

Representative Research #1

On-Skin paintable Biogel for Long-Term High-Fidelity Electroencephalographic Recording

Science Advances 2021 [[project page](#)]

Contribution:

- EEG signals become noisier and the detection accuracy decreases over time

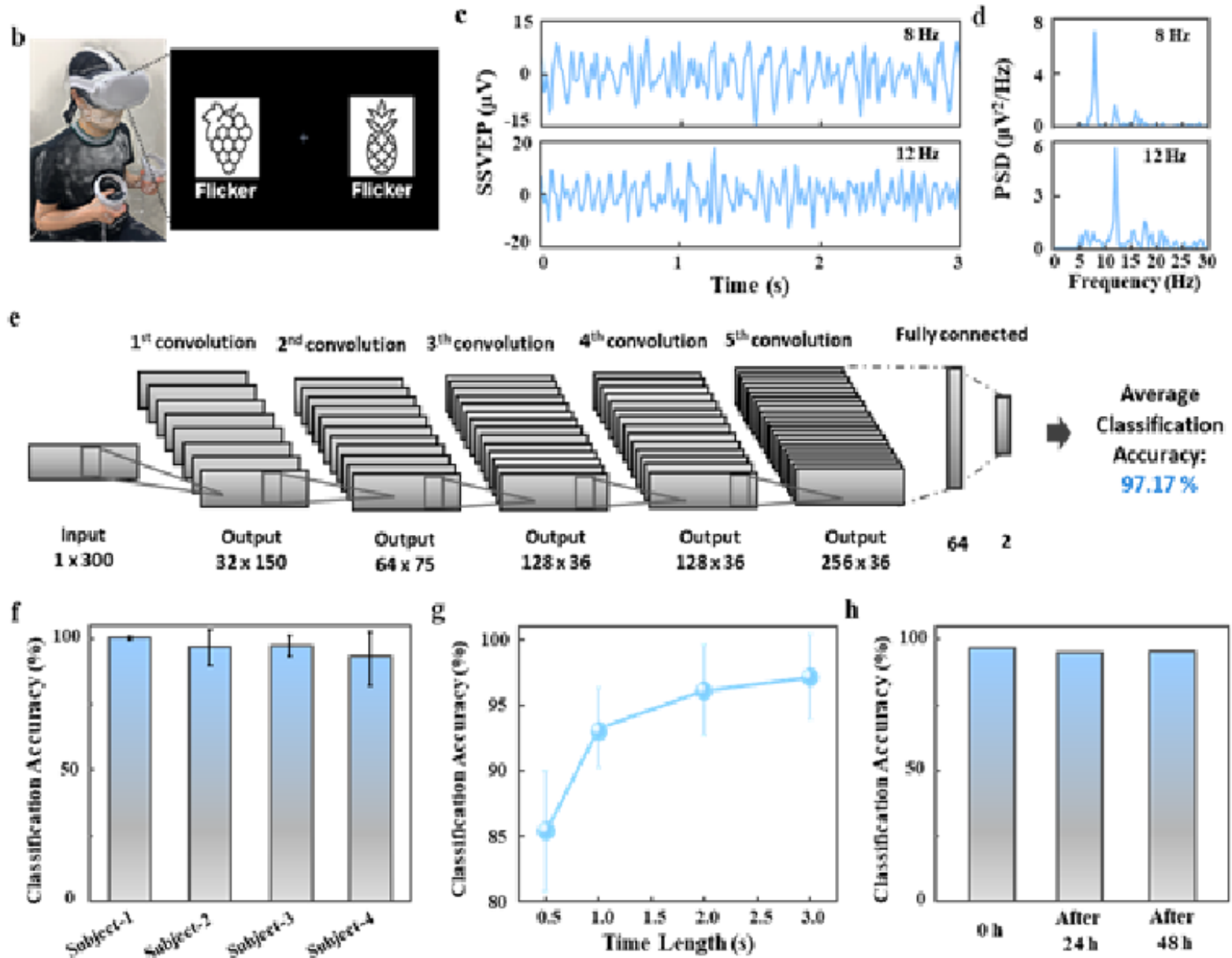
High-level Idea:

