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Proposal of Spring Assist Unit for Walking Disabilities

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Resume

Haruki Baba

- Educational Background
  - National Institute of Technology Hachinohe Collage
    - Apr 2012 – Mar 2017: Faculty of Mechanical Engineering
  - Iwate Prefectural University
    - Apr 2018 – Mar 2020: Faculty of Software and Information Science
    - Apr 2020 – present : Graduate school of Software and Information Science
- Field of study
  - Medical and healthcare information

Background and Purpose

Background

- The percentage of elderly people in the world's population is increasing.
- The number of functionally impaired people will also increase.
- People with such diseases or latter-stage elderly often have walking disabilities which increases their risk of falling and consequently injuring themselves.

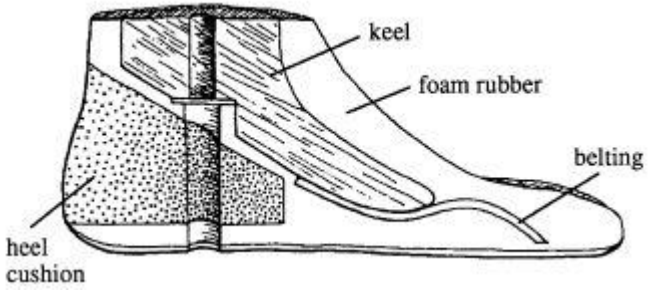
Purpose

- Developing a spring assist unit that fits in the heel of a shoe and helps walking disabled people raise their heel when beginning to walk.

Walking assistance mechanism in passive foot prosthesis

- The Solid-Ankle Cushion Heel (SACH) foot

1D10, Ottobock, Germany



- The energy storage and return (ESAR) foot

Vari-Flex, Össur, Iceland

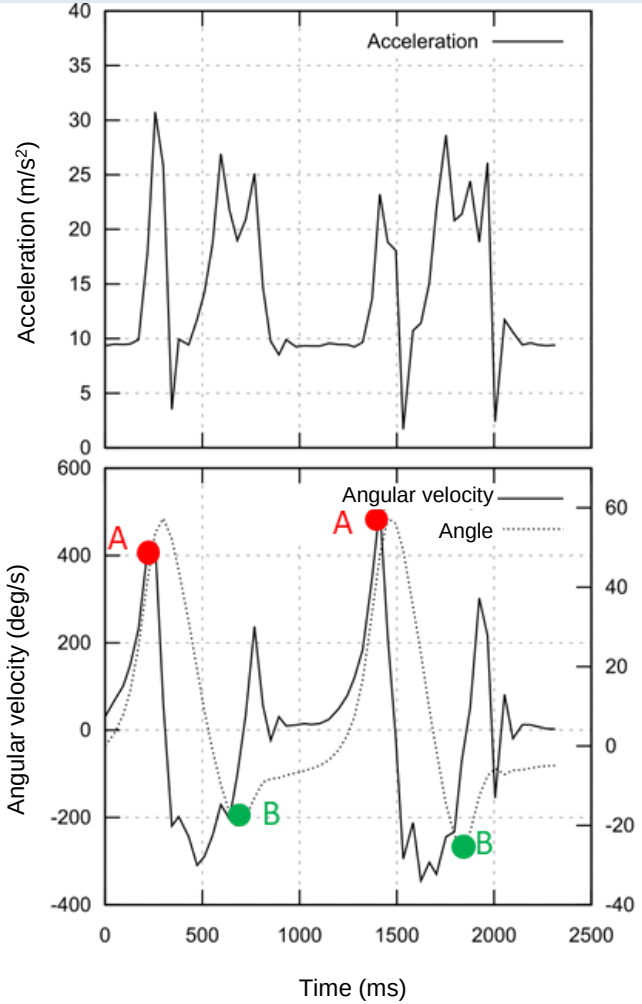
NOITAVONNI

Existing Works :

