Design of Wearable Guide Blind Auxiliary System

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Abstract. Aiming at the safety problem of blind people, this design is studied from obstacle detection, fall help, travel navigation and missing alarm. This design uses Gould map SDK to develop a navigation APP suitable for blind people. An obstacle detection system is designed by ultrasonic testing, and obstacles in 5m can be detected. A fall detection system is designed using a gyroscope to quickly detect the state of the blind. After testing, all functions of the system are running well.

Introduction

Studies have shown that 70% of human activities depend on vision. If vision is lost or visual impairment occurs, it will cause huge problems for people's lives, studies, and work, even if they cannot move. According to the World Health Organization, there are approximately 45 million blind people in the world, and it is growing at an annual rate of 7 million. Another 180 million people have visual impairments, of whom 90% of visually impaired people live in developing countries. As a country with a large population, the number of blind people in China accounts for 18% of the total global blindness, reaching more than 800 million.

In recent years, many scholars and laboratories at home and abroad have conducted research on blinding aids. In foreign countries, guide aids such as guide dogs, guide crutches, guide cars etc. are now widely used[1,2]. For example, the guide blind car developed by Yamanashi University in Japan, the obstacle avoidance system OAS designed by Shoval in the American University Robotics Laboratory, and the navigation device designed by a Spanish scholar using a bat sound wave positioning system. In China, research on guide aids has also been carried out, such as the development of various guide crutches and blind guide robots.

This design is proposed for this huge group of visually impaired people, with significant research significance, development prospects and market value. For the blind traveler, it is easy to get lost. This design uses the Golder Maps SDK to develop a navigation app that is suitable for the blind, and designed a lost alarm function. For road safety issues, this design proposes an obstacle detection and reverse-saver system design. Ultrasonic detection of the surrounding obstacles can detect obstacles within 5m, and make voice prompts and vibration tips. The inversion detection system is designed with a gyroscope to quickly detect the blind state and can send a distress signal when the blind person is upside down.

System Overview

Overall System Design Overview

Figure 1 shows the overall block diagram of the system, from right to left are the obstacle detection system, the main controller and the inversion detection system, navigation APP. The obstacle detection system and the main controller and the navigation APP and the main controller communicate via the Bluetooth module.
System Function Implementation

Master Control System
This design uses the AT89C51 MCU system as the main control system, composed of AT89C51 microcontroller, clock circuit, power circuit, download circuit, Bluetooth module interface circuit.

Obstacle Detection System
Obstacle detection system consists of AT89C51 microcontroller, US-100 ultrasonic detection module, HC-05 Bluetooth module[3]. The US-100 ultrasonic module can detect obstacles within 5m. When the TX pin inputs high level above 10US, the system sends eight 40 kHz ultrasonic pulses and then detects the echo signal. In this mode, the module converts the distance value to 2 times the time value of 340m/s, and outputs high level through the Echo terminal. The distance value can be calculated according to the duration of this high level:

\[ D = \frac{t \times 340}{2} \]  

The calculated obstacle distance is sent to the main control module through the Bluetooth module for unified processing. Figure 2 shows the physical wiring diagram of the obstacle detection system.

Fall Detection System
The fall detection system uses a 6-axis accelerometer MPU6050 as a blind attitude detection sensor[4]. The 6-axis accelerometer MPU6050 and host controller AT89C51 one-chip computer communicating port as the figure 3 shows.
System Software Implementation

The workflow of the obstacle detection system and fall detection system is shown in Figure 3.2(a)-(b).

(\textbf{a}) Obstacle detection system  \hspace{2cm}  (\textbf{b}) Fall detection system

As shown in Figure 4(a), when the obstacle detection system detects an obstacle within 5m in front of the user, the distance between the user and the obstacle is sent to the master controller through the Bluetooth module, and the master controller sends a voice prompt to the user after judgment. At the same time, the vibration motor sends different intensity vibration signals to the user to prompt the user and the obstacle.

As shown in Figure 4(b), when the user accidentally falls during walking, the fall detection system sends the attitude data when the user falls down to the main controller. When the main controller detects the fall data for the first time when you enter the time, you can still detect the fall data after 30s. The controller emits an audible and visual alarm to ask for assistance from people around. When the time is 2 minutes, the fall controller can still detect the fall data. Then the host controller sends a “SOS” signal to the mobile phone via Bluetooth. When the navigation app receives the “SOS” signal, the distress signal and location information will be sent to the guardian and the guardian phone will be dialed. Of course, the user can send a "SOS" signal by pressing a key when he or she needs rescue.
The Development of Navigation APP

Software Development Kit

The project uses the pedestrian navigation SDK provided by Gold er Map and the online speech synthesis SDK and speech dictation SDK provided by the HKUST[5].

Navigation APP Design

The design idea of the navigation app is like this. The first is the user enters the destination. When the screen of the mobile phone is off, the user presses the volume button to wake up the navigation app, and then the user presses the volume up button for a long time and will hear the prompt “please enter the destination”. At this time, the user needs to input the destination by voice. For example, "Carrefour supermarket". Then the user will hear the answer "Whether to navigate to Carrefour," when the user answered "yes", the navigation begins, or prompt "please enter the destination", continue to perform the above steps. The user can end this navigation by voice during navigation.

The development platform used in this design is the Android Studio 2.2 version. The specific development process is divided into the following steps:

1. Get Golder Key and apply for Android Key at Golder Open Platform Console.
2. Start Android Studio, create a new Empty Activity application project.
3. Download and install the navigation development package and voice development package.
4. Configure the following files in the project.
   A. Configure the AndroidManifest.xml file and set permissions in AndroidManifest.xml in the main directory of the project directory to ensure that the navigation function can be used normally. It should be noted that the Android 6.0 system adds some permissions.
   B. Configure the layout layout file. Define the AMapNaviView in the XML that defines the application layout in the project directory res/layout/activity_main.xml file.
   C. Implement navigation. In the navigation Activity Java file, implement path planning, navigation and other functions. The implementation steps are as follows: First, obtain the AMapNaviView instance and set the listener. Then, obtain the AMapNavi instance and set the listener. Next, implement the life cycle of AMapNaviView and ensure that AMapNaviView can display properly. Then, when the navigation object AMapNavi object is successfully initialized, path planning is performed. Finally, when the path planning is successful, navigation begins.

Figure 5. Navigation interface.

Figure 5 shows the navigation interface of the navigation APP. We can see that the navigation APP has successfully planned the path and marked the starting point and the destination and the current location of the user.
Conclusion

In this paper, the design of a wearable guidance system is proposed, which enriches the selection range of blind people to guide blind equipment, provides a new experience, and adds a layer of security for the safety of the blind people. The design combines the navigation and obstacle detection to design a new wearable guide device, which can not only guide the direction of the blind people walking, but also prompt the blind to avoid the obstacles. Not only that, the device also provides a function of fall detection and one touch alarm, which provides guarantee for timely rescue. The functions proposed in the initial stage of the project have been well tested through actual tests.

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