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Computer-Aided Design AND APPLICATIONS

Computer-Aided Medical Approach to Intelligent Fuzzy Edge Computing in the Development Model of Aging Sports Health Industry within the Mass Health Industry Context

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Abstract. With the accelerated process of population ageing, the number of elderly people of advanced age in China has increased, and the number of disabled and semi-disabled elderly people due to injury, illness and aging has been increasing, and the demand for health and elderly-related products and services from the elderly groups is increasing day by day, so that the existing health and elderly industry can no longer meet these demands. The aim of this paper is to study the development model of the ageing health industry based on intelligent fuzzy edge computing in the context of the big health industry. The basic connotation of healthy ageing is introduced, the development model of the ageing health industry is analysed, an intelligent gateway system based on the IoT edge is designed, an ageing care system is built, and intelligent fuzzy edge computing and intelligent system applications are combined. The best task offloading computing node is selected from the candidate computing nodes by fuzzy logic reasoning. Finally, it is demonstrated experimentally that the fuzzy logic-based computational task offloading node selection method proposed in this paper outperforms local computing, Random algorithm and minimizing computational time delay algorithm in terms of execution time of computational tasks and the number of unexecuted computational tasks, and the aged care system meets the demand and can promote the scientific development of the healthy aged care industry.

Keywords: Intelligent Fuzzy, Edge Computing, Ageing Health, Industrial Development, Computer-Aided Medical Approach
DOI: https://doi.org/10.14733/cadaps.2024.S9.292-303

1 INTRODUCTION

Nowadays, cloud computing and edge computing are playing an increasingly important role in the field of IoT, where the main body of cloud computing (cloud server) has a lower cost of use and flexible and adjustable computing resources compared to traditional hosts, and can integrate resources according to the use of resources while providing powerful computing power to achieve maximum resource utilization; the main body of edge computing (edge device) is close to the data source and has The main body of edge computing (edge devices) is close to the data source and has certain computing power, so it can perform simple data processing operations locally and provide fast feedback on data processing results [2],[12]. The key to solving this problem is how to make full use of the advantages of cloud servers and edge devices and deploy ageing health services on cloud servers and edge devices [5],[13].

In view of the demand for healthcare for the elderly in the context of ageing, Aaisha Makkar has studied the integration of special towns with the healthcare industry in the context of the vigorous development of special towns. In addition to studying the value and current situation of healthcare towns, they also proposed development strategies for healthcare towns in terms of healthcare industry, wellness, retirement and holiday, with a view to injecting new vitality into the construction of healthcare towns.[1] Hichem Sedjelmaci used SWOT analysis to explore the opportunities and challenges for the development of healthcare services for the elderly. They proposed five development models: smart elderly services, health management services, anti-ageing/healthcare services, medical care integration and elderly financial services, which can provide theoretical references to promote the transformation and upgrading of industrial structure and seize the strategic development opportunities of elderly medical services[10]. In order to prevent, slow down, or stop the decline in older people's physical and mental abilities, the WHO Guidelines on Integrated Care for Older People offer evidence-based guidelines for health care practitioners. Edge computing is a new technology in the Internet of Things (IoT) paradigm, allowing sensitive data to be sent to distributed devices quickly and without latency.Aya M. Kishk proposes an RSP for edge computing (EC).Firstly, the resource characteristics are standardised and normalised. Secondly, for task scheduling, a fuzzy control-based edge resource scheduling (FCERS) is proposed. The results show that the technique improves the efficiency of resource scheduling and quality of service (QoS) in EC [6]. This provides a reference for ideas to promote healthy ageing. Researchers might develop a computer-aided medical system that utilizes intelligent fuzzy edge computing. This system could process medical data collected from wearable devices and sensors used by elderly patients. Fuzzy logic would help handle the uncertainty and variability often present in medical data from older individuals. The system might assist doctors in diagnosing and treating age-related health conditions by providing real-time insights and personalized recommendations.

In this paper, an ageing care system is designed to achieve the mutual integration of edge computing technology and service system applications. The system is equipped with functions such as medical health and sleep analysis. This paper further validates the usability of the fuzzy logic-based computational task offloading node selection method by experimentally testing the functionality of the caretaker system. It brings new ideas to solve the general problems of population ageing, the lack of awareness of the health and elderly care industry among management parties, the contradiction between the demand and supply of the health and elderly care industry, and the shortage of health and elderly care talent resources, and helps to actively cope with population ageing.

