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Multi-Function Intelligent Crutch Implementation

Qun Zhang[1], Shanpeng Liu[2]

[1]College of Information and Intelligence, Hunan Agricultural University, Changsha, Hunan, China
[2]College of Resource & Environment, Hunan Agricultural University, Changsha, Hunan, China

Abstract: *With the continuous development of modern science and technology, in all aspects of life more and more towards the direction of intelligent, but less intelligent products, for the elderly, the elderly now faced with memory loss, walking, visually impaired life inconvenience, children work pressure big, can't fulfill the duty of care for the elderly, social demand for older products also continue to increase, There are huge business opportunities in the market of products for the aged, but the current products for the aged cannot meet the needs of the society, and the travel safety of the elderly has become a hot issue concerned by the society. Therefore, this multi-functional intelligent crutch is developed to solve the travel problems of the elderly. This intelligent walking stick has realized the functions of walking support, instant communication, detection of body status, obstacle warning, fall alarm and so on, which is highly innovative and practical.*

Keywords: *Intelligent crutch; MPU6050; The GSM module; Android APP*

1. Research Background

The aging of the population in today's society has become a problem that cannot be ignored, especially in recent years, the aging process has become more rapid, and many countries have entered an aging society. In addition to developed countries such as Europe and the United States, some developing countries have also begun to experience an aging population. As the largest developing country in the world, China has gradually entered an aging society [1]. Due to the large population base in my country, the wave of aging will bring a violent impact on the society. As the age increases, the mobility of the elderly gradually weakens. Many elderly people have mobility impairments or even lose their mobility. Children are under great work pressure and cannot fulfill their obligations to take care of the elderly. This not only greatly threatens the health of the elderly, but also seriously reduce the quality of life of the elderly, so elderly mobility products have a broad market space. The behavior pattern of the elderly is the basis and source of the design of elderly walking aid products. Only based on the behavior pattern of the elderly and the needs of the elderly can we design smart crutches that meet the needs of consumers. The common behavior patterns of the elderly can be analyzed from the following points, namely, the decline of mobility of the elderly, the concern of the elderly about health problems, and the desire of the elderly for emotional companionship. With the increase in the number of elderly people, the society's demand for aging products is also increasing, and the market for aging products contains huge business opportunities. The aging of the population not only creates opportunities for aging products, but also brings challenges, and puts forward higher requirements for aging products. At present, the design of aging products in my country presents problems such as product design homogeneity, unclear product positioning, and obstacles in product use. In order to solve the dilemma faced by the design of aging products, promote the innovation of aging product design, combine the characteristics of the Internet era, integrate Internet thinking into the design of aging products, and seek the development and innovation of aging product design, so as to meet the needs of elderly consumers and improve the consumption of the elderly.

In [2], the authors proposed an intelligent crutch based on ultrasonic ranging, and developed an intelligent crutch based on ultrasonic ranging technology with positioning, obstacle removal, rest, and alarm, which can effectively help the elderly avoid risks. However, there is no major change in how to respond in the event of a fall or emergency in the elderly, and how to connect with family members and children in an emergency. The intelligent crutches designed in “Design and implementation of multifunctional intelligent crutches for the elderly” proposed in [3] use infrared obstacle avoidance, which is a breakthrough compared to traditional crutches, but is greatly restricted by environmental factors when used, and its function single.

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2. Product Description

2.1. Function overview

This smart crutch can provide walking support, instant communication, detection of physical status, obstacle warning, fall alarm and other functions. When the elderly encounter an emergency, the posture of the crutch can be detected through the MPU6050, and then the GSM communication module can be used to send SOS messages to family members to reduce risk of travel for the elderly. An APP has been developed to assist the use of crutches. All data is uploaded to the cloud. In the APP, the real-time location and case history of the elderly can be queried, and health indices such as exercise volume and heart rate can be recorded, and corresponding line graphs have been generated to help analyze the physical condition of the elderly. The smart crutches use the STM32 microcontroller based on the ARM Cortex-M3 core as the control core [4], and the nRF52832 low-power Bluetooth module [5], which is combined with the Android APP and cloud database. The data is uploaded to the cloud, and children can remotely view the relevant data of the elderly through the APP, so that children no longer worry about the safety of the elderly. The “walking guardian” smart crutches developed in this work are mainly aimed at the elderly with memory loss, inconvenience in legs and feet, and inconvenience in life due to weakened eyesight. It can provide walking support, instant communication, detection of physical status, obstacle warning, and fall alarm. The crutches make full use of the advantages of “internet +” and combine traditional crutches with “internet +”, which helps to travel safely and protect the personal safety of the elderly.

