Walking Master: Disabled Elderly Walking Empowerment Products

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Abstract

For a civilised society, how to treat their elder citizens and achieve healthy and active aging is a significant issue. This paper tackles the great need for walking aids for elderly people with movement difficulties, and designs two possible products for the target population. To truly meet their demands and satisfy the technical requirements, we analysed the literature and existing cases and conducted a questionnaire survey and simulation experiment. The results show that muscle function degradation and severe disease are the main causes for walking difficulties. The results also reveal that security and convenient operating mechanisms are priority concerns to the customers. Based on these, we have done several sketches and designed two concept products with a computer vision module. This paper confronts the urgent needs of elderly people and proposes a possible blueprint for better walking aids.

Keywords: Walking aid， Myasthenia gravis， Pension industry， Product design， Product analysis

1 Introduction

At present, the supply and demand of care services for disabled elderly are seriously unbalanced within the context of social aging. In addition, a number of elderly people have been immensely affected by myasthenia gravis. Myasthenia gravis is a rare autoimmune neuromuscular disease. It mainly affects neuromuscular junctions, resulting in the inability of the muscle to contract properly, which causes muscle weakness and fatigue. The disabled elderly are more likely to rely on the help of family members and personal caregivers rather than community public services or walking autonomously. Without help, elderly with walking problems cannot live life normally. Therefore, design of walking aids is an essential solution aimed at improving the lives of the elderly and empowering them in walking through achieving the necessary strength. There have been some products on the market helping elderly people with walking problems, which manifests the demand and significance of such products. However, there are still some constrains on these products according to existing studies. In a recent review article, we found that some products on the market have focused on application in different situations, like adapting to walking on a variety of surfaces. But they lack application of technology, for example, in intelligent voice control (ZA, XD, & YH, 2019). In other findings, constraints of elderly care machinery lie in multiple functions with a single button, increasing the burden of memory on the elderly. In terms of suitable customers, some products are only suitable for the elderly with mild disability. Some studies have found that previous falls not only cause physical trauma and disability in elderly, but also lead to psychological problems such as depression, anxiety, and fear of falling that produce avoidance behaviours. As one grows older, thinking may no longer as clear as that of the young, and judgment is weakened, memory is declining. Hence, not all old people can accept new things. Based on the constrains of existing products, our research aimed at finding practical demands of the elderly, and how we could design products to both encompass specific needs and develop an all-round product for aiding locomotion. Meanwhile, psychological problems were a key factor to consider. Facing the problems above, our products make a novel contribution to the subdivision of walking assistance and community mutual assistance for the future. In the context of healthy aging, our products highlight convenient physical care for the elderly that is humanistic. The proposed product assists caregivers in

home institutions in completing care tasks, improving care efficiency and professionalism so as to improve care quality, while making effective use of socialised professional medical resources and pension services.(Faruqui & Jaeblon, 2010)(Allet et al., 2009)

In the pursuit of healthy aging, the deep integration of the Internet and traditional industries can fully integrate the internet. As early as 1999, China has announced that it had become an aging society, the proportion of the elderly in the social population is still increasing, and a series of problems related to the elderly are becoming increasingly prominent. Our research aims to fully harness the advantages of artificial intelligence under the rubric of "Internet +", so as to solve the problem of lack or inadequacy in the design of care products for the disabled elderly. It is our hope that this research can help more disabled elderly to develop stronger self-care ability, to better solve all kinds of problems encountered in daily life.

2 Background

2.1 Literature review

Modes of helping the elderly at home are gradually developing towards humanisation, improved technology, and intelligence. However, special aging machinery products such as intelligent wheelchairs and intelligent hearing aids that are required during the healing period of certain diseases that have short-term Period of recovery (ZA et al., 2019). On a global scale, foreign limb rehabilitation product industries are often more developed than that of China. Limb rehabilitation products in China are not welcomed by customers due to their low positioning accuracy, difficulty in controlling force, and poor quality of after-sale support (MX, L, YL, & LS, 2020). The vast majority of semi-disabled elderly people suffer from lower limb motor dysfunction and are unable to walk upright (JP, G, ZD, B, & FW, 2021).

