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Construction of Family Intelligent Elderly Care System

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Abstract: With the aging of China becoming more and more serious, providing for the aged has become a problem that must be solved. The price of old-age care in nursing homes is high and does not conform to the characteristics of the elderly in China. When there is a choice, they are more willing to choose home-based care. However, there are many basic diseases of the elderly, and many accidents cannot be grasped at the first time. Therefore, it has become a practical need to combine the Internet of things technology with the automatic care of the elderly to design an intelligent family pension system. The system should be able to monitor the behavior of empty nesters at home and indoor data, including sleeping and eating behavior, indoor number of people, indoor temperature and humidity. This paper is also based on these ideas of system design. In this paper, the overall structure of the family intelligent elderly care system is designed, and the feasibility, functionality and corresponding sensing devices of the system are analyzed. If the system can be completed, it can provide protection for the healthy life of the elderly living alone.

Keywords: Family Pension, Internet of Things, Sensor

1. Introduction

There are two main ways to provide for the elderly in China: family pension and institutional pension [1]. On the one hand, China's family planning has been implemented for many years, and many only children have to face the plight of taking care of their elderly parents alone, or even the parents of both spouses, under the heavy pressure of work [2]. On the other hand, due to the current social development and urbanization, many young people in small cities have left their homes. They all choose to go to big cities to find better jobs and obtain better social resources. They can't stay with their parents all the time. The increase of the number of empty nesters has led to a great challenge to the traditional model of family pension [3]. On the other hand, the way of institutional pension now presents a polarized situation. High end pension institutions provide meticulous services and advanced facilities, but the high price makes most ordinary income families shy away; The equipment of general nursing homes is backward, and children can't know whether the elderly are taken care of in the nursing homes in real time. Caregivers have not received more professional training, and the level of care is very limited. Many families are not very confident in sending their empty nesters to general nursing homes for care, and their recognition is not high. Moreover, many elderly people are resistant to the old-age care method of going to the old-age institution, thinking that they do not feel warm and comfortable at home [4, 5]. At the same time, the number of beds in old-age institutions is limited, and sometimes the supply even exceeds the demand. Not all empty nesters have the opportunity to enter old-age institutions to spend their twilight years in peace [6]. A large number of empty nesters lack caregivers at home. Because of their weak memory and action, they may forget, or because of some emergencies, they fail to complete some daily tasks according to their previous habits, such as eating, going out for a walk, sleeping, etc. If some abnormal events are not paid attention to in time, they may be accompanied by some accidents. These problems make the traditional way of providing for the aged face this unprecedented challenge. How to make the mode of providing for the aged more perfect has become an urgent problem for the country to solve [7].

With the rapid development of the Internet of things, big data and cloud platform, intelligence provides a new way to solve the traditional pension model. In recent years, the concept of intelligent elderly care has become more and more

familiar to people. With the rapid development of network and wireless sensor technology, Internet of things technology plays a more important role in people's daily work and life [8]. The Internet of things combines various information sensing devices and systems with the Internet via the access network to form a large-scale intelligent network.

This paper constructs an intelligent family pension system based on the Internet of things. The empty nesters and their guardians are the main audience of this system.

2. Research Status at Home and Abroad

The aging trend is becoming more and more serious, and there is a large market vacancy in the field of elderly care system. With the rapid development of Internet of things, mobile Internet and intelligent hardware, many companies and scientific research organizations at home and abroad have begun to explore this field.

2.1. Foreign Research Status

The aging of the population is an inevitable outcome of social and economic development. Since the 1960s, some developed countries in Europe and the United States have gradually stepped into an aging country. As we entered the aging society earlier, France, Sweden and other countries paid more attention to the elderly care than our country. In particular, we want to integrate the high-tech intelligent elderly care hardware products with the professional knowledge of employees in the elderly care field. After decades of research, intelligent elderly care products have been relatively perfect in these developed countries. They have better research and development technology of the elderly monitoring system, and have established a relatively complete intelligent elderly care system, so that intelligent elderly care is not just a simple concept [9].

