

# Hoseung Cha

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

222, Wangsimni-ro 222, Seongdong-gu, Seoul, 04763, SOUTH KOREA

☎ (+82) 10-4037-2405 | ✉ [hoseungcha@gmail.com](mailto:hoseungcha@gmail.com) | 🏠 [hs-cha.github.io](https://hs-cha.github.io) | 📷 [hs-cha](#) | 🌐 [hoseungcha](#)

*“An expert is a man who has made all the mistakes which can be made, in a narrow field”—Niels Bohr*

## Summary

Ph.D @ Hanyang university. 7+ years of experience in signal processing/analysis of bio-signals, including EEG (Electroencephalogram), EMG (Electro-oculogram), and EOG (Electro-oculogram). 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

### Computational Neuroengineering Lab @ Hanyang University

POSTDOCTORAL RESEARCHER

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

*Seoul, S.Korea*

*Sep 2020 - Dec 2020*

### Computational Neuroengineering Lab @ Hanyang University

POSTGRADUATE RESEARCHER

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

*Seoul, S.Korea*

*Sep 2015 - Feb 2016*

### Computational Neuroengineering Lab @ Hanyang University

UNDERGRADUATE RESEARCHER

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

*Seoul, S.Korea*

*Mar 2013 - Aug 2013*

## Education

### Hanyang University

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

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

*Seoul, S.Korea*

*Mar 2016 - Aug 2020*

### Hanyang University

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

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

*Seoul, S.Korea*

*Sep 2013 - Aug 2015*

### Yonsei University

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

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

*Wonju, S.Korea*

*Mar 2008 - Aug 2013*

## Honors & Awards

- 2019 **Best Paper Award**, 55th Korean Society of Medical & Biological Engineering [Click]
- 2019 **Best Poster Paper Award**, 54th Korean Society of Medical & Biological Engineering [Click]
- 2018 **Young Investigator Award**, SMIT2018-IBEC2018 Joint Conference [Click]
- 2018 **Young Investigator Travel Award**, SMIT2018-IBEC2018 Joint Conference [Click]
- 2016 **Best Poster Award**, International Biomedical Engineering Conference [Click]
- 2015 **Excellence Poster Paper Award**, 50th Korean Society of Medical & Biological Engineering [Click]
- 2010 **Highest honor (top 1% students for 2010 spring semester)**, Yonsei University

*Incheon, S. Korea*

*Yeosu, S. Korea*

*Seoul, S. Korea*

*Seoul, S. Korea*

*Seoul, S. Korea*

*Daegu, S. Korea*

*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. Seonghun Park, **Ho-Seung Cha**, Jinuk Kwon, Hodam Kim, and Chang-Hwan Im, Development of an Online Home Appliance Control System Using Augmented Reality and an SSVEP-Based Brain-Computer Interface  
*International Winter Workshop on Brain-Computer Interface (BCI)*, Gangwon, S. Korea, Feb 26-28, 2020
14. **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
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)

17. Chunghwan Kim, **Ho-Seung Cha**, and Chang-Hwan Im, Development of a Facial Motion Capture System Based on Facial Electromyogram Recorded around the Eyes for Social Virtual Reality Applications

*The Institute of Electronics and Information Engineers*, Jeju, S. Korea, July 19-21, 2020

16. Kang-min Choi, **Ho-Seung Cha**, Sangjun Lee, Jimin Park, Suhye Kim, and Chang-Hwan Im, Real-time EOG-Based Eye Tracking Method in VR Environment using Arbitrary Multichannel Electrode Configuration

*The Institute of Electronics and Information Engineers*, Jeju, S. Korea, July 19-21, 2020

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

## Patents

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### 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

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### 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

- create personal homepage using GitHub page [Click]

Sep 2020 -

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

DEVELOPER

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

Yonsei University

Sep 2010 - Dec 2010

## Skills

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

## References

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

Seoul, S. Korea

PROFESSOR, CHAIR | DEPARTMENT OF BIOMEDICAL ENGINEERING @ HANYANG UNIVERSITY

- Office: +82-2-2220-2322
- E-mail: ich@hanyang.ac.kr
- Homepage [Click]

### Won-Du Chang (Ph.D.)

Pusan, S. Korea

ASSISTANT PROFESSOR | DEPARTMENT OF COMPUTER ENGINEERING @ PUKYONG NATIONAL UNIVERSITY

- Office: +82-51-629-6246
- e-mail: chang@pknu.ac.kr
- Homepage [Click]

### YoungJin Jung (Ph.D.)

Pusan, S. Korea

ASSISTANT PROFESSOR | DEPARTMENT OF RADIOLOGICAL SCIENCE AT HEALTH SCIENCE DIVISION @ DONGSEO UNIVERSITY

- Tell: +82-51-320-2871
- E-mail: microbme@dongseo.ac.kr
- Homepage [Click]