



# Hoseung Cha

PH.D. · POSTDOCTORAL RESEARCHER · BIOSIGNAL/DATA SCIENTIST

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*"The first step is to establish that something is possible; then probability will occur."*

## Summary

Ph.D @ Hanyang university. 7+ years of experience analyzing in biosignal/data such as electroencephalogram (EEG), electromyogram (EMG), electrooculogram (EOG), etc. My research topics include myoelectric control, brain-computer interfacing, and computational neuroscience. Skilled in the application of machine learning or deep learning algorithms using Matlab and Python. I have developed various real-time biosignal-based applications such as 1) facial expression recognition system based on EMG [Click], 2) silent speech recognition system based on EMG, 3) lip shape recognition system based on EMG [Click], 4) Triple blink detection system based on EOG [Click], etc.

## Experiences

### Bio-Interfaced Translational Nanoengineering Group @ Georgia Tech

Atlanta, GA, USA

(PROJECTED) POSTDOCTORAL RESEARCHER CANDIDATE

(Projected) March 2021 - Jan 2022

- Prof. Woon-Hong Yeo's Lab [Click]

### Computational Neuroengineering Lab @ Hanyang University

Seoul, S.Korea

POSTDOCTORAL RESEARCHER

Sep 2020 - Dec 2020

- Prof. Chang-Hwan Im's Lab [Click]

### Computational Neuroengineering Lab @ Hanyang University

Seoul, S.Korea

POSTGRADUATE RESEARCHER

Sep 2015 - Feb 2016

- Prof. Chang-Hwan Im's Lab [Click]

### Computational Neuroengineering Lab @ Hanyang University

Seoul, S.Korea

UNDERGRADUATE RESEARCHER

Mar 2013 - Aug 2013

- Prof. Chang-Hwan Im's Lab [Click]

## Education

### Hanyang University

Seoul, S.Korea

PH.D. IN BIOMEDICAL ENGINEERING, GPA: 98.9/100

Mar 2016 - Aug 2020

- Thesis: Development of Face-Machine Interfaces Using Facial Electromyogram for Interactive Virtual Reality Applications

### Hanyang University

Seoul, S.Korea

M.S. IN BIOMEDICAL ENGINEERING, GPA: 98.2/100

Sep 2013 - Aug 2015

- Thesis: Development of a transient visual evoked potential (tVEP)-based brain switch system [Click]

### Yonsei University

Wonju, S.Korea

B.S. IN BIOMEDICAL ENGINEERING, GPA: 95/100

Mar 2008 - Aug 2013

- Received four scholarships for excellence in grades in 2009 and 2010 (total four semesters)

## Honors & Awards

2019	<b>Best Paper Award</b> , 55th Korean Society of Medical & Biological Engineering [Click]	Incheon, S. Korea
2019	<b>Best Poster Paper Award</b> , 54th Korean Society of Medical & Biological Engineering [Click]	Yeosu, S. Korea
2018	<b>Young Investigator Award</b> , SMIT2018-IBEC2018 Joint Conference [Click]	Seoul, S. Korea
2018	<b>Young Investigator Travel Award</b> , SMIT2018-IBEC2018 Joint Conference [Click]	Seoul, S. Korea
2016	<b>Best Poster Award</b> , International Biomedical Engineering Conference [Click]	Seoul, S. Korea
2015	<b>Excellence Poster Paper Award</b> , 50th Korean Society of Medical & Biological Engineering [Click]	Daegu, S. Korea
2010	<b>Highest honor (top 1% students for 2010 spring semester)</b> , Yonsei University	Wonju, S.Korea