- Use VR to strengthen visual intents of subjects
- Augment datasets by sliding time window

Result:

- constructed high-accuracy BCI system for long-term
- improve detection accuracy from 90% to 99%

Representative Research #1



Representative Research #2

Evaluation of Memory Characteristics of informational processing capacity of Cultured Neuron

Contribution:

- What calculations living neural network is good at is still un-known

High-level Idea:

- Evaluate an information processing capacity of a cultured neuron by reservoir computing
- Measure the IPC of memory characteristics by how fast it could reach the target function(f)

$$f = \text{binary step function}(\gamma) = \begin{cases} 1 & (t \leq \gamma) \\ 0 & (t > \gamma) \end{cases}$$

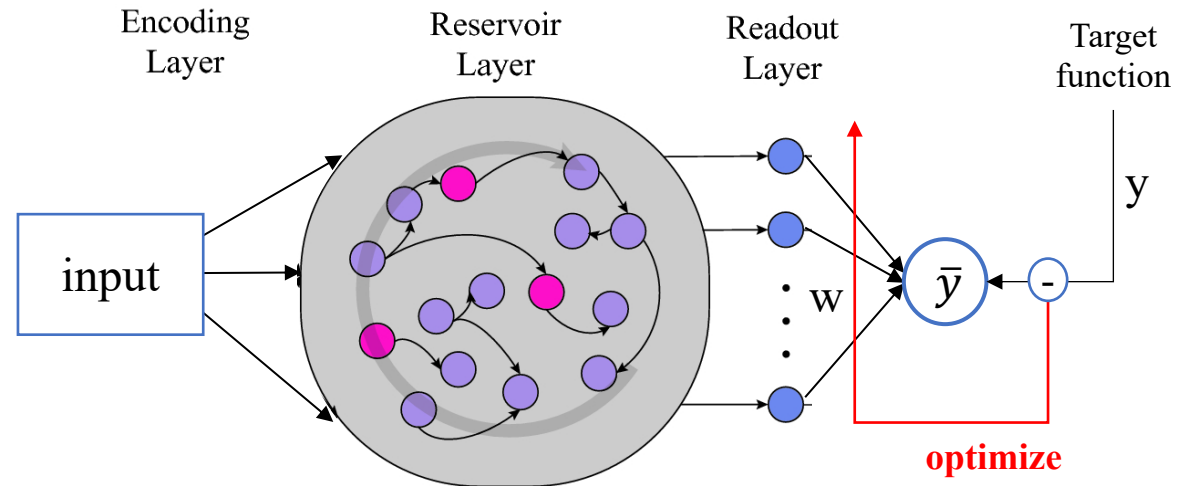
Result:

- Sometimes the function converged, sometimes it didn't. I couldn't figure out what affect it

Representative Research #2

Settings:

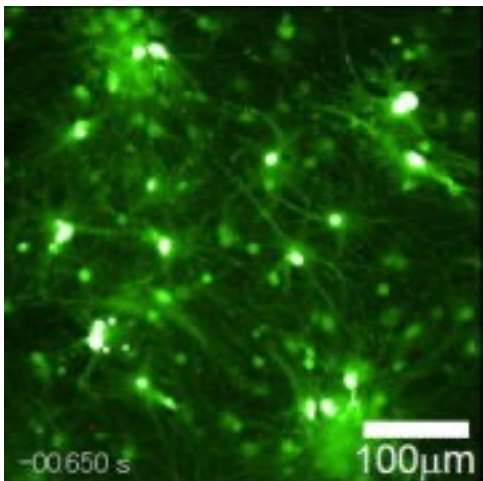
- 26400 Electrodes
- 1024 Readout
- 32 Stimulus input



Reservoir computing for evaluate IPC

Methods:

- Stimulate 1 electrode every 1s
- Calculate linear combination of all neurons
- Update weights based on difference between output and target function(RLS algorism)
- $f = \text{binary step function}(\gamma) = \begin{cases} 1 & (t \leq \gamma) \\ 0 & (t > \gamma) \end{cases}$



