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Research on purchase intention and optimization strategy of intelligent four-legged robot for the blind based on STS-UTAUT model

Yunxiao Zhang[1],Xinyu Zhu[2],Cong Zhang[3],Zifeng Gao[4]
[123]Beijing Institute of Graphic Communication,Beijing,China
[4]University of Southampton， Southampton,United Kingdom

Abstract

In recent years, assistive robots for the visually impaired have begun to enter peoples lives as an innovative tool. This study aims to explore the factors influencing the purchase intention of intelligent quadruped robots for the visually impaired, enhance public acceptance of these robots, and provide practical suggestions for their design. The study integrates the Technology Acceptance Model (TAM) with the Social Technology System (STS) theory to develop a STS-UTAUT integrated model for the purchase intention of intelligent quadruped robots for the visually impaired. Based on this model, 11 research hypotheses are proposed, and data are collected through in-depth interviews and other research methods, with empirical analysis conducted using SPSS. The study also analyzes the impact weights of each variable on the purchase intention of intelligent quadruped robots for the visually impaired. The findings indicate that both social environment and technology application significantly influence the purchase intention of these robots. The STS-UTAUT integrated model enables designers to better understand the needs of the visually impaired, leading to the development of more suitable intelligent quadruped robots, thereby improving their quality of life and social participation.

Keywords: intelligent robot for the blind; willingness to use; integrated user adoption model; social technology system theory

1 Introduction

According to data from the World Health Organization (WHO) in 2020, approximately 1.2 billion people worldwide suffer from some form of visual impairment, including at least 43 million blind individuals and at least 238 million with low vision. Among these, China has the highest number of visually impaired individuals globally. By 2023, the number of visually impaired people in China had surpassed 17 million, with about one in every 80 people facing visual impairment, accounting for approximately 18% of the global visually impaired population. For those with severe visual impairment and blindness, the inability to rely on vision to perceive their surroundings poses significant challenges and inconveniences in daily travel. As society evolves, environmental complexities have increased, making it a critical issue for many researchers to help blind individuals travel independently, with safety and social participation being the core concerns.

Currently, various measures are in place to help the blind achieve safer and more efficient independent travel. Among these, the most widely used method is guide dogs for the blind. However, guide dogs have limited breeds and require significant resources and effort for training, which makes them costly and limited in number. Additionally, due to the emotional issues associated with the limited lifespan of dogs, their widespread adoption is hindered. With the continuous advancement of technology, intelligent guide devices such as smart guide sticks and wearable guide devices have emerged. However, these devices have limited environmental detection capabilities and cannot preemptively identify and avoid obstacles at a distance. They also impose high travel pressure, have poor environmental adaptability, and cannot ensure the safety of the visually impaired community.

As an emerging field, robotics is characterized by strong interdisciplinary integration and high application levels, with broad applications in both theoretical research and practical use. Bionic quadruped robots, as mobile platforms with flexible movements, can operate in various complex terrains, including stairs, slopes, gullies, and gravel, making them more adaptable to different environments compared to wheeled and tracked robots. Therefore, intelligent quadruped robots for the blind, which integrate technologies such as navigation and obstacle avoidance and human-machine interaction, are seen as a solution to overcome the limitations of traditional guide dog tools. Currently, there are examples of intelligent guide dog robots entering the market and beginning commercialization. The worlds first six-legged guide robot, developed by Professor Gao Fengs team at Shanghai Jiao Tong University, features a unique six-legged design that offers significantly better stability than traditional four-legged guide dogs, produces less noise when walking, and integrates visual, auditory, and force sensors. This enables precise navigation, dynamic obstacle avoidance, traffic light recognition, and real-time communication with visually impaired users through voice interaction. The robot has an accuracy rate of over 90% in voice recognition and a response time of less than one second. It is now in the field testing phase, and as of April 2025, it has received orders for 20 units.

Although intelligent guide quadruped robots have gradually been commercialized, there is currently a lack of research on users willingness and acceptance of these robots. Therefore, it is worth exploring how to enhance the acceptance rate of intelligent guide quadruped robots among visually impaired users by optimizing their technical design, which can further boost their willingness to purchase. To this end, this paper aims to integrate the Social Technology System (Sociotechnical System, STS) theory and the Integrated Technology Acceptance Model (Technology Acceptance Model, TAM) to construct a comprehensive research model. The study will analyze and hypothesize the factors influencing the acceptance of intelligent guide quadruped robots. By collecting relevant questionnaires and using SPSS to verify and analyze the impact of these factors on users willingness to purchase, the paper will propose design suggestions for future improvements in intelligent guide quadruped robots. The goal is to increase the willingness and acceptance of both society and the visually impaired community to purchase these robots, thereby promoting their social participation.