## PUBLISHED

11. **Ho-Seung Cha**, Seong-Jun Choi, and Chang-Hwan Im\*, Real-time Recognition of Facial Expressions using Facial Electromyograms Recorded around the Eyes for Social Virtual Reality Applications  
*IEEE Access*, vol. 8, pp. 62065-62075, Mar. 2020. [Link] [pdf]
10. **Ho-Seung Cha**, Chang-Hee Han, and Chang-Hwan Im\*, Prediction of Individual User's Dynamic Ranges of EEG Features from Resting-State EEG Data for Evaluating Their Suitability for Passive Brain-Computer Interface Applications  
*Sensors*, vol. 20(4), pp. 988, Feb. 2020. [Link] [pdf]
9. Seonghun Park, **Ho-Seung Cha**, and Chang-Hwan Im\*, Development of an Online Home Appliance Control System Using Augmented Reality and an SSVEP-Based Brain-Computer Interface  
*IEEE Access*, vol. 7, pp. 163604-163614, Nov. 2019. [Link] [pdf]
8. Do Yeon Kim, Jinuk Kwon, Joo-Young Kim, **Ho-Seung Cha**, Yong-Wook Kim, In Young Kim, and Chang-Hwan Im\*, New Method for Pure-Tone Audiometry Using Electrooculogram: A Proof-of-Concept Study  
*Sensors*, vol. 18, Art.No.3651, Oct. 2018. [Link] [pdf]
7. Jeong-Hwan Lim, Yong-Wook Kim, Jun-Hak Lee, Kwang-Ok An, Han-Jeong Hwang, **Ho-Seung Cha**, Chang-Hee Han, and Chang-Hwan Im, An emergency call system for patients in locked-in state using an SSVEP-based brain switch  
*Psychophysiology*, vol. 54, pp. 1632-1634, May 2017. [Link] [pdf]
6. Han-Jeong Hwang, Chang-Hee Han, Jeong-Hwan Lim, Yong-Wook Kim, Soo-In Choi, Kwang-Ok An, Jun-Hak Lee, **Ho-Seung Cha**, Seung Hyun Kim, and Chang-Hwan Im\*, Clinical Feasibility of Brain-Computer Interface Based on Steady-State Visual Evoked Potential in Patients with Locked-in Syndrome: Case Studies  
*Psychophysiology*, vol. 54, pp. 444-451, Dec. 2016. [Link] [pdf]
5. Won-Du Chang, **Ho-Seung Cha**, Do Yeon Kim, Seung Hyun Kim, Chang-Hwan Im\*, Development of an electrooculogram-based eye-computer interface for communication of individuals with amyotrophic lateral sclerosis  
*Journal of NeuroEngineering and Rehabilitation*, vol. 14, Art. ID 89, Sep. 2017. [Link] [pdf]
4. Won-Du Chang, **Ho-Seung Cha**, Chany Lee, Hoon-Chul Kang, and Chang-Hwan Im\*, Automatic Identification of Interictal Epileptiform Discharges in Secondary Generalized Epilepsy  
*Computational and Mathematical Methods in Medicine*, vol. 2016, Art. ID 8701973, Jun. 2016. [Link] [pdf]
3. Won-Du Chang, **Ho-Seung Cha**, Kiwoong Kim, Chang-Hwan Im\*, Detection of eye blink artifacts from single prefrontal channel electroencephalogram  
*Sensors*, vol. 124, pp. 19-30, Feb. 2016. [Link] [pdf]
2. Won-Du Chang, **Ho-Seung Cha**, Chang-Hwan Im\*, Removing the Interdependency between Horizontal and Vertical Eye-Movement Components in Electrooculograms  
*Sensors*, vol. 16(2), pp. 227, Feb. 2016. [Link] [pdf]
1. **Ho-Seung Cha**, Won-Du Chang, YoungSeok Shin, and Chang-Hwan Im\*, EEG-based Neurocinematics: Challenges and Prospects  
*Brain-Computer Interfaces*, vol. 2(4), pp. 186-192, Feb. 2016. [Link] [pdf]

## SUBMITTED

2. **Ho-Seung Cha** and Chang-Hwan Im\*, Performance Enhancement of Facial Electromyogram-based Facial-expression Recognition for Social Virtual Reality Applications Using Linear Discriminant Analysis Adaptation  
*Virtual Reality*, Submitted
1. **Ho-Seung Cha**, Won-Du Chang, and Chang-Hwan Im\*, Deep-Learning-Based Real-Time Silent Speech Recognition using Facial Electromyogram Recorded Around Eyes for Hands-Free Interfacing in Virtual Reality Environment  
*IEEE Transactions on Emerging Topics in Computing*, Under review

