Original Research Article

Research on the Blind Path Clearing Unmanned Vehicle Design Based on the Inclusive Design Concept

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Abstract: Based on the concept of inclusive design, this paper explores the design of an unmanned vehicle to solve the safety problems of visually impaired people in the process of using blind roads. Firstly, through literature review and market research, this paper points out the problems of inclusiveness and lack of usability in existing blind track infrastructure construction. Then, through user survey and interview, the travel characteristics and psychological needs of visually impaired people are analyzed, and according to this, the blind road obstacle clearing unmanned vehicle system design scheme is proposed, aiming at improving the travel safety and autonomy of visually impaired people.The research provides a new research perspective for the design of transportation for special groups, and can provide a reference for promoting social inclusion and equality and promoting scientific

Keywords: Inclusive design; Blind path; Obstacle clearing; Unmanned vehicle; Visually impaired people; Map application; Technology; Data transmission method; Text introduction

1. Research background

In today's society, the visually impaired people are faced with various travel challenges, and the blind road is their main navigation tool, safety and reliability are crucial. However, the blind path often cannot play its due function due to the existence of obstacles, which not only increases the difficulty of travel for the visually impaired people, but also poses a threat to their safety. Therefore, this paper is committed to exploring an innovative solution - obstacle clearing unmanned vehicle, through technical means to clear road obstacles, so as to provide a safer and more convenient travel environment for the visually impaired.

1.1. Research Status Review

At present, China has received extensive attention in infrastructure construction. In terms of visually impaired facilities, although blind path construction has certain standards, it often lacks necessary execution in actual construction and maintenance. At present, there are many problems in the practical application of barrier-free facilities in China, especially in ensuring the basic travel needs and safety of visually impaired people. The blind path is often affected by road facilities such as manhole covers and tree pits, and there is a lack of effective protection measures. As a result, the actual utility of the blind path is greatly reduced, and the basic needs of the visually impaired people cannot be met.

1.2. Research Purpose and Significance

1.2.1. Improve the Travel Safety of the Visually Impaired

The visually impaired people may encounter a variety of obstacles when walking in the blind path, such as roadblocks, garbage, improperly parked bicycles, and so on. These obstacles pose a great threat to the travel of the visually impaired people. Blind road obstacle clearing Unmanned vehicles can automatically identify and

locate obstacles on the blind road through lidar, vision sensors and other technical means, and remove them in time to reduce the obstacles of visually impaired people in travel.

1.2.2. Explore and Implement More Inclusive and Inclusive Design

The Future Lifestyles for the Blind Project is not only about improving the quality of life for blind and visually impaired people, but also about promoting social inclusion and equality. By promoting inclusion and respect for blind and visually impaired people, the Future Lifestyles for the Blind project will help reduce discrimination and prejudice in society and enhance social harmony and stability.

2. User analysis

2.1. Research and Analysis of Basic Characteristics

According to the main data of China Disabled Persons' Federation - National Disabled Persons' Population base Database, there are about 40 million visually disabled persons who have applied for disability certificates, which are distributed in different age levels . Among them, about 1.1 million are 0-14 years old, about 20 million are 15-59 years old, and about 17 million are 60 years old and above. In the survey, the visually impaired people, mainly aged 40-60 years, accounted for more than 95% of the samples, of which 20-40 years old and under 20 years old accounted for 50% and 27% of the total.We conducted in-depth interviews and social engagement surveys with blind people to understand their travel expectations and needs.

2.1.1. The Intensity of the need to go out

A survey of the mobility needs of the blind reveals two different life patterns. First, about 20% of blind people travel less frequently due to vision limitations and inadequate infrastructure. They often choose not to go out alone and their range of activities is limited.The remaining 80 percent of blind people, on the other hand, showed a stronger need to get out. They not only participate in daily life, work and study, but also often go out alone or accompanied by others for business or entertainment.

2.1.2. Blind Roads Cannot Meet the Travel needs of the Nlind

Despite these needs, it is rare to see blind people walking in the blind. Through the investigation of the use of the blind track, it is found that the use and management of the blind track in China are worrying, and the blind track is often occupied by non-motor vehicles and various sundry objects.

