HYUNG-SOON PARK

INVITED TALK 5

BCI-based Hand Rehabilitation Robot for Neurorehabilitation Post Stroke

Sunghyun Jo1, Seungmin Ye1 and Hyung-Soon Park1*

[1] Department of Mechanical Engineering, KAIST, Daejeon 34141, Republic of Korea

***Corresponding author:** hyungspark@kaist.ac.kr

Abstract

Hand impairments following a stroke can impact their ability to perform daily activities including grasping, reaching and hand manipulation. Considering motor cortex for hand movement is the largest among any other body parts, there is a need for more effective hand rehabilitation interventions post-stroke for promoting greater brain plasticity. Brain-Computer Interface (BCI) systems establish direct communication between the brain and the external environment, facilitating the repeated activation of closed-loop motor circuits damaged by stroke. Detecting a user's hand movement intentions in EEG-based BCI systems remains one of the most challenging tasks within the BCI related research topics. This study introduces a BCI-based dexterous hand rehabilitation robot for post-stroke grasping training, combining an EEG-vision hybrid intention recognition system with an 8-degree-of-freedom (DOF) hand rehabilitation glove. First, development of high-DOF dexterous wearable hand rehabilitation robot for assisting movement of five fingers in multiple DOFs. The soft wearable robotic glove consists of biomimetic tendon mechanism for actuating eight joints in hand. It is light weight, soft, and compact for comfortable assist in the hospital as well as home environment. Second, development of real-time intention recognition algorithm for various grasping tasks will be presented. Since the biological signals such as EEG and EMG are not enough to distinguish intentions for various hand grasping postures, the study will present multi-modal sensor system for high-DOF hand movement intention recognition. The system was evaluated with eight stroke survivors showing promising improvement over similar studies.

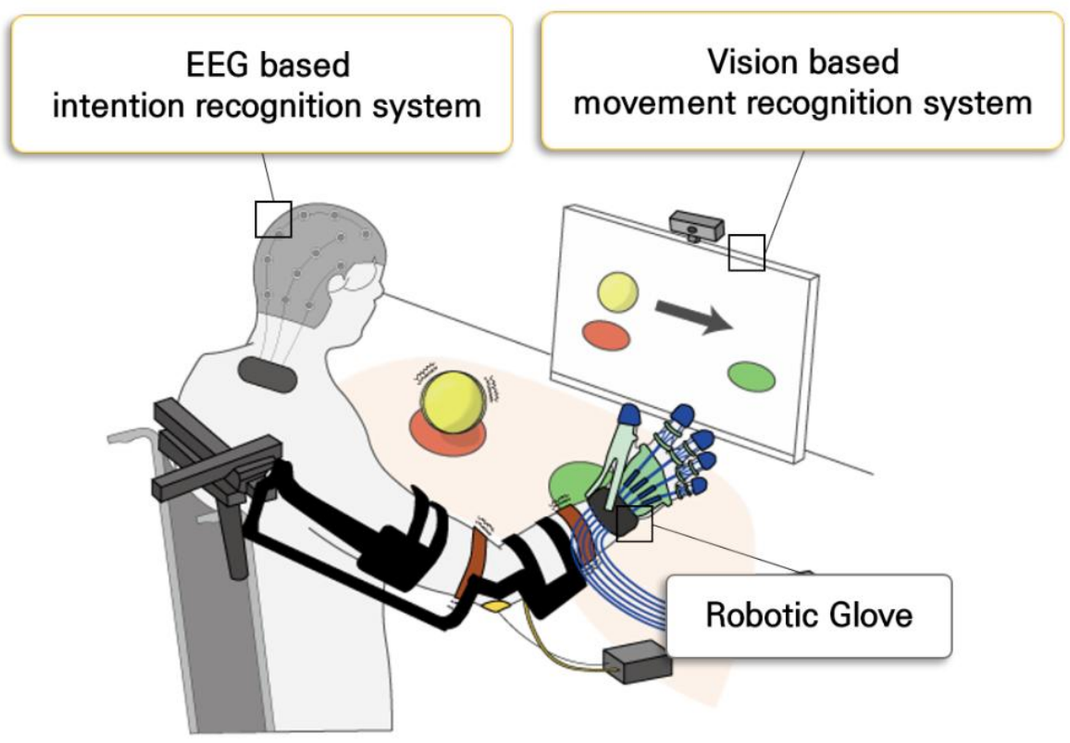
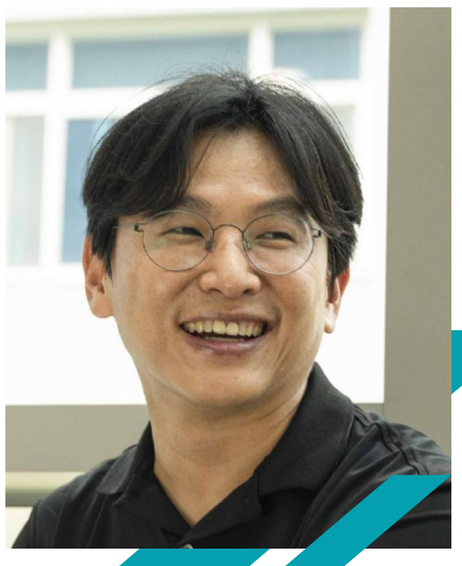


