

95. 旅行困難者が本当に海や山に旅行できるの？を実現するユニバーサルツーリズム支援機器・システムの研究開発

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概要

This study examines whether people with mobility difficulties can use wheelchairs to explore the sea or highlands on their own, or with minimal assistance. We focused on electric wheelchairs, which require less assistance work and burden on caregivers, are comfortable to ride even on rough roads, and allow easy transfers on the ground.

Keywords: universal tourism; mobility difficulties; travel difficulties; highlands and seashore play trial.

背景および目的

1. INTRODUCTION

Concerns about accessible tourism have increased in Japan in recent years, as evidenced by the 2005 Ministry of Land, Infrastructure, Transport and Tourism's Universal Design Policy Outline, the 2008 Tourism Universal Design Guidebook, the 2011 Japan Tourism Agency's accessible tourism Promotion Project, and the 2012 Tourism Nation Promotion Basic Plan. To actively promote accessible tourism the development of supportive services and software, such as tourist destinations, travel agencies, accessible tourism consultation desks, and accessible tourism concierge training, is emerging.

The accessible tourism Intention Survey conducted by the Hyogo Prefecture (2022) between May and July 2022, which surveyed 463 physically challenged people, 634 elderly people, and 828 parents of children attending a support school, asked the following questions:

■ Have you ever given up on traveling because of your age or physical challenges? (N=463)

73.9% of physically challenged people who use wheelchairs answered "yes."

■ What are the necessary elements to prevent you from giving up on traveling? (N=463)

Respondents who use wheelchairs (N=92) said:

1. Barrier-free facilities, 81.5%
2. Specific information, 48.9%
3. Support during the trip, 48.9%

■ What would you like to do on a trip if all the necessary requirements were met? (N = 463)

1. Doing activities and relaxing with family and friends in nature, 45.4% (The rest omitted)

■ What would you like to do in nature? (N = 344)

1. Camping (including cooking meals outdoors), 50.6%
2. Trekking, mountain climbing, and forest plateau walks, 35.8%
3. Wild vegetable or mushroom picking and fruit picking, 33.1%
4. Swimming in the sea or playing in a river, 28.8%

The intentions of people with mobility difficulties (i.e., physical challenges) can be summarized as follows:

1. The proportion of people with physical challenges who have given up on traveling is highlands.

2. They want information about travel destinations, barrier-free facilities, and support.
3. They want to camp in nature, walk in the highlands, and play in the sea or river.

With the above in mind, we have assumed the research objective from our previous study. We aimed to conduct an effective verification study to design optimal accessible tourism support tools for people with mobility difficulties. We considered what tools would enable wheelchair users to enjoy highlands and beach areas as they desire.

方法

2. PRELIMINARY INVESTIGATION

2.1 The Hippocampe wheelchair

The purpose of the present study is to obtain useful knowledge to support the optimal design of accessible tourism support tools for people with mobility challenges who wish to travel. We set three main tasks:

1. Develop accessible tourism wheelchair that would be effective for a variety of people (those with mobility difficulties due to physical challenges).
2. Explore the accessible tourism support tool and types of support suitable for Japan's topography, such as playing in the sea and trekking, from the user's perspective.
3. Confirm the differences between the equipment suitable for the situation of people with various physical challenges and the necessary assistive supports.

The first accessible tourism wheelchair used in this study was a French product called the Hippocampe (Fig.7-R). First, we conducted demonstration experiments on the Hippocampe with wheelchair users on the coast and in the highlands. This process included field trials for multiple wheelchair users with mild to severe physical challenges on the Takeno coast and at the Tajima Highlands Botanical Gardens. These are two representative tourist spots in the Tajima region of northern Hyogo, Japan.

To our knowledge, this is the first field verification study using the Hippocampe wheelchair. All investigation assistants in this work were qualified people who were experts in, or who have experience in, assisting people with physical challenges.

