colorado, Boulder, created a wireless ecosystem with its own wireless implantable devices and

Internet of Things (IoT) infrastructure to enable high-throughput neuroscience experiments over the internet. This innovative technology could enable scientists to manipulate the brains of animals from anywhere around the world. The study was published in the journal *Nature Biomedical Engineering* on November 25

"This novel technology is highly versatile and adaptive. It can remotely control numerous neural implants and laboratory tools in real-time or in a scheduled way without direct human interactions," said Professor Jae-Woong Jeong of the School of Electrical Engineering at KAIST and a senior author of the study. "These wireless neural devices and equipment integrated with IoT technology have enormous potential for science and medicine."

The wireless ecosystem only requires a mini-computer that can be purchased for under $45, which connects to the internet and communicates with wireless multifunctional brain probes or other types of conventional laboratory equipment using IoT control modules. By optimally integrating the versatility and modular construction of both unique IoT hardware and software within a single ecosystem, this wireless technology offers new applications that have not been demonstrated before by a single standalone technology. This includes, but is not limited to minimalistic hardware, global remote access, selective and scheduled experiments, customizable automation, and high-throughput scalability.

"As long as researchers have internet access, they are able to trigger, customize, stop, validate, and store the outcomes of large experiments at any time and from anywhere in the world. They can remotely perform large-scale neuroscience experiments in animals deployed in multiple countries," said one of the lead authors, Dr. Raza Qazi, a researcher with KAIST and the University of Colorado, Boulder. "The low cost of this system allows it to be easily adopted and can further fuel innovation across many laboratories," Dr. Qazi added.

One of the significant advantages of this IoT neurotechnology is its ability to be mass deployed across the globe due to its minimalistic hardware, low setup cost, ease of use, and customizable versatility. Scientists across the world can quickly implement this technology within their existing laboratories with minimal budget concerns to achieve globally remote access, scalable experimental automation, or both, thus potentially reducing the time needed to unravel various neuroscientific challenges such as those associated with intractable neurological conditions.

Another senior author on the study, Professor Jordan McCall from the Department of Anesthesiology and Center for Clinical Pharmacology at Washington University in St. Louis, said this technology has the potential to change how basic neuroscience studies are performed. "One of the biggest limitations when trying to understand how the mammalian brain works is that we have to study these functions in unnatural conditions. This technology brings us one step closer to performing important studies without direct human interaction with the study subjects."

The ability to remotely schedule experiments moves toward automating these types of experiments. Dr. Kyle Parker, an instructor at Washington University in St. Louis and another lead author on the study added, "This experimental automation can potentially help us reduce the number of animals used in biomedical research by reducing the variability introduced by various experimenters. This is especially important given our moral imperative to seek research designs that enable this reduction."

The researchers believe this wireless technology may open new opportunities for many applications including brain research, pharmaceuticals, and telemedicine to treat diseases in the brain and other organs remotely. This remote automation technology could become even more valuable when many labs need to shut down, such as during the height of the COVID-19 pandemic.

More information: Raza Qazi et al, Scalable and modular wireless-network infrastructure for large-scale behavioural neuroscience, *Nature Biomedical Engineering* (2021). DOI: 10.1038/s41551-021-00814-w

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