2 RESEARCH ON THE DEVELOPMENT MODEL OF AGING HEALTH INDUSTRY BASED ON INTELLIGENT FUZZY EDGE COMPUTING IN THE CONTEXT OF BIG HEALTH INDUSTRY

2.1 Healthy Ageing

The basic connotation of healthy ageing is a healthy ageing life, which is mainly reflected in:

1. For the individual, the elderly themselves maintain a relatively healthy physical and mental state and can actively participate in social activities;

2. For the group, the majority of the elderly population should be healthy, self-caring and mentally happy, and the proportion should be increasing;

3. For society, the trend of ageing, i.e. the increasing size and proportion of the elderly population, does not have an undue negative impact on society and society can still develop in a sustainable, healthy and balanced manner.

The theory of healthy ageing focuses on the main factors affecting the health of older people and aims to achieve a state of healthy physical, psychological and social functioning for the majority of older people and to protect the development of society from being overly affected by the ageing of the population. Environment, socioeconomic circumstances and risky behaviours can all interact to affect biological influences and hasten aging. Then, everyone's primary priority when looking for strategies to enhance their mental health should be exercise. The symptoms of depression can be lessened by having good physical health, but mental health issues can sometimes make physical health worse. According to the ethical principle of social responsibility, each person is responsible for carrying out their civic responsibilities, and their deeds must benefit society as a whole. Imbalances in hormones, genetics, concurrent conditions including chronic disease, living conditions, Behavioural health issues, Environmental and social influences are the main factors that affect the health of older people. This theory has positive implications for maintaining the basic health and improving the quality of life of the elderly population, and promoting the sustainable and healthy development of society. Exercise reduces arthritis pain and enhances function, mood and quality of life. Examples of this include walking, biking and swimming. Adults with arthritis should get up more often throughout the day and sit less. The recommended amount of moderate-intensity exercise per week is 150 minutes. Depression and dementia are two important aspects of old age quality of life to take into account. Ageing does not negatively affect quality of life when all other factors are under control. Rather, a prolonged period of good quality of life is feasible.

2.2 Development Model of the Ageing Health Industry

1. Serving the elderly population as the core, with networked technical means

This industry relies on the Internet platform, realising online and offline interaction through the Internet, achieving precise communication between the government, social organisations, market players and individuals, and realising the integration and innovation of the traditional service industry, with the core of serving the elderly population. To build this network, three pillars are needed:First, the cloud, including cloud computing and big data infrastructure, these technological innovations enable customers to use information resources more conveniently and at lower cost, promoting further productivity improvements and business model innovation. The art of business model innovation involves simultaneously changing an organization's value proposition to customers and its underlying operating model in a way that enhances advantage and value creation. For both new and existing businesses, business models are crucial. They support management and staff motivation, talent acquisition, and investment attraction for young, developing businesses.I/O networks, storage hardware, and processing hardware Facilities for data centers, such as power, rack space and network connectivity are the major components of the big data infrastructure. The second is the net, which includes the Internet and also extends to the Internet of Things. The third is the end, which refers to the personal computers, wearable devices, sensors, etc. that users directly touch, and even applications in the form of software. The end is both the source of the "cloud'' data and the interface between supply and demand for services, including both the users of services - mainly older people, as well as children, relatives and friends who have the obligation to support

and help them - and the providers of services: Mainly social forces, as well as government departments and institutions with the responsibility to support the bottom line.