2.2 Takeno Coast Survey

Our study participants transferred from own wheelchair to the Hippocampe, drove along the coast and into the water. They left the Hippocampe for a moment, floated underwater, boarded the standup paddleboard, and returned to the Hippocampe. They made their way from the water to the beach and then back to the starting point.

2.2.1 Takeno Coast Survey method

Three caregivers (qualified Hippocampe instructors) completed the questionnaire survey. The subjects' and caregivers' impressions were evaluated using a 5-point semantic differential scale.

The survey items for the caregivers included five items on the ease of caregiving, five items on the ease of use of the Hippocampe, and five items on the performance desired for accessible tourism wheelchair.

For the subjects, survey items referred to the beach/underwater experience and included seven items on whether they enjoyed being in nature, five items on refreshing experiences, five items on caregiving, five items about the Hippocampe, and six items on the accessible tourism wheelchair.

2.2.2 Takeno Coast Survey Results

The Hippocampe is a water-resistant outdoor wheelchair, so it can be used in the ocean and float in the water. This feature is not found in other wheelchairs. Despite this advantage, there are negative aspects to the chair, such as the need for instructors to handle it, and users' comfort when getting in and out of it.

The results of the subject survey are as follows:

1. For wheelchair users, the ocean experience was enjoyable and allowed them to experience nature.

2. For people with severe physical challenges, there were issues with transferring from their everyday wheelchairs and getting into a proper seating position.
3. Outdoor wheelchairs place a premium on water resistance, so there are trade-offs with seating comfort.

2.3 Highlands Survey

In the highlights portion of the experiment, participants travelled to the Tajima Highlands Botanical Gardens, where they transferred from their car and own wheelchair to the Hippocampe. They left from the Gardens' Center House (departure point), moving to Shiki no Niwa, O-Katsura (where they made a U-turn), Azumaya, and returned to the Center House.

2.3.1 Highland Survey method

Three caregivers (Hippocampe instructors) completed a questionnaire. These assistants' feelings were evaluated using a 5-point scale. To measure the care burden, the main assistant pushing the wheelchair was fitted with a heart rate monitor. We also confirmed each subject's impressions. The survey items for the caregivers included: five items on the ease of caregiving, five items on the ease of using the Hippocampe, and five items on the performance desired from a accessible tourism wheelchair.

For the subjects, the survey items for the highland experience included: seven items on whether they enjoyed nature, five items on refreshing experiences, five items on caregiving, five items on the Hippocampe, and six items on accessible tourism wheelchairs in general.

2.3.2. Highlands Survey Results

For the wheelchair users, the experience of hiking in the highlands was enjoyable and allowed them to experience nature. For caregivers, the wheelchair functions suitable for hiking in the highlands were generally acceptable, in terms of the Hippocampe's performance; it was stable, safe, and comfortable when driving on unstable terrain, navigating steps, and performed well over rough terrain, but they felt the need for an electric assist function for unstable areas, such as slopes and narrow passages.

In a demonstration experiment of the Hippocampe outdoor wheelchair without an electric-assist function, the assistants' heart rate measurements showed a highest recorded rate of 164 bpm, indicating that the chair required strong physical strength in this context.

For our subjects, the Hippocampe's functions were suitable for hiking in the highlands, as they reported it to be stable, safe, and comfortable when driving on unstable terrain and navigating steps, and they were pleased with its performance on rough terrain.

However, they reported difficulties with the ease of transferring from an everyday wheelchair and the ease of adjusting the wheelchair's seating position.

2.4 Summary of Preliminary Investigation and Hypothesis Setting

2.4.1 Challenges revealed:

1. Difficulty in transferring, maintaining the seated position, and comfort when driving on rough roads
2. The need for an electric assist function on slopes
3. The need for multiple caregivers

2.4.2 Purpose of this study

The main aims of the present study were to enable people with travel challenges to enjoy the sea and mountains comfortably, if possible, by moving around in a wheelchair with minimal assistance. We also aimed to reduce caregivers' burdens.