2.2. Investigation and Analysis of Psychological Characteristics

In the article "Research on Travel Public Facilities Design for Visually Impaired People"[1] , the psychological characteristics of visually impaired people have been fully studied.The particularity of environment perception Visually impaired people perceive the environment in a unique way, which is quite different from ordinary people. For example, visually impaired people with residual vision may only be able to make out bright colors or large areas of objects, and this limited visual ability forces them to rely more on other senses, such as hearing and touch, in everyday life. For people who are completely blind, hearing, touch and smell become especially important. They may perceive their environment by listening to the sounds around them (such as the footsteps of pedestrians, the movement of vehicles), or navigate by touch (such as feeling the texture of a road, discerning the structure of a building). In contrast, someone with normal vision may be able to pick up the same information with just a glance.

It is hoped that through the design and implementation of specific functional modules, including route planning obstacle clearing, online navigation monitoring system for the blind, auxiliary travel medical reserve

and accompanying comfort function.

3. Function and appearance design of blind road obstacle clearing unmanned vehicle

3.1. Route Planning Obstacle Clearing Function

3.1.1. Urban map Planning and Real-time Monitoring

The unmanned vehicle uses the advanced urban map and GPS system to monitor urban road conditions in real time and automatically plan the obstacle clearing route. According to the integrated GPS and GIS system in the Journal of Intelligent Transportation Systems, the unmanned vehicle can receive information about changes in road conditions in real time and automatically adjust the driving route to clear the roadblocks in the most efficient way. The robot arm function of the unmanned vehicle can be accurately operated to remove small obstacles such as bicycles and stones on the road.

3.1.2. Response to Special Circumstances

When the street vendors occupy the blind lane or temporarily park, the unmanned vehicle will remind the transfer through the voice broadcasting system. The intelligent voice system can automatically adjust the broadcast content according to the situation, remind the existence of obstacles and require their transfer, so as to protect the passage of the blind lane.

3.2. Companion Comfort Function

3.2.1. Interactive Comfort Function

Based on the voice and emotion of the visually impaired, the technology recognizes the emotional changes of the visually impaired, and provides appropriate reassurance and encouragement to help them feel more comfortable and confident in social situations. The interactive features built into the driverless car can calm the anxiety of the visually impaired, especially during social activities.

3.2.2. “Guide dog” Program

This program simulates the function of a guide dog, describes the surrounding environment through speech, and communicates with the visually impaired. Such programs can use advanced speech recognition and synthesis technology to provide the visually impaired with detailed environmental description and walking guidance, helping them safely find the right direction and reach the destination.

3.3. Online map APP for the Blind

3.3.1. Voice Navigation

This feature is particularly suitable for blind users, as it is able to provide navigation instructions in voice form using advanced speech synthesis and natural language processing technology. This technology can recognize and interpret the user’s speech input and provide clear, easy-to-understand speech feedback, and modern speech synthesis systems are able to output speech in a manner close to natural language, which is extremely important for users with limited vision.

3.3.2. Surrounding Information Query

This function integrates geographic information system (GIS), which can provide users with detailed information about the surrounding environment. By using GIS data, the Blind Map APP is able to identify the user’s location and provide information about nearby facilities, such as distance, type, etc.

3.3.3. Route Planning

Combining real-time traffic data and advanced route planning algorithms, this function can provide users with a variety of travel options. These algorithms take into account traffic flow, road conditions and user preferences to provide the best route choice.

3.4. Data Transmission Mode of Unmanned Vehicle

3.4.1. Sensor Data

A variety of sensors equipped with unmanned vehicles, such as lidar, cameras and ultrasonic sensors, are the basis for its core functions. By firing laser pulses and measuring their reflection time, Lidar accurately creates a three-dimensional map of the surrounding environment, effectively detecting the location and distance of obstacles, and Lidar can detect objects within a few millimeters of accuracy. The cameras provide visual information to help the car "see" road signs and traffic signals. Ultrasonic sensors are used for the detection of close-range objects, often used in parking and low-speed driving scenarios. The combined use of these sensors enables autonomous vehicles to operate safely in a variety of road conditions.

