Detecting Gait Changes with Front-Facing Video and MediaPipe: A Hemiplegic Patient Case

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Biography

In 1987, he received a doctor of engineering from the Tokyo Institute of Technology for research on speeding up amorphous silicon thin film transistors.

From 1980 to 1987, he worked at Tokyo Institute of Technology as a research associate in the Department of Electronic and Physical Engineering, and from 1987 to 1990 as a research associate in the Faculty of Engineering, Takushoku University. 1990 to 1990, he worked at West Tokyo University of Science (now Teikyo University of Science) as an associate professor. 2007 to 2012, Department of Media Information Systems, Department of Life Sciences, he has worked as a professor.
Currently working on health status change detection using several kinds of sensors, video analysis and machine learning.

Topics of research interest of our group

Our research group is in charge of creating a health management system that applies various sensing technologies in a group that conducts joint research with occupational therapists and physical therapists working in hospitals.
Specifically, we are developing activity assessment from a rehabilitation approach utilizing digital technologies through medical-engineering collaboration.

INTRODUCTION

Previous work

At Global Health 2022 & 2023, we presented application results of MediaPipe in the field of rehabilitation.

(1) The patient undergoing rehabilitation was asked to wear walking aids, and the walking patterns before, during, and after wearing them were analyzed with MediaPipe to confirm the effectiveness of the walking-assisted aid attachment.

(2) Effectiveness could be evaluated from the following points of view:

- Height of left and right ankles
- Normalized shoulder angle
- Blurring of the nasal trajectory

Y. Uchida, et. al., International J. of Advances in Life science, vol.15, no 1&2, 2023, pp. 45-55 and vol. 16 no 1 & 2, year 2024, pp. 80- 91.
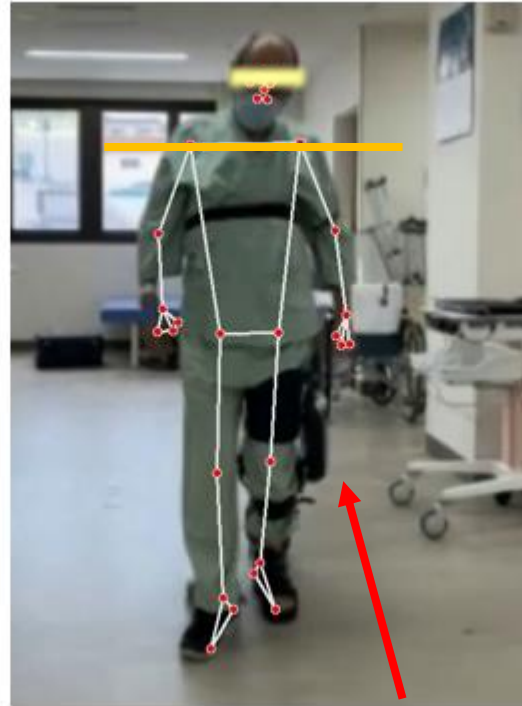
Height of left and right ankles
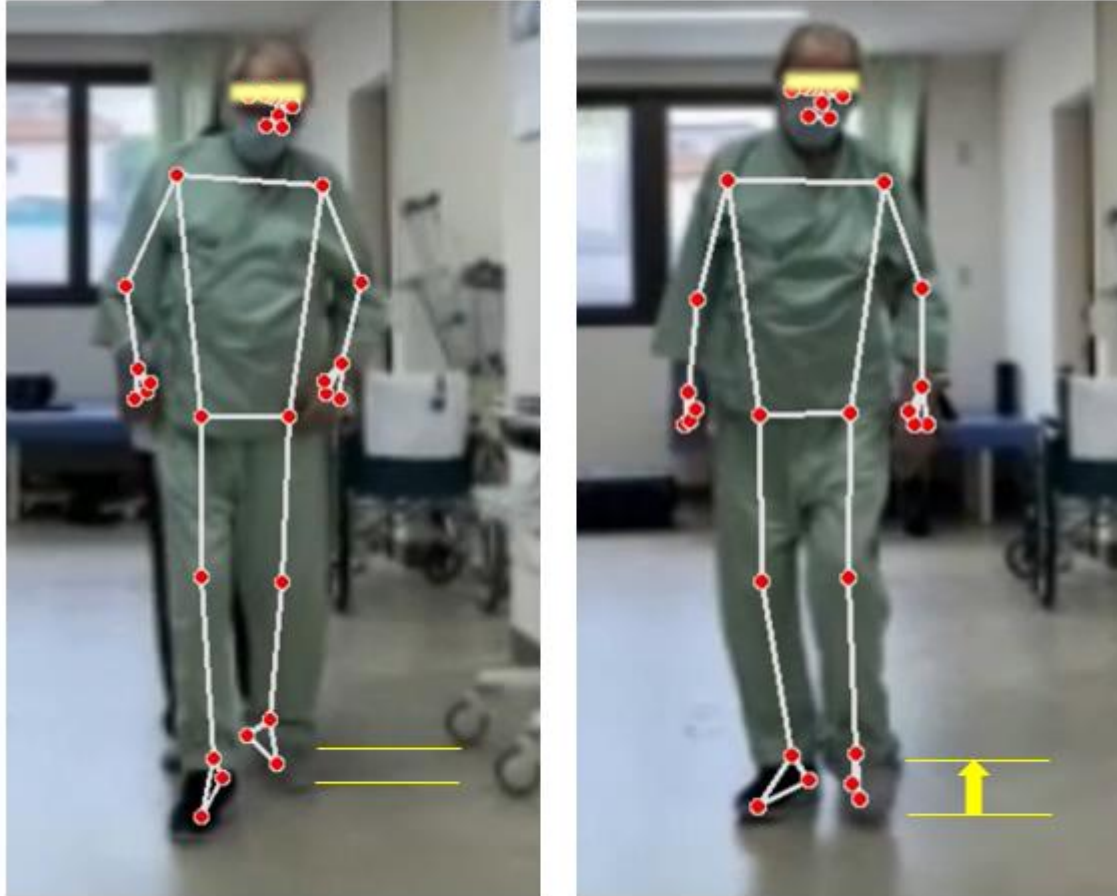
The image illustrates the state of walking when the walking aid device is removed.
After removing the assistive device, the patient's heel portion of the gait remained high and showed improvement.