2.4.3 Hypotheses

1. Reduction in assistance work. A person with travel challenges and a single caregiver can travel on a beach or plateau (the Hippocampe requires three expert caregivers).
2. Reduction in assistance burden. An electrically assisted wheelchair would reduce the assistance support burden, and people with mild physical challenges could travel on the beach or plateau by themselves.

3. Comfortable travel. Ensure ease of transfer. A seated posture can be maintained, and a comfortable ride is possible, even on rough roads.

3.HYPOTHESES VERIFICATION INVESTIGATION

3.1 Verification investigation schedule

表 1. Verification investigation schedule.

Survey content	Date	Experiment location	Experimental Overview
2024 Subjects survey	9/28/2024	Takeno Coast	Wheelchair users with different functional challenges, experimental equipment (Research prototype early model)
	10/26	Tajima Highlands Botanical Gardens	
2025 Subjects survey	7/5/2025	Takeno Coast	Wheelchair users with different functional challenges, experimental equipment (Research prototype late final model)
	9/23	Tajima Highlands Botanical Gardens	

3.2 Subjects: Three wheelchair users, one elderly

表 2. Subjects’ attributes, ADL.

Subject	Gender, Age	Communication Skills	Status of Physical Functions
A	Male, Teens	Judged by facial expressions	Lack function in both upper and lower limbs
B	Male, 50s	Simple conversation possible	Lack of function in upper right limb, significant functional impairment in lower right limb
C	Male, 50s	Normal conversation possible	Tibiofibular nerve palsy, severe impairment of right ankle function
D	Female,80s	Normal conversation possible	Unable to walk long distances or for long periods of time

Subjects’ attributes ADL.

3.3 Prototype

表 3. Verification equipment overview.

experimental equipment	w, l, weight, wheel diameter	output	battery
Assisted e. wheelchair research prototype, early model 2024.	620(W) 900 (L),57 kg 265m (diameter), double off-road tires	200W×2	36Ah lead battery
Assisted e. wheelchair research prototype, late final model, 2025	860 (w), 900 (L), 56 kg, 350 mm(diameter), double off-road tires	200W×2	30Ah lithium ion

We designed a prototype that would meet our needs. We partnered with UDA Co., Ltd. to produce it. We ensured its basic performance capabilities, such as an electric assist function, small size, light weight, and ride comfort, and considered the

specifications of tires, casters, etc. for driving performance. We equipped it with 200W x 2 motors and 36Ah batteries to provide optimal driving capabilities, a flip-up arm support that makes it easy to transfer, and a flip-up foot panel that makes it easy for users to place their feet on the ground or lift their feet when transferring. The back support can be folded forward for easy storage and loading into a car, and it has three adjustable angles. The frame structure is lightweight, rigid, and has a high suspension effect, ensuring a comfortable ride on rough terrain. The chair features double drive tires with a larger diameter than those found on chairs for use in more urban contexts. The casters are also large in diameter, to prevent tripping over steps. The chair has a range of 25km, top speed of 6km/h, step-over height of 5cm, seat width of 400–460mm, seat depth of 380–480mm, a back height of 550mm, and back support angles of 0°/10°/20°. The electric assist controller can be attached in any position on the back support, or left or right arm support. This means that caregivers can operate it from the back support, and wheelchair users who want to propel themselves can operate it using either the left or right arm. The research prototypes were made into early and late final models.

Concerns about the early prototype, such as interference with sand on rough beaches, were resolved with the late final model of the assisted electric wheelchair.

3.4 Takeno Beach and Tajima Kogen Botanical Gardens Surveys methods:

Three caregivers (the same Hippocampe instructors) answered the questionnaire and rated their feelings using a 5-point scale. The difference between this experiment and the previous one was that the number of caregivers was reduced from three to one. The same verification route was verified. Last time, the entire route was assisted by three people at all times, but this time, the route was divided into three parts, and the same caregivers were in charge of only a single part of the route, so they worked with all subjects.