3.4.2. Network Data Transmission

the blind road clearing unmanned vehicle system transmits the collected data to the background system through the network (such as 4G/5G or satellite network). This transmission includes not only basic information such as the real-time position and speed of the vehicle, but also more complex data such as dynamic changes in the surrounding environment and detailed information about obstacles. Because of its high speed and low latency, 5G network is widely regarded as the ideal choice for data transmission in unmanned vehicles. In this way, the unmanned vehicle can update information about its status and surrounding environment in real time, ensuring safe driving.

3.5. Research on Blind Track Maintenance Feedback Mode:

3.5.1. Sensor Detection

The sensor equipped with the unmanned vehicle can monitor the physical condition of the blind path in real time. These sensors accurately detect bumps, depressions and cracks with high sensitivity and accuracy. The advantage of this approach is that it provides continuous, automated monitoring of blind track conditions, ensuring that problems are detected and fixed in a timely manner. The sensor system consists of the following parts

LIDAR:The use of lasers to scan the surrounding environment can accurately measure the roughness of the blind surface and other physical characteristics.

Ultrasonic sensor:by transmitting and receiving ultrasonic signals, measure the bump on the surface of the blind channel.

Optical sensor:Through the analysis of captured optical images, detect cracks on the blind path and other visual defects.

Ground Penetrating Radar (GPR):suitable for detecting structural problems below blind paths, such as subsidence or voids.

Feedback platform:A platform that feeds data back to city management or traffic management departments can make maintenance work more efficient. The location information and photos provided can help relevant departments quickly locate and solve problems.

3.6. Research on the Modeling of Blind road Obstacle Clearing Unmanned Vehicles

3.6.1. Appearance Research

The overall appearance of the unmanned vehicle is mainly modular, which is divided into three parts: the mechanical arm part is used to clean obstacles; At the same time, armrests are installed at the rear of the car. Armrests are made of aluminum alloy as a whole. The front mechanical arm is composed of hydraulic grab bucket and grab bucket, which have various functions such as grasping, pulling and stripping. It can complete the whole process of obstacle clearing, obstacle stripping, clearing and leveling[2] . The operation area covers the blind path and the half meter area near the blind path, which is enough to ensure the safety of the visually impaired people.

3.6.2. Material Selection

The selection of carbon fiber composite materials is based on their high strength, lightweight characteristics and excellent corrosion resistance and water resistance. These features make autonomous vehicles more robust while remaining light, helping to improve mobility and energy efficiency. Aluminum alloy as an internal structural material, also has high strength and lightweight characteristics, and after rust treatment, can further improve durability and reliability.

3.6.3. Flexibility and Stability

the switching ability of multiple working modes enables the unmanned vehicle to adapt to different obstacle clearing tasks and improve work efficiency. Stability considerations in design, such as anti-rollover design, ensure safety in complex road conditions. The integration of radar, laser sensors and emergency braking functions is based on the latest developments in autonomous driving technology and aims to improve the safety and autonomy of driverless cars.

4. Usage Procedure

4.1. Self-obstacle Clearing

Plan the time for the application to clear the blind obstacles, plan the cleaning route, and create a user map dedicated to the visually impaired group. Users plan the optimal path to the obstacle location with the help of the accessibility navigation application based on the task information. The car follows the instructions and drives automatically to the destination, continuously updating the user on its location and progress. The user can understand the obstacle characteristics and cleaning process through auditory feedback and adjust the operation mode through voice command if necessary.

4.2. User Functions

First, the user can remotely control the unmanned vehicle system through voice input, touch command or preset shortcut, and help the unmanned vehicle to reach the destination through voice input. During the driving process, there is a certain interaction and comfort effect, and voice prompts and chats are accompanied. After the journey is over, the user automatically returns to the pre-parking position through voice. Confirm that no exception occurs, reach the specified position, and close the program.

5. Conclusion

Autonomous vehicle systems can help blind people avoid obstacles and provide them with a clean blind environment, thereby improving their travel safety and convenience.The vehicle system can complete the

obstacle clearing and maintenance tasks independently, reducing the waste of manpower and resources, and improving the efficiency and economy. The design and implementation of unmanned vehicle systems require a certain amount of technology and resource investment, which can promote scientific and technological progress and social development, and drive the development and innovation of related industries.At the same time, the autonomous vehicle system provides more services and support for the blind to travel, thus promoting social justice and inclusion, and improving the quality of life and happiness of people with disabilities.

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