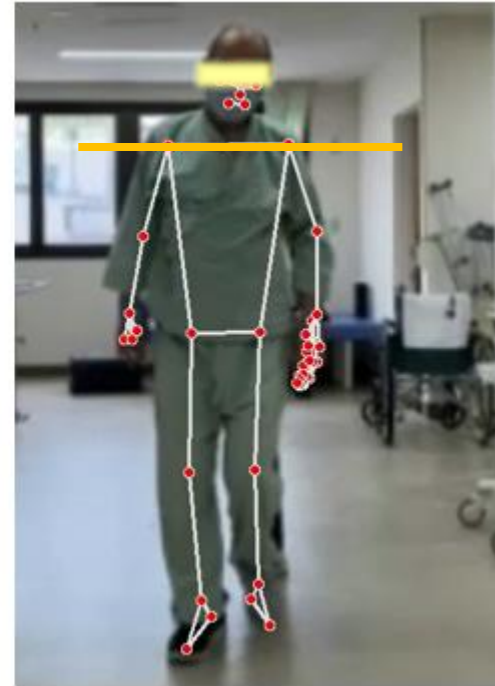# Normalized shoulder angle and height of ankle

Before assisted aid walking attainment
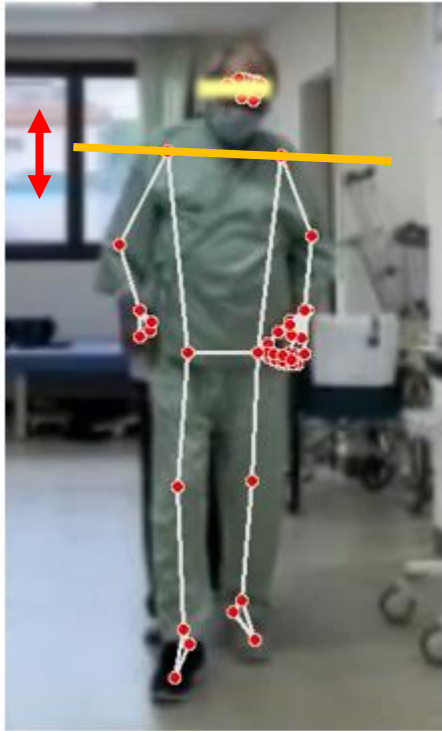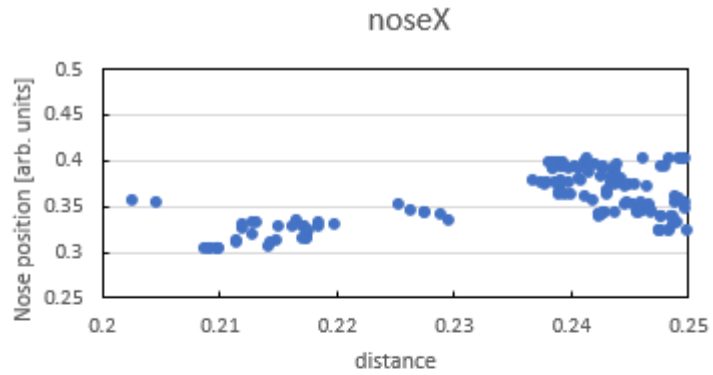
During assisted aid walking attainment
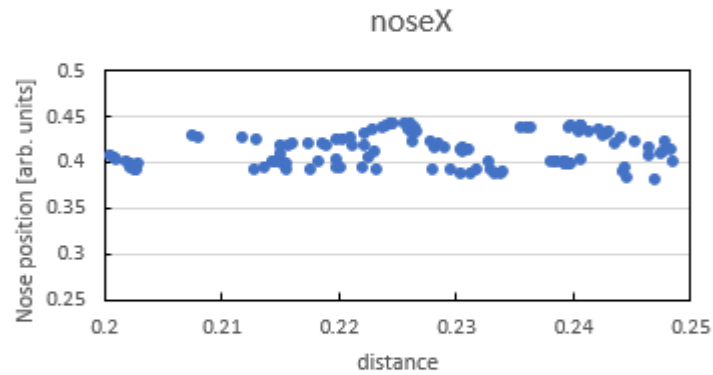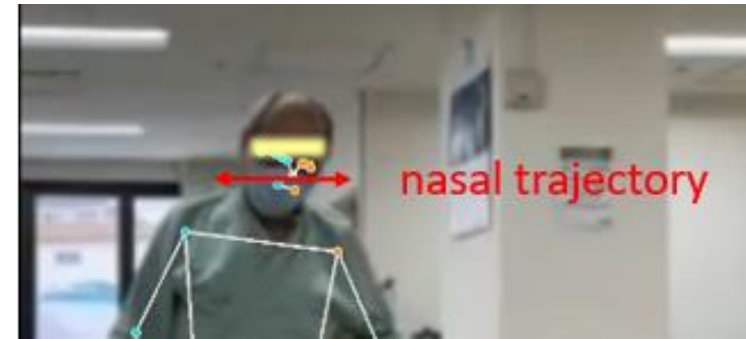
After assisted aid walking attainment