2 Model overview

2.1 Social Technology Systems (Sociotechnical System, STS)

The theory of social-technical systems emphasizes the interaction and collaborative optimization between social and technical systems. Any system is composed of social subsystems and technical subsystems, which are interdependent and dynamically interact to determine the overall performance and user experience of the system. The social subsystem primarily includes soft elements such as people, culture, organizational structures, and social relationships; the technical subsystem encompasses hard elements such as physical tools, technologies, processes, and infrastructure. The core logic is to optimize the system while ensuring compatibility between social and technical elements, as optimizing technology alone or ignoring social factors can lead to system failure. In current research on integrating artificial intelligence into assistive robots for the blind, there is a lack of consideration for the open social relationship space in which the blind use AI-integrated quadruped assistive robots. The theory of social-technical systems suggests that when designing products, human social considerations should be integrated, as assistive technology is not a single, self-contained category but a comprehensive set of related equipment, technologies, and subsequent services defined by the application object. Therefore, combining the study of assistive products with a social systems perspective can better capture the social nature of technology.

2.2 Integrated User Adoption Model (UTAUT)

In 1989, Davis introduced the Technology Acceptance Model (Technology Acceptance Model, TAM) to describe and validate how users acceptance of technology primarily stems from behavioral intention. This model has since been widely adopted as a theoretical framework in the information technology field. Behavioral intention is composed of two key elements: perceived ease of use, which reflects the users perception of how easy or difficult it is to learn new technology; and perceived usefulness, which describes the individuals belief that the new technology can enhance their work performance or improve their quality of life.

Following the establishment of TAM as a foundational theory in the field of information technology acceptance, American scholars Venkatesh and Davis, among others, integrated and supplemented the early TAM model in 2003 to propose the Integrated User Adoption Theory (Unified Theory of Acceptance and Use of Technology, UTAUT). Research has shown that this model integrates the characteristics of multiple models, offering significant advantages in more specifically analyzing users acceptance of new technologies. Therefore, this study initially selected this model as the theoretical foundation, drawing on other scholars applications and modifications of the model to construct a model for the acceptance intention of users towards AI-assisted four-legged robots for the blind. The aim is to provide valuable references for the design, optimization, and promotion of such applications by deeply analyzing and discussing users acceptance of AI-assisted four-legged robots for the blind. This model emphasizes four core dimensions: effort expectancy, performance expectancy, social impact, and convenience conditions. Among these, “effort expectancy (Effort Expectancy, EE)” refers to the users subjective perception of the psychological or physiological effort required to use the technology, i.e., whether the user believes the technology can be used “without much effort”. In this study, it can be understood as whether the interaction buttons of the AI-assisted four-legged robot for the blind meet ergonomic standards and whether voice commands are clear; “performance expectancy.”(Performance Expectancy, PE) refers to users expectations that the technology they use can directly enhance their work or life performance. For example, the navigation accuracy of a blind assistance robot enhanced by AI can directly boost work efficiency. (Social Influence, SI) represents the attitudes and pressures from significant others or the social environment towards the technology users perceive, reflecting the influence of social norms and group consensus. (Facilitating Conditions, FC) refers to the external resources and environmental conditions that support the use of technology, emphasizing the objective feasibility of implementing the technology.

2.3 The modified STS-UTAUT fusion model is constructed

In the STS theory, the focus is on the social subsystem, the technological subsystem, and their interrelationships. The social and technological systems are interdependent. In the context of enhancing public acceptance of AI-assisted four-legged robots for the blind, their interactions collectively influence the acceptance and willingness to purchase such robots. At the social subsystem level, STS theory highlights how public opinion and participation in assistive blind activities affect the acceptance of these robots. Therefore, at this level, attention is given to the relationships between stakeholders and the attributes of the stakeholders themselves, using the social psychological framework proposed by Lim et al. Specifically, the social subsystem can be analyzed from two dimensions: public opinion acceptance and participation in assistive blind activities. Throughout this process, social psychological public opinion has a direct impact on the participation in assistive blind activities, as illustrated in Figure 1.

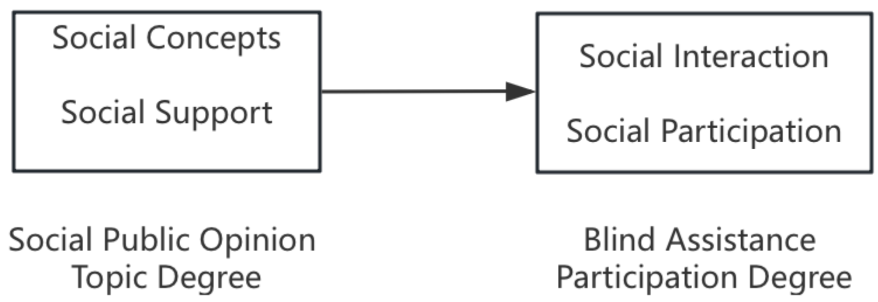

Figure 1 Social subsystem

In this context, public opinion acceptance primarily encompasses social perceptions and social support. Social perceptions form an inclusive framework for public opinion, significantly influencing the publics attitudes, emotions, and preconceived notions about technology products. These perceptions further influence the acceptance and willingness to purchase such devices among individuals involved in assistive technology for the blind. Social support includes resources, support, and opportunities provided for assistive technology. Adequate social support can reduce the barriers for the blind to use assistive technology products and increase their usage frequency. The level of participation in assistive technology for the blind directly reflects their social interaction with family members, friends, and other community members, as well as their involvement in community activities and social interactions. If AI-assisted quadruped robots can enhance the social interaction and participation of the blind, it will increase their willingness to purchase these products.

