AI-Powered Home Healthcare Guardian System Innovation and Social Value White Paper

For medical institution managers, pension service providers and smart health investors

Executive Summary

With the acceleration of the aging of the Chinese population and the increasingly obvious trend of chronic diseases, the traditional medical system is facing unprecedented challenges. This white paper shows an innovative health care system based on advanced AI technology architecture (LLM+RAG+Agent+Workflow) for elderly care institutions, medical service providers and policy makers, and how the health care system can achieve continuous monitoring, early warning and intelligent prediction for the elderly and patients with chronic diseases in the home environment can effectively solve the key problems in long-term home care, fill the gap beyond hospital treatment, and create significant social and economic value.

Our team has successfully implemented the home health protection system for more than 1,000 households in many first-tier cities in China, and has accumulated rich practical experience and user feedback. Verified by multiple real-world cases, the system has achieved a 42% increase in nursing efficiency, a reduction in emergency response time to 90 seconds, and a 22% reduction in the readmission rate of high-risk seniors. Through contactless monitoring technology, the system fills a gap beyond hospital treatment, creating significant social and economic value with a return on investment ratio of 1:3.6.

We sincerely invite all relevant institutions to further explore the possibility of cooperation and jointly promote the widespread implementation of smart elderly care services.

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1. Market Background and Challenges

1.1 Analysis of the Current Market situation

China's home care market is experiencing explosive growth and is expected to reach $800 billion by 2025 and possibly exceed $3 trillion by 2030. This growth was primarily driven by the following factors:

Population ageing: The 2020 national census showed that there were nearly 200 million people aged 65 and over, accounting for 14% of the total population, and more than 260 million so far
"90-7-3" pension model: 90% care at home, 7% in intermediate facilities, and 3% in nursing homes
Chronic diseases at a younger age: The incidence of chronic diseases such as cardiovascular disease, diabetes, and Alzheimer's disease continues to rise

According to industry forecasts, by 2030, the scale of China's chronic disease management market will exceed 2 trillion yuan, and the demand for home health care will grow by leaps and bounds.

1.2 Core Pain Points

There are significant pain points in the long-term management of chronic diseases in the traditional medical model:

Insufficient medical resources: Hospital beds are limited to meet the long-term monitoring needs of patients with chronic diseases
→ Our system extends monitoring to the home environment through contactless monitoring technology, effectively reducing the pressure on hospital resources

Monitoring gap: Lack of professional monitoring of a patient's health between discharge and the next follow-up visit
→ The system provides 24/7 continuous monitoring to make up for the gap period of medical monitoring and achieve all-weather health protection

Intervention lag: abnormalities are often not detected in time, and the best intervention time is missed
→ The three-level warning system ensures that abnormal situations are detected in time and intervened quickly, significantly improving the timeliness of intervention

Disconnect between medical care and elderly care: Medical care and elderly care services are separated, making it difficult to provide integrated care

→ An open and collaborative ecosystem connects healthcare, seniors, and families, enabling seamless integration of data and services

Inadequate service provision: Surveys show that only about one-third of community institutions provide home health services, and less than 15 per cent provide family beds, rehabilitation and nursing services
→ Technology empowerment enables a limited number of professionals to reach a wider range of service audiences and improve service access

1.3 Key Needs and Challenges

Key needs in the area of long-term home care include:

Unobtrusive monitoring: Non-invasive, continuous health monitoring
Accurate early warning: hierarchical health protection system
Trend analysis: Evidence-based analysis and prediction of health trends
Adaptable solutions: Flexible systems that can be integrated into the elderly care facility and home environment

Key challenges include:

Uneven quality of services: Service levels vary significantly between regions and institutions
Shortage of skilled workers: especially in rural and remote areas
Uneven distribution of resources: the gap between urban and rural areas is obvious
Complex system coordination: It is difficult to integrate cross-agency and cross-professional services

1.4 Our Practical Experience

As an industry leader, our team has extensive experience in the development and deployment of intelligent health guard systems:

Large-scale practice: As of 2024, more than 1,000 home health guardian systems have been successfully tested and deployed in many cities across the country
Multi-scenario verification: covering a variety of application scenarios such as high-end elderly care communities, tertiary hospitals, and community elderly care service centers
Technology accumulation: With a number of related scientific research technologies, it has established one of the health behavior databases of the elderly in the health care industry in China.
Cross-border cooperation: Establish in-depth cooperative relations with a number of top medical institutions, pension service providers and insurance companies

2. In-depth Insight into the Global Industry

2.1 Global Ageing Trends and China's Particularities

According to the WHO, the proportion of the global population over the age of 65 will increase from 9.3% in 2020 to 16% in 2050. China's aging population presents the following particularities:

Rapid aging: The proportion of the population aged 65 has gone from 7% to 14% in just 25 years (24 years in Japan and 115 years in France).
Scale effect: In 2025, the number of disabled elderly people will exceed 50 million, equivalent to 60% of the total population of Germany
Demand stratification: The ratio of high-end/mid-range/inclusive market demand presents a 3:5:2 structure

2.2 Technology Evolution Roadmap

Home care technology has undergone four generations of evolution:

Phase	Timeline	Core Tech	Monitoring Focus	Product Forms
1.0	2015-2018	Wearables	Single metrics	Smart bands/BP monitors
2.0	2018-2021	IoT + Cloud	Multi-metric	Home health systems
3.0	2021-2024	AI + Edge	Behavior patterns	Ambient sensing systems
4.0	2024-2030	Multimodal LLMs	Predictive care	Medical decision support

Source: Frost & Sullivan China Smart Elderly Care Technology Development Report

2.3 Industry and Policy Support

The Chinese government is actively promoting the application of AI in elderly care services:

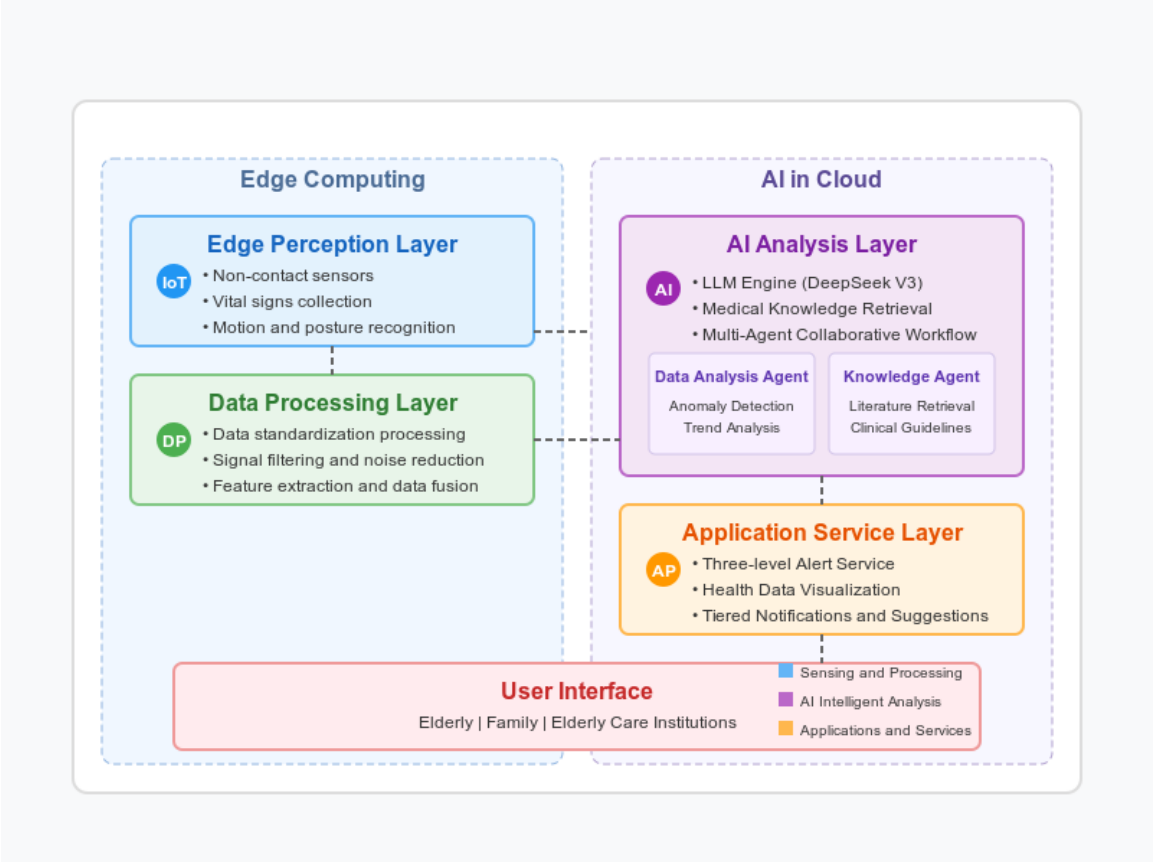
2021-2025 Smart Pension Industry Development Action Plan: Clarify the path for the development of smart products and services
January 2024 Guidelines: Further promote the application of smart home systems and AI technology in home ageing