To measure the caregivers' physical burden, a heart rate monitor was attached to the main caregiver pushing the wheelchair. Since the assistance sections were different, the heart rate burden comparison was limited to the most strenuous uphill section between the Hippocampe and the electric assist prototype (the same caregiver assisted the same subject).

The survey items for caregivers included: five items related to ease of providing care, five items related to ease of using the electrically assisted prototype, and five items related to the performance desired in the accessible tourism wheelchair.

結果および考察

4.INVESTIGATION RESULTS

Demonstration experiment results using the prototype assisted electric wheelchair.

4.1 Our prototype driving tests suggested that wheelchair users may be able to explore the seaside or highlands on their own, or with little assistance. We successfully reduced the required number of caregivers/assistants. With the prototype, a person with travel difficulties and an assistant were able to drive on the beach, and the chair user could drive in the highlands alone (the Hippocampe required three assistants). H1 is generally supported (see Figs.1,2).

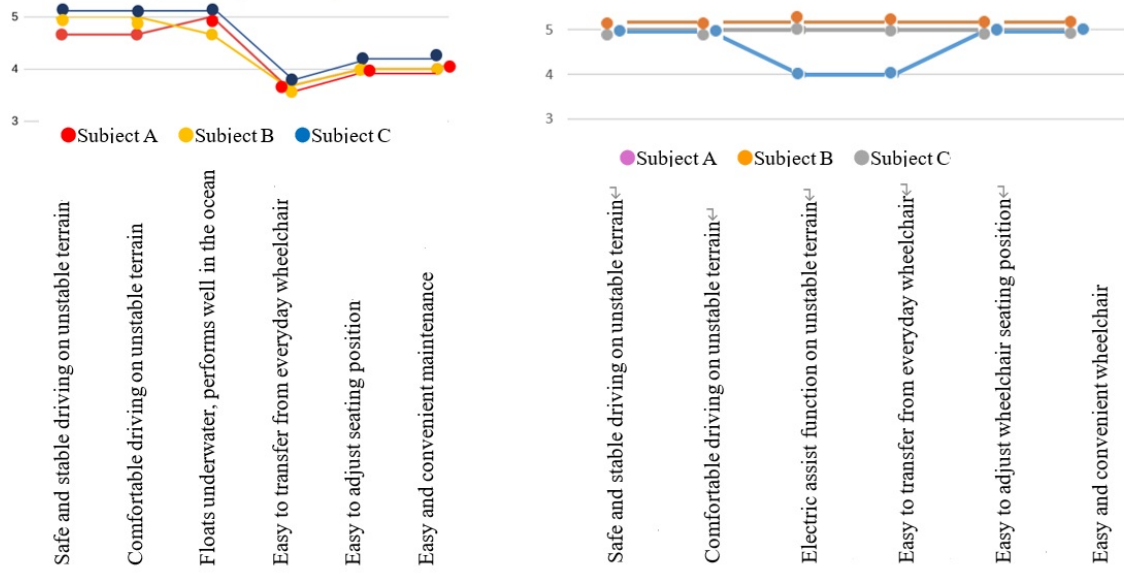


Figure 1. Caregivers' evaluations (on the beach).