Cultured neurons
(rat cortex)

Representative Research #2

Optimizing Algorithm: RLS algorithm

$$e(t) = \mathbf{W}(t)\mathbf{x}(t) - y$$

$$\mathbf{Q}(t) = \mathbf{P}(t)\mathbf{x}(t + 1)$$

$$\mathbf{k}(t) = \frac{\mathbf{Q}(t)}{1 + \mathbf{x}^T(t + 1)\mathbf{Q}(t)}$$

$$\mathbf{P}(t + 1) = \mathbf{P}(t) - \mathbf{k}(t)\mathbf{Q}^T(t)$$

$$\mathbf{W}(t + 1) = \mathbf{W}(t) + e(t)\mathbf{k}(t)$$

$$\mathbf{P}(0) = \mathbf{I}, \mathbf{W}(0) = \mathbf{0}$$

Representative Research #3

The Effect of Electrode Adhesiveness on Motion Artifact in EEG monitoring

JSBME 2021, Young Investigator Workshop

Contribution:

- **Causes of the motion artifact of EEG are diverse and difficult to assess although it is the biggest problem of EEG**

High-level Idea:

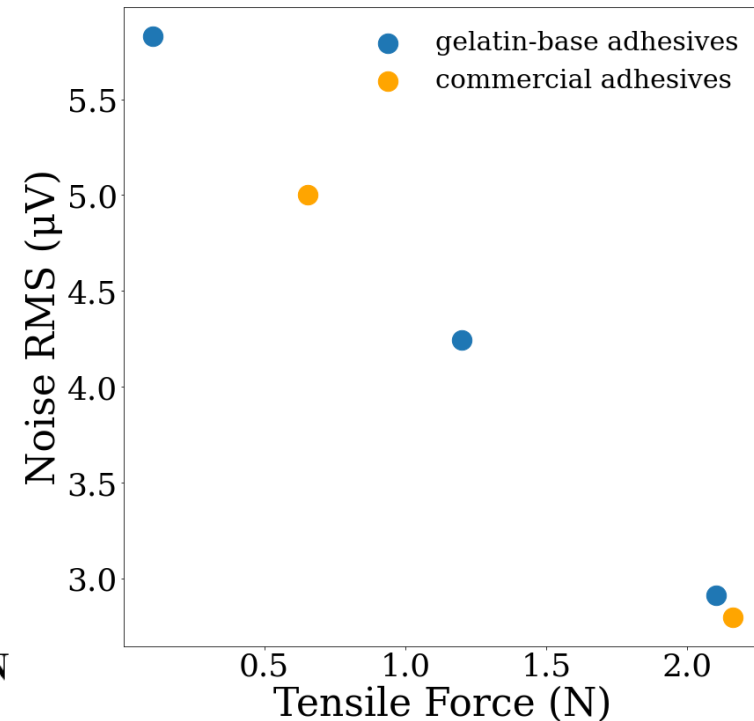
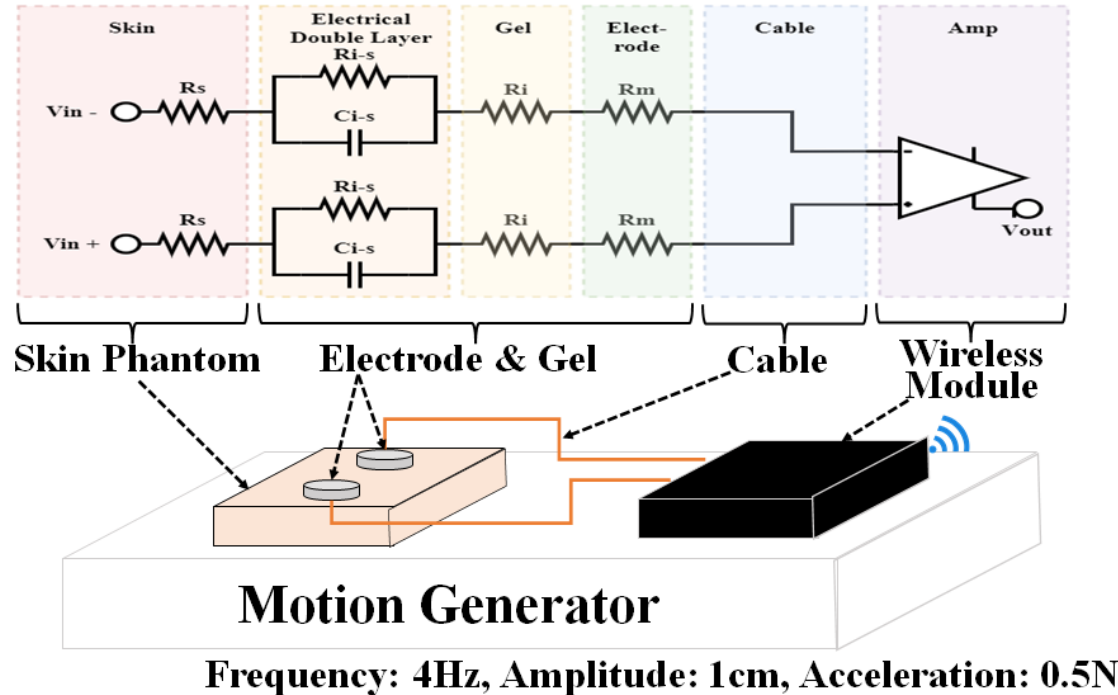
- **Make an instrument that can measure only motion artifact**
- **Create artificial measurement systems that don't use test subjects**