Several products have been designed and each of them has its advantages and disadvantages. At present, there are some walking aids in the rehabilitation market, such as walking sticks, handcarts with no power, lower limb exoskeletons, etc. (JP et al., 2021). Using a sensor device to drive the support rod, a mechanical device that assists the elderly in standing and walking lift the elderly person to a normal standing posture with certain movements. In addition, it can balance the weight of the elderly with counterweights to prevent them from falling. However, it has a multiple functions for one button, which increases the understanding burden on the elderly (MX et al., 2020). Another device, designed by Tu, is cute and fashionable, and has functionality to collaborate with other smart home devices to form an intelligent home care system, which is more popular among the elderly (ZA et al., 2019). But there is excessive reliance on intelligent systems, a lack of basic guarantee for physical keys, and a high difficulty of operation. A walking assistant wheelchair for semi-disabled elderly has a wheeled structure and only rolling friction, which makes it low resistance and easy to move (JP et al., 2021). But despite automatic alarming for emergencies it has a low probability of in-time rescue and relief in case of an accident. Lacking night vision function, this product is only suitable for use in the bright environments.

2.2 Research question

Building on the existing literature within our research topic and considering the circumstances of our target market, we focus on solving the following two problems: What is the *real need* of the elderly with walking problems? And, how can our walking aid design empower the elderly to walk like able-bodied people in diverse situations?

3 Methods and Results

3.1 Research Design

We conducted case studies of other products on the market. By summarising their advantages and disadvantages, we can further clarify the thought process and design direction of our target products.

We designed a detailed questionnaire which includes people's desired functions, the priorities and the factors to be considered when purchasing a walking aids. Starting from the impact of walking difficulties on the travel of the elderly, we investigated the current daily life care of elderly in China, the reasons why those with walking difficulties use walking aids, and the core needs of target consumer groups for this product. To make our outcomes reliable, multiple choices are provided for the questions. Also, respondents can write down their needs if the options we provide are not covered.

More importantly, by demonstrating different periods of myasthenia gravis in patients and simulating different scenarios of their walking mode, the team's product developers were able to better understand their specific walking dilemmas through simulation. They were thus able to tailor the product's functions to the multifaceted walking needs of seniors with myasthenia gravis.

3.2 Findings and discussions

3.2.1 Questionnaire result

We used bar charts and pie charts to evaluate the questionnaire results, making the data more visual and intuitive:

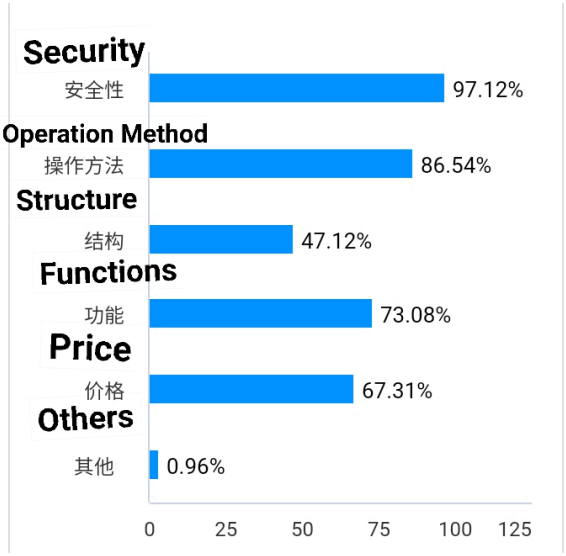

Figure 1: *What factors do you consider when buying an assistive device?*

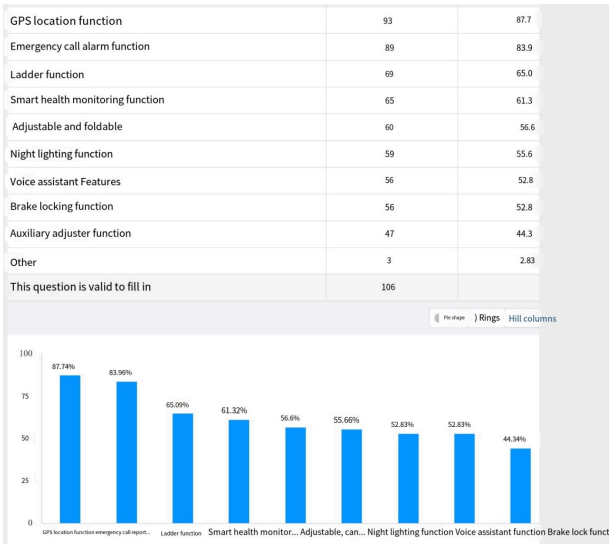

Figure 2: *What features do you expect smart walking AIDS for the elderly to have?*

We found that elderly people have trouble walking not only because of muscle issues, but also severe diseases like stroke. The responses to several of these questions are representative. We found that the target group valued product safety and convenience greatly. GPS location function and emergency call alarm functions are the features people most want it to have. Considering that more than half of the elderly take care of themselves, we need to design a product which is easy to use without the help of others.

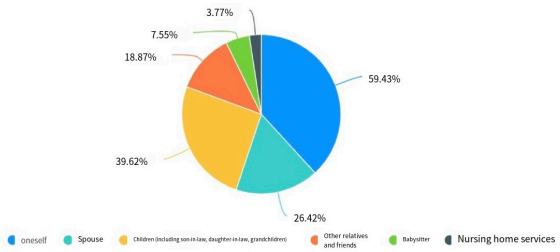

Figure 3: *Who will take care of the old people in your family?*

3.2.2 Case study

Our careful study and pros and cons analysis of other products on the market enlightened us with some key points when designing ours.

1. Wearable device（e.g. Inmodi, Honda Walking Assistant）

Wearable devices like Inmodi are applicable for elder people who have trouble walking and are worn on their legs and knees. With the help of this kind of device, elderly can stand, sit, and walk with both hands free. Additional functions like knee-joint health assessment supported by AI that can in real-time monitor the the condition of patients. Nevertheless, the weight of the device might be too heavy for particular patients who could not even lift the device by their legs. The device could cause additional injuries to a patient’ s body.

2. Wheeled Device（e.g. Invacare Stand Assist Premier, Ottobock Wheelchair）

Wheeled devices like Invacare Stand Assist Premier are defined as walking aid devices that are move by wheels. These devices are normally detachable and adjustable for the patients with proper ergonomic design. Heavy objects can easily be carried by the wheels and patients can walk with less effort. However, when the device encounters obstacles like stairs, it is hard for elderly to climb up and down. And the wheeled device always takes up too much space, which could be inconvenient when navigating some small-scale area.

3. Crutch Device (e.g. We WALK)

Crutch devices are considered as intelligent walking sticks for elderly. These devices are lighter than the others, and can adapt to different crutches. Additional functions are, for example, real-time monitoring of walking and giving feedback, pairing with personal devices through specialised apps. Nonetheless, shortcomings are obvious. Crutches could be a huge burden for the arm. It is impossible for old people with weakness in their arm muscles.

We take the advantages and disadvantages from these three types of devices into consideration. We can extract their functions and remix them into our design, and make innovations to avoid some of the disadvantages.

3.2.3 Stimulate Experiment

Our simulation experiments also shed significant light. Our team found that regardless of the degree of myasthenia gravis, there will be unstable walking, difficulty in grasping the road condition correctly, and likelihood of falling down. As for this experiment’s results, we concluded that if the patients have the need to travel, they will continue to rely on walking aids to assist them to walk, however, patients with different degrees of illness rely on walking aids in different modes. In this case, our team will design different types of walking aids to meet the walking needs of different groups of people. The common features of the products are as follows.