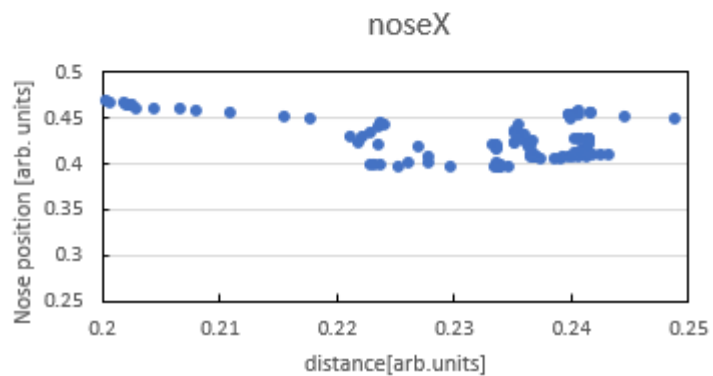Walking assisted aid attachment

Blurring of the nasal trajectory

Before utilizing walking-assisted aid attachment.

Utilizing walking-assisted aid attachment

After utilizing walking-assisted aid attachment

Before assisted aid attachment	During assisted aid attachment	After assisted aid attachment
2.90E-02	4.30E-04	1.40E-04

Aim of this study

We will show the results of an investigation into whether MediaPipe can be used to detect gait changes during rehabilitation.

*This research was approved by the Ethics Committee of Teikyo University of Science.
*There are no conflicts of interest regarding this study.

EXPERIMENTAL

3m

Video recordings of the walking condition on the ORPHE ANALYTICS screen were recorded using the Snipping tool and analyzed using MediaPipe. During the measurement, walking at a distance of 3 m was filmed using a smartphone camera from the frontal plane. The subject, a patient, is a female in her 40s, right-handed. When she was discharged from the hospital, she was walking with a T-cane and Short Leg Brace (SLB) outdoors.
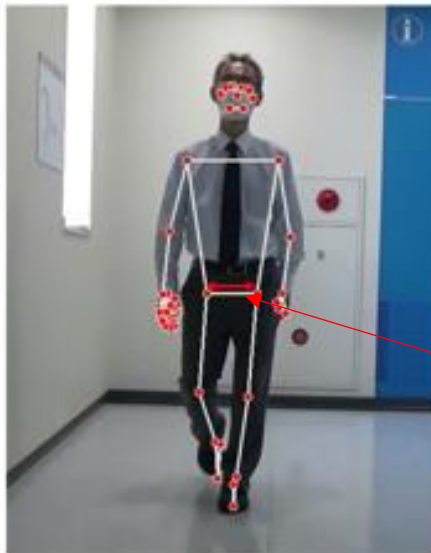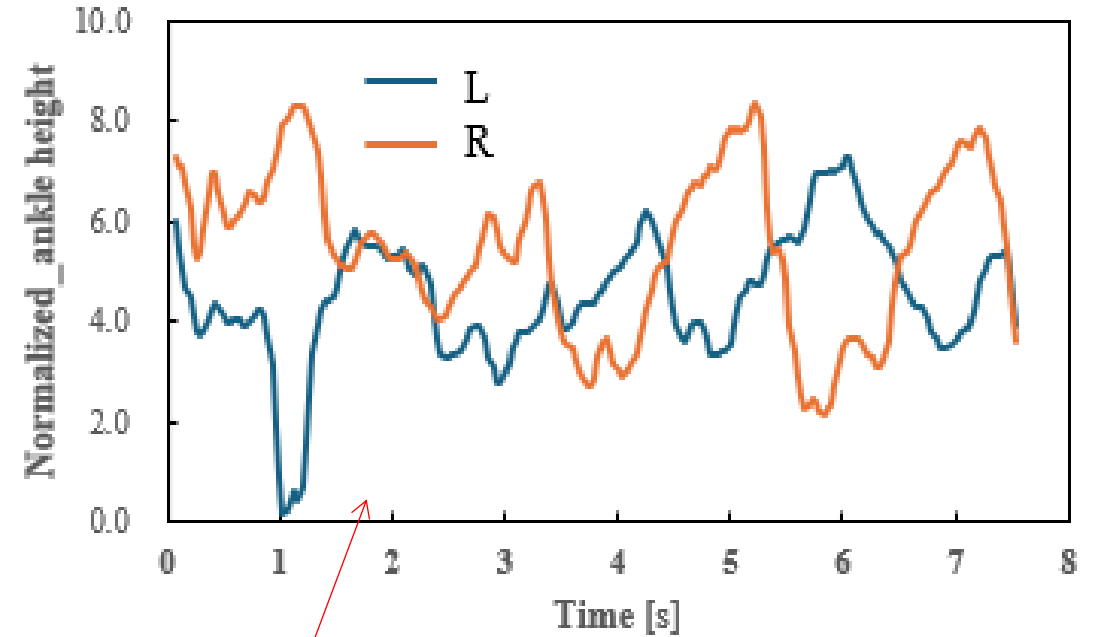
For reference, a subject without walking disabilities (subject B in the paper) videotaped a male subject in his 60s at a university.

