Investigation of the application of MediaPipe to gait analysis

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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 and Physical Electronics, and from 1987 to 1990 worked at Takushoku University as a research associate in the Faculty of Engineering. In 1990, he was appointed associate professor at the Department of Electronics and Information Science, Nishi Tokyo University of Science (now Teikyo University of Science). From 2007 to 2012, he was a professor in the Department of Media and Information Systems, and from 2012 to the present, he is a professor in the Department of Life Science.
Currently working on health change detection using sensors and machine learning.

Topics of research interest of our group

Our research group is in charge of creating a health management system that applies wearable devices and various sensor technologies in a group that conducts joint research with occupational therapists and physical therapists working in hospitals. Specifically, we are currently working on the integration of two-dimensional sensor arrays and image analysis technology to detect signs of changes in physical condition based on long-term measurements.

Introduction

The number of fatalities among the elderly due to falls and crashes is about four times that of traffic accidents.

A fracture from a fall can leave the patient bedridden and cause serious problems for the patient and family.

Consumer Affairs Agency https://www.satsuki-jutaku.jp/journal/article/p=1774

Research report on detection of falls

- The use of acceleration sensors and smart phones
- The system detects the body's tilt and the way the feet come out when walking, and uses deep learning technology on a server or other device to detect differences from normal behavior.

Currently, the mainstream is a system that reports after a fall occurs. There is no problem in using it in facilities, etc., but in the case of an elderly person living alone, there is a possibility of delay in discovering a fall at home.

The above suggests that the importance of predicting changes in physical condition in advance is critical.

In recent years, devices for measuring lower limb function have become widespread.

・The equipment used in rehabilitation medicine and sports requires detailed data and specialized knowledge of equipment operations.

・It is also difficult to make decisions related to health conditions in daily life.

Conventionally, image-based video analyses have long been used in rehabilitation and other medical and healthcare fields, such as the research on joint field, but it is very difficult and expensive to manage.

MediaPipe is free software from Google.

・Numerical data can be obtained using software that specializes in facial and poses data.

・ It is also possible to display three-dimensional (3D) skeletons from two-dimensional (2D) detection on the screen. The ability to see images of the skeleton as it is projected onto the physique is a point that is easily accepted in rehabilitation facilities.

Aim of this work

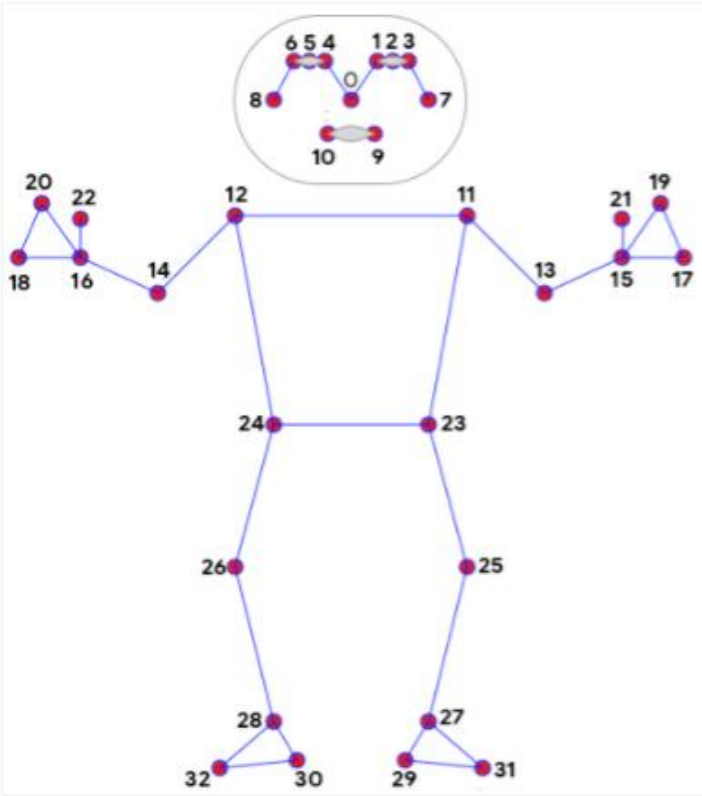
We examine the possibility of gait analysis by video using MediaPipe.

This research was approved by the Ethics Committee of Teikyo University of Science.