In foreign countries, intelligent elderly care focuses more on how to make use of the living environment of the elderly. The life trust first proposed the concept of smart home care, and they designed a fully intelligent apartment for the elderly. Sensors and various electronic chips are embedded in the floor and household appliances to monitor the daily behavior of the elderly at home. For example, when the elderly fall at home, the pressure sensor embedded in the floor of the apartment obtains abnormal data and notifies the medical staff through the Internet. When some household appliances are always on, the management staff of the apartment will receive an alarm and conduct hazard investigation or rescue in time; Launched at the Seattle Research Institute, it mainly uses various micro sensors installed on daily necessities interacting with the elderly to obtain data, analyze the work and rest rules of the elderly, reasonably infer whether the elderly take medicine and sleep on time, and push them to their guardians; Adaptive home is a project of the University of Colorado, which aims to explore self programmed home. In this home environment, users do not need to operate in person, and all household appliances automatically set their tasks [10]. When users want to change their daily habits, the adaptive home software can be updated for each different user at any time. However, this project also has problems such as users' low interest in programming all household appliances and insufficient operating ability. Comhome system is a new smart home system developed by the Swedish Internet Technology Research Institute. The apartment used for the experiment is equipped with sensors, voice switches and other equipment. The designer studies the scope of different home activities and the impact of new technologies on these home activities in the experimental apartment [11]. Some other companies are committed to image recognition through cameras. For example, the University of Dundee is trying to use cameras to recognize the movements of the elderly. When the elderly have accidents such as falling and fainting, it will timely notify the local hospital for assistance. However, this scheme is difficult in practical operation and has no practical application value.

2.2. Domestic Research Status

China's relevant research in the field of intelligent elderly care began in 2012, which is relatively late. It is still in the development stage from 2014, and the technical research in the field of intelligent elderly care lags behind developed countries. However, due to the acceleration of China's population aging in recent years, relevant technical research has been gradually carried out and achieved considerable results. In 2015, the national development and Reform Commission proposed that it is necessary to combine the family pension service system with "Internet +" to provide diversified services for the elderly through modern information technology and improve the efficiency of services. Due to the rapid development of the Internet field and the downward trend of the price of some hardware equipment, the development speed of Internet of things technology and intelligent hardware products has been significantly improved compared with the previous ones.

According to the keyword search on HowNet, there are two main directions of research on intelligent family pension in China. One is from the sociological perspective, that is, from the perspective of management, application, service and prospect, to study intelligent family pension, and the other is from the perspective of natural science to design and develop relevant intelligent pension systems. In terms of intelligent elderly care technology, we mainly explore and study the intelligent elderly care mode and intelligent wearable devices based on the Internet of things [12].

Many urban communities in China have tried to promote products related to intelligent elderly care. Beijing provides e-companion Xiaoxin and bkcn wristband intelligent terminal services for empty nesters who are alone at home. The design of wristbands makes monitoring convenient and simple; Shanghai has developed intelligent elderly care cloud platform, intelligent health detection, indoor monitoring and environmental monitoring system; Yantai has launched online shopping, distribution, telemedicine and other services to provide convenient life services for the elderly with mobility difficulties. However, due to the variety of functions, users

have a poor sense of use. There are also the smart community elderly care platform in Nanjing, the informatization elderly care service project in Suzhou, and so on [13].

In addition, scientific research institutions of some universities have also carried out research and development related to intelligent elderly care. The medical monitoring system designed by Shanghai Jiaotong University acquires images through the camera placed at home, analyzes them, and provides remote care and medical assistance in this way. However, the development cost of the system is very high, and it does not have commercial advantages. A detection device for elderly falls based on ZigBee technology was developed by Zhejiang University. Because the device has a single function, its market competitiveness is also not large [14].