normalization by the width of the hips
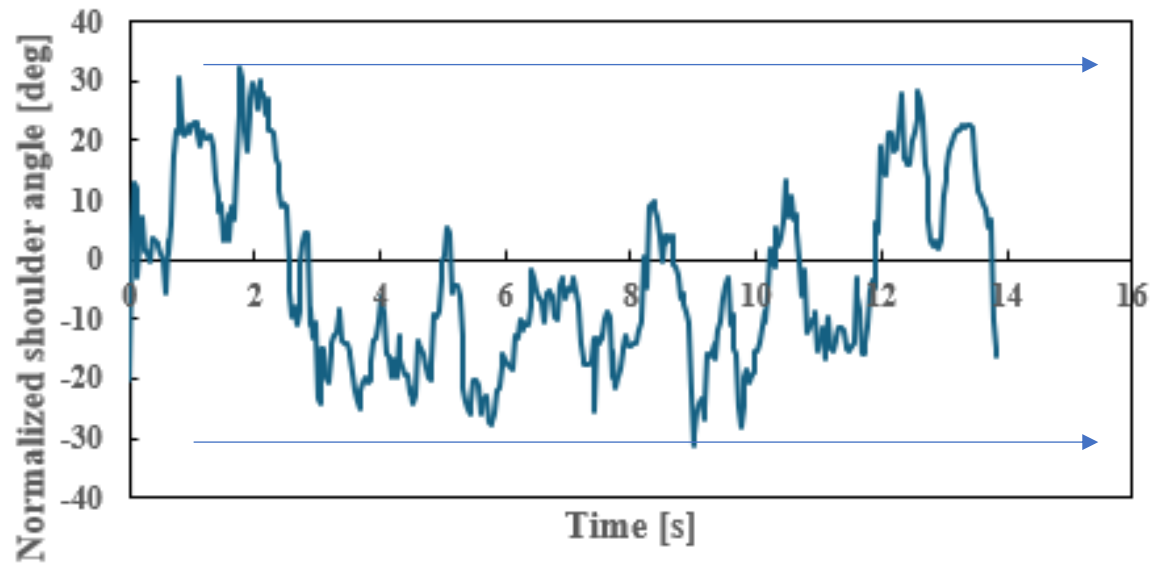
Height of left and right ankles
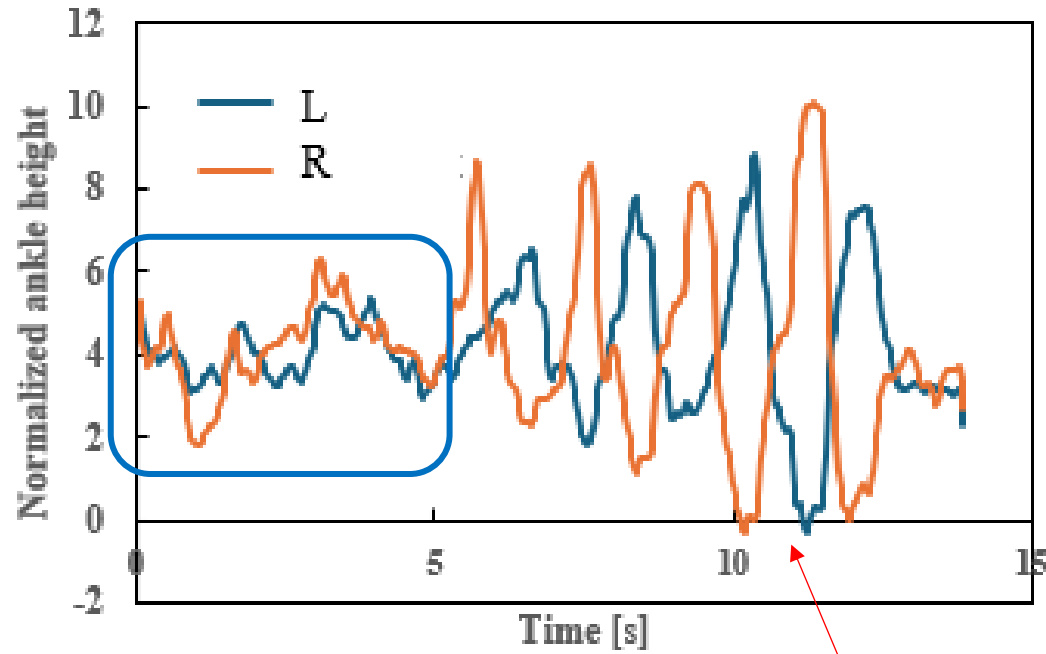
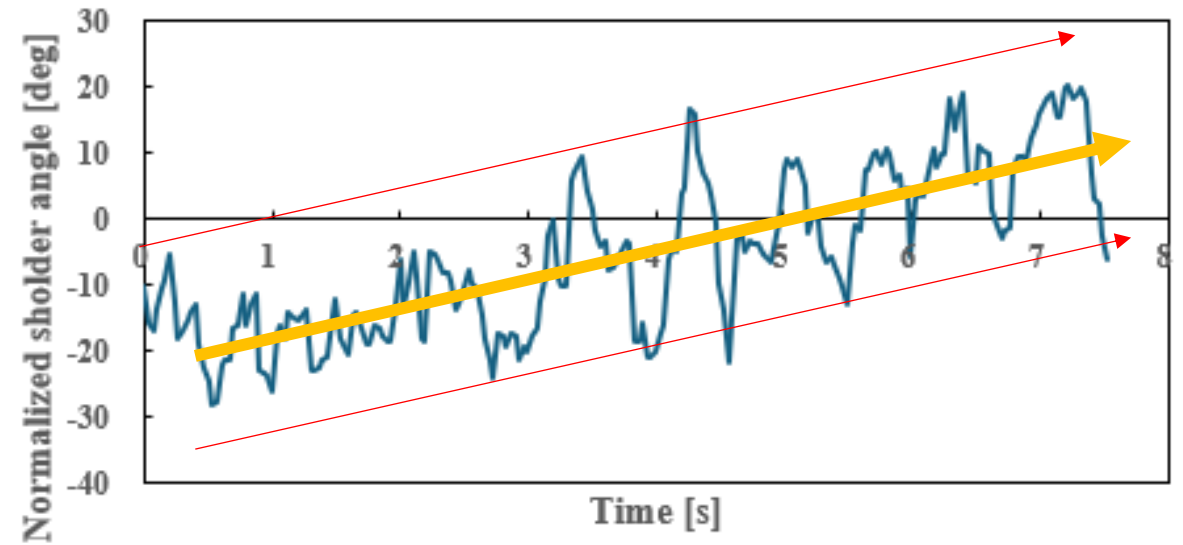Normalized ankle height during gait at 72 days after onset.