## INTERNATIONAL

15. **Ho-Seung Cha**, Seongjun Choi, and Chang-Hwan Im, Real-Time Electromyogram-Based Facial Expression Recognition Using Riemannian Geometry Features for VR Applications  
*41st International Conference of the IEEE EMBS*, Berlin, Germany, July 26, 2019
14. Seong-Jun Choi, **Ho-Seung Cha**, and Chang-Hwan Im\*, Emotion Inference Method Using Facial EMG-based Facial Expression Recognition Technology for VR Applications  
*SMIT2018-IBEC2018 Joint Conference*, Seoul, South Korea, November 9, 2018.
13. **Ho-Seung Cha** and Chang-Hwan Im\*, New Strategy for Minimizing Training Time In EMG-Based Facial Expression Recognition for Virtual Reality Applications  
*SMIT2018-IBEC2018 Joint Conference*, Seoul, South Korea, November 9, 2018.
12. Seongjun Choi, **Ho-Seung Cha**, and Chang-Hwan Im, User Authentication for Virtual Reality Applications Based on Facial EMG Induced by Facial Expression Changes  
*40th International Conference of the IEEE EMBS*, Honolulu, USA, July 18, 2018
11. **Ho-Seung Cha** and Chang-Hwan Im, Prediction of individual user's suitability for passive BCI applications using short resting EEG recordings  
*7th International BCI Meeting*, Pacific Grove, California, USA, May 22, 2018
10. **Ho-Seung Cha**, Won-Du Chang and Chang-Hwan Im, Real-time Recognition of Lip Gestures Based on Facial EMG  
*3rd Annual International Biomedical Engineering Conference*, Seoul, Korea, November 11, 2016
9. **Ho-Seung Cha**, Won-Du Chang and Chang-Hwan Im, A Real-Time Lip Gesture Recognition System using Facial EMG  
*38th Annual International Conference of the IEEE EMBS*, Orlando, Florida, USA, August 19, 2016
8. Won-Du Chang, **Ho-Seung Cha**, and Chang-Hwan Im, Improved Electrooculogram-based Eye-writing Recognition Using a New Feature Extraction Method  
*2nd Annual International Biomedical Engineering Conference*, Gyeongju, Korea, November 12, 2015
7. **Ho-Seung Cha** and Won-Du Chang, Young-Seok Shin, Dongpyo Jang and Chang-Hwan Im, EEG-Based Neurocinematics: Potential Brain Indices for Rating Films  
*37th Annual International Conference of the IEEE EMBS*, Milano, Italy, Aug 25 - 29, 2015
6. Jeong-Hwan Lim, Yong-Wook Kim, Chang-Hee Han, **Ho-Seung Cha**, and Chang-Hwan Im, An Emergency Call System for Patients with Severe ALS Using Less-Stimulating SSVEP-Based Brain Switch  
*37th Annual International Conference of the IEEE EMBS*, Milano, Italy, Aug 2015
5. Won-Du Chang, **Ho-Seung Cha**, and Chang-Hwan Im, A Novel Method to Detect Eye Blink Artifacts from a Frontal Single-Channel Electroencephalogram  
*International Biomedical Engineering Conference (IBEC) 2014*, Gwangju, Nov 20, 2014
4. Won-Du Chang, **Ho-Seung Cha** and Chang-Hwan Im Kang, and Chang-Hwan Im\*, A New Method for Detecting Eye-Blink Artifacts from a single-Channel Electroencephalogram  
*36th Annual International Conference of the IEEE EMBS*, Chicago, Illinois USA, Aug 2014
3. Won-Du Chang, **Ho-Seung Cha**, and Chang-Hwan Im\*, Enhanced Template Matching Using Dynamic Positional Warping for Pattern Recognition in Electroencephalogram  
*36th Annual International Conference of the IEEE EMBS*, Chicago, Illinois USA, August 2014
2. Jeong-Hwan Lim, Jun-Hak Lee, Yong-Wook Kim, Han Choi, Chang-Hee Han, **Ho-Seung Cha**, and Chang-Hwan Im\*, Implementation of a Steady State Visual Evoked Potential (SSVEP)-Based Online Brain-Switch System Using a Chromatic Stimulus

1. **Ho-Seung Cha**, Jeong-Hwan Lim, Chang-Hee Han, Han-Jeong Hwang, Won-Du Chang and Chang-Hwan Im\*, A Transient Visual Evoked Potential (tVEP)-based Brain Switch System

36th Annual International Conference of the IEEE EMBS, Chicago, Illinois USA, Aug 2014.