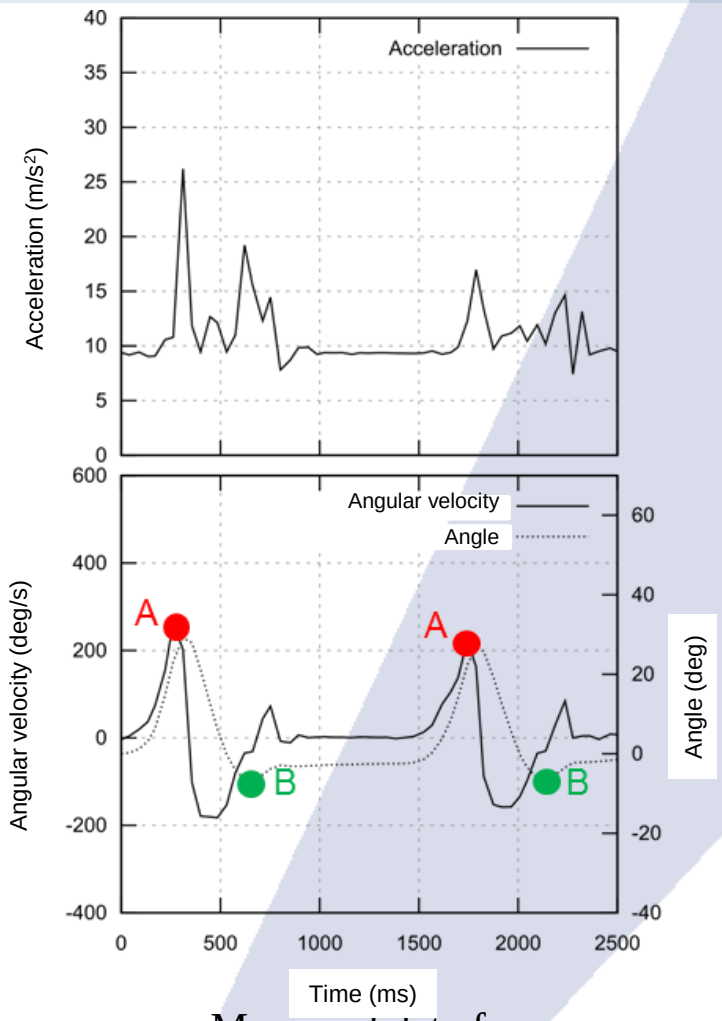
Differences in gait between hemiplegia patient and healthy person