2.2. Advantages

The research and development of this product is to take the social hot issue of the large number of elderly people in China's aging society and the difficulty of family care as the research object, and the most commonly used crutches for the elderly to travel as the research entry point. Combined with scientific and technological elements, it is determined to solve the safety problem of the elderly traveling.

(1) Using the low energy Bluetooth NRF52832, connect the crutches and APP. It can well combine the crutches around the elderly with technological elements to achieve remote guarding and safe travel for the elderly. The development of APP for the elderly intelligent crutches is to meet the requirements of the Internet era, use Internet thinking to enhance user interaction, and perfectly combine the functionality and interactivity of the product to make the product both usable and fashionable.

(2) The innovative and seamless combination of smart crutches and Android smartphones. When the mobile phone is not carried, the system can monitor and give early warning through GSM+GPS. If an emergency occurs, it will automatically send a distress message; when the user travels with a mobile phone, the smart crutches Connect with Android mobile phone through BLE low energy Bluetooth to realize voice warning, navigation and other functions.

(3) The crutches use the MPU6050 attitude sensor to warn the elderly in emergency situations of falls. The innovative handle end is embedded with heart rate and blood oxygen monitoring modules to monitor the health status of the elderly in real time. When there is an emergency, it can give real-time early warning, and the relevant data can be uploaded to the cloud for storage. Performing periodic analysis and generate periodic health reports.

(4) Using the GPS+Beidou dual-mode module, dual-mode positioning can make full use of the information and satellite resources of the two satellite positioning systems. Compared with single-mode positioning, the speed is faster, the accuracy and reliability are stronger, and it can also be verified with each other.

According to the “2020 national aging development bulletin” issued by the aging health department of the national health and health commission, as of 0:00 on November 1, 2020, there were 264.02 million elderly people aged 60 and above in the country, accounting for 18.70% of the total population. %; the national elderly population aged 65 and above is 190.64 million, accounting for 13.50% of the total population; the national dependency ratio of the elderly population is 19.70%, an increase of 7.80 percentage points over 2010. Nearly half of them are empty nesters, and many suffer from cardiovascular and cerebrovascular diseases, strokes and other diseases, making life inconvenient. At the same time, due to the high cost of medical care, as well as the current situation of many only children and heavy parenting pressure, these elderly groups will form a huge consumer market. The extreme vacancy in the market has spawned the demand for corresponding products, but the so-called smart crutches currently sold in the

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market and on major shopping platforms only have simple sound and light alarms, lighting combined with warning lights and other very few functions, but they are very important for the safety of the elderly. There is no good guarantee, and there are many hidden dangers left, which cannot meet the needs of the market at all. According to consumers' reactions, it is hoped that a multi-functional smart crutch will appear in the market to fill the vacancy in the market. Therefore, the product has certain practicability and can meet the travel needs of the elderly.

2.3. Application market analysis

The elderly pay more attention to the practicality and price advantage of products when consuming. They often want to buy high-quality and low-cost products. The health expenditure of the elderly is very large. With the decline of physiological functions, health is a strong appeal of the elderly group. The investment of the elderly in health products accounts for a large proportion of their total consumption expenditure, and the market prospect is good. Through the analysis of the two major e-commerce platforms of Taobao and Jingdong, the same type of products have a single function, only a simple sound and light alarm, lighting combined with warning lights and other very few functions, but there is no good guarantee for the safe travel of the elderly, and left Many security risks are completely unable to meet the needs of the market.

3. Functional Analysis

The traditional elderly crutches have relatively simple functions and are just simple walking aids. This design advocates creating a multi-functional smart crutch, integrating internet technology into the design of the elderly crutches, and using internet thinking to innovate the concept of the elderly intelligent crutches. “Walking treasure cane” smart crutches are mainly aimed at the problems of memory loss, inconvenience of legs and feet, and inconvenience in life caused by weakened eyesight in the elderly.

3.1. Crutches function

The traditional elderly crutches have a relatively simple function and are just simple walking aids. This design advocates creating a multi-functional smart crutch, integrating Internet technology into the design of the elderly crutches, and using Internet thinking to innovate the concept of crutches. The system integrates eight modules: LED, buzzer, ultrasonic, low-power Bluetooth BLE, MPU6050, GSM wireless communication, MAX30102 heart rate sensor, and GPS module, which implement the following functions:

(1) Instant messaging, as shown in Fig. 1: This function is used to communicate with family members in a timely manner. If the elderly travel without a mobile phone, the smart cane will send its current location to the family through GSM, if the mobile phone is carried, the smart cane will use Bluetooth communicate with your mobile phone, and call your family with one-touch dialing through the crutches.