### DOMESTIC (S. KOREA)

15. Seonghun Park, **Ho-Seung Cha**, and Chang-Hwan Im, New Method for Estimating Emotion Arousal Changes of a Group of Individuals During Movie Screening Using SSVEP

Korean Society for EEG and Neurophysiology, Seoul, South Korea, Dec 7, 2019

14. **Ho-Seung Cha**, Seongjun Choi, Chunghwan Kim, and Chang-Hwan Im, Real-time Electromyogram-Based Facial Expression Recognition Using Riemannian Geometry Features for VR application

Engineering in circadian rhythm and ubiquitous healthcare (Uhealthcare), Seoul, South Korea, Dec 5, 2019

13. **Ho-Seung Cha** and Chang-Hwan Im, Development of Silent Speech Recognition System Based on Facial Electromyogram Recorded around Eyes for Hands-free Interactions in Virtual Environments

Korean Society of Medical & Biological Engineering (KOSOMBE), Incheon, Nov 7, 2019

12. Kang-min Choi, **Ho-Seung Cha**, and Chang-Hwan Im, Real-time Eye Gaze Tracking Method Using Electrooculogram Signals Recorded around Eyes in Virtual Environments

Korean Society of Medical & Biological Engineering (KOSOMBE), Incheon, Nov 7, 2019

11. Jung-Hwan Kim, **Ho-Seung Cha**, Seoungjae Lee, Chuljin Park, In Young Kim, Se-Keun Park, and Chang-Hwan Im, Development of Dyslexia Diagnosis System Using Electrooculogram: a Proof-of-concept Study

Korean Society of Medical & Biological Engineering (KOSOMBE), Incheon, Nov 7, 2019

10. Seong-Jun Choi, Chunghwan Kim, **Ho-Seung Cha**, and Chang-Hwan Im, Development of Facial Motion Capture Technology Based on Facial Electromyogram Using Deep Learning

Korean Society of Medical & Biological Engineering (KOSOMBE), Incheon, Nov 7, 2019

9. **Ho-Seung Cha**, and Chang-Hwan Im, Development of Avatar Expressing Emotions in Real Time Using Facial Electromyogram-based Facial Expression in Virtual Environment

Korean Society of Medical & Biological Engineering (KOSOMBE), Yeosu, May 9, 2019

8. **Ho-Seung Cha**, Seong-Jun Choi, Hodam Kim, and Chang-Hwan Im, Performance Comparison of Classification Techniques for the Facial Expression Recognition Based on Surface EMG

Korean Society of Medical & Biological Engineering (KOSOMBE), Chonbuk university, Cheonbuk, Nov 11 2017

7. **Ho-Seung Cha**, Won-Du Chang, Young Seok Shin, Dong Pyo Jang, and Chang-Hwan Im, Neurocinematics: Development of Indices of Evaluating Cinematic Using EEG

Korean Society of Medical & Biological Engineering (KOSOMBE), Pusan, May 13, 2016

6. Jeong-Hwan Lim, Yong-Wook Kim, **Ho-Seung Cha**, Chang-Hee Han, and Chang-Hwan Im, An Emergency Call System for Patients with Severe ALS Using Less-Stimulating SSVEP-Based Brain Switch

Korean Society for Computational Neuroscience, Seoul, August 19, 2015

5. **Ho-Seung Cha**, JongYoep Lim, Da-sol Jeon, Won-Du Chang, and Chang-Hwan Im, Electrooculogram-based Real-time Digit Input System

Korean Society of Medical & Biological Engineering (KOSOMBE), Daegu, S. Korea, May 8, 2015