WD: SmartWatch 3, Sony

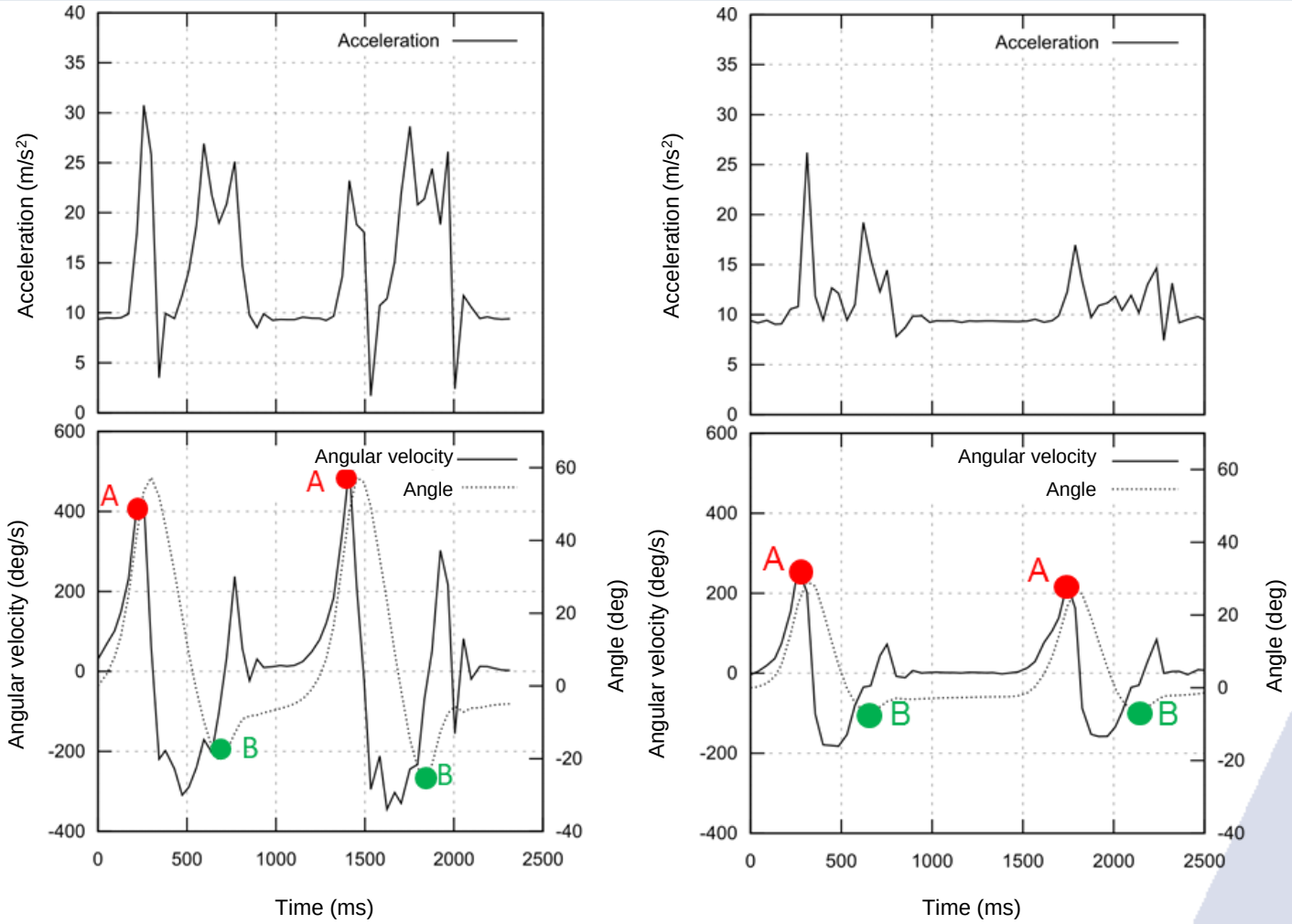
WD mounted on foot



Measured data for unimpaired participant



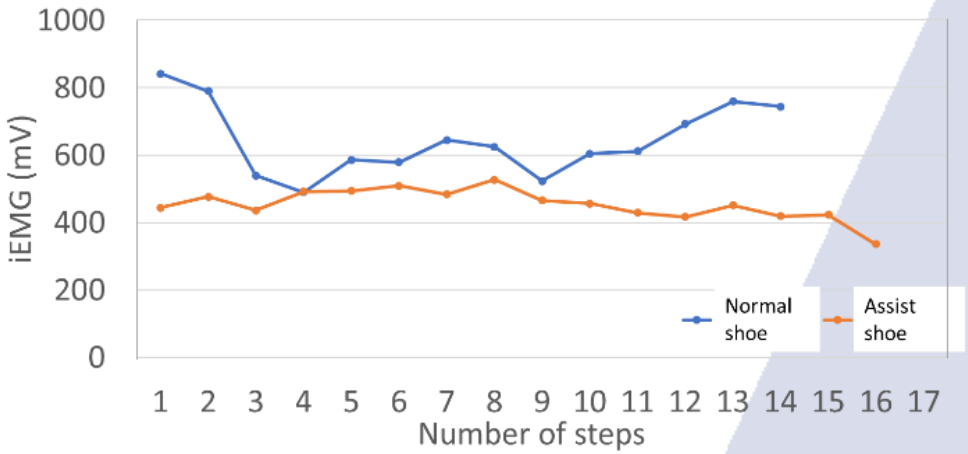
Measured data for participant with walking disability


Acceleration
Acceleration (m/s²)
Angular velocity
Angle
Angular velocity (deg/s)
Angle (deg)
A
B
Time (ms)
Acceleration
Acceleration (m/s²)
Angular velocity
Angle
Angular velocity (deg/s)
Angle (deg)
A
B
Time (ms)