These policies provide strong support for the widespread adoption of AI technology in the elderly care sector.

3. Technical Architecture Design

3.1 Overall System Architecture

The health guard system described in this white paper adopts the distributed architecture of "edge computing + cloud intelligence" to build a four-layer technology stack:



3.1.1 Edge Perception Layer

Sensing device: non-contact radar sensor (60GHz millimeter wave).
Acquisition capability: resting heart rate (accuracy ± 1bpm), respiration rate (accuracy ± 1rpm), motion recognition (7 basic movements).
Deployment method: No need to wear, installed in the bedroom, living room and other main activity areas
Data security: Edge computing pre-processing, only transmitting feature parameters to protect privacy

3.1.2 Data Processing Layer

Data standardization: Unified multi-source heterogeneous data format (using ISO/IEEE 11073 standard).
Signal Processing: Filtering, Noise Reduction, Outlier Handling (based on Moving Median Filtering).

Feature extraction: time-domain features (mean, variance, peak), frequency domain features (energy distribution, spectral density).
Data fusion: spatiotemporal alignment and comprehensive analysis of multi-sensor data

3.1.3 AI Analysis Layer

LLM Engine: Understanding of Medical Expertise Based on DeepSeek V3
RAG system: real-time retrieval and knowledge enhancement of medical literature
Multi-agent workflow: a collaborative decision-making system based on LangGraph
Medical Knowledge Graph: A professional knowledge base containing 300,000+ medical concepts and relationships

3.1.4 Application Service Layer

API interface: Standardized RESTful API and WebSocket real-time communication
User portal: A multi-terminal access interface for healthcare workers, the elderly, and their families
Notification system: multi-channel, hierarchical warning notification mechanism
Data visualization: Intuitive display of health data trends and analysis reports

3.2 Core Technology Implementation

3.2.1 LLM Medical Understanding Techniques

The system uses the DeepSeek V3 large language model as the core engine to improve medical understanding through the following technologies:

Medical professional fine-tuning: Domain adaptation based on 800,000+ medical literature and clinical guidelines
Contextual learning: Supports long text comprehension with 16K tokens to grasp the complete medical context
Inference Chain Enhancement: Chain-of-Thought technology is used to improve the ability of medical logical reasoning
Medical entity relationship extraction: Accurately identify the correlation between symptoms, diseases, and indicators

Model performance indicators:- Medical terminology comprehension accuracy: 93.5% - Medical reasoning ability (MedQA benchmark): 78.9% - Medical knowledge coverage: covering 12 major disease areas

3.2.2 RAG Expertise Enhancement Technologies

Improves the system's medical professionalism through Retrieval Augmented Generation (RAG) technology:
Knowledge base construction:
Medical literature database: 300,000+ journal papers, real-time update
of clinical guidelines database: major chronic disease management guidelines at home and abroad (2022-2024 edition)

Drug knowledge base: covering common chronic disease drugs and interactions

Vector retrieval engine:
using FAISS+ElasticSearch hybrid retrieval architectureMedical
text vectorization: using BioMedLM dedicated embedding model
relevance sorting: TF-IDF mixed scoring with semantic similarity