4. Jeong-Hwan Lim, Yong-Wook Kim, Jun-Hak Lee, **Ho-Seung Cha**, and Chang-Hwan Im, Implementation of a Steady State Visual Evoked Potential-based "Less Stimulating" Brain Switch System Using a Chromatic Stimulus

Korean Society of Medical & Biological Engineering (KOSOMBE), Daegu, May 8, 2015

3. **Ho-Seung Cha**, Jeong-Hwan Lim, Han-Jeong Hwang, Chang-Hee Han, and Chang-Hwan Im, Development of the Brain Switch System Using CTVEP

*Korean Society of Medical & Biological Engineering (KOSOMBE), Osong, May 9, 2014*

2. Won-Du Chang, **Ho-Seung Cha**, and Chang-Hwan Im, A Study on Automatic Detection of Spikes from a Single-Channel Electroencephalogram

*Korean Society of Medical & Biological Engineering (KOSOMBE), Osong, May 9, 2014*

1. **Ho-Seung Cha**, Jeong-Hwan Lim, Han-Jeong Hwang, Chang-Hee Han, and Chang-Hwan Im, Development of a VEP-based brain switch system

*Korean Society of Medical & Biological Engineering (KOSOMBE), Incheon, Nov 8, 2013*

### INTERNATIONAL

1. Chang-Hwan Im, **Ho-Seung Cha**, Seong-Jun Choi, Electronic Device, Avatar Facial Expression System and Controlling Method Thereof  
Filed, *US 16/534,579*, Aug 2019. [pdf]

### DOMESTIC (S. KOREA)

9. Chang-Hwan Im and **Ho-Seung Cha**, Apparatus and Method for User Authentication Using Facial EMG by Measuring Changes of Facial Expression of HMD User  
Issued, *KR 1020944880000*, Mar 2020. [pdf]
8. Won-Du Chang, Chang-Hwan Im, **Ho-Seung Cha**, Asynchronous Eye-Character Recognition Method and Apparatus Using Electromyogram Data  
Issued, *KR 10-2019-0124660*, vol. 54, pp. 1632-1634, Oct 2019. [pdf]
7. Chang-Hwan Im, Kang-Min Choi, **Ho-Seung Cha**, Method for Tracking Eye of HMD User and HMD for Tracking Eye of User  
Issued, *KR 10-2019-0117185*, Sep 2019. [pdf]
6. Chang-Hwan Im, **Ho-Seung Cha**, Seong-Jun Choi, Learning Method and Apparatus for Facial Expression Recognition, Facial Expression Recognition Method Using Electromyogram Data  
Filed, *KR 10-2019-0023580*, Mar 2018. [pdf]
5. Chang-Hwan Im, **Ho-Seung Cha**, Seong-Jun Choi, Facial Expression Registration Method for Facial Expression Recognition and Facial Expression Recognition Method Using the same  
Filed, *KR 10-2018-0031888*, Mar 2018. [pdf]
4. Chang-Hwan Im, **Ho-Seung Cha**, Emotion Recognition Method and Device Using Electromyogram Signal  
Filed, *10-2018-0080953*, Mar 2018. [pdf]
3. Won-Du Chang, Chang-Hwan Im, **Ho-Seung Cha**, Kwang-Ryeol Lee, Method and System for Recognition of Eye-Character based on Tracking Technique of Electro Oculogram Gaze  
Issued, *KR 10-2016-0117716*, Jun 2017. [pdf]
2. Chang-Hwan Im, Won-Du Chang, **Ho-Seung Cha**, System and Method for Detecting Spikes Whose Widths Are Within a Certain Range in Time-series Data  
Issued, *KR 10-2014-0058590*, Dec 2015. [pdf]
1. **Ho-Seung Cha**, Chang-Hwan Im, Jeong-Hwan Lim, Han-Jeong Hwang, Chang-Hee Han, Won-Du Chang, Method and apparatus for generating signals using transient visual evoked potential  
Issued, *KR 10-2013-0168546*, Jul 2015. [pdf]

## Software

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3. Facial electromyogram-based facial expression recognition system  
*C-2018-036477*, Dec 2018. [Click]
2. F-avatar  
*C-2018-036476*, Dec 2018. [Click]
1. Bio-Control  
*C-2018-030968*, Nov 2018. [Click]