In the technical subsystem, technology is typically placed in specific contexts and the application systems of technology are thoroughly analyzed. Verbeek proposes a human-technology-world model to highlight how humans interact with the external world through technology, where design serves as a direct intermediary between technology and people. This means that technology does not directly hinder users willingness to use it; instead, design elements that facilitate direct interaction with people are more relevant and intimate for users. Therefore, when analyzing public acceptance and purchase intentions for intelligent assistive robots, it is also important to examine how design features can highlight the technological attributes of the product. As technology continues to advance, digitalization and intelligence have become key trends in the design of technology products. In the design of intelligent assistive robots, key considerations should include the ease of operation, cost, practicality, resource availability, and intelligence elements.

In the process of studying the UTAUT model, researchers made adjustments to two aspects of the model based on their specific research needs. Firstly, in the UTAUT model, the core dimension of social influence encompasses various social factors such as family, friends, healthcare providers, and public opinion. However, this dimension treats social factors merely as external variables that unidirectionally impact the technology acceptance process, without considering the feedback from social factors on technology perception. This limitation hinders a comprehensive understanding of the complex relationship between technology characteristics and social interactions, particularly in explaining the social dynamics of user technology acceptance. In contrast, the STS theory emphasizes the interaction between social systems and technology systems. Therefore, incorporating STS theory into this study provides an additional consideration and supplement to the UTAUT model, particularly in terms of social factors. While STS theory highlights the interaction between technology and society, it lacks a quantifiable method for measuring the impact of social and technological factors on the system. The traditional UTAUT model offers a quantitative assessment of user technology acceptance, primarily based on behavioral intentions, thus providing a quantitative framework for understanding and validating user technology acceptanceThe deficiencies in the previous model have been addressed. Therefore, from the perspective of STS theory, the UTAUT model has been optimized to construct a theoretical framework that influences the purchase intention of AI-assisted four-legged robots for the blind. This not only overcomes the limitations of the UTAUT model in social factors but also leverages the model to address the quantitative assessment shortcomings of STS theory in specific technology adoption behaviors. Secondly, since the willingness to use intelligent assistive four-legged robots is based on the willingness to purchase, the original willingness to use has been revised to willingness to purchase, allowing for the study of how external factors influence users purchasing intentions. Additionally, in this study, the cost of acquisition overlaps with one of the influencing factors —— in the original models convenience conditions and effort expectations. Setting up this indicator would lead to redundant factors in the model, so it has been removed in this study.

The integrated STS-UTAUT framework, as illustrated in Figure 2, connects the social and technical subsystems. It views the technical system as a composite that encompasses its technical features and how these features are perceived and accepted by users. The framework analyzes how the technical design of products influences users perception of social factors and how these perceptions, in turn, affect users acceptance of technology. This model clearly illustrates how the social and technical subsystems interact to influence societys willingness to purchase intelligent assistive robots for the blind. By validating this model, it can provide a more comprehensive reference for the design of AI-assisted quadruped robots and other technological products, thereby enhancing user acceptance and satisfaction.

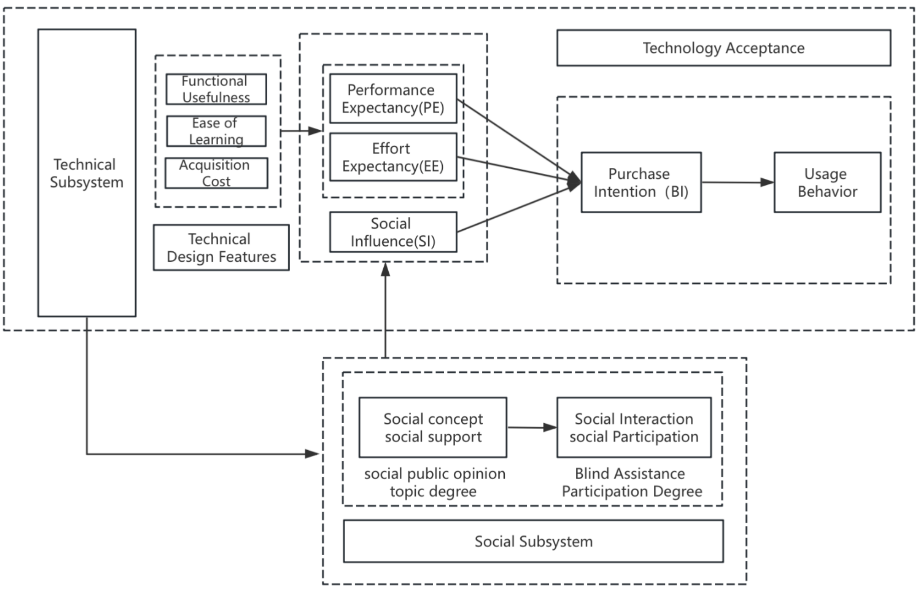

Figure 2 STS-UTAUT fusion model

3 The STS-UTAUT model is used to analyze the influencing factors of the purchase intention of the four-legged robot for the blind