Features of MediaPipe

- Free software
- Get to CSV data from 33point
- The image of the skeleton is shown projected onto the subject.

Pose Landmark Model of Mediapipe



0. nose
1. left_eye_inner
2. left_eye
3. left_eye_outer
4. right_eye_inner
5. right_eye
6. right_eye_outer
7. left_ear
8. right_ear
9. mouth_left
10. mouth_right
11. left_shoulder
12. right_shoulder
13. left_elbow
14. right_elbow
15. left_wrist
16. right_wrist
17. left_pinky
18. right_pinky
19. left_index
20. right_index
21. left_thumb
22. right_thumb
23. left_hip
24. right_hip
25. left_knee
26. right_knee
27. left_ankle
28. right_ankle
29. left_heel
30. right_heel
31. left_foot_index
32. right_foot_index

By using the pose landmark model, we can obtain 3-axis coordinate data corresponding to the x, y, and z axes.

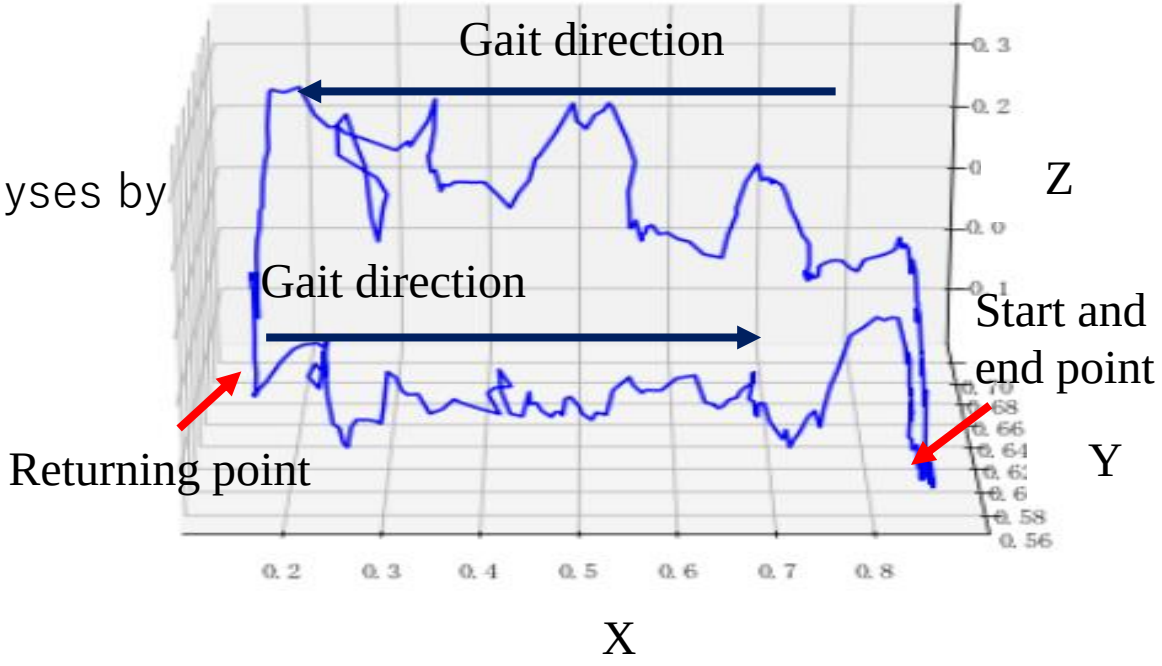
https://google.github.io/mediapipe/solutions/pose