In addition to university scientific research organizations, some domestic companies have also conducted more in-depth research and design development in this field. Companies such as Xiaomi and Huawei, which are in the forefront of the Internet industry, have launched intelligent wearable bracelets with different functions to obtain and monitor some daily health data of users, and provide feedback on health conditions for users, such as heartbeat, respiration, daily walking steps, sleep times, etc. the elderly can carry out their own health detection through the data fed back by the smart bracelets. At the same time, the "Xiaoyi camera" invested by Xiaomi transmits the acquired content to the guardian's mobile client through WiFi, and the guardian's client app also has the function of remote control, which can change the shooting direction of the camera, so as to obtain the status of the elderly at home to the greatest extent. However, the design of camera monitoring is a personal privacy issue. Some elderly people are resistant to camera monitoring and are unwilling to expose their lives to the camera. Moreover, because it can only be placed at home and the monitoring angle is limited, it can only help children "take care" of their parents to a certain extent. A project called "intelligent home care system for the aged" based on Internet of things technology is developed by China Science and technology pulikon, which connects all sensor nodes through ZigBee. The specific functions include indoor positioning, sleep monitoring, fall monitoring, bathroom monitoring and so on. The behavior monitoring of the elderly at home is relatively comprehensive, but it also has some inevitable problems: the cost of a complete system is too high, close to 10000 yuan; Even if the price is quite expensive, there is still a problem that the accuracy of the indoor positioning function is not high [15].

Most of today's intelligent elderly care products combine advanced technologies such as Internet technology, wireless sensor technology, machine learning and artificial intelligence technology, and Internet of things technology. Connect the daily behavior, daily life and other data of the elderly into the network for analysis and prediction, so that the daily life of the elderly can be further guaranteed. However, there are still some deficiencies in the intelligent elderly care products on the market at present, such as high cost, high production difficulty, inability to quantify, and single function. It can be seen that there are still many points in this field that need to be improved and optimized by industry researchers [16].

3. Overall System Architecture Design

In this system, you build a relatively simple Internet of things system, connecting Android mobile phones, various sensors and other hardware devices based on TCP / IP network communication protocol, and connecting things with people through wireless networks. It mainly realizes the monitoring of the daily living behavior of the elderly who are alone at home and the judgment of abnormal conditions, so as to protect the healthy and safe living of the elderly alone.

The system mainly includes three parts: terminal, cloud and client. The terminal is mainly responsible for acquiring, preliminary processing and transmitting data to the cloud server. The hardware is composed of Arduino development board, various sensors and WiFi communication modules. The sensors placed at home collect data. After data processing, they are connected to WiFi hotspots through esp8266 module to realize data transmission. The software is coded using Arduino ide; The cloud server is responsible for the reception, processing, storage and transmission of data. The behavior identification and abnormal judgment of the elderly, the indoor number identification and abnormal judgment, and the abnormal judgment of temperature and humidity data are all completed in the cloud. Relevant data are stored in the database and transmitted; The client provides an intelligent elderly care app client application, which connects to the cloud server through the network, and is mainly responsible for data reception, display and user action reception.

4. Feasibility Analysis

Whether consumers can be successfully persuaded to use smart home pension products mainly depends on the following points: first, this product must propose strategies that satisfy consumers. Secondly, the solution strategy must be able to match the three levels of general technology, mass production capacity and current building conditions. Finally, it also has the following attributes: ease of use, scalability, maintainability, upgradeability, purchasability, reliability and service.

Because the system designed in this paper needs to be investigated from the aspects of technology, economy and market, the following is a feasibility analysis from the three aspects of technology, economy and society of the system.

4.1. Technical Feasibility

Wireless network sensor technology, intelligent hardware, Android development and other technologies are now very mature, and there are many intelligent products that combine sensor, cloud server and Android development for development, so the technical difficulties can be overcome.