R:Hippocamp outdoor wheelchair

L:Early prototype electric wheelchair

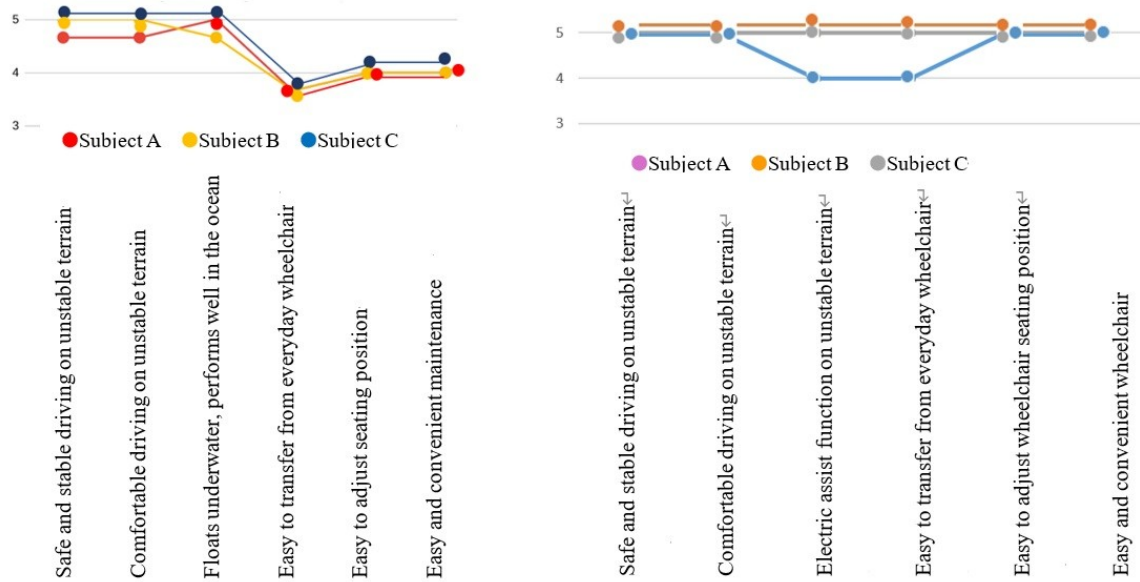


Figure 2. Caregivers' evaluations (in the highlands)

R:Hippocamp outdoor wheelchair

L:Early prototype electric wheelchair

4.2 From the caregivers' perspective, the functions of the electric-assisted wheelchair were suitable for both coastal and highland driving. The chairs were proven to be stable, safe, and comfortable on diverse geographical features, and it was easy to transfer from a standard chair to these chairs. The burden on the caregiver was significantly reduced, as evidenced

by the heart rate monitoring. People with mild to moderate physical challenges were able to drive the wheelchair themselves (see Figs.3).



図 3. Experimental scene of the subjects.