Trajectory analysis for timed up and go

Photo of timed up and go

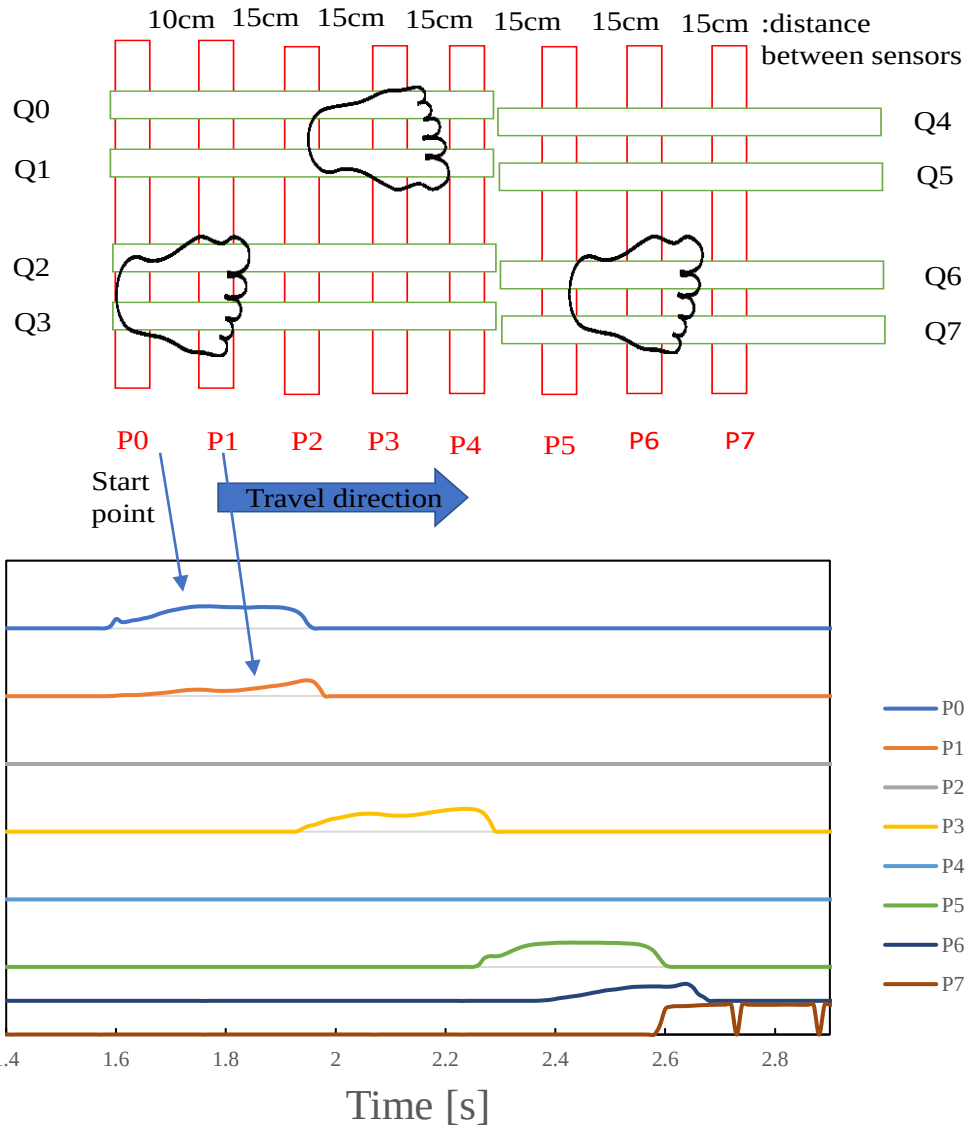
We investigated the possibility of using the CSV data output by MediaPipe to perform gait analysis using the elderly patient experience set.

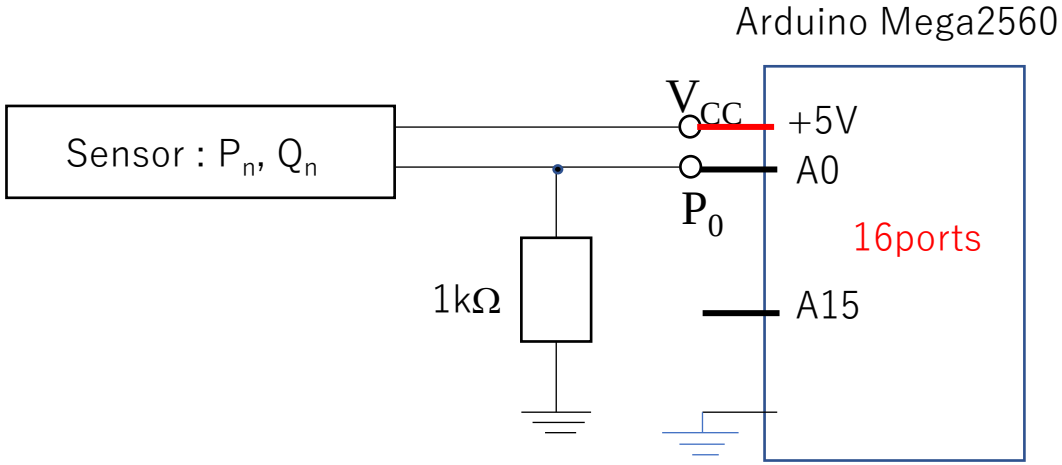
Trajectory analyses by mediapipe



A detailed ankle trajectory is obtained. The video analysis of the timed up-and-go test confirmed that the maintenance of the integrity of the specifications.