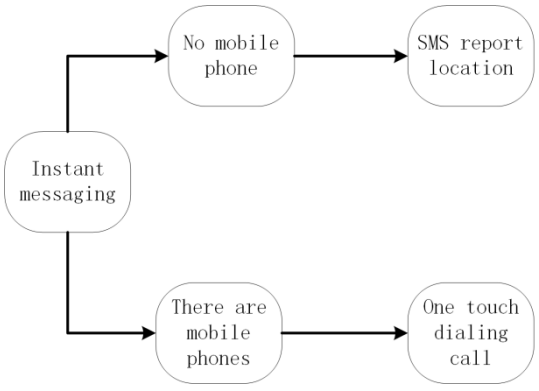

Figure 1: Working diagram of instant messaging

(2) Fall alarm, as shown in Fig. 2: If the elderly travel encounters an emergency, the MPU6050 module will calculate the posture of the crutch, upload the crutch information to STM32, and the control core will issue a series of instructions, the smart crutch can pass multiple. In this way, you can send a text message to your family to report your location information or make a direct call to the preset family phone. At the same time, the crutches will emit an alarm sound. If the emergency is lifted or misused,

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the crutches have the function of one-key deactivation of the alarm to eliminate the misoperation of the elderly.

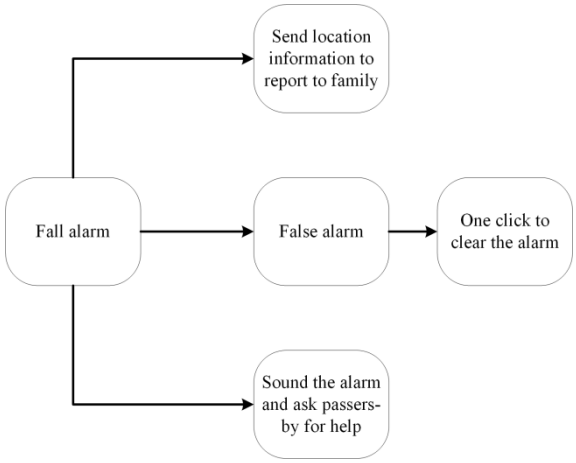

Figure 2: Fall warning working diagram

(3) Obstacle avoidance by lighting, as shown in Fig. 3: The vision of the elderly decreases with age, especially when traveling at night, they may not be able to detect the surrounding obstacles in real time. Therefore, the smart crutches use ultrasonic sensors to warn the surrounding obstacles, and ultrasonic waves detect the obstacles. Through the judgment of the return time, the distance of the obstacles is calculated, and the alarm sound is used to remind the elderly to realize the early warning function of obstacles. It is convenient for the elderly with poor eyesight, and can be supplemented by LED lights when the brightness is not enough.

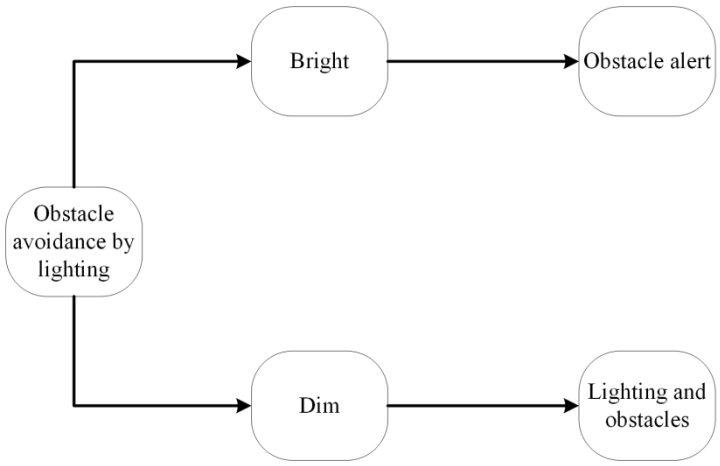

Figure 3: Lighting obstacle avoidance working diagram

(4) Health monitoring, as shown in Fig.4: The MAX3012 heart rate sensor is embedded in the handle of the crutches. When the elderly hold the crutches, they can monitor the heart rate and blood oxygen of the elderly in real time with their fingers, and upload the data to the cloud through Bluetooth. You can view it through the APP, and if there is an emergency, you can notify your family through text messages and phone calls in time to reduce the danger caused by missing the golden rescue time. Family members can query the real-time location of the elderly through the APP to provide assistance.