Result integration strategy:
Dynamic search depth: adaptive adjustment of search scope according to query complexity.
Multi-source evidence fusion: comprehensive consideration of the consistency and authoritative
Knowledge conflict resolution of multiple literatures: weight allocation based on publication time and evidence level

3.2.3 Multi-agent Collaborative Workflow Technology

The system is designed with multiple professional agents (agents) to work together:

Data Analysis Agent:
Function: Responsible for data cleaning, anomaly detection and trend analysis
Technology implementation: Based on Prophet time series prediction model + anomaly detection algorithm
Key capabilities: Identify short-term fluctuations and long-term trend changes in physiological indicators

Medical Knowledge Agent:
Function: Responsible for retrieving relevant medical literature and clinical guidelines.
Technical Implementation: HyDE (Hypothetical Document Embeddings)-based Retrieval Enhancement
Key Capabilities: Provide evidence-based medical evidence to support decision-making

Report Generation Agent:
Function: Responsible for comprehensive analysis of results and generation of personalized health reports Technical
implementation: Customized generation based on template + LLM
Key capabilities: Adjust the degree of professionalism for different audiences (doctors/nurses/families).

Alarm Management Agent:
Function: Responsible for hierarchical early warning triggering and notification
Technology implementation: Hybrid decision-making system based on rule engine +

machine learning
Key capabilities: Hierarchical push according to urgency to reduce false alarm rate

The collaboration between agents is realized through the workflow framework built by LangGraph:

- Workflow orchestration: task dependency management based on DAG (directed acyclic graph)

- Message passing mechanism: asynchronous communication + event-driven architecture

- Decision coordination: Confidence-weighted multi-agent consensus mechanism

- Execution monitoring: full-process logs and explainability tracking

3.3 Explanation of Terms

To help non-technical readers understand the terminology in this white paper, the following brief explanations are provided:

- **LLM (Large Language Model):** An advanced AI model that understands and generates human language and is used in this system to understand medical concepts and health data analysis.
- **RAG (Retrieval Enhanced Generation) technology:** A technology that enhances the accuracy of AI-generated responses by retrieving the latest medical literature in real time, ensuring that system decisions are based on the latest medical evidence.
- **Agent:** An AI component with specific functions that can autonomously complete specific tasks, such as data analysis and medical knowledge retrieval.
- **Workflow: Define** the way and process for multiple agents to work together to ensure that complex tasks can be handled efficiently by the system.
- **Edge computing:** A technical approach to processing data close to where it is generated, reducing the amount of data transferred, protecting privacy, and improving responsiveness.
- **Millimeter-wave radar:** A sensor that uses 60GHz electromagnetic waves to detect human activity and can monitor vital signs through clothing and bedding without contact.

4 Functional Value and Application Practice

4.1 Three-Level Alert System

The system provides hierarchical warning services to meet the needs of different guardianship scenarios:

4.1.1 Emergency Event Alarm (Level 1)

Trigger conditions:

Fall event detection: Sudden acceleration changes based on radar sensor recognition
Heart rate abnormality: Resting heart rate> 100bpm or <45bpm for more than 10 minutes
Abnormal breathing: Respiration rate>30 beats/min or <8 times/min
Prolonged inactivity: non-sleep time motionless for more than 4 hours

Response mechanism:

Multi-channel notification: push + SMS + phone automatic outbound call
Response level: push within 30 seconds, manual confirmation within 2 minutes
Escalation process: automatic upgrade notification scope is not responded

4.1.2 Attention Event Alert (Level 2)

Trigger conditions:

A single indicator continuously deviates from the baseline: heart rate/respiratory rate continuously deviates from the personal baseline by >20% for 3 consecutive days
Multiple indicators deviate slightly at the same time: 2-3 indicators deviate from the baseline by 10-20% at the same time
Changes in activity patterns: daily average activity volume decreases by >30% or sleep quality continues to deteriorate

Response mechanism:

Notification method: APP push + daily report mark
Response level: Intervention within 12 hoursSuggested
Intervention means: remote guidance or arrange follow-up

4.1.3 AI Medical Analysis and Prediction (Level 3)

Analysis Dimension:

Long-term Trend Analysis: Health Trend Prediction Based on 3 Months of Data
Correlation Analysis: Lifestyle Habits and Health Indicators Correlation
Risk Prediction: Predict health risks in the next 30-90 days based on existing data

Output form:

Monthly health analysis report
personalized intervention suggestions
doctor decision-making assistance information

4.2 All-round Monitoring and Data Visualization

The system covers four core guardian dimensions:

Physiological indicator monitoring: basic vital signs such as heart rate and respiratory rate (24/7 continuous monitoring).
Gait analysis: walking stability assessment, fall risk prediction (using gait instability index).
Sleep quality assessment: sleep stage (deep sleep/light sleep/REM/awake), sleep quality score
Activity status monitoring: daily activity volume, activity pattern recognition, abnormal stationary detection

The data visualization system provides multi-dimensional health data display:

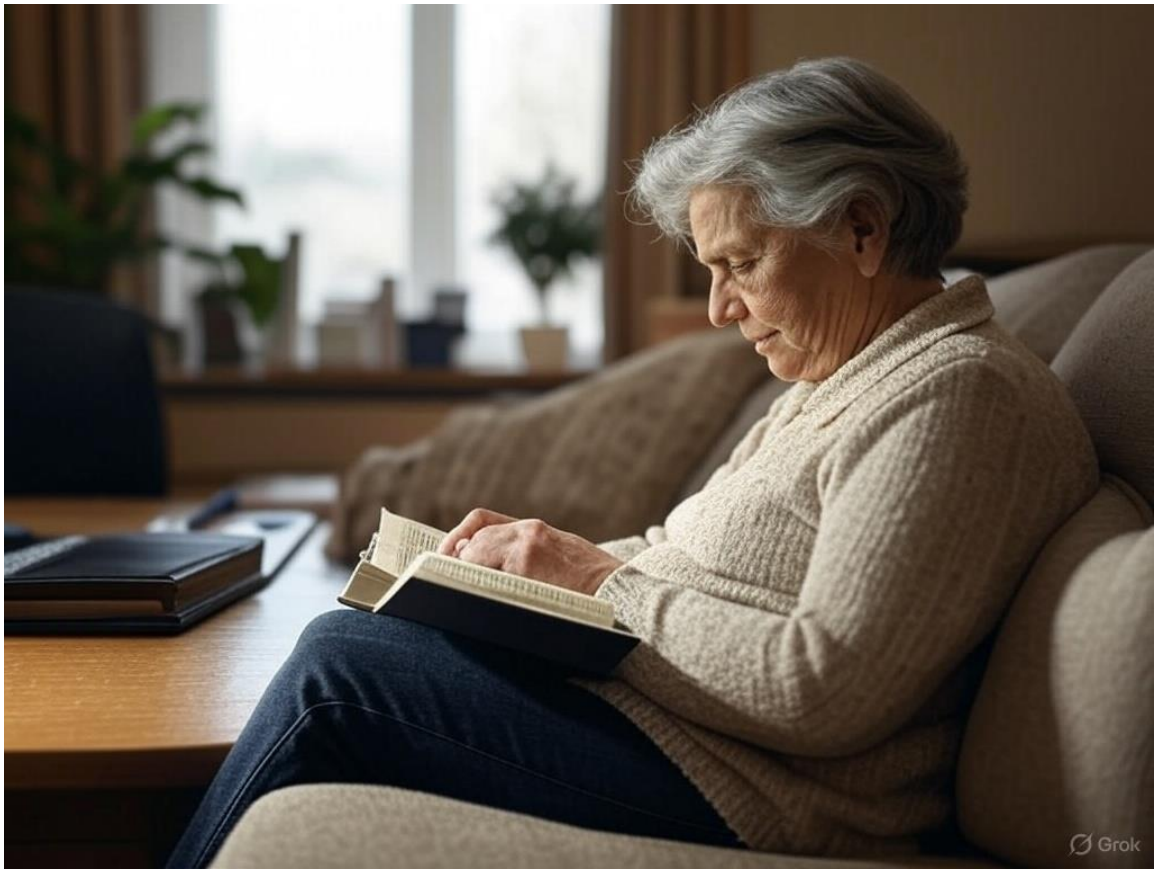
- Daily/weekly/monthly trend charts

- Multi-dimensional health index radar charts

- AI comprehensive analysis reports

4.3 Application Scenario Practice

4.3.1 Application Practice in Elderly Care Institutions



Deployment cases in a number of high-end elderly care institutions (January-December 2024) show that:

Efficiency improvement: The work efficiency of nursing staff has increased by 42%, and the number of elderly people that a single person can effectively monitor has increased from 15 to 26.