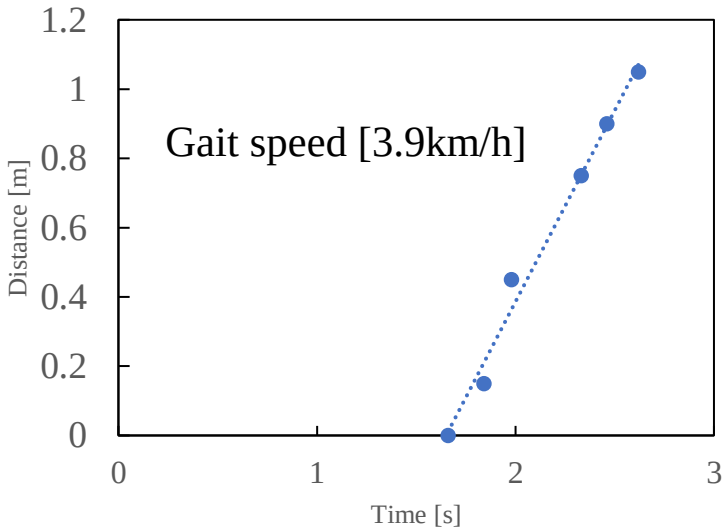
Output signals obtained sensor P:no-restriction





The output waveforms almost corresponding to gait.

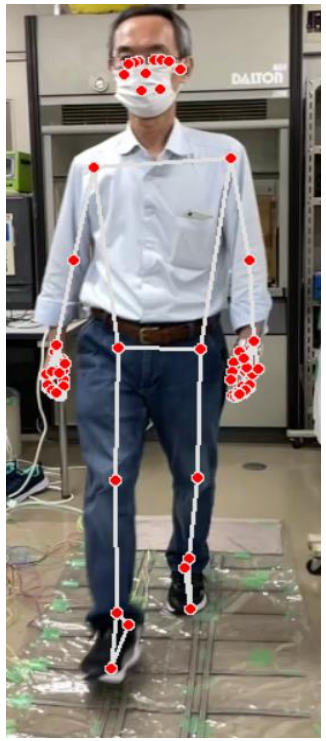
Calculated gait speed from the data.



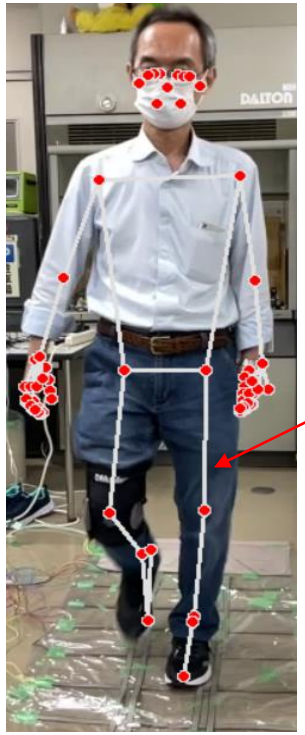
A man in the 60s at normal gaiting speed