2. Meeting the needs of the elderly as the standard and humanising the user experience

In times of technological change, there are two major contradictions: the "rapid pace of technological change" and the "slow pace of conceptual change" and the "difficulty in using and operating". These two contradictions are highlighted by the huge number of elderly people, their different health conditions, income differences and consumption habits, as well as the differences between urban and rural development and the development of traditional elderly care services. Preindustrial, industrial, and metropolitan stages are three distinct historical phases in the evolution of cities that sociologists analyzing urbanization trends have identified. Whereas, rural planning may be structured at several levels, ranging from plans at the global, national, and regional levels to plans at the village level.Low care quality, poor accountability, ignorance, and restricted access to facilities are the main issues facing by the healthcare system. In contrast, in urban areas with poor infrastructure for walking, cycling and public transportation, diabetes is connected to obesity and a lack of physical activity. High rates of anxiety, depression and mental illness are also associated with urbanization. Therefore, the development of the Internet + rural health and elderly care industry, whether from the point of view of the social benefits of industrial development or from the economic benefits of market players, must uphold a standard, namely to better meet the needs of the elderly and to achieve a humanised user experience. For example, the design of mobile phones for the elderly should enhance the volume and magnify the font size according to the declining hearing and eyesight of some elderly people. Experts advise limiting the volume entering your ears to no more than 70 decibels. Therefore, 16 pixels is the recommended minimum font size for mobile screens. To read anything smaller, users will need to pinch and zoom. And elderly services need to be differentiated according to the health status of the elderly: for those in a state of disability or semi-disability, provide them with combined medical and nursing services. More than 30% of over 65 and more than 50% of those over 75 have a disability of some type. These could include issues with hearing, seeing, walking, and thinking.

3. Diversify industrial development with the aim of achieving comprehensive health

In terms of industrial form, the development of the Internet+ rural health and elderly care industry requires a large platform, service providers and specialisation, forming three major clusters: firstly, a terminal equipment cluster, containing a variety of devices such as first aid mutual aid, health management, home care and intelligent positioning; secondly, a call centre, containing four major functions: an answering centre, a data information centre, an active care centre and an offline service command and dispatch centre: thirdly, an offline professional service The third is the offline professional services cluster, which contains a series of services such as emergency assistance, rehabilitation and medical care, domestic services, learning services, entertainment services and financial services. For example, with the help of Internet+, the health and elderly care industry can be integrated into the medical and health care sector, providing a full range of medical services for the elderly through wearable devices for remote diagnosis, online medical treatment and instant call for help; the health and elderly care industry can be integrated into education technology, opening up learning channels for the elderly through online education and playmate education; the health and elderly care industry can be integrated into the financial sector, providing more suitable financial products for the elderly; The integration of the health and retirement industry into the retail industry can provide more convenient shopping for the elderly; the integration of the health and retirement industry into the tourism industry can provide more personalized tourism products for the elderly and enrich their lives. Geriatricians are general practitioners with additional training in the care of elderly patients. By selecting a slot and paying for an online consultation, one can choose the doctor.Globally, the number of linked wearable devices has increased from 325 million in 2016 to 722 million in 2019, more than doubling in only three years. Devices used in healthcare include

wearable fitness trackers, smart watches, wearable ECG monitors, blood pressure monitors, and biosensors.

2.3 Edge Computing Technology

Edge computing is widely used in many fields such as intelligent manufacturing, vehicle networking, smart cities and mobile Internet, promoting the development of the Internet of Things. In traditional cloud computing, computing resources are concentrated in the cloud platform, and task offloading is to offload some highly concurrent tasks to the cloud nodes with sufficient resources for processing, but due to the excessive scale of the cloud computing platform, various cloud platform systems are isolated from each other, making the utilization of computing resources poor. When computing resources including storage, processing power, databases, networking, analytics, artificial intelligence and software applications are delivered via the internet is referred to as cloud computing. In the edge computing environment, edge computing nodes with different processing capabilities are scattered throughout the system network. When end devices perform task offloading, they need to collaborate with computing resources of the entire network and offload computing tasks to one or more computing nodes for execution through corresponding offloading decisions. How to collaborate with various computing nodes with different computing capabilities to reasonably allocate the offloaded computing tasks to the computing nodes, so as to minimize the data transmission overhead and maximize the utilization of computing resources, has become a hot issue in the field of edge computing.

2.4 Fuzzy Logic

The fuzzy logic algorithm is divided into three main steps: fuzzification, fuzzy inference and defuzzification. Decomposing a system's input and output into one or more fuzzy sets is the process of fuzzification. Then, the technique of applying fuzzy logic to map a given input to an output is known as fuzzy inference. And, the act of extracting a single number from the output of the aggregated fuzzy set is known as defuzzification.Defuzzification can take many different forms, such as center of gravity (COG), mean of maximum (MOM), and center average approaches. The fuzzy inference process is the mapping of affiliation to predefined IF/THEN rules and merging the results obtained from all the rules; defuzzification is the process of converting fuzzy conclusions into concrete numerical quantities. The flow of the fuzzy logic algorithm is shown in Figure 1.