Safety guarantee: The average response time to emergency events has been shortened from 8 minutes to 90 seconds, and 16 serious fall events have been successfully prevented throughout the year.

Abnormal detection: The accuracy rate of early warning of potential health problems is 78%, and health abnormalities are detected 48 hours in advance on average.

Satisfaction improvement: The satisfaction of residents and their families has increased by 35%, and the service renewal rate of institutions has increased by 22%.

Operating costs: Labor costs have been reduced by 28%, and the average annual operating cost per bed has been saved by about ￥24,000 .

4.3.2 Hospital Extended Service Practice

The application in a cardiovascular hospital affiliated to a 985 university shows that:

In-hospital application: unaccompanied ward guarding, reducing nursing manpower investment by 30%, and realizing 24-hour non-perceptual monitoring
Discharge follow-up: Remote monitoring of the health status of discharged patients covered 1,600 person-times, the readmission rate decreased by 24%, and patient satisfaction increased by 41%.
Treatment optimization: Provide doctors with health data in patients' daily life, drug adjustment is more accurate, and the treatment plan adjustment cycle is shortened from an average of 45 days to 18 days
Medical insurance saving: Each patient saves an average of ￥8,200 per year in medical insurance expenditure, and the overall return on investment ratio is 1:3.6

4.3.3 Community Health Care Practices

In a community in Guangzhou, it has been proved that:

Chronic disease management: The early perception rate of abnormal conditions in patients with cardiovascular disease and diabetes has reached 65%, and the emergency medical treatment rate has decreased by 32%.
Rehabilitation guidance: Personalized rehabilitation recommendations based on real-time data increased rehabilitation compliance by 48% and shortened functional recovery cycle by 26%.

Community service: A closed-loop management model of "community-hospital-family" was constructed, and the score of the elderly's health self-management ability increased by 31%.
Family burden: Reducing the burden of family caregivers, the mental health index of caregivers increased by 23%, and the absenteeism rate decreased by 35%.

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5. Social Value and Business Model

5.1 Multi-dimensional Value Creation

5.1.1 Medical Dimension Value

Fill the medical gap: Cover home environment monitoring outside of hospital treatment to achieve medical continuity.

Advance health intervention: Through early warning, health intervention is advanced before the disease becomes serious.

Precise medical treatment: Based on long-term personal data, assist doctors in formulating more precise treatment plans.

Reduce the medical burden: Reduce the emergency treatment and hospitalization rate caused by acute attacks of chronic diseases. Data shows that it can reduce the hospitalization rate of high-risk elderly people by 22%.

5.1.2 Pension and Social Value

Improving service quality: Enhancing the medical and preventive medical capacity of elderly care institutions
Optimize resource allocation: Achieve accurate allocation of medical resources and improve coverage
Reduced healthcare costs: Preventive interventions reduce overall healthcare expenditures, with a return on investment ratio of 1:3.6
Promote the integration of medical care and elderly care: Break through the data barriers between medical care and elderly care to achieve continuous care

5.2 Collaborative Business Model

The system adopts an open and collaborative business model to build a win-win ecosystem:

5.2.1 B2B Cooperation Model

Cooperation with Pension Institutions:

Value Proposition: Improve Service Quality and Create Differentiated Competitive Advantages

Cooperation Model: Equipment + Service Subscription, Charging by Bed

Typical Case: Strategic cooperation has been reached with a number of high-end pension chain institutions across the country

Cooperation with Medical Institutions:

Value proposition: Expand the scope of out-of-hospital services and increase the dimension of medical data