Accuracy check of video angle for MediaPipe

Results from the front angle

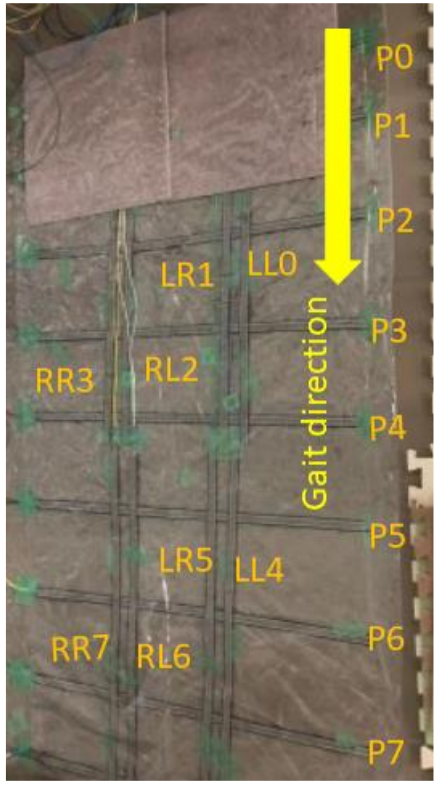


No restriction

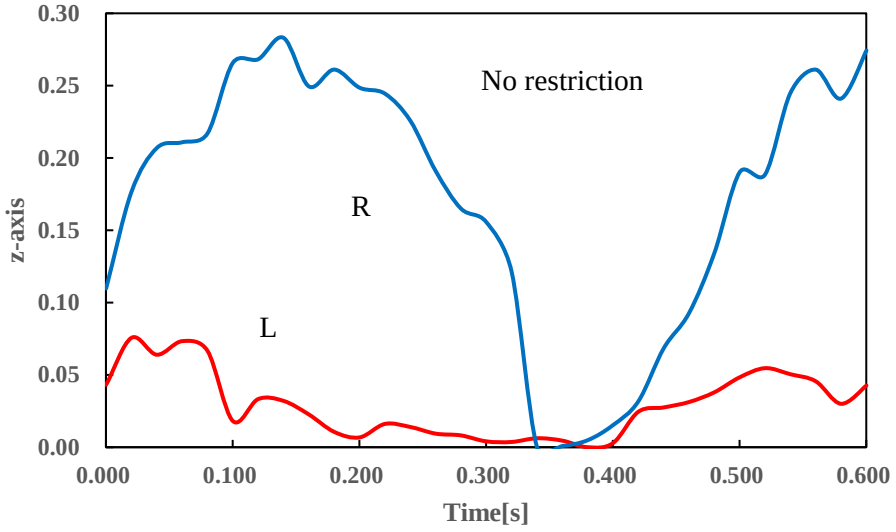


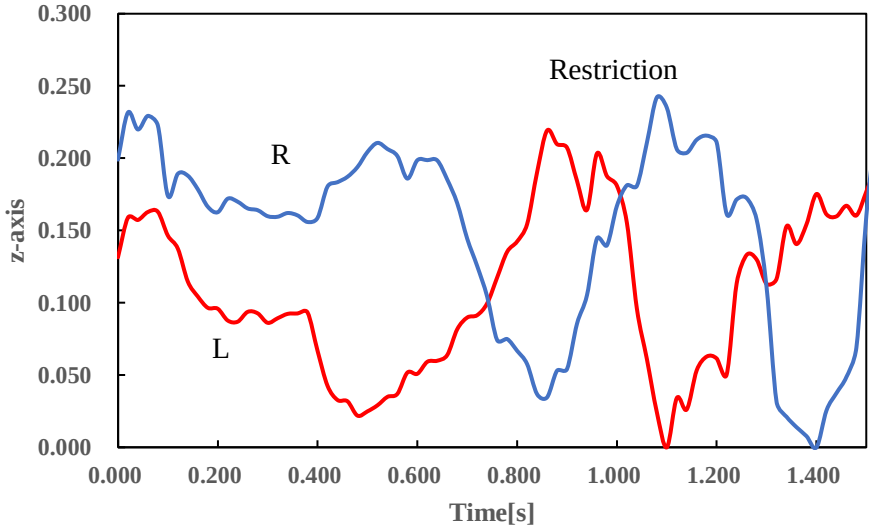
Right knee restriction

The skeletons are projected onto the subject.



Pressure sensor position





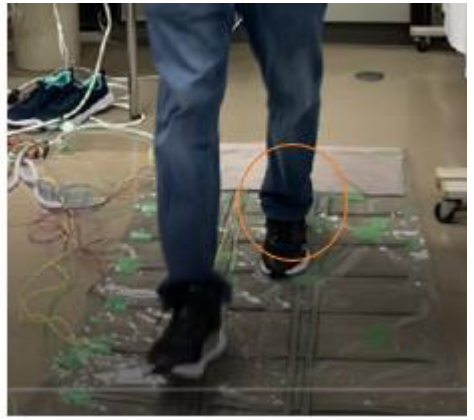
Z-axis value trajectory analysis results

It can be judged that the area obtained from the z value and time is larger in the case where the knee is restricted, and the time the heel is in contact with the ground is shorter.