1) Satisfy the basic walking support function.
2) The product safety.
3) AI voice interaction fall imitation system.
4) The flexibility of the product structure and the lightness of the product itself.

4 Product design

4.1 Product 1

Based on previous literature review, the data collected, and competitor analysis, our group’s walking device was designed to solve the problem of inconvenient walking, caused by myasthenia gravis and stroke, for the elderly. The main functions of our product are to prevent elderly people from falling down and have the competence to

walk independently even in nighttime conditions. Equipped with simple solid keys and universal wheels, our walking aid design is easily-operated and practical. In our vision, the material should be lightweight and the aid should be collapsible. Besides, considering the needs of the elderly to carry items when they go out, it is equipped with relevant hooks onto which users can place their items conveniently.

Two highlights of our products are an intelligent obstacle-identification function and intelligent voice assistant functions, which enable users to control our product through direct voice command. Integrating the computer vision technique, the product can adapt its form to some degree, allowing AI to improve the living quality of elderly people unconsciously.

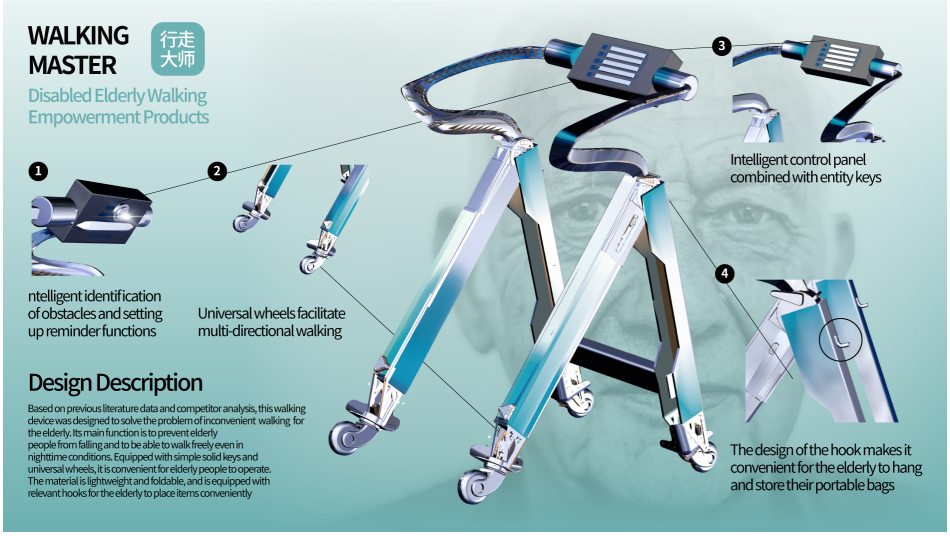

Figure 4: *Product 1, a hand-pushed walking aid.*

4.2 Product 2

Based on previous literature data and case analysis, this walking device was designed to solve the problem of inconvenient walking for the elderly, especially the mild patients who can use it with a single hand. Its main function is to assist elder people in walking stably and easily climbing up and down stairs. It is equipped with a phone magnet to control, a pair of wheel systems to climb stairs, sensors to detect and switch the modes automatically, etc. The height and the length of the device are adjustable to adapt to different physical situations, giving every user a customised experience of the device.

Here are four main design highlights for this product.

1) Ground Mode: the wheels are designed to adjust balance automatically. Stair Mode: the wheels can rotate, powered by electricity, to climb up and down the stairs. It's worth mentioning that the modes are automatically switched by LIDAR.

2) Wheel system: two pairs of double wheels can rotate not only horizontally but also vertically.

3) Smart Magnet: to attach smart phone or tablet as an intelligent control and monitor of health.