3.1 research hypothesis

To verify the model and assess the impact weights of its internal variables, this study examines the technical subsystem perspective. The design features of the intelligent four-legged robot for the blind are selected as external variables, focusing on ease of operation, acquisition cost, and functional practicality. As previously discussed, in the UTAUT model, Performance Expectation (PE) refers to users expectations that using the technology will directly improve their work or life performance. Therefore, Functional Practicality is set as an external variable to measure whether users believe the intelligent four-legged robot for the blind can genuinely enhance work efficiency and quality of life. Effort Expectation (EE) reflects users subjective perception of the mental or physical effort required to use the technology. Thus, Ease of Operation is established as an external variable to influence users effort expectation, indicating whether they believe the intelligent four-legged robot for the blind can be used with minimal effort. Acquisition Cost emphasizes the objective feasibility of implementing the technology and the effort required to acquire the product. The original models Social Impact (SI) is introduced from the perspective of the social subsystem in the STS theory, considering the technical design features of functional practicality, ease of operation, and acquisition cost as influencing factorsIn this study, the intelligent four-legged robot technology subsystem is used as an overall external variable to be carried out externally

In view of the above considerations, based on the integrated "STS-UTAUT" model structure, the following assumptions are constructed:

1）H1a: The functional utility of intelligent four-legged robot for the blind has a significant positive impact on performance expectations.

2）H1b: The functional utility of intelligent four-legged robot for the blind has a significant positive impact on efforts and expectations.

3）H2a: The operability of intelligent four-legged robot for the blind has a significant positive impact on performance expectations.

4）H2b: The operability of intelligent four-legged robot for the blind has a significant positive effect on the expectation of effort.

5）H3a: The acquisition cost of intelligent four-legged robot for the blind has a significant negative impact on performance expectations.

6）H3bThe acquisition cost of intelligent four-legged robot for the blind has a significant positive effect on the expectation of efforts.

7）H4a: The overall evaluation of the technical subsystem of intelligent four-legged robot for the blind has a significant positive impact on the evaluation of the social subsystem.

8）H5a: The social subsystem evaluation of intelligent four-legged robot for the blind has a significant positive impact on the social impact.

9）H1: The performance expectation of intelligent four-legged robot for the blind has a positive impact on the purchase intention.

10）H2: The efforts of intelligent four-legged robots to assist the blind are expected to have a negative impact on the purchase intention.

11）H3: The social impact of intelligent four-legged robot for the blind has a positive impact on the purchase intention.

Based on the variables determined by the model and combined with the proposed hypothesis, the STS-UTAUT hypothesis model is shown in Figure 3.

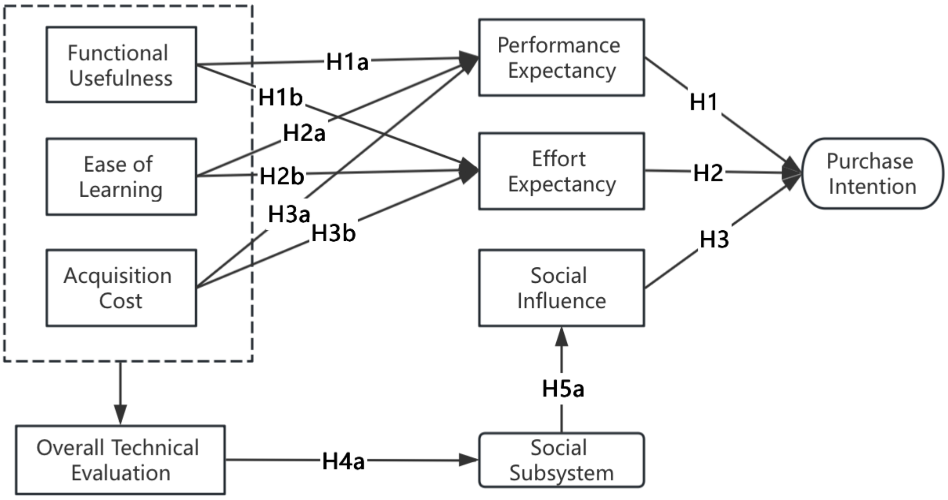

Figure 3 STS-UTAUT hypothesis model

3.2 Interview content design and sample selection

The article designs interview questions based on the STS-UTAUT integration model and research hypotheses, covering technical subsystems, social subsystems, core variables, and purchase intentions. To ensure the accuracy and comprehensiveness of the interview results, the researchers adopted a mixed sampling strategy that combines purposive sampling and snowball sampling, tailored to the specific needs of the target population in this study. In the process of purposive sampling, the core variables of the STS-UTAUT integration model —technical subsystems and social systems—were used as a guide to select three types of research subjects: first, visually impaired users who have previously used guide tools, as this group is directly involved in technology adoption; second, family members and community workers, who often have a significant social influence on technology adopters and whose opinions and views directly impact purchasing decisions; third, experts with professional perspectives in the field, who often have social influence and can explain the relationship between technology and social development, thereby enhancing the models variables.