4.2. Economic Feasibility

The hardware requirements involved in the system, such as

passive infrared sensor, RFP film pressure sensor, esp8266 WiFi module and conversion module, are cheap. For cloud servers, many companies now provide cloud server leasing, which saves the cost of building private servers. In addition, Android phones need to be used for actual testing in the later stage, and the price is not expensive. Therefore, considering the economic cost, the development plan of the system is feasible.

4.3. Social Feasibility

Home based intelligent elderly care can bring great benefits to society. First, it can make the elderly care service more comprehensive and professional, and can meet the special needs of some elderly people. It also solved the contradiction that children could not take care of the elderly while working. Secondly, organizing the elderly to learn intelligent operation, improving the elderly's acceptance of today's technology, enriching their lives with scientific and technological means, and preventing them from being abandoned by the high-tech era can reduce their social loneliness. Third, in the era of Internet of things networking, people's lives are gradually becoming intelligent. Relying on the network information platform to realize intelligent elderly care can not only promote the development of the information industry itself, but also solve the problems of the traditional elderly care service industry that are not comprehensive, professional and unbalanced. Intelligent elderly care provides a substantive solution to the elderly care problem. At the same time, China is in the development stage of Internet of things research. With the deepening of the pilot community construction of the intelligent family pension project, the intelligent family pension based on the Internet of things can be promoted, and "Internet +" can be used to create a more intelligent and comprehensive intelligent family pension system to meet the needs of the pension market. This system can solve some practical problems existing in the current pension service industry in design, so there is no problem in social feasibility.

5. Main Sensors

5.1. Infrared Sensor

Passive infrared sensor is a kind of temperature sensitive sensor, which utilizes pyroelectric effect. The human body has a constant body temperature, usually 36-37 degrees, so the infrared light it emits has a specific wavelength of about 7-10 microns. The passive infrared sensor works by detecting infrared rays of about 10 microns emitted by the human body. The infrared ray is enhanced by the finnel filter and concentrated on the infrared induction source. The infrared induction source uses pyroelectric elements. When receiving the temperature change of the infrared radiation of the human body, the charge balance is broken, and the charge is released outward to generate a current. The subsequent detection circuit can generate a detection signal.

When the temperature in the monitoring range of the sensor changes by ΔT, the pyroelectric effect will generate corresponding ΔQ charges on the two electrodes, and weak ΔV will be generated between the two electrodes. When the ambient temperature is stable and $\Delta t = 0$, the sensor has no output. When the human body enters the detection area, a temperature difference and an output signal are generated due to the difference between the human body temperature and the ambient temperature. Pyroelectric sensors are placed at various locations in the home, such as kitchen, toilet, dining room, bedroom, etc., to monitor the number of people in the house.

5.2. Pressure Sensor

RFP thin film pressure sensor is only 0.1mm-0.2mm thick and has good flexibility. The standard RFP film pressure sensor is composed of two pieces of polyester film, and the inner surface of the film has conductors and semiconductors. When the external force acts on the sensing point, its resistance value will change regularly with the external force. When the pressure is 0, the resistance value is the largest, and the resistance value decreases with the increase of the pressure. The resistance signal output by the RFP thin film pressure sensor can be converted into a voltage signal or a high-low level through the special resistance voltage conversion module of the RFP thin film pressure sensor.

In this experiment, the RFP thin film pressure sensor can be placed on the mattress. If the output is high, the elderly will be judged to be out of bed. If the output is low, the elderly will be in bed. By detecting the high and low levels, the time for the elderly to get in and out of bed is recorded, and whether the elderly go to bed and get up is judged according to the length of time.