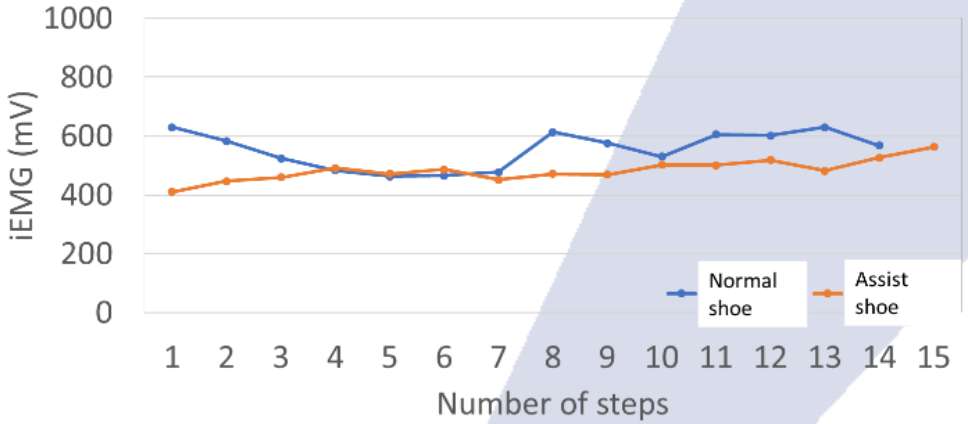
Prototype of shoe to assist people with walking disabilities

Assist shoe prototype

EMG sensors placement



Person with walking disability #1



Person with walking disability #2

Structure of Spring Assist Unit

- The developed assist unit comprises a conical coil spring and a V-shaped attachment cover.
- The spring is thinner when stepping.
- Spring power is 3, 5, 9, and 11 Kg.

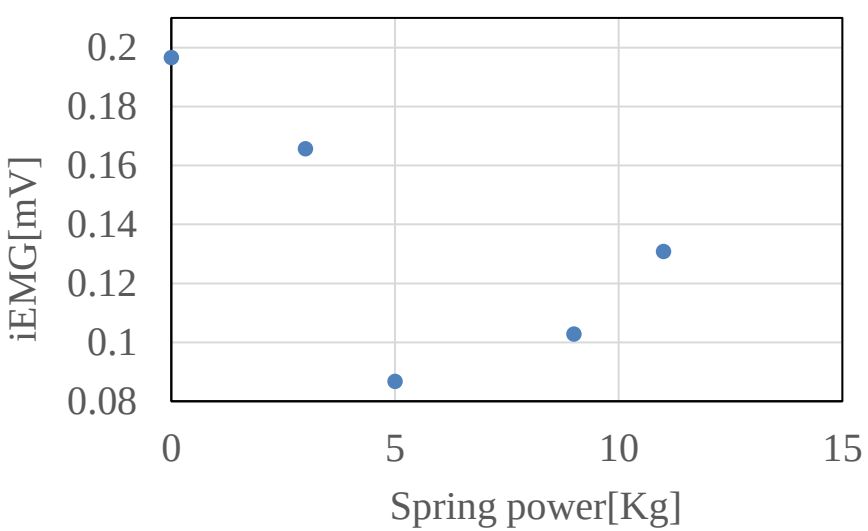
Spring assist unit (heel-up spring)

Pair of shoes with built-in spring assist units

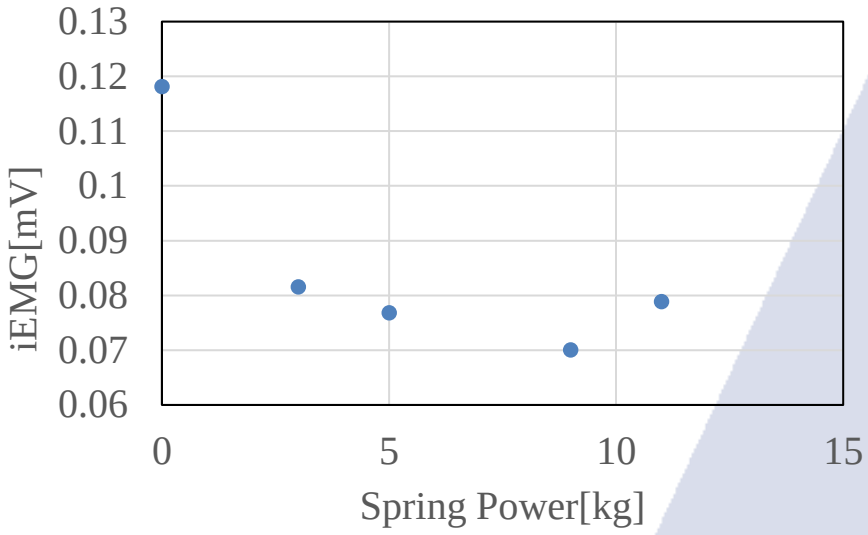
Assistance effect

- Focused to clear
  - Affection to reduced the magnitude of muscle.
  - Affection to walking posture.
- Participants wear shoes with each of the spring stiffnesses and walk straight for 6 m to measure
  - iEMG.
    - To measure the magnitude of muscle.
    - Participants were ten healthy students.
  - Motions of the head and mid-hip.
    - To analyze effects to walking posture.
    - MS-Kinect was used to measure.
    - Participants were five healthy students.