Berg introduced the key principle of reliability of snowball sampling in his research on snowball sampling (Snowball Sampling). He noted that the reliability of snowball sampling depends on the quality of the recommendation chain. For hidden groups, such as visually impaired users and marginalized communities, which lack a sampling frame, the sample must be gradually expanded through the social networks of initial respondents to ensure that the sampling process and results are repeatable and minimize bias. Therefore, for the hidden group of visually impaired users, this study employs the snowball sampling method. Initially, contact is made with visually impaired users through channels such as the Blind Association and special education institutions. The sample is then expanded based on the respondents social networks to select family members and relevant community workers, ensuring the reliability of the sample selection.

In terms of sample structure adaptability, scholar Patton proposed the maximum variance sampling (Maximum Variation Sampling) method. This method selects samples with significant differences to maximize the diversity and potential patterns of research phenomena across different contexts, groups, or conditions, thereby enhancing the comprehensiveness and insight of research conclusions. In this study, a multi-sample matrix was constructed using maximum variance sampling, achieving a gender distribution of 12 males and 8 females; covering three generations in terms of age: young (20-30 years), middle-aged (31-50 years), and elderly (over 51 years); and forming a three-tier structure in terms of social roles: potential users of technology acceptance, social influencers, and professionals. The interview subjects included 3 traditional users of assistive devices and 3 users of smart devices, aiming to capture the heterogeneity of technology acceptance behaviors in different social contexts.

The sampling process strictly adheres to the ethical guidelines outlined in the Belmont Report, which includes obtaining informed consent from all participants, explaining the research purpose in written or verbal form, informing them about the methods of data anonymization, and stating their right to voluntary withdrawal. Considering the special nature of the sample, especially for visually impaired users, an accessible interview environment is prioritized during the interviews. This involves a combination of online voice interaction questionnaires and offline interviews to ensure maximum convenience for participants and to avoid sensitive privacy issues. The content of interviews with family supporters and professionals is de-identified to ensure the fairness of the research process and protect the rights of the participants. These procedures not only comply with academic ethical standards but also enhance the authenticity of participant feedback, thereby laying a solid foundation for the internal validity of the research conclusions.

To sum up, the sampling process of this study has both methodological theoretical rigor and research adaptability of sample structure, and follows ethical norms throughout the whole process. A scientific and feasible sampling framework is constructed, which provides a reliable sample basis for subsequent qualitative data analysis and model verification.

Table 1 Interviewee information sheet

group types	Sample number	sex	age	background information
Visually impaired users	#01	man	20 years old	Students at the school for the blind have tried out smart guide sticks and glasses to help the blind
	#02	man	44 years old	Blind masseurs use a guide stick
	#03		55 years old	Patients with cataracts, moderate visual impairment, have tried using intelligent guide sticks
	#04	man	51 years old	Moderate visual impairment, using a walking stick
	#05		54 years old	Blind people use guide dogs
	#06	man	27 years old	Congenital amblyopia, mild visual impairment, has tried AI smart zoom glasses
Family members and community workers	#07		31 years old	Interviewee #05 Family member
	#08		45 years old	Interviewee #02 Family member
	#09	man	24 years old	Volunteer for a blind aid organization
	#10		25 years old	A teaching assistant at a school for the blind
Experts and researchers	#11	man	44 years old	A rehabilitation doctor who has participated in the clinical application of helping the blind
	#12	man	42 years old	A researcher in the field of artificial intelligence

Table 2 Interview Questionnaire

Variable classification	Interview topic (the wording will be adjusted according to the interviewee, but the core meaning remains the same.)
Functional utility	1. Do you think the intelligent four-legged robot can effectively improve the travel safety of you or your relatives (such as accurate obstacle avoidance, step recognition, etc.)?
	2. Do you think the navigation function of robots (such as route planning and traffic signal recognition) can significantly improve the travel efficiency of relevant personnel?
	3. Do you think the endurance of the robot (such as battery life and charging convenience) can meet the daily use needs of relevant personnel?
Easy to learn	4. Do you think the robots interaction (such as voice commands, joystick operations) is easy to understand?
	5. Do you think the robots feedback mechanism (such as voice prompts, tactile vibrations) can clearly convey environmental information?
	6. Can you quickly understand and process the robots instructions or prompts during operation?
Get the cost	7. Do you think the price of this robot on the market will be considered for purchase?
	8. Do you think the government or social organizations may provide purchase subsidies or preferential policies?
	9. Do you think it is convenient to obtain after-sales service (such as maintenance, technical support) for the robot?
social influence	10. Do your family/friends support you/related personnel to use the intelligent four-legged robot for the blind?
	11. Do you think public opinion is tolerant of technology products to help the blind (such as guide robots)?
	12. Do you think the use of this robot will improve the independent participation of relevant people in society?