R:SubjectC running along the coast

CR:SubjectC running alone in the highlands

CL:Subject B running along the coast

L:Subject B running along in the highlands

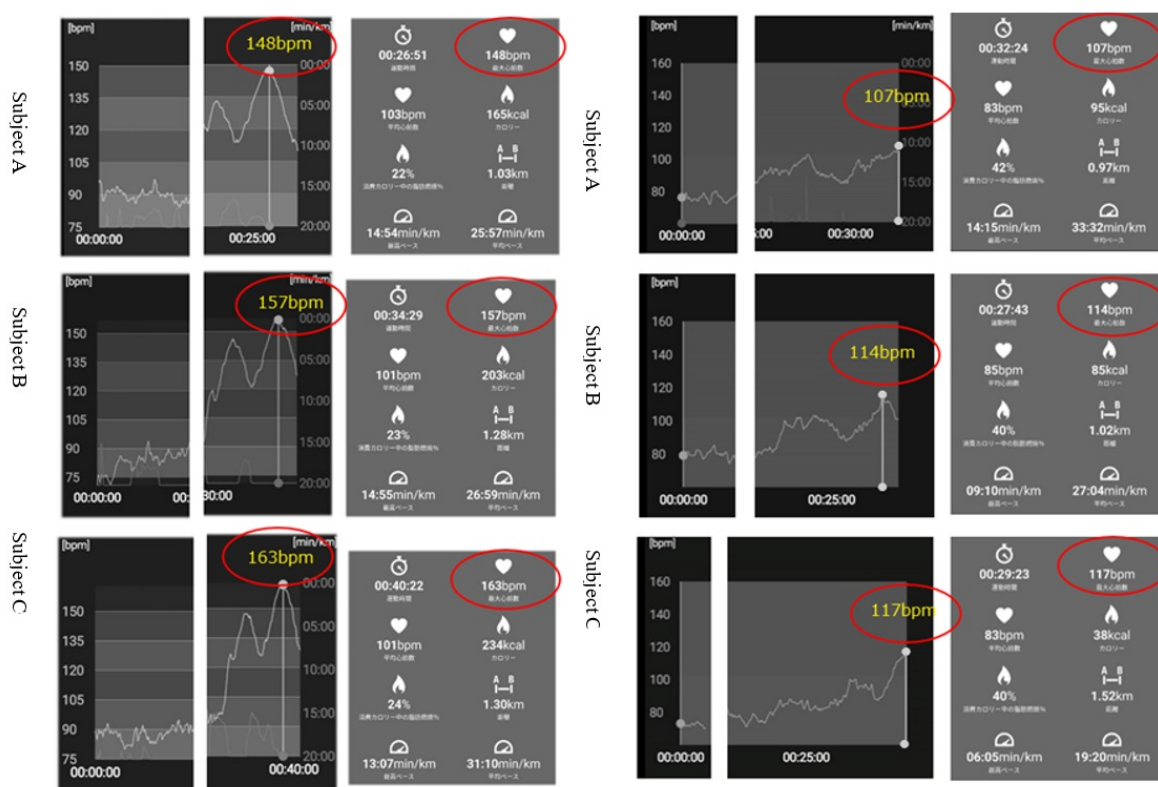


図 4. Primary caregiver's maximum heart rate

L:Early prototype electric wheelchair

R:Hippocamp outdoor wheelchair

Overall, the electric assist function was successful in reducing the number of caregivers required and easing the burden of caregivers on slopes. H2 is generally supported (see Figs.1-L,2-L,4).

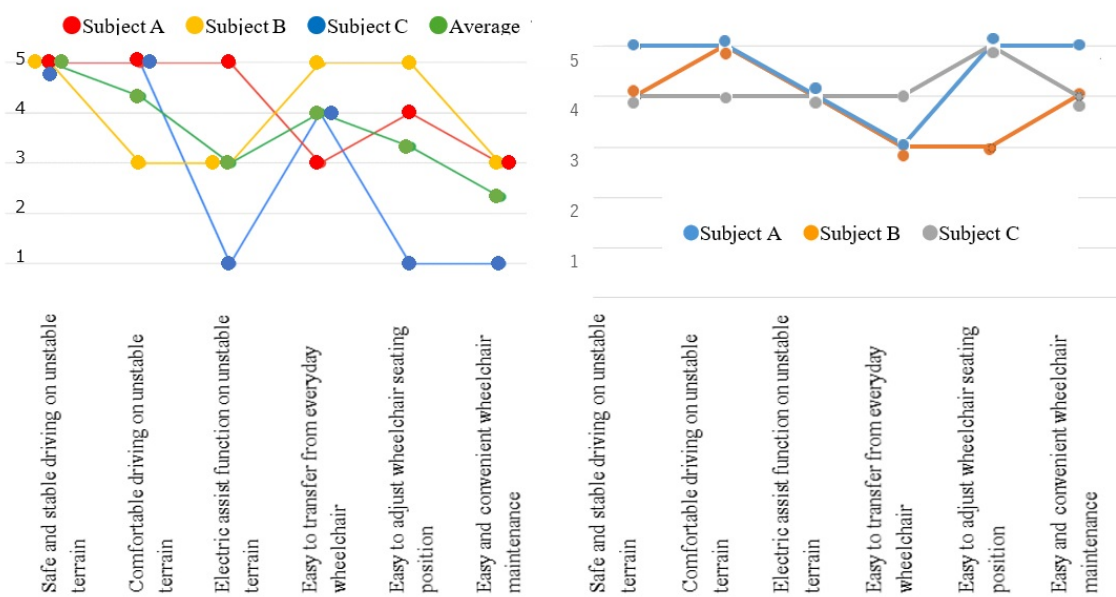


Figure 5. Subjects' evaluations (on the beach)

