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Versatile Modular Research Platform for Brain-Wide Neuroscience in Navigating Non-Human Primates

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Introduction: Simultaneous high-throughput neural recordings across multiple brain areas significantly enhance our understanding of the neural basis underlying complex animal behaviors. In this study, we developed a versatile, modular research platform for brain-wide recording and modulation in non-human primates engaged in navigation tasks and validated its high performance.

Material, Methods and Results: We developed a highly customizable and modular research platform (Fig.1a) that integrates cranial implants with electrode protection, a low-cost wearable eye-tracking and scene-capturing system, a behavioral event alignment system, 3D-printable monkey chairs, and tailored hardware and software solutions. This platform enables ultra-high-throughput electrophysiology, supporting the simultaneous recording of over 10,000 channels in non-human primates. Additionally, it integrates with Automated Guided Vehicle (AGV) carts, allowing animals to navigate in two-dimensional spaces. Using a macaque driving-foraging paradigm, we validated the system's efficiency and reliability for systems neuroscience studies (Fig.1b). Furthermore, an electrically stimulated blindfolded driving-foraging paradigm demonstrated the platform's potential for visual prosthetics research.

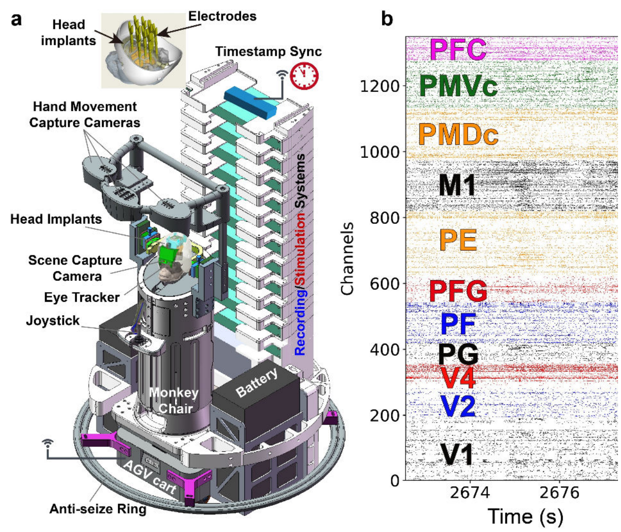

Figure 1: *(a) Main part of the research platform. This platform employs a monkey driving-foraging task as the experimental paradigm and integrates multiple application modules for neuroscience research: 1. Behavioural monitoring of non-human primates, including eye tracking, hand movement monitoring, cart tracing, and joystick force recording. 2. Brain-wide systems neuroscience research, encompassing the design and surgical solutions for whole-brain cranial implants based on CT/fMRI, as well as ultra-high-throughput electrophysiological recording and data analysis solutions. 3. Visual prosthetics research: capturing external visual scenes with a scene capture camera, converting them into multi-channel electrical stimulation signals on line, and transmitting these signals to the monkey's cortex to induce phosphenes or shape perception. (b) Raster plot of spike signals recorded simultaneously from over 1,300 channels across more than 10 brain areas, when the monkey is performing a foraging task.*

Conclusion: Our approach not only enhances the efficiency and accessibility of brain-wide systems neuroscience research but also supports BCI studies based on high-density ultra-flexible electrodes.

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