4 Analysis of the purchase intention of intelligent four-legged robot for the blind

4.1 Technical subsystem factors have a direct effect on purchase intention

4.1.1 Positive correlation between functional utility and performance expectation

Interview data shows that the practicality of a product significantly influences users expectations of its performance. For example, interviewee #01 mentioned: “Based on the blind assistance robots Ive seen, their navigation accuracy is much better than the guide sticks I used before. They can detect steps and obstacles in advance and provide voice prompts for traffic light status when crossing the road, making my travel safer.” This feedback supports hypothesis H1aThe practicality of the functions can directly impact performance expectations. Furthermore, Rehabilitation Specialist #11 noted, “In medical settings, if robots can integrate real-time environmental perception and emergency avoidance features, it will significantly enhance the independent mobility of visually impaired patients." This further demonstrates that the practicality of these functions enhances users willingness to purchase by meeting their core needs for safety and efficiency.

4.2.2 Synergistic effect of ease of operation and expectation of effort

The impact of ease of operation on user acceptance varies. Currently, the voice commands for smart assistive robots are straightforward and clear, and the tactile feedback is very intuitive. As aesthetic standards continue to improve, these devices have become more compact. However, for the visually impaired, the button layout on the handle needs to better align with their tactile habits. According to interviewee #03, "At my age, my hands are quite shaky. Last year, I learned to use the shortcut keys on the elderly phone, and it took me over ten tries to get the buttons right. If the buttons on the handle were as small as sesame seeds, or if I had to press a specific combination of keys to move, I would probably need to carry an instruction manual when going out, which would be quite troublesome." This viewpoint supports hypothesis H2bThe ease of operation positively influences the effort expectations. Meanwhile, interviewee #02 mentioned, "When I first started using it, my girlfriend helped me learn the basic operations. If the robot could provide more detailed voice instructions, it would be even better." This shows that the ease of learning should take into account the cognitive differences across different age groups to reduce the usage barrier.

4.3.3 The double-edged sword effect of obtaining costs

The price is the primary factor influencing purchasing decisions. Fang Zhou, vice president of the Hangzhou Barrier-Free Environment Promotion Association, revealed that the prices of domestic robot dogs range from less than 10,000 yuan to 22,000 yuan. Considering the maintenance costs, this is a significant factor for most visually impaired families when making a purchase decision. As interviewee #08 noted, "Currently, the public prices of assistive robots for the blind are mostly between 10,000 and 20,000 yuan. This amount is equivalent to half a years nursing fee for a mother or the cost of an electric mobility scooter. However, if the robot only has basic obstacle avoidance and voice navigation functions, and the price exceeds 20,000 yuan, I would choose to wait and see. It would be better to hire a caregiver on a monthly basis." This feedback aligns with Hypothesis H3aThe consistency is specifically reflected in pricing, indicating that the higher the perceived acquisition cost, the lower the users performance expectations. However, interviewee #06 commented, "Although the robot is powerful, the price is too high. If the government could offer subsidies or installment options, I would be more willing to try it." This suggests that optimizing technology can enhance users perception of product value, thereby reducing the acquisition cost. However, community worker #09 noted, "High costs may limit the products reach to a few high-income groups. It needs to be made more accessible through public welfare partnerships or insurance coverage." This highlights the urgent need to integrate technological subsystems with social support.

5.2 The social subsystem factors have an indirect effect on the purchase intention

5.2.1 The two-way influence of public opinion and participation in helping the blind

A supportive and inclusive environment will significantly boost users willingness to purchase. However, public opinion on assistive technology for the blind currently reflects a mix of support and skepticism. As Family Member #07, an interviewee, noted: "Community volunteers generally support the promotion of assistive technology, seeing it as a way to use technology to free up human labor. However, several children of visually impaired seniors have privately told me that they are not willing to be the first to try, fearing they might become test subjects for the technology." This contradiction supports Hypothesis H5aThat is, the tolerance of public opinion affects social influence by directly affecting user confidence, and the tolerance of public opinion is also formed based on the evaluation of the technical subsystem, which also verifies hypothesis H4aInterviewer #12 stressed that "media publicity and public education are key, and social prejudices should be gradually eliminated by showing the actual performance of robots in complex scenarios through cases.”