Normalized ankle height during gait at 109 days after onset

It can be used to determine the stance and swing phases.
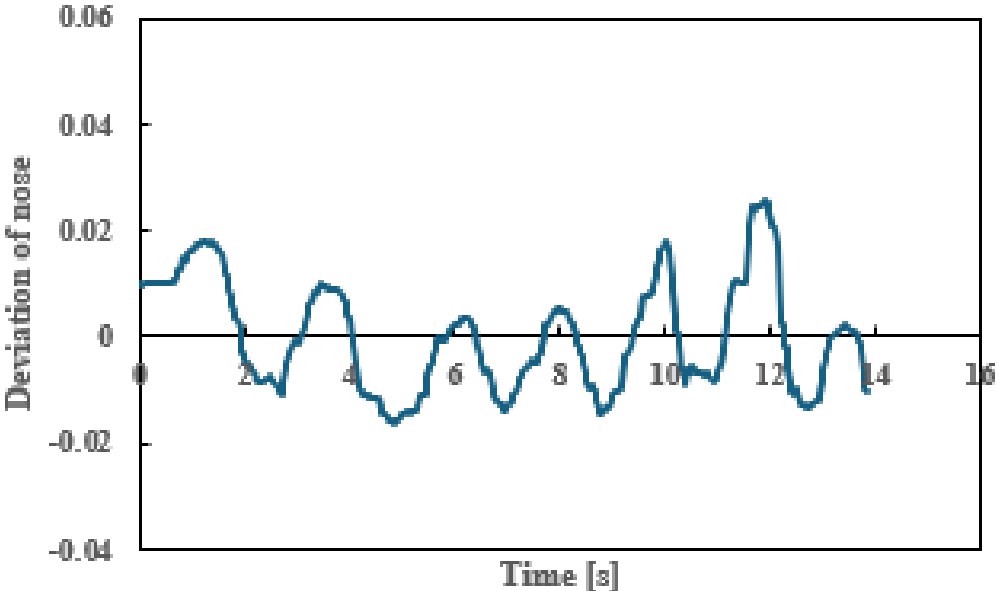
Normalized shoulder angle

Angle of the right shoulder with respect to the left shoulder at 72 days after onset.
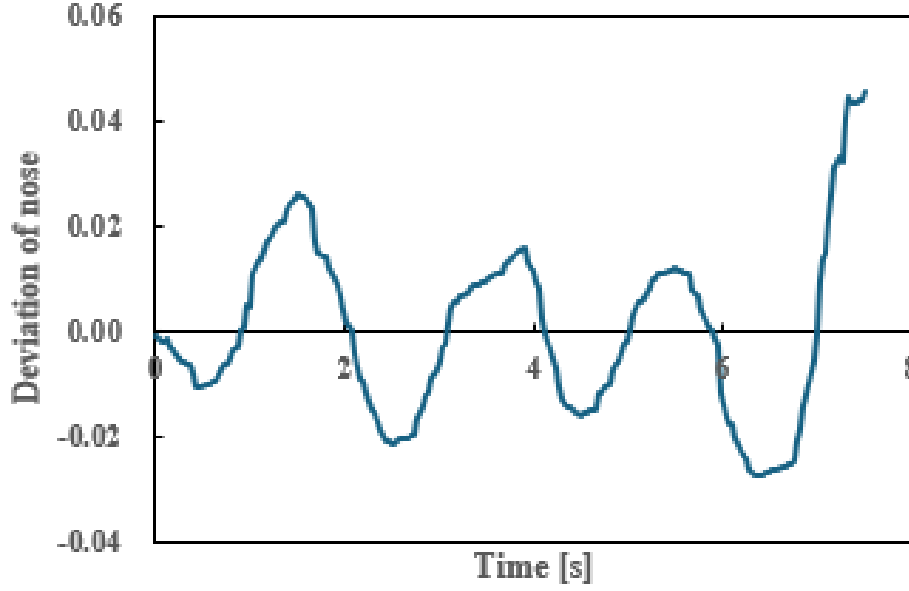

Angle of the right shoulder with respect to the left shoulder at 109 days after onset.