L:Early prototype electric wheelchair

R:Hippocamp outdoor wheelchair

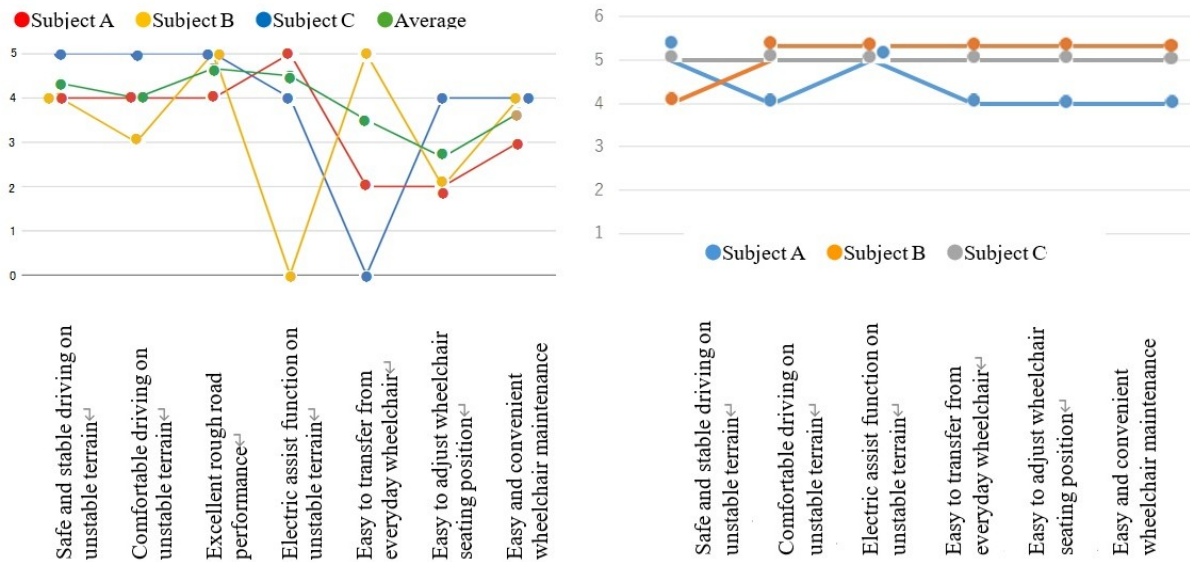


Figure 6. Subjects' evaluations (in the highlands)

L:Early prototype electric wheelchair

R:Hippocamp outdoor wheelchair

4.3 The functions of the electric-assisted wheelchair have been shown suitable for the subjects' coastal and highlands driving. It is stable, safe, and comfortable when driving on unstable terrain. H3 is generally supported (Fig.5-L,6-L,).

5.CONCLUSIONS

The effectiveness of an electric assist function in assisting wheelchair users when traveling along the coast or in highlands on slopes or unstable terrain has been confirmed. We were able to reduce both the number of caregivers required and the physical burden on them. In addition, the electric assist function allows users to move independently, resulting in high user satisfaction.



図 7. Experimental equipment

R:Three experts are needed to assist with the Hippocamp run.

L:Assisted e. wheelchair research prototype, late final model

We also found that the wheelchair could become unable to move due to even subtle factors, such as the condition of the sand on a beach.

We created the final model of the assisted electric wheelchair research prototype and solved the issues with the first model.

Finally, we will continue to increase the number of subjects and conduct verification studies in other highlands and coastline areas.

(完)

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