Affection to reduced the magnitude of muscle (1/2)



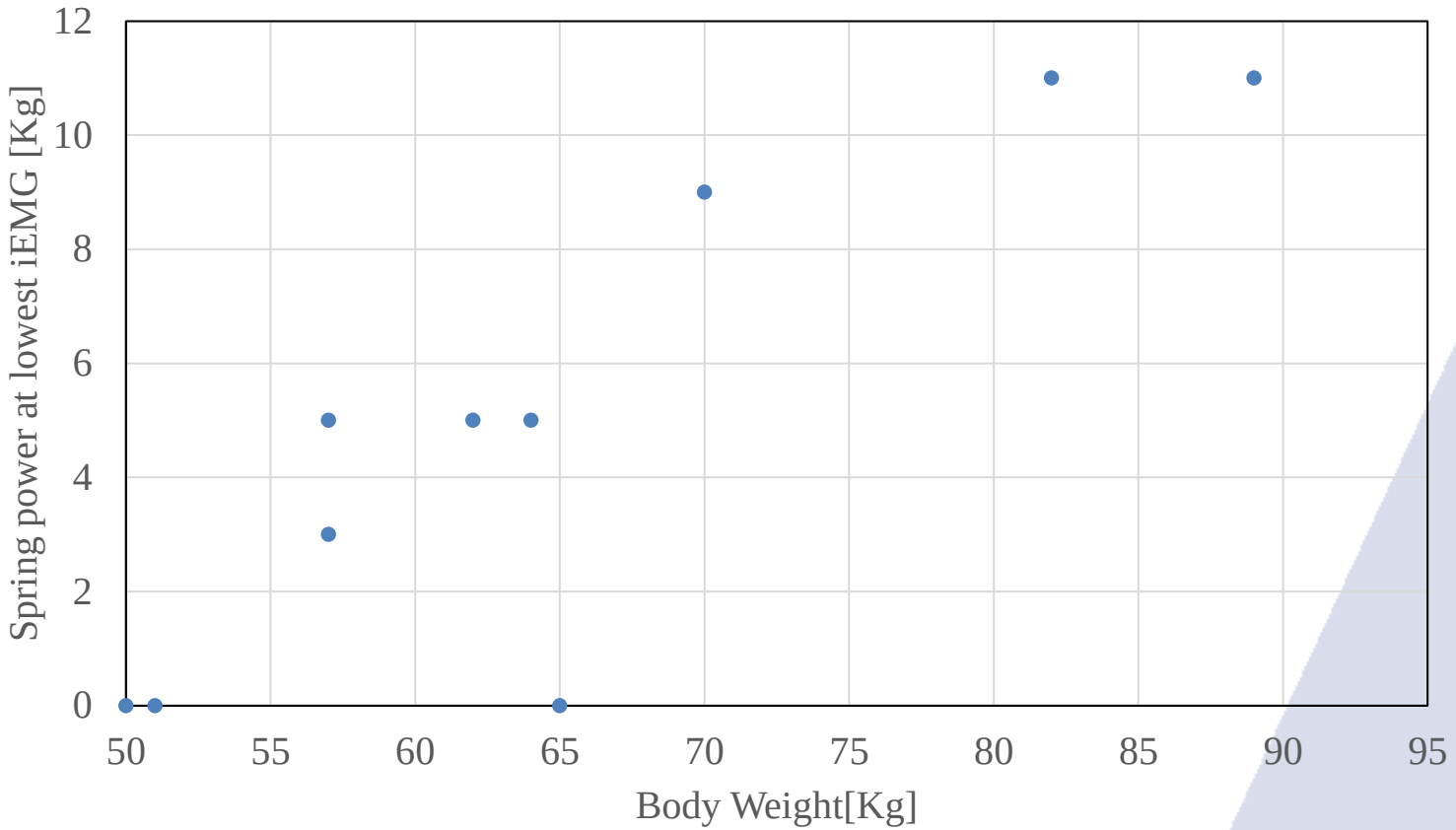
Participant A(Weight: 57Kg)



Participant B(Weight: 70Kg)

- Examples of the measured iEMG vs. spring stiffness are shown.
- The iEMG values are lower for every spring stiffness than without the spring assist unit.
- The value was the lowest at the specified spring stiffness.