Blurring of the nose position

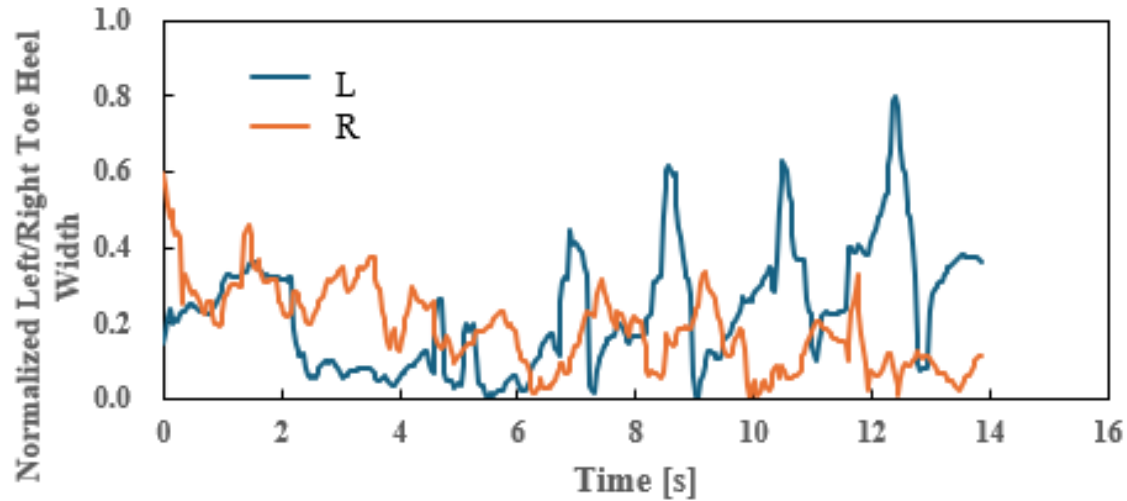Nasal blurring in the left and right
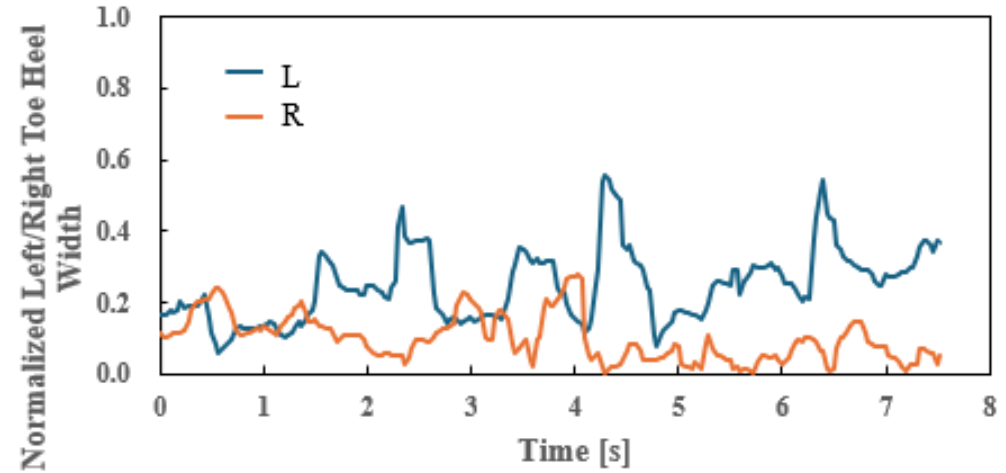directions at 72 days after onset.

variance value 1.6×10^{-4}

Nasal blurring in left and right
direction at 109 days after onset.

variance 2.7×10^{-4}.

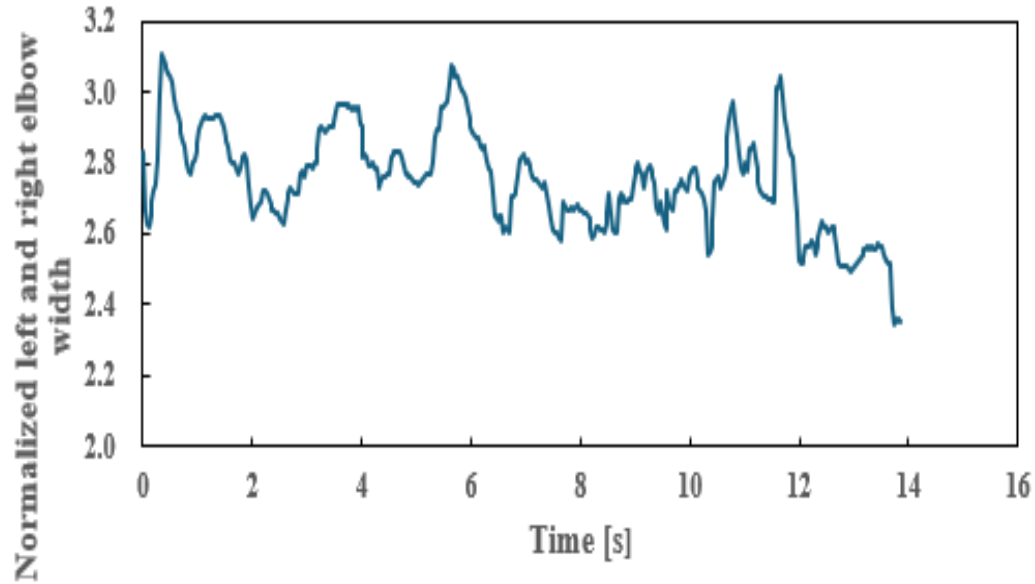# Change in the width between the toe and heel