Cooperation model: technology empowerment + revenue sharing

Typical case: follow-up project of discharged patients from the cardiology department of a tertiary hospital

5.2.2 B2B2C Cooperation Model

Cooperation between insurance companies:

Value proposition: reduce the risk of claims and provide value-added services

Cooperation model: bundled insurance products, charging by user

Typical case: high-end medical insurance value-added services of a large insurance company

Community Service Cooperation:

Value Proposition: Building a Community-level Health Support Network

Cooperation Model: Government Purchasing Services + User Payment

Typical Case: A Pilot Project of Smart Elderly Care in a Street in Guangzhou

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6. Future technology prospects

6.1 Technology Development Roadmap

In the next 3-5 years, the system will continue to innovate in the following directions:

6.1.1 Multimodal Perception Technology

Deep multi-modal sensing data fusion: Integrate a variety of non-contact sensing technologies such as millimeter-wave radar, audio, and vision

Physiological Indicators Extension: Expand to more health indicators such as blood pressure estimation and blood glucose fluctuation inference

Environmental perception: comprehensive analysis based on environmental parameters (temperature, humidity, air quality).

6.1.2 AI Algorithm Upgrade

Personalized model: Exclusive health model based on individual physiological characteristics and historical data
Small-shot learning: Quickly adapt to new user characteristics with small amounts of data
Explainable AI: Enhance the transparency and explainability of AI decision-making and improve trust in healthcare

6.1.3 Innovation of Interactive Experience

Multimodal interaction: Human-computer interaction system of natural language + gestures + expressions
Virtual health assistant: A personalized health management assistant based on a large model
Immersive visualization: AR/VR health data display to improve intuitive understanding

6.1.4 Ecosystem Expansion

Open APIs: Supports integration with third-party applications and devices
Data interoperability: Comply with FHIR standards and enable cross-system data sharing
Ecological cooperation: Seamless connection with smart home, telemedicine and other systems

6.2 Frontier Research Directions

The cutting-edge technology directions that the team is exploring:

Federated learning: Implements collaborative training of multi-center data under the premise of protecting privacy
Quantum Algorithms: Exploring the application of quantum computing in medical data processing
Biofeedback: A real-time biofeedback intervention system based on monitoring data
Digital twin: Build a digital twin of personal health to achieve accurate health prediction

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VII. Conclusions

The health guardian system based on AI technology (LLM+RAG+Agent+Workflow) provides innovative solutions for long-term home care. Through non-contact sensing technology and advanced AI algorithms, the system realizes continuous monitoring, early warning and health prediction for the elderly and patients with chronic diseases, filling the monitoring gap beyond hospital treatment.

The system's three-level alert system realizes all-round coverage from emergency treatment to long-term health trend prediction, providing support for health management in different scenarios. Practice has shown that the system can effectively improve the service

efficiency of elderly care institutions, expand the service scope of hospitals, optimize the community health care model, and create significant medical, social and economic value.

With the acceleration of population aging and the intensification of the trend of chronic diseases at a younger age, the social value of such innovative technologies will become more prominent. Through an open ecosystem of multi-party collaboration, the health guardian system is expected to become an important link connecting medical care, elderly care, communities and families, and contribute to the construction of a healthy China.

Cooperation method

Partnership Opportunities

We sincerely invite the following institutions and individuals to explore the possibility of cooperation:

- **Elderly care institutions:** improve service quality, reduce operating costs, and create differentiated competitive advantages
- **Medical institutions:** Expand the scope of out-of-hospital services, improve the effectiveness of chronic disease management, and reduce the rate of readmissions
- **Insurance companies:** reduce claims risk, provide value-added services, and develop innovative insurance products
- **Local governments:** Enhance the capacity of community elderly care services and optimize the allocation of medical resources
- **Scientific research institutions:** jointly carry out applied research and technological innovation in related fields

Next Steps

If you are interested in learning more or working together, we offer the following support:

- **System demonstration:** Make an appointment for on-site or online system function demonstration
- **Pilot projects:** Customize a small-scale pilot program for your organization
- **Technical consultation:** Provide professional technical consultation for specific scenarios
- **Investment Opportunities:** Learn about project investment and partnership opportunities

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