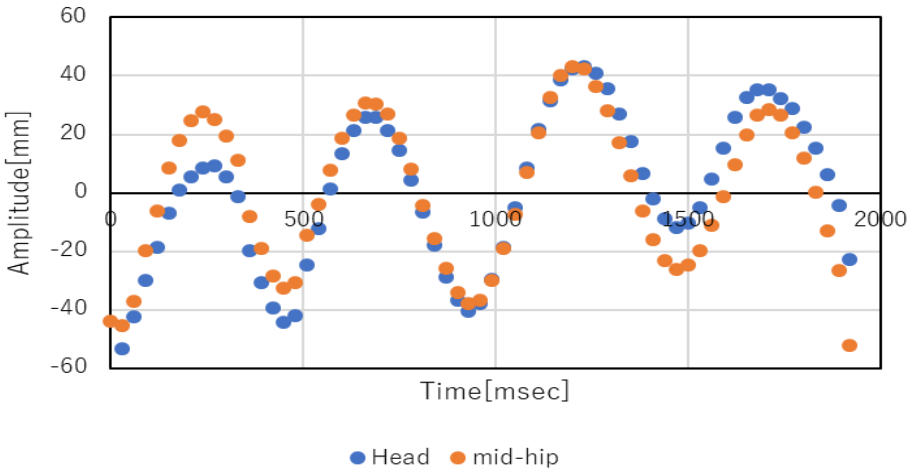
Affection to reduced the magnitude of muscle (2/2)



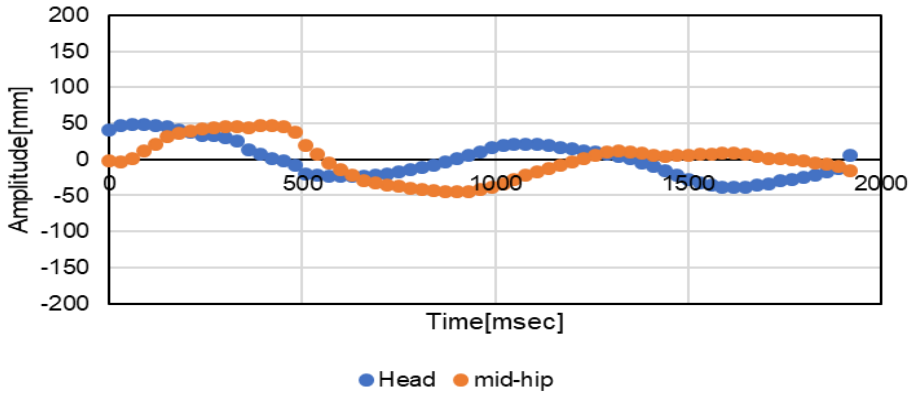
Lowest iEMG vs. participant body weight

- The spring stiffness magnitude at the lowest iEMG is linearly bigger, a participant gets more weight.