Normalized Width between the toe and heel of the right and left foot at 72 days after onset.
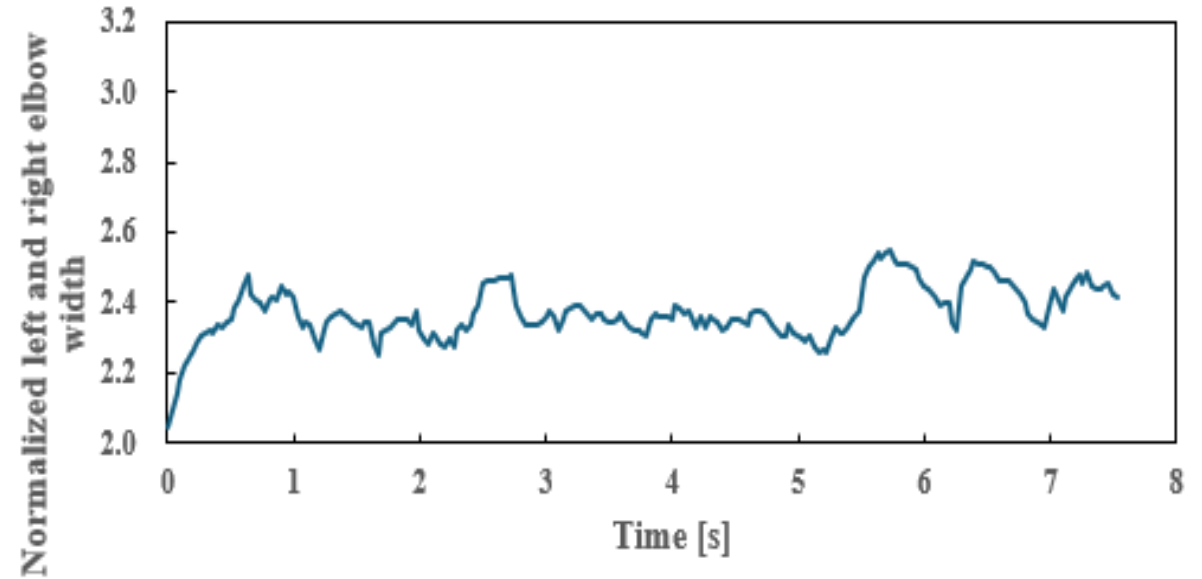
Normalized width between the toe and heel of the right and left foot at 109 days after onset.

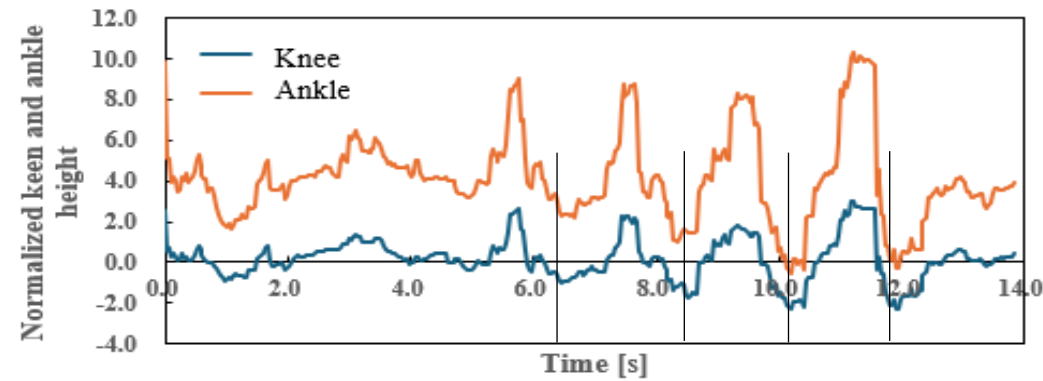# Blurring between the left and right elbow widths

Blurring between the left and right elbow width at 72 days after onset.
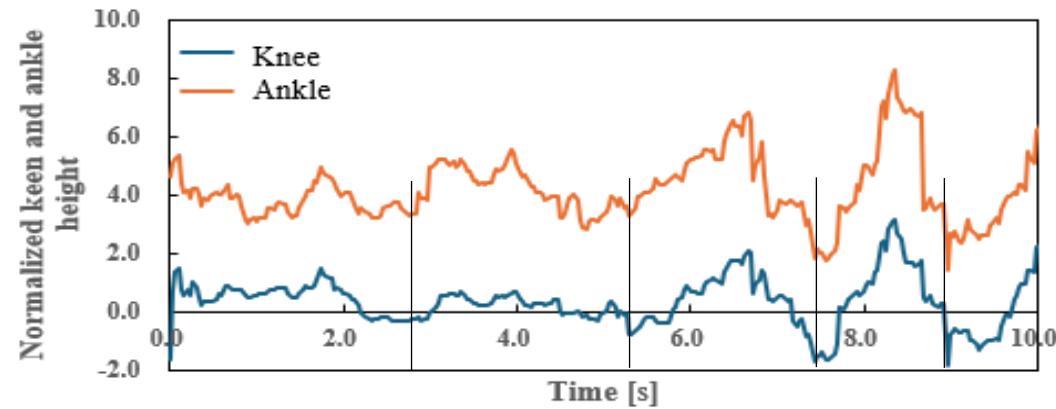
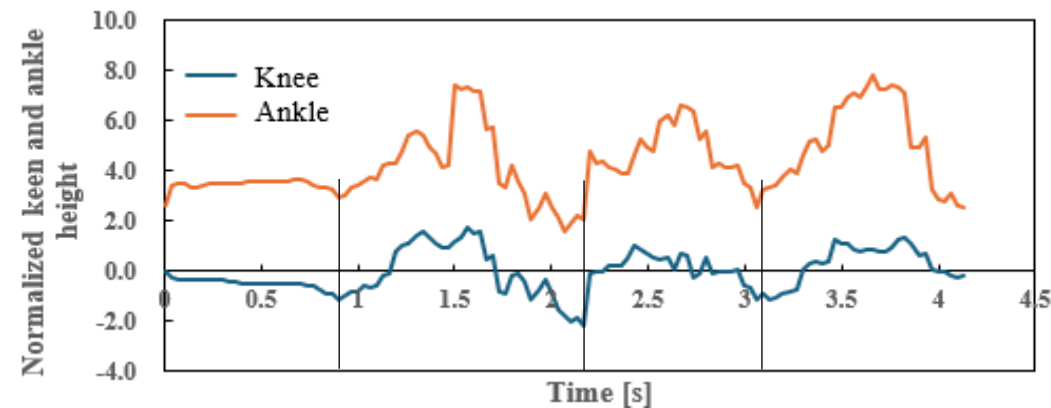Normalized left and right elbow width at 109 days after onset.