5.2.2 Feedback effect of technical characteristics on social perception

The optimization of the technology subsystem can indirectly enhance social support. Teaching Assistant #10 from the School for the Blind noted, “If robots can provide real-time information about their surroundings, they can not only assist with travel but also facilitate interaction between visually impaired students and society.” The implementation of AI technology in specific industries is not straightforward. For example, elderly companionship robots are characterized by their proactive interaction. Industry experts explain that these robots have precise facial tracking and sound localization capabilities. No matter which direction they are called from, the robot can locate the sound and come to the user, initiating communication. This functional design enhances users social engagement, increasing the social subsystems acceptance of technology, which in turn boosts users performance expectations and purchase intentions, confirming hypothesis H2 found 。

Through a comprehensive analysis of the text, as shown in Figure 4, the formation of purchase intention is the result of the dynamic interaction between technological and social factors. Performance expectations and social impact have the most significant positive effect on purchase intention, while the negative impact of effort expectations indicates that the price and operational complexity of the product are still potential obstacles to user decision-making. Notably, the overall evaluation of the technical subsystem indirectly influences purchase intention through the social subsystem, which generates social evaluations. This research confirms the core logic of coordinated optimization of technology and society in the STS theory.

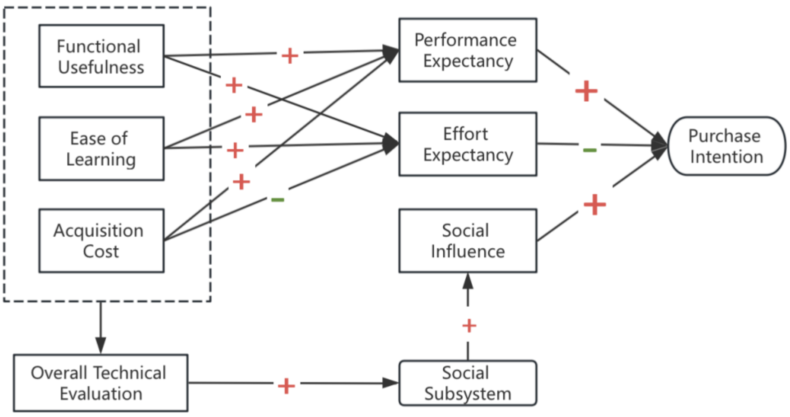

Figure 4 Influence diagram of purchasing intention

6 Optimization strategy of intelligent four-legged robot for the blind

As the demand for social support and psychological inclusion among the visually impaired grows, social needs are influencing technology design, driving its optimization. The design of intelligent four-legged robots for the visually impaired should ensure both practicality and ease of use, while also considering their role in enhancing social factors. This involves not only the functionality of the product as an auxiliary tool but also its role as a significant platform for promoting social participation among the visually impaired. Therefore, when designing such robots, it is essential to consider the interaction between the social and technical systems to maximize the purchasing willingness of the visually impaired community. The core variables affecting user performance expectations, effort expectations, and social perception include the functional practicality, ease of operation, and cost of acquisition within the technical subsystem. To enhance the acceptance and purchasing willingness of the visually impaired community towards intelligent four-legged robots, it is necessary to optimize technical design while considering the synergistic effects of social support, aiming to build a more inclusive and sustainable product ecosystem. Based on this, the article examines the factors influencing the purchasing willingness of visually impaired users, synthesizing the results from previous analyses. It proposes optimization strategies for intelligent four-legged robots from three aspects: enhancing functional practicality, optimizing ease of operation, and controlling acquisition costs, to guide design practices.

6.1 Functional practicability: improve the adaptability of technology by focusing on precise demand

The practicality of a function, as a core element of a technical subsystem, directly influences users perception of the products value. Research indicates that the navigation accuracy, obstacle avoidance capabilities, and endurance performance of intelligent four-legged robots are the primary concerns for users. For instance, the six-legged guide robot developed by Professor Gao Fengs team at Shanghai Jiao Tong University has achieved dynamic obstacle avoidance and precise navigation in complex terrains through multi-modal sensor fusion technology. However, its environmental perception stability in extreme weather conditions, such as heavy rain and dense fog, still needs improvement. To address this, it is recommended to introduce a redundant sensing system, such as combining millimeter-wave radar with thermal imaging technology, to compensate for the limitations of optical sensors in low visibility environments. Additionally, to meet the urgent need for travel safety among visually impaired users, the design logic of medical emergency equipment can be referenced to develop an emergency avoidance mode. When a sudden danger is detected, the robot can guide users to avoid danger through high-intensity tactile feedback and immediate voice alerts, and automatically send location information to emergency contacts. Optimizing endurance is also crucial. As mentioned by interviewee #01, frequent charging affects user experience, which can be addressed through modular battery design. For example, using detachable battery packs compatible with wireless fast charging technology allows users to flexibly configure their power based on travel duration, while also supporting public transportationBarrier-free charging piles in public places form ecological linkage. The improvement of functional practicability should be guided by user needs, and the gap between product performance and user expectations should be narrowed through technical iteration and scenario-based testing.