Affection to walking posture : Motion of participant C

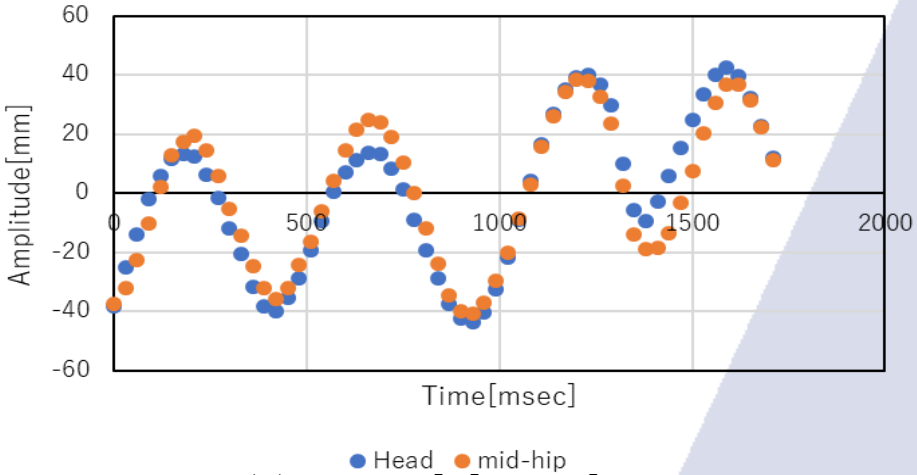


(a) Up and down direction UD

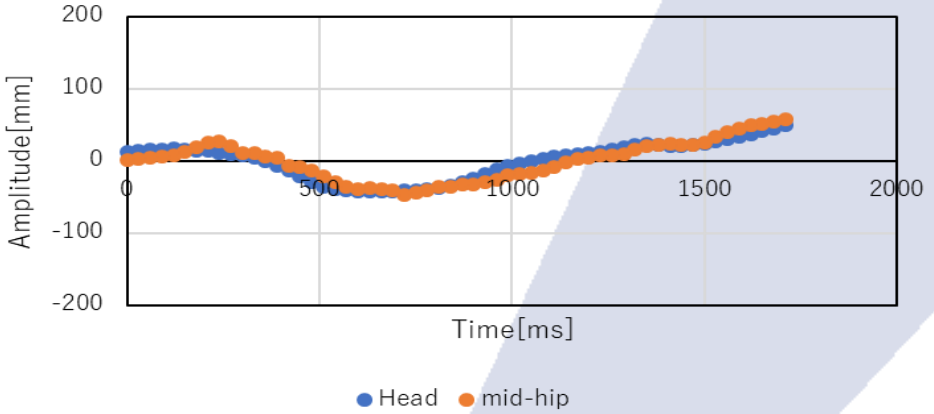


(b) Right and left direction RL

Without a spring assist unit



(a) Up and down direction UD



(b) Right and left direction RL

With a spring assist unit

Average range of peak to peak in RL and UD [mm]

Spring power			0[Kg]	3[Kg]	5[Kg]	9[Kg]	11[Kg]
Paticipant A	Head	RL	47.28	34.10	28.54	21.49	30.29
		UD	36.04	33.48	41.07	44.84	42.06
	Mid-hip	RL	32.20	17.11	22.65	17.94	17.44
		UD	29.66	25.80	28.71	22.32	33.61
Paticipant B	Head	RL	47.51	72.87	76.96	71.06	81.35
		UD	13.46	14.68	16.01	18.51	19.18
	Mid-hip	RL	18.83	24.34	22.50	26.19	29.52
		UD	25.87	26.81	28.95	22.72	25.00
Paticipant C	Head	RL	65.83	57.55	56.28	69.76	69.74
		UD	67.89	58.62	62.61	66.90	66.97
	Mid-hip	RL	33.35	33.74	29.23	35.00	32.37
		UD	60.87	67.42	68.07	65.31	54.42
Paticipant D	Head	RL	38.53	41.79	48.00	30.45	51.25
		UD	34.61	37.23	34.01	27.94	30.43
	Mid-hip	RL	31.46	35.64	44.38	23.28	40.88
		UD	38.68	48.60	45.03	45.38	26.01
Paticipant E	Head	RL	34.44	53.31	77.44	63.40	67.88
		UD	30.45	23.43	36.62	21.16	34.64
	Mid-hip	RL	39.86	68.98	71.58	79.92	83.73
		UD	38.71	38.20	34.67	32.90	37.70

Conclusion and Future work

- Conclusions
  - Proposed the spring assist unit for walking disability to easily raise their heel and smoothly walk.
  - The iEMG values for every spring stiffness are lower than those without the spring assist unit.
  - The magnitude of the spring stiffness at the lowest iEMG is linearly bigger and the body weight was greater.
    - There is a correlation between body weight and the optimal spring stiffness.
  - Measured the position of the head and mid-hip with and without the spring assist unit for each spring stiffnesses.
  - The spring assist unit does not affect walking posture.
- Future works
  - Measure the same data for walking disabled people.
  - Launch the commercial version.

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