Temporal changes in knee and ankle during gait

Normalized left knee and left ankle height at 72 days after onset

Normalized right knee and right ankle at 109 days after onset.

Normalized right knee and right ankle of B

The parameters that are considered to reflect the effects of rehabilitation based on the experimental results for the subjects in this study are shown in the figure. (Due to space limitations in the photos, they are also shown in the photos of healthy subjects.)
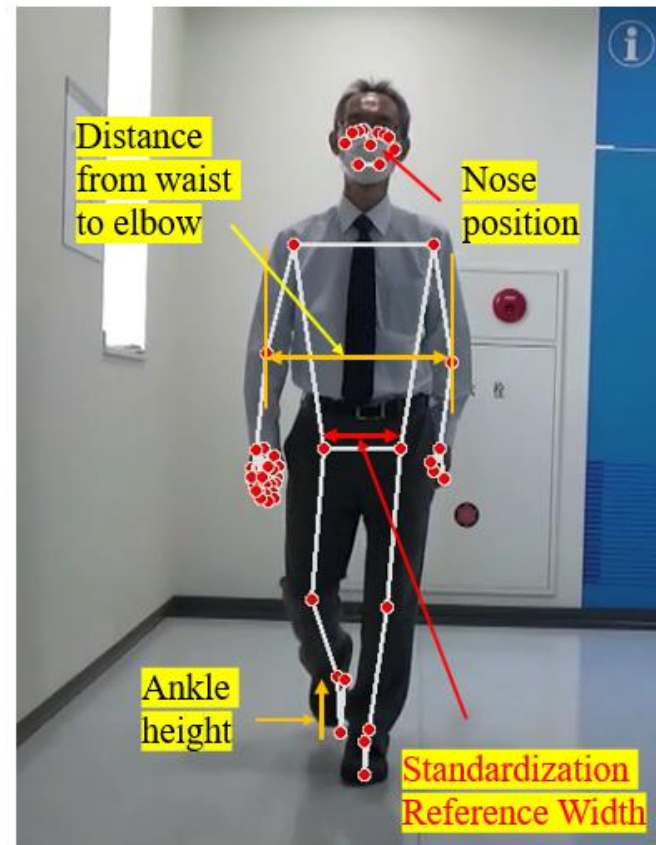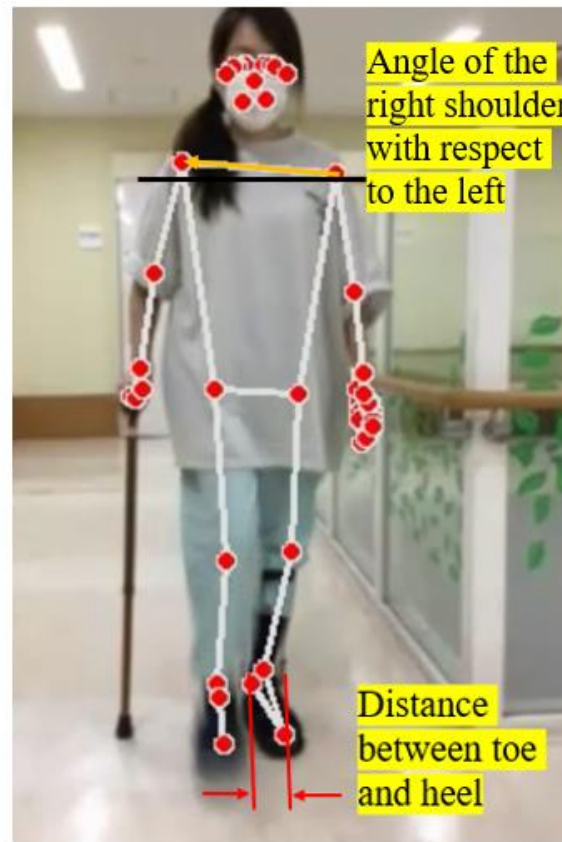
Conclusions

The effect of rehabilitation was verified using images taken from the forehead direction with MediaPipe.

- Standardization by the width of the hips reduced the influence of the distance from the camera.
- Changes in gait were confirmed by measuring ankle height during walking, tilt of the left and right shoulders, width between the toes and heels, and width between the left and right elbows.
- A method for evaluation using images from the forehead plane was presented for cases where it is difficult to take images from the sagittal plane due to limitations in the actual rehabilitation setting.
- In clinical gait assessment, both walking ability and walking pattern evaluation are crucial.
- Quantitative instrumental gait analysis is recommended but remains insufficient at present.
- The evaluation was conducted over a short time and distance, so it cannot be said to be highly relevant to assessing walking ability in real-life situations.
- However, some of the patients studied showed improved walking ability in real life.

Acknowledgment