UC San Diego RESEARCH AFFAIRS Office of Innovation and Commercialization

# (SD2020-421) Virtual Electrodes for Imaging of Cortex-Wide Brain Activity: Decoding of cortexwide brain activity from local recordings of neural potentials

Tech ID: 32602 / UC Case 2020-421-1

## BACKGROUND

As an important tool for electrophysiological recordings, neural electrodes implanted on the brain surface have been instrumental in basic neuroscience research to study large-scale neural dynamics in various cognitive processes, such as sensorimotor processing as well as learning and memory. In clinical settings, neural recordings have been adopted as a standard tool to monitor the brain activity in epilepsy patients before surgery for detection and localization of epileptogenic zones initiating seizures and functional cortical mapping. Neural activity recorded from the brain surface exhibits rich information content about the collective neural activities reflecting the cognitive states and brain functions. For the interpretation of surface potentials in terms of their neural correlates, most research has focused on local neural activities.

From basic neuroscience research to clinical treatments and neural engineering, electrocorticography (ECoG) has been widely used to record surface potentials to evaluate brain function and develop neuroprosthetic devices. However, the requirement of invasive surgeries for implanting ECoG arrays significantly limits the coverage of different cortical regions, preventing simultaneous recordings from spatially distributed cortical networks. However, this rich information content of surface potentials encoded for the large-scale cortical activity remains unexploited and little is known on how local surface potentials are correlated with the spontaneous neural activities of distributed large-scale cortical networks.

## **TECHNOLOGY DESCRIPTION**

Researchers from UC San Diego have harnessed the rich information content of the local neural potentials recorded from brain surface to infer the cortex-wide brain activity. By using electrocorticography signals recorded from a small region on the brain surface, the inventors are able to computationally construct brain potentials across whole brain.

# APPLICATIONS

This invention may allow large area mapping of neural dysfunctions and neurological disorders without requiring extremely invasive neural surgeries. Virtual implants will use data from clinical ECoG recordings on brain surface that are routinely performed in patients before brain surgeries and compute the brain potentials across the whole cortex. Neural circuit dysfunctions are the cause of most neurological diseases, including epilepsy, Parkinson's disease, dystonia, depression and schizophrenia. For example, when applied to epilepsy, virtual implants will precisely determine the exact coordinates of the neuronal population generating seizures, unlike conventional local recordings resulting in low success rate (50%) for epilepsy surgeries. That will greatly impact the outcome and success rate of brain surgeries. Furthermore, brain-computer interfaces (BCI) have shown great promise for tetraplegia (paralysis), but penetrating microelectrodes cause extensive tissue damage limiting decoding ability and the lifetime of prosthetics less than a year. Virtual implants will enable less invasive long-term BCI by enabling decoding of spike activity from surface ECoG arrays. Virtual implants will lead us to new findings on neural dynamics that is unattainable otherwise and facilitate development of targeted treatments for neurological disorders affecting one billion people worldwide.

Permalink

# CONTACT

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#### **OTHER INFORMATION**

#### KEYWORDS

neural decoding, large-scale brain

activity, neural network, wide-field

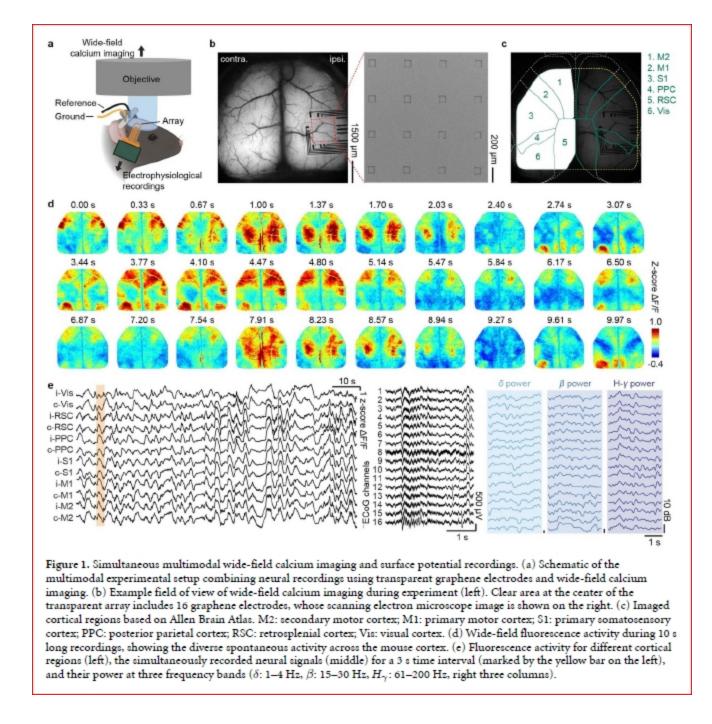
imaging, electrophysiology

#### CATEGORIZED AS

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**RELATED CASES** 

2020-421-1



#### STATE OF DEVELOPMENT

Inventors have demonstrated the possibility of inferring cortex-wide activity from locally recorded ECoG signals. The research team implanted transparent graphene microelectrode arrays over the mouse somatosensory cortex and performed simultaneous ECoG recordings and wide-field calcium imaging of the dorsal cortex in awake, head-fixed mice. By developing a recurrent neural network model using locally recorded ECoG signals as inputs, we successfully demonstrated virtual imaging of the averaged spontaneous activity from multiple cortical areas and the cortex-wide activity with pixel-level spatial resolution.

Please see the citation below for the published paper, in which the researchers designed a neural network

model to show that both the mean activity of different cortical regions and the pixel-level cortex-wide neural

activity can be decoded using locally recorded surface potentials. These findings demonstrated that the

locally recorded neural potentials indeed contain rich information for large-scale neural activity and the

surface potential responses in different frequency bands and different recording channels provide distinct

information about the large-scale neural activity.

#### INTELLECTUAL PROPERTY INFO

#### This patent-pending technology is available for commercial development.

See related technologies by research team:

https://techtransfer.universityofcalifornia.edu/NCD/33396.html

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## **RELATED MATERIALS**

Liu X, Ren C, Huang Z, Wilson M, Kim JH, Lu Y, Ramezani M, Komiyama T, Kuzum D. Decoding of cortex-wide brain activity from local recordings of neural potentials. J Neural Eng. 2021 Nov 15;18(6). - 11/15/2021

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