Fig.1. BCI-based hand rehabilitation robot system

Keywords: Soft wearable hand rehabilitation robot, Neural plasticity, Brain-computer-interface

CURRICULUM VITAE



Name:	Hyung-Soon Park
Academic positions:	Professor
Workplace:	KAIST, Department of Mechanical Engineering
Address:	291 Daehakro, Yuseonggu, Daejeon 34141, Republic of Korea
Email:	hyungspark@kaist.ac.kr
Expertise:	Rehabilitation robotics, Biomechanics, Muscle synergy in human movement, Brain-computer-interface

Education History

[Doctorate]	1996-2003	Department of Mechanical Engineering, KAIST
[Master]	1994-1996	Department of Mechanical Engineering, KAIST
[Bachelor]	1990-1994	Precision Engineering and Mechatronics, KAIST

Professional Background

2004-2009	Research Scientist, Rehabilitation Institute of Chicago, IL USA
2006-2009	Research Assistant Professor, Department of Biomedical Eng. Northwestern Univ., Chicago, IL, USA
2009-2013	Staff Scientist, National Institutes of Health, Bethesda, MD, USA
2013-current	Professor, Department of Mechanical Eng., KAIST, South Korea

Selected Awards and Honors

1.	Oct, 2008	NIDRR, Mary Switzer Distinguished Fellow
2.	Jan, 2016	Gold Award, Samsung Human-Tech
3.	Dec, 2018	Hakbo Art (Assistive Robot Technology) Award, KROS
4.	April, 2019	Academic Achievement Award, Korean Society of Mechanical Engineers
5.	Dec, 2024	Technology Innovation Award, KAIST

Selected Publications

1. CB Park, JS Hwang, HS Gong, HS Park, Patient-specific design and fabrication of a trapeziometacarpal joint orthosis using a computed tomography image-based finite element model, Int. Journal of Bioprinting, 2024
2. SH Heo, HS Park, Proximity Perception-Based Grasping Intelligence: Toward the Seamless Control of a Dexterous Prosthetic Hand, IEEE/ASME Transactions on Mechatronics, 2024
3. E. Rho, et. Al, Multiple Hand Posture Rehabilitation System Using Vision-Based Intention Detection and Soft-Robotic Glove, IEEE Trans. On Industrial Informatics, 2024
4. Y. Lee, and HS Park, Design Optimization of a Soft Robotic Rehabilitation Glove Based on Finger Workspace Analysis, Biomimetics 2024
5. KS Lee, YS Kim, HS Park, Shape Memory Alloy-Based Reactive Tubular (SMART) Brake for Compact and Energy-Efficient Wearable Robot Design, ACS Applied Materials and Interfaces, 2024