## Press

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3. VR Avatars Copy Your Facial Expressions. When you smile, they smile with you

*News-H*, Jan 2019. [Link (Korean)] [Link (English)]

2. VR Avatar looks exactly like me!

*Dong-A Ilbo*, Dec 2018. [Link] [Click to see the article capture]

1. Why don't we rate movie using "brainwave indices"?

*DongaScience*, Dec 2014 [Link]

## Projects

### RESEARCH PROJECTS

#### Recognizing Facial Expressions Based on Facial Electromyogram for Interactive VR Applications

PARTICIPATING RESEARCHER

- PI: Prof. Chang-Hwan Im
- develop real-time facial expression recognition system [Click to see the paper] [Click to see the video]

*Samsung Science & Technology  
Foundation @ Samsung Electronics*

*Sep 2017 - Aug 2020*

#### Development of Non-invasive Integrated BCI SW Platform To Control Home Appliance and External Devices By User's Thought Via AR/VR Interface

PARTICIPATING RESEARCHER

- PI: Prof. Chang-Hwan Im
- develop emotion recognition system using facial electromyogram [Click to see the patent]

*Korea Institute of Science and  
Technology (KIST)*

*Apr 2017 - Dec 2023*

#### Development of Multimodal Brain-Machine Inference System Based on User Intent Recognition

PARTICIPATING RESEARCHER

- PI: Prof. Inyoung Kim
- develop EEG indices for predicting user's BCI application suitability [Click to see the paper]

*Information & Communication  
Technology Promotion (IITP)*

*May 2013 - Feb 2017*

#### Development of Bio-Signal Analysis Algorithm for Wearable Devices

PARTICIPATING RESEARCHER

- PI: Prof. Chang-Hwan Im
- develop an eye-gaze direction detection system using electrooculogram
- develop an silent speech recognition system using electromyogram
- contribute C-lab team's spin-off (Linkface)[Click to see the article]

*Samsung Electronics*

*Oct 2016 - Dec 2016*

#### Development of Eye Tracking Source Technology Based on Electrooculogram for HCI Application

PARTICIPATING RESEARCHER

- PI: Prof. Won-Du Chang
- design and conduct experiments for recording electrooculogram signals [Click to see the paper]
- conduct EEG data analysis and abnormal EEG data/pattern classification of epilepsy patients

*National Research Foundation  
(NRF)*

*May 2015 - Apr 2017*

#### Development of real-time bio-signal-based cultural content evaluation technology focused on large customers

PARTICIPATING RESEARCHER

- PI: Prof. Dong pyo Jang
- develop EEG indices for evaluating cinematics [Click to see the paper] [Click to see the article]

*Korea Institute of Industrial  
Technology (KITECH)*

*May 2013 - Feb 2016*

#### Development of original technologies for brain-computer interface based on the spatiotemporospectral analysis of brain activity patterns

RESEARCH ASSISTANT

- PI: Prof. Won-Du Chang
- develop transient visual evoked potential (tVER)-based brain switch system[click to see the patent]

*Ministry of Science, ICT and Future  
Planning*

*Oct 2013 - July 2014*

### PERSONAL PROJECTS

## Personal homepage

ADMINISTRATOR

Sep 2020 -

- create personal homepage using GitHub page [Click]

## Key board-based braille input system for visually impaired

DEVELOPER

Yonsei University

Sep 2010 - Dec 2010

- visual programming class project (A+) @ Yonsei University.

## Skills

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<b>Data analysis experiences</b>	Bio-electric signals (EEG/EMG/EOG) · GSR · 3D motion data · Images
<b>Research techniques</b>	Machine learning · Deep learning · Time-frequency signal analysis · Real-time Data Analysis
<b>Programming</b>	Matlab · Python · C++/C
<b>Web/Media</b>	Adobe premiere
<b>Language</b>	Korean · English

## References

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### Chang-Hwan Im (Ph.D.)

Seoul, S. Korea

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### YoungJin Jung (Ph.D.)

Pusan, S. Korea

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