5.3. Temperature and Humidity Sensor

DHT11 is a temperature and humidity composite sensor calibrated for digital output signal. It uses special temperature sensing technology and digital module acquisition technology. It is basically composed of an NTC temperature measuring element and a resistance type moderate sensing element, and a high-performance 8-bit microcontroller is connected to these two elements. Therefore, DHT11 has fast response, strong anti-interference, excellent quality and high cost performance. Each DHT11 sensor will be factory calibrated in an extremely accurate humidity calibration room. The calibration coefficients are stored in the OTP memory in the form of program codes. These calibration coefficients are called during the internal processing of detection signals when the sensor is used. In terms of packaging, the product is packaged as a 4-pin single row of pins, so in terms of connection, the sensor can be connected to Arduino through three digital lines, and the single line serial interface is very simple and fast.

6. Requirement Analysis

6.1. Functional Requirements

The elderly living alone are the main service objects of the

intelligent family pension system designed in this paper. According to the previous research, it is concluded that the needs of empty nesters for the family pension system are mostly concentrated in two aspects: health and living environment. In terms of health, with the growth of age, the physical function of the elderly is not as good as before, and they are inconvenient to move. Many elderly people have some chronic diseases and potential diseases, so it is necessary to speculate about their physical condition through whether their daily behavior is normal. In terms of living environment, children guardians hope to monitor the environmental data at home, such as indoor number, indoor temperature and humidity. Based on the above analysis, it is concluded that the functional requirements of the intelligent family pension system include the following:

6.1.1. Real Time Monitoring and Abnormal Judgment Function

It is divided into elderly behavior monitoring, indoor environment monitoring and network transmission monitoring. The behavior detection of the elderly is to identify the sleeping and eating behaviors of the elderly according to the data obtained by the sensors, and use algorithms to judge whether the daily behaviors of the elderly are abnormal; Indoor environment monitoring uses passive infrared sensors to identify the number of people in the room, and temperature and humidity sensors to monitor whether the indoor temperature and humidity are normal. When the data is normal, it will be displayed in real time. When the data is abnormal, the intelligent family pension system client will push prompt and alarm to the user in time; Network transmission ensures the data transmission of the terminal, cloud server and client of the intelligent elderly care system. If there is any transmission abnormality, it should be displayed on the client interface.

6.1.2. Sensor Binding and Detection Function

It can bind sensor devices and detect the operating status of sensors. Sensors are the only source to obtain data on the behavior of the elderly and the environment at home, and are the core of the intelligent family pension system. When the sensor is abnormal, it shall push a message prompt to the user in time.

6.1.3. Historical Report Query Function

Users should be able to query the daily behavior report, abnormal event report and sensor operation abnormal report of the elderly in the last six months, and pay close attention to the elderly. If the old person is often abnormal, the children can take the old person to the hospital for further inspection. If a sensor is always abnormal, the children can consider replacing the sensor to ensure the normal use of the system.

6.2. Non Functional Requirements

6.2.1. Security

Security is a concern for all users. The system needs to solve the following two security problems:

1. Security of user identity authentication.
2. Data encryption during transmission and storage.

6.2.2. High Concurrency

When a large number of users access the network at the same time, the system needs to process a large number of data from sensors, so it needs to have the ability to handle high concurrent data access.

6.2.3. Scalability

Extensibility is one of the principles of software design. The purpose is to add new functions or modify and improve existing functions more easily when software needs to change requirements later. On the other hand, in order to enable more sensors to access the network through WiFi, the designed code architecture needs to meet the future scalability needs of the system. Improving scalability can make it more convenient to add more functions later.

6.2.4. Timeliness

The processing time and the speed of sensor data acquisition are very important points in the intelligent elderly care system. In the face of various factors such as network broadband, the processing speed of requests is likely to slow down. Because it involves the health and safety of the elderly, too long processing time may lead to some serious consequences, so timeliness is a problem that the system must pay attention to.

7. Conclusion

This paper proposes to build a set of intelligent home care system based on the Internet of Things, which is combined with the automatic watching of the elderly to realize the intelligent care of the empty nest elderly. The sensors used should be cheap, which can make up for the high price of intelligent elderly care products in the market and meet the needs of ordinary income families for monitoring the behavior of the elderly living alone.

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