Construction and Application of Regionalized Smart Elderly Care Service Platform Under IoT Technology

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Abstract: With the continuous deepening of population aging in China, effectively addressing elderly care issues through technological means has become a top priority. This research addresses the issues of limited coverage and single content in current smart elderly care services and explores the method of constructing a regional smart elderly care service platform based on Internet of Things (IoT) technology. By designing the platform's overall framework, hardware system, software functionality, and data storage solution, intelligent monitoring and analysis of the health status and daily behaviors of elderly individuals within a designated region are achieved. Using a specific community as an example, the study demonstrates the platform's effectiveness in improving the quality of life for the elderly. The research indicates that IoT technology can efficiently support regional smart elderly care services, playing a crucial role in promoting the development of elderly care services in China. This study lays the foundation for further enhancing platform functionality and expanding its application scope in the future.

Keywords: IoT, smart elderly care, service platform

1 Introduction

China is currently experiencing an accelerating aging population, with over 250 million individuals aged 60 and above. Traditional manpower-based elderly care methods face challenges such as limited service resources and difficulties in ensuring service quality. Enhancing the quality of elderly care services using modern technology is an urgent priority. Currently, smart elderly care services have limited coverage, primarily focused on nursing homes and home environments, unable to meet multi-dimensional personalized needs and suffering from low user engagement. To address these issues, this study aims to establish a regional smart elderly care service platform that covers community areas, enabling intelligent sensing of the health status and daily behaviors of elderly individuals and providing personalized services. The research presents an overall platform design scheme, designs both hardware and software systems, and validates the platform's effectiveness through case studies. This study serves as a reference for further improving regional smart elderly care services and promoting the development of elderly care services in China[1]. The motivation behind this research is to address the current issues of limited coverage and single service content in elderly care services in China, with the objective of utilizing Internet of Things (IoT) technology to construct a regional smart elderly care service platform [1].

PMBDA 2023, December 15-17, Nanjing, People's Republic of China

DOI 10.4108/eai.15-12-2023.2345314

2 Related technologies and research status

2.1 Current Development of IoT Technology

With the advancement of the Internet, communication networks, and sensing technology, Internet of Things (IoT) technology has made significant progress. Currently, IoT technology has been applied in various fields such as smart homes, smart healthcare, and intelligent transportation, enabling data collection, network transmission, and analytical applications through sensors. In the field of elderly care services, IoT technologies like RFID, sensor networks, video surveillance, and GPS positioning have provided possibilities for the development of smart elderly care service platforms[2].

2.2 Advances in Smart Elderly Care Services Research

Smart elderly care, as an important means to address the challenges of an aging society, is gaining widespread attention. China is currently experiencing an accelerated aging population, with over 250 million individuals aged 60 and above. Traditional manpower-based care methods face severe challenges, including resource shortages and difficulties in ensuring service quality. Therefore, it is imperative to use modern technologies such as IoT, big data, and artificial intelligence to enhance the quality of elderly care services. Existing research has shown that intelligent sensing of the activities of elderly individuals can enable real-time monitoring of their health status, timely problem detection, and assistance provision, effectively improving the quality of life for the elderly. Currently, IoT-based smart elderly care platforms and products have been preliminarily applied in elderly care facilities and home care environments, yielding certain positive results [3].

2.3 Analysis of Existing Issues

Current research on smart elderly care services faces limitations in terms of regional coverage, single service content, and low user adoption rates. How to utilize IoT technology to create a smart elderly care service platform within a regional scope, enabling multi-dimensional monitoring of elderly care and enhancing the willingness of elderly individuals to use these services, is a challenging issue that urgently needs to be addressed [4].As shown in Tab 1.

Table 1: Current Issues in Smart Elderly Care Services and Proposed Solutions

category	Problems/Challenges
Status quo problem	Limited geographical coverage; Single service content; The user access rate is not high
Solution direction	Use the Internet of Things technology to build a smart elderly care service platform within the region; To realize multi-dimensional monitoring for the aged; Improve the willingness of the elderly to use

3 Building a regionalized smart elderly care service platform based on the internet of things

3.1 Overall Platform Design

The region-specific intelligent elderly care service platform developed in this research adopts a B/S architecture, integrating the Internet of Things (IoT) data collection module, network transmission module, data processing module, and service application module to achieve intelligent sensing and monitoring of the health status and daily behaviors of elderly individuals within a designated area. The platform utilizes a B/S architecture to separate service providers from users. It boasts scalability, enabling the easy integration of new hardware devices, and compatibility with devices from different manufacturers. With its scalability and compatibility, the platform can diversify elderly care services by adding sensing devices and optimizing algorithms [5]. By employing IoT technology, it can expand its coverage to monitor elderly individuals from various dimensions, thus providing personalized services tailored to different elderly individuals.