Results of visual examination of left right ankle joint flexion

Screen of what appears to be maximum flexion of the left right ankle joint

The screens were clipped at what appears to be the maximum flexion of the left right ankle joint.

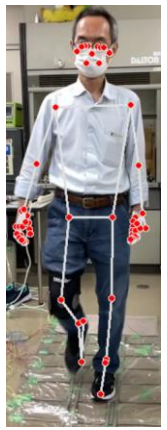


No restriction

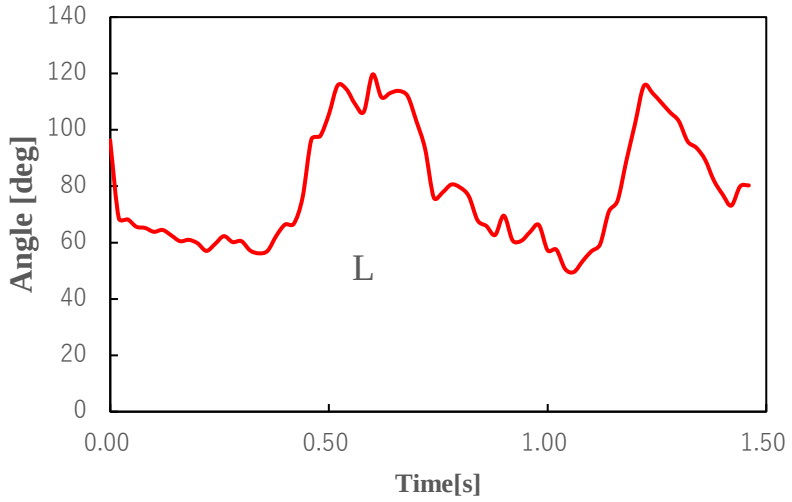
The range of motion of the right ankle joint is obviously small.

Restriction of knee motion

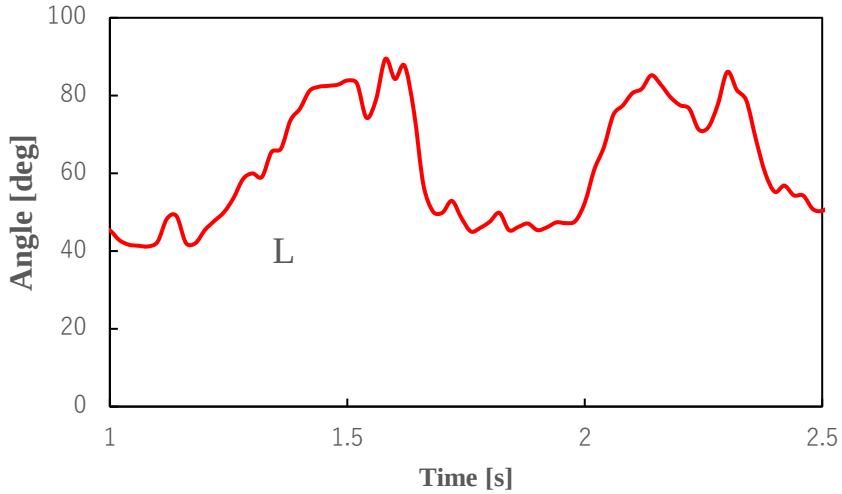
Comparison of maximum flexion of left and right ankle joints