4) Folding seat with soft cushion: 2 pieces can be combined into an individual seat.

5 Conclusions and Future Directions

5.1 Limitations

Though some simulation experiments and questionnaires have been conducted and modelling is successfully completed, our research still has three main limitations, resulting from limited time and resources.

Firstly, we've only collected about 200 valid questionnaires, which is not a large-scale survey. Though it can reflect people's attitude and functions needed for the product, the data would be more representative were there more.

Secondly, with more time, we would conduct data analysis experiments to find whether there are relationships between answers to the questions and gender, region, as well as financial condition factors with the help

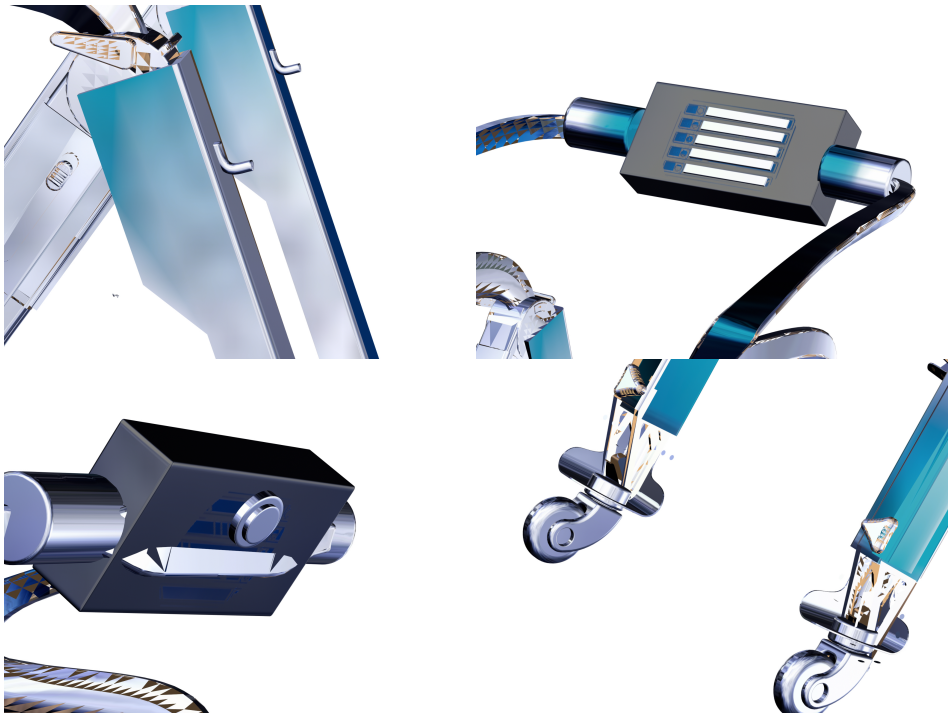

Figure 5: *Details on product 1.*

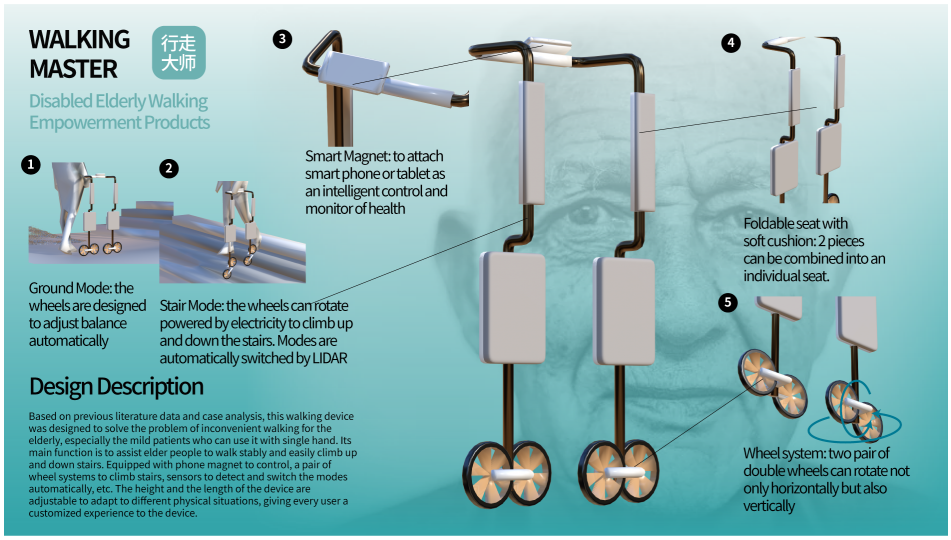

Figure 6: *Product 2, a walking aid used with one hand.*

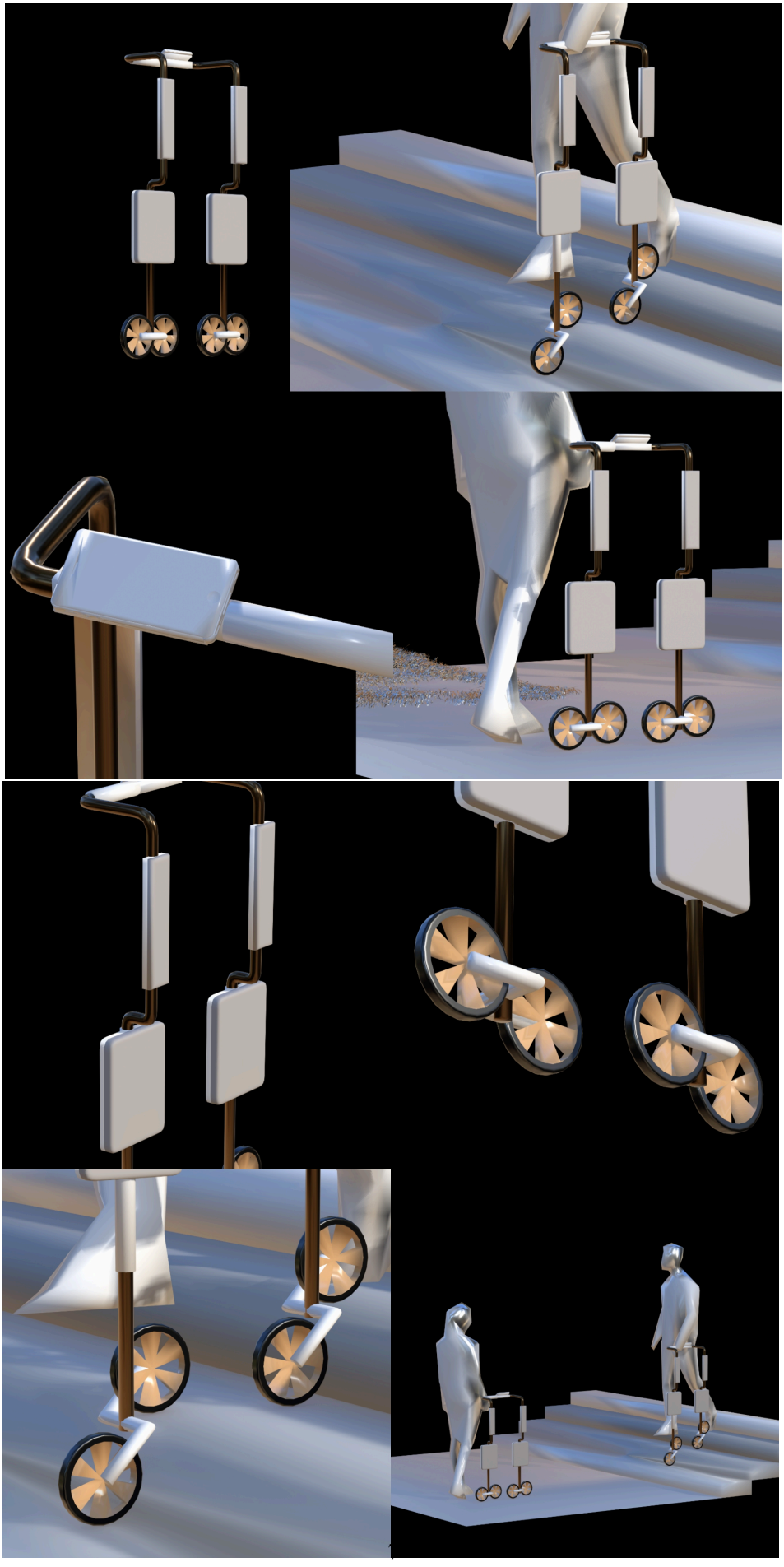

Figure 7: *Function demonstration 2.*

of MATLAB or Python. In this way, we could understand the requirements more specifically for targeted customers.

Thirdly, there's a long way to go before a commercial product is realised. When we consider how to make a viable product, we will face the difficulty of material selection, marketing, cooperation with hardware departments and and developing complex software. Many details still need to be considered and solved.

5.2 Future Directions