To better understand and represent the functionality of this platform, we can construct the following conceptual formula:

$$P(f) = I(W) + T(N) + D(DP) + S(SA) \quad (1)$$

Where: P(f) represents the platform's functionality. I(W) represents the input of the IoT data collection module. T(N) represents the transmission function of the network transmission module. D(DP) represents the data processing function of the data processing module. S(SA) represents the service application function of the service application module. Specifically, the overall platform framework adopts a B/S architecture, with the server-side deployed in the cloud, responsible for data storage, analysis, and services, while the client-side serves as the data collection terminal and user access point. The server and client are connected through networks like 4G/5G. This framework offers flexible scalability, allowing for the easy incorporation of various types of terminals.

3.2 Hardware System Design

The hardware system design primarily consists of IoT terminal nodes and a data collection network. The terminal nodes are designed as wearables, equipped with various sensors to collect health and behavioral data. These terminal nodes can include devices like smartwatches, blood pressure monitors, etc., used for gathering health-related data. Additionally, robots and sensors are installed in homes to capture behavioral data. The data collection network predominantly utilizes self-organizing ZigBee technology to ensure reliable connections. Furthermore, to enhance stability, a wired network is set up as a backup. All collected data is aggregated at a regional gateway and then transmitted to the platform server via the internet. This way, the hardware system effectively collects and transmits health and behavioral data, providing a reliable foundation for subsequent data analysis and processing [6].

3.3 Software System Design

The software system design primarily comprises three components: the data communication module, the data storage module, and the intelligent processing module. These components work together to facilitate data interaction between terminals and the platform, organize and store data, and perform intelligent analysis and processing. The data communication module manages data exchange between terminals and the platform to ensure reliable data transmission. The data storage module employs MySQL databases for structured data storage and utilizes HBase for unstructured data storage, facilitating efficient management and retrieval of various data types. The intelligent processing module leverages big data and AI technologies to analyze data, extract valuable insights, and support service applications. To ensure system security, the software system implements security mechanisms like RBAC access control and data encryption to protect user data privacy and security. Additionally, the system exhibits high interoperability, enabling effective communication and integration with different types of hardware devices and terminals. This design allows the entire intelligent elderly care service platform to efficiently process and analyze data, providing personalized services and care for elderly individuals [7].

3.4 Data Storage Design

The platform's data storage design employs a distributed database structure comprising multiple database nodes. Structured data such as user basic information, health data, and service records are stored in relational databases, with related table structures established based on data attributes for SQL queries. Unstructured data, such as user-generated audio, video, images, etc., are stored in non-relational databases. All database nodes are synchronized for both data scalability and system fault tolerance. The platform employs distributed database technologies such as MySQL and utilizes technologies like Hadoop for structured and unstructured data storage. Additionally, data warehousing techniques are used for data preprocessing to create multidimensional data models. The platform also establishes data warehouses for extracting, cleaning, and integrating raw data. This allows for the consolidation of data in different formats and from various sources into multidimensional data models, such as individual data models for each elderly person encompassing health, lifestyle, and other dimensions. This enables complex personalized analysis and discovery. Data preprocessing and modeling tasks are handled by offline computing nodes, ensuring uninterrupted operation of online services. Furthermore, online analytical processing (OLAP) technology is utilized to support interactive data analysis and rapid queries. Regarding data storage, the platform employs a distributed architecture, deploying storage clusters in multiple data centers to achieve data redundancy and load balancing. A substantial amount of unstructured data is stored in Hadoop HDFS, and technologies like Hive are used for data analysis. This data storage architecture ensures high availability and scalability to cope with the platform's increasing data volume and user demands [8].

4 Platform application demonstration

4.1 Application Scenario Setting

In this study, we selected a community in District X of Beijing, China, for the platform application demonstration. This community covers a total area of 2 square kilometers and has a registered population of approximately 28,000 people, with over 5,000 individuals aged 60 and above. Based on preliminary research, it was found that elderly individuals in this community commonly face issues related to poor health, a high prevalence of chronic diseases, and a lack of companionship and care. To address the actual needs of the elderly, this study established two major application scenarios: Smart Health Management and Smart Companionship. Smart Health Management primarily targets elderly individuals who live alone or have limited mobility, while Smart Companionship caters to relatively healthier elderly individuals. The development of these two scenarios aims to provide comprehensive services for the elderly.