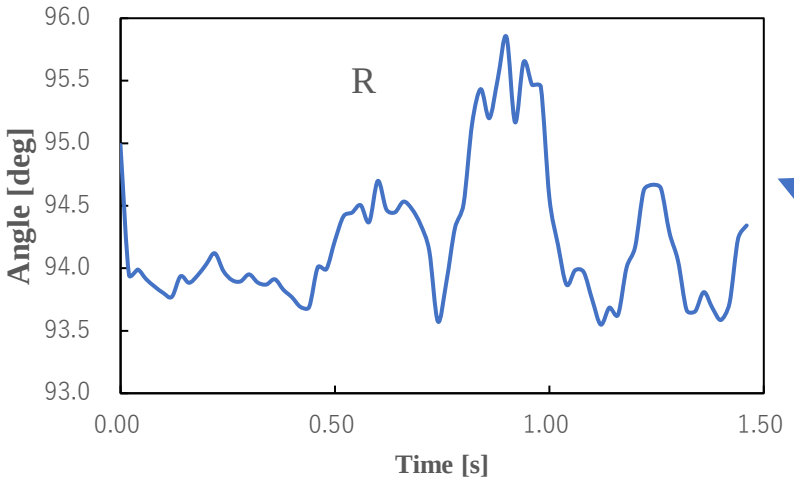


From front

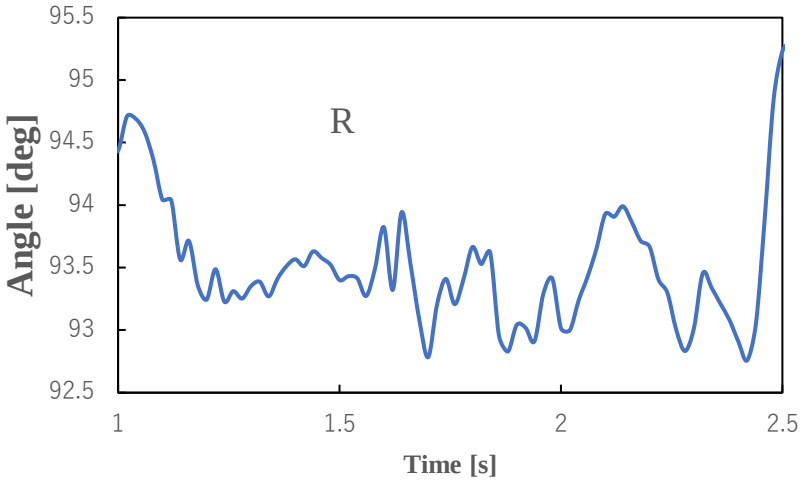


From oblique upward





The range of motion of the right ankle joint is obviously small.



Gait speed

Checked some landmark points for correct measurements.

We considered the part of the image that was considered to move as little as possible on the screen. In the present image, the shoulder area was close to the central part, therefore, we have chosen this point.

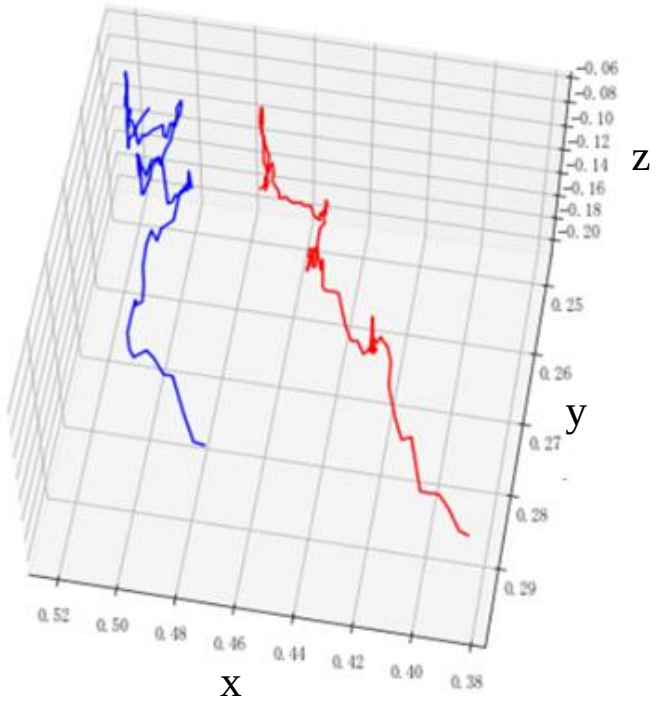


Figure shows the 3D display of the trajectory of the right shoulder position. Because the slope of the change in the right shoulder position is almost 45^{o}, it was easy correct the velocity from motion on the screen.

Conclusions

The ability to obtain skeletal displays and numerical data, as with MediaPipe, is expected to rapidly improve the potential of video analysis in the medical insurance field.

However, the limitations of the shooting conditions when introducing this software should be considered.

ACKNOWLEDGMENT

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