6.2 Easy to learn: humanized design reduces the threshold of use

The ease of operation directly impacts users psychological acceptance of technology, especially for the elderly with visual impairments and first-time users of smart devices. Complex operational procedures can pose significant barriers to use. Research indicates that improving the clarity of voice interactions and the tactile friendliness of physical controls are crucial areas for optimization. For instance, as mentioned by interviewee #03, the button layout does not align with tactile habits. To address this, the tactile standards for Braille can be referenced, and tactile codes or differentiated textures can be designed on the handle or body surface to help users quickly identify function keys through touch. Additionally, enhancing the natural language processing capabilities of voice interaction systems, including dialect recognition and personalized wake word settings, can prevent command misinterpretations due to accent differences. For example, the intelligent voice assistant developed by Tencent AI Lab has achieved high-precision recognition of dialects such as Cantonese and Sichuanese. Applying this technology to assistive robots can significantly enhance user experience. Furthermore, for users with different cognitive abilities, adaptive learning features can be introduced. By analyzing users common routes and commands, the robot can automatically simplify the interaction process and provide progressive guidance based on user habits. For example, during the first use, the robot can teach users step-by-step through voice instructions, and as they become more proficient, the prompts can be reduced. The optimization of ease of operation should be integrated throughout the products entire lifecycleIn the future, from industrial design to software interaction, the principle of accessibility should be followed to ensure the inclusiveness of technology.

6.3 Cost of access: enhance accessibility through a multi-dimensional synergy mechanism

The cost of acquisition is the primary barrier to users purchasing decisions. As shown in Table 3, most current assistive devices for the blind range from 100 to several thousand yuan, while the market price of intelligent four-legged robots is generally 10 to 20 times higher than that of traditional guide tools, significantly limiting their accessibility. To address this issue, efforts must be made on both reducing technology costs and enhancing social support. Technically, modular design and open-source hardware can help reduce R&D costs. For example, Boston Dynamics Spot robots open-source SDK allows developers to customize functional modules, avoiding resource waste from redundant development. Socially, a three-pronged subsidy system involving government, enterprises, and non-profit organizations should be established. The Insurance Plan for Assistive Technology Products for the Disabled, proposed by the Hangzhou Barrier-Free Environment Promotion Association, allows users to pay an annual fee for robot maintenance and upgrades, reducing long-term usage costs. Additionally, including assistive robots in the medical insurance directory or the subsidy range for disabled persons assistive devices can directly alleviate users financial burden. For instance, the Shanghai Management Measures for Disabled Persons Assistive Devices Service (2021 revision) covers 11 categories of assistive devices, such as walking sticks and smart guide glasses. In the Pudong New Area pilot program, AI guide glasses have been included in the subsidy scope, with subsidy standards divided into basic and special benefitsDuring the special pilot period of smart devices, the maximum subsidy for a single unit is 10,000 yuan. The transplantation of such policies to the field of four-legged robots will significantly improve the purchase intention. Cost optimization is not only a technical and economic issue, but also a social equity issue, which needs to be realized through institutional innovation to achieve universal technology benefits.

Table 3 Price list of sightseeing tools

7 Epilogue

The intelligent four-legged robot for the blind, as an innovative platform that integrates technology and humanistic care, not only facilitates independent travel and social participation for the visually impaired but also reflects the ethical value and social responsibility of empowering disadvantaged groups through technology. This study, based on the STS-UTAUT integration model, systematically analyzes the interactive influence mechanisms of the technical and social subsystems on users purchase intentions, highlighting the necessity of optimizing both technical design and social support. The research shows that functional practicality directly influences purchasing decisions by enhancing users trust in product performance, while ease of use reduces users psychological aversion to technological complexity by lowering the usage threshold. Controlling acquisition costs requires a dual effort from technological cost reduction and social subsidies. Moreover, the inclusiveness of public opinion and community involvement in assistive technologies serve as external drivers for technology acceptance and important media for the feedback of technological features into social cognition. This finding confirms the core logic of dynamic coexistence between technology and society in STS theory and provides a theoretical basis for shifting the design of assistive technology products from a single-function orientation to the construction of a social ecosystem.

The future development of intelligent four-legged robots for the blind must strike a balance between technological advancement and social integration. On one hand, breakthroughs in artificial intelligence, multimodal perception, and flexible bionic technology will enhance the robots environmental adaptability, natural interaction, and endurance. On the other hand, the role of social subsystems needs to shift from policy support to institutional innovation. Current regional subsidy pilot programs show that a government-led, enterprise-participated, and public welfare-coordinated model can not only reduce users economic burden but also promote technological research and development through large-scale application, creating a virtuous cycle. It is worth noting that the scope and data sources of this study are still limited. Future research could expand the geographical distribution and age range of participants, particularly focusing on the needs of visually impaired individuals and elderly users in rural areas. Additionally, longitudinal tracking studies could be introduced to analyze how technology acceptance evolves over time. From a broader perspective, optimizing intelligent four-legged robots for the blind is not only an engineering challenge but also a social equity issue. In the context of the 14th Five-Year Plan emphasizing the inclusive use of technology and barrier-free environments, achieving widespread accessibility through interdisciplinary collaboration, policy innovation, and the evolution of social awareness is essentialThe leap of “enjoyment” is a true implementation of the ultimate mission of “technology for good”.

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