4.2 Functionality Design

In the Smart Health Management scenario, physiological data from the elderly are collected using implanted sensors. This data, in combination with a medical database and an expert system, is subjected to intelligent analysis. This enables real-time assessment, warnings, medical advice, and seamless connectivity with designated hospitals and community healthcare personnel. The Smart Companionship scenario focuses on emotional communication and activity organization. It incorporates features such as voice chats and video calls to allow elderly individuals to receive care from family members and volunteers. Additionally, it utilizes interest-based recommendations and location services to promote community activities tailored to the elderly, encouraging them to participate and engage beyond their homes [9].

4.3 Implementation Process

Before the platform's trial operation, the community conducted promotional campaigns to encourage elderly individuals to use the platform. This involved configuring smart devices, including wearable sensors and home service robots, and installing them in households. Health profiles for the elderly were established, and medical data was collected. A WeChat mini-program was developed to enable online access to platform functions. During the trial operation period, assistance was provided to elderly individuals to address usage-related issues through methods such as a hotline, in-person training, and volunteer services. Based on the trial operation feedback, further improvements and enhancements were made to the platform's services.

4.4 Effectiveness Evaluation

This study conducted an effectiveness evaluation of the platform from three aspects: user satisfaction, health monitoring, and lifestyle behavior statistics. User satisfaction was assessed through a questionnaire survey, revealing that 93% of elderly individuals could independently master and use the various platform functions, and they found the operation convenience to be satisfactory. Additionally, 88% of the elderly reported a significant improvement in their

quality of life and happiness due to the platform, with 76% expressing their willingness to use the platform services in the long term. Next, the study analyzed the effectiveness of the platform's health monitoring function. It was observed that continuous monitoring led to improvements in the health conditions of many elderly individuals living alone, such as increased medication compliance and better blood sugar control. In cases of emergency, some elderly individuals received timely responses and active interventions from the platform, preventing serious consequences. By analyzing lifestyle behavior data on the platform, it was found that some elderly individuals who were previously socially isolated and had low participation levels were encouraged by the platform to leave their homes, make new friends, participate in various community activities, and lead more fulfilling lives, with a noticeable reduction in feelings of loneliness. The evaluation results indicate that the regional smart elderly care service platform based on Internet of Things (IoT) technology can effectively enhance the health and quality of life of elderly individuals, making a significant contribution to their ability to enjoy a healthy, dignified, and joyful later life [10].As shown in Fig 1.

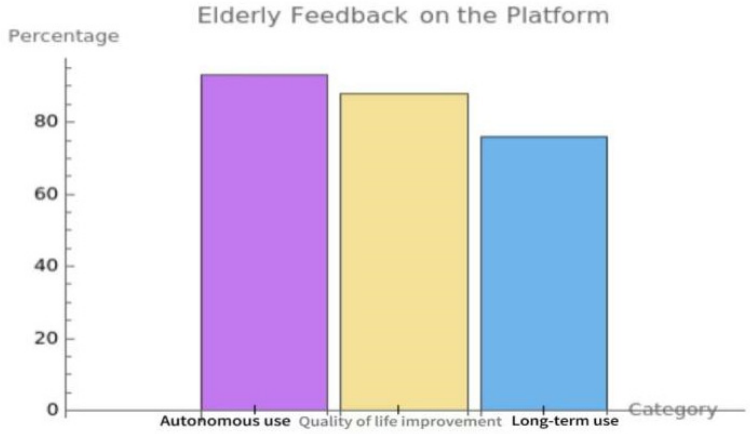

Figure 1: Elderly Feedback on the Platform

5 Conclusion

This study addressed the existing issues in current smart elderly care services and explored the method of constructing a regional smart elderly care service platform supported by Internet of Things (IoT) technology. Firstly, the paper analyzed the current development status of IoT technology and smart elderly care services, identifying the limitations of current services. Next, it designed the platform's overall framework, hardware system, software system, and data storage solution. Finally, through the application case in the community, it is evident that the platform has significantly improved the health monitoring and quality of life for elderly individuals, providing a successful example for the development of smart elderly care services in China. This research demonstrates that the IoT-enabled regional smart elderly care service model can promote doctor-patient communication, reduce care costs, enhance community service capabilities, and ultimately benefit elderly individuals, families, and society as a whole. It provides valuable insights for the construction of a new era's healthcare and elderly care

service system in China. Subsequent research will further expand the platform's scale, enrich its service content, enhance user experience, and extend services to more elderly populations.

Project: Research on the development path of smart pension in Liaoning Province under the background of big data, the basic scientific research project of Liaoning Provincial Department of Education in 2022（LJKMR20221958）

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