As AI technology make great strides in the fields of computer vision and voice recognition, our products can attain a high accuracy in identifying obstacles and instructions, making them more reliable and intelligent. Cooperating with big-tech companies can be a possible way for our product designers to integrate new techniques in our products (Sakano, Murata, Goda, & Nakano, 2023).

In a commercial aspect, according to previous literature commercial analysis, China's elderly care industry is currently facing many problems, which also means huge potential and opportunities for the walking aids products(Y, C, & ZC, 2017). There are four major problems in the commercial pension service market. Firstly, the domestic pension market is still in the early stage of development, and the business model is not mature. Secondly, there is a lack of leading enterprises, with the positioning of incumbents somewhat fuzzy. Thirdly, the number and quality of elderly care service personnel is low, and the turnover rate is high. There is a mismatch between supply and effective demand. If our designs become reality, such elderly care products can cooperate with community pension institutions and commercial insurance companies to provide corresponding walking assistance work. In the case of many families where the elderly and their children are separated for a long time, this will improve the quality of life of the elderly in old age and help healthy aging.

On the level of humanistic care, products of the kind we propose here provide essential support for key elements of healthy aging among elder citizens who suffer from walking difficulties (Sorock, 1988). By using our product, the radius of their activities would be expanded, therefore they are more likely to have healthy social relationships, which is essential to their mental health (Roman de Mettelinge & Cambier, 2015). Starting from the fall-prevention function, our product offer them a new chance to live their lives in retirement to the fullest.

Author Contributions and Declarations

Jiang Yulin: Display board production, sketch design, overall project progress control. *Gao Xiaoya*: Copy writing, overleaf editing, analyse the limitations and future, AI literature review. *Deng Yazhuo*: Literature review and summary, copy writing. *Li Kexin*: Video making, questionnaire results analysis, mind maps. *Long Wozai*: Modeling, case analysis, copy writing. *Pan Zhijun*: Modeling, product design, sketches, literature review.

Funding: This research received no external funding.

Research Guidelines: This study has followed the research guidelines of the Business Analysis and Innovation Entrepreneurship, Cambridge Programme 2023.

Ethical principles were followed according to the guidelines of the Business Analysis and Innovation Entrepreneurship, Cambridge Programme 2023" . Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability: Please contact the corresponding author(s) for all reasonable requests for access to the data.

Acknowledgments: We would like to give our thanks to our faculty professors and teachers at Cambridge University for their guidance.

Conflicts of Interest: The authors declare no conflict of interest.

Intellectual Property: The authors attest that copyright belongs to them, the article has not been published elsewhere, and there is no infringement of any intellectual property rights as far as they are aware.

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