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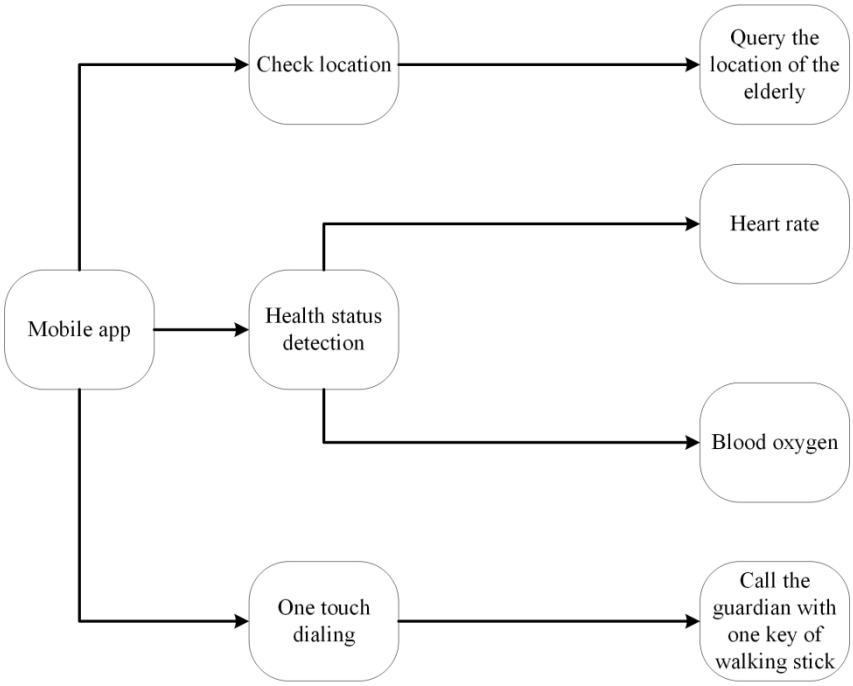

Figure 4: Working diagram of mobile phone APP

3.2. Android APP features

(1) Map query function, the Android APP can use the AutoNavi map API, the family members of the elderly can query the location of the elderly in real time. When the elderly get lost and cannot go home, if they carry a mobile phone, the one-key home function can be realized through the APP for real-time navigation for the elderly.

(2) Emergency early warning function: If the elderly are playing activities, if it is inconvenient to take out the mobile phone to dial or forget the number, they can use the one-button dial function of the crutches and activate the dial function of the mobile phone through Bluetooth, so that they can get in touch with their families in time. After the crutches fall to the ground for 10 seconds, the family phone will be automatically dialed. If the mobile phone is not carried, a distress message will be sent through the GSM module. It reduces the risk caused by the lack of timely rescue when the elderly encounter an accident.

(3) We also set up a current affairs news module in the APP for the elderly to use for leisure and entertainment.

(4) Health status detection: When the elderly carry their mobile phones, they can record the health data and related exercise data of the elderly in real time, and upload them to the cloud for data backup and analysis in real time. The APP records the data graph of the recent period of time, which is of great reference value for the analysis of the physical condition of the elderly. You can click on the user to view the detailed information of the individual.

4. Performance Test

4.1. Test plan

(1) After the hardware environment is built, ensure that the power supply and the power supply voltage of each module are stable and effective

(2) The modules are tested separately in order, the order is: passive buzzer module, HC-SR04 ultrasonic module, MAX30102 heart rate module, MPU6050 module, GPS+BD positioning module, SIM900A communication module, DS3231 storage module and nRF52832 Bluetooth module, to ensure that in the hardware environment, each module can run

(3) Integrate all modules and hardware environment, and test whether the functions are implemented one by one

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4.2. Test environment setup

(1) Use two 14500 lithium batteries (3.8V/section), output 5V voltage through the step-down module, and supply power to each module in parallel

(2) Use Keil5 to compile the HEX file generated by a single module, burn the main control chip STM32F103C8T6, and observe whether it has an effect

(3) Use the serial debugging assistant sscom33.exe to receive the feedback information of a single module, and continue to debug until the function of the module is realized

(4) Concentrate all modules in a project directory of Keil5, realize code integration, and test whether the functions are implemented one by one after burning

4.3. Test equipment

(1) Hardware system of smart crutches

(2) Laptop computer with MCU compilation environment Keil5, serial port debugging assistant sscom33.exe and CH340 serial port driver

(3) Oscilloscope

4.4. Analysis of results

10 seconds after the crutch falls, the GSM module automatically sends a distress message

5. Conclusion

The so-called “the old roots of trees wither first, the old feet of people withered”. Paying attention to the health of the elderly is primarily concerned with the walking problem of the elderly. “Walking guardian” smart crutches use the design elements of modern technology, follow the original form of traditional crutches, start from the concept of humanization, and use low-power Bluetooth NRF52832, and Android smart phones to reflect the shortcomings of the existing crutches. Combined with the MPU6050 attitude sensor and the GPS + Beidou dual-mode module for innovative design, it not only meets the needs of modern people, but also is accurate, reliable and safe.

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