Result:

- **Our system enables to quantify the motion artifact among different electrode.**
- **We firstly prove that the adhesiveness relates to motion artifact**

Representative Research #3

EEG measurement Circuit

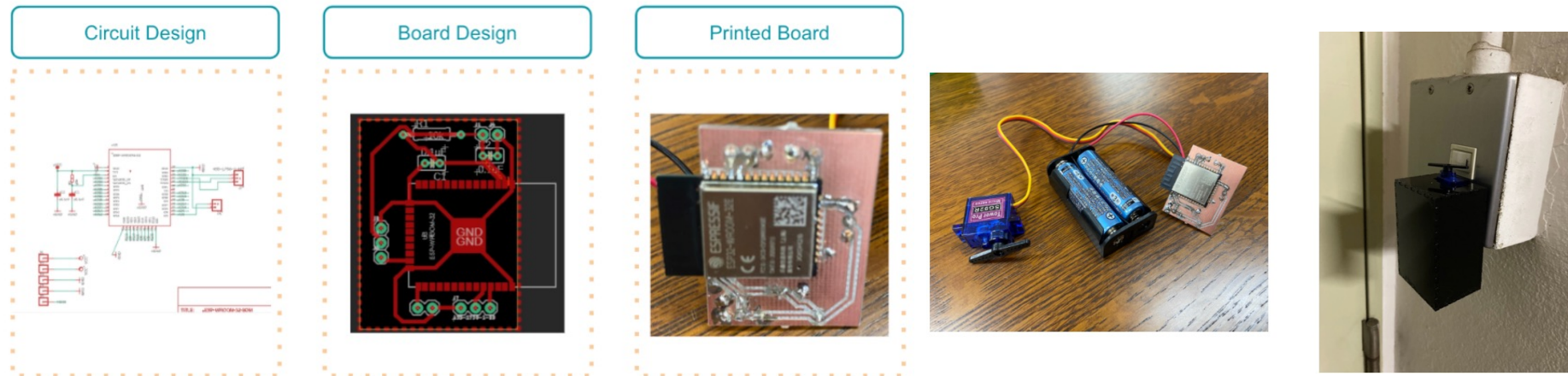


Result:

- Create artificial measurement systems for motion artifact (left figure)
- the result proved relationship between adhesiveness and motion artifact (right figure)

Side Projects

Remote Switch: Bluetooth socket programming, Microcontroller design



Cultured Brain Robot: Close-loop reservoir computing, robot control