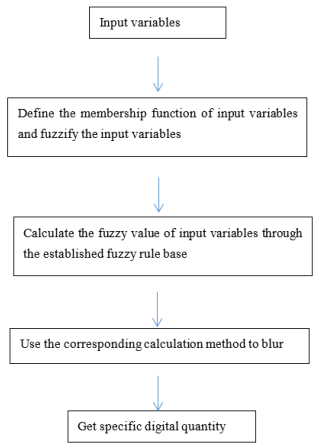

Figure 1: Flow of fuzzy logic algorithm.

Since fuzzy logic algorithms do not require mathematical modelling and use fuzzy rules in the form of human language to achieve multi-criteria decision making for multi-criteria indicators, they are widely used in multi-parameter decision making in various fields. The term "multi-criteria decision-making" relates to selecting choices when there are several, frequently competing criteria. Fuzzy decision-making is employed when there are ambiguous or insufficient data to support the solution. It can supply computing power and work around a device's hardware restrictions, such as low energy, storage, and computational capacity. The main focus of mathematical fuzzy logic is on logics that use a truth-functional explanation of partial truth. It makes it easier for you to operate machinery and consumer goods. Classification is a crucial use of fuzzy approaches in data mining.

3 INVESTIGATION AND RESEARCH ON THE DEVELOPMENT MODEL OF AGING HEALTH INDUSTRY BASED ON INTELLIGENT FUZZY EDGE COMPUTING IN THE CONTEXT OF BIG HEALTH INDUSTRY

3.1 Overall Design of the Caretaker System

The system focuses on the health and sleep conditions of the elderly, including body temperature and heart rate monitoring, sleep monitoring and analysis; it can monitor the environment in real time so as to monitor the home environment more safely; it supports remote control and human-computer interaction through the gateway client WebUI, mobile terminal APP and Chinese voice recognition system. Overall, the caretaker system integrates five major functions: medical health, sleep analysis, environment detection, accessibility following and intelligent control, as shown in Figure 2.

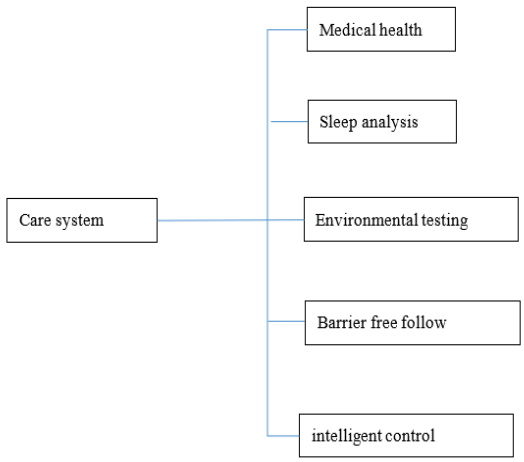

Figure 2: System functions.

The caretaker system consists of a caretaker robot, a network node cluster of remote interaction terminals and a cloud service. In this regard, the Edge Intelligent Gateway is integrated as a core hardware module to the service robot. An edge gateway receives data from edge devices, analyses it, sends back pertinent information, provides network translation between networks utilizing various protocols, and eventually lowers bandwidth requirements. Intelligent edge lowers expenses, security risks, and latency, which increases the effectiveness of the related business. The caretaker system

uses the service robot as the data processing and control centre, combined with deployed sensor nodes, such as smart wearable and environment sensing devices, as well as actuating nodes such as door locks and lights, to interconnect smart devices and robots in the home environment through device access protocols to achieve data sharing and jointly complete system functions.

From the perspective of an edge gateway, the service robot is equivalent to a removable device that hosts an edge smart gateway. And from the perspective of the service robot, the edge intelligent gateway is the control hub of the robot, aggregating data from all sensor nodes in the home environment to the robot, helping the robot to process data, including storing and analysing data, and forwarding data and commands to external terminals or sensor nodes.

3.2 Design of a Fuzzy Logic Based Offloading Node Selection Method for Computing Tasks

In this paper, based on the fuzzy values of LT, RTD and NCP input variables, the satisfaction level (SCN) of task offloading to candidate computation nodes is obtained by rules in the rule base, and the satisfaction level is classified into five levels {very poor, poor, average, good, perfect}.

When the computational task length is LT, the computational capacity of the computational node is NCPH, and the ratio of the transmission delay of the task offload to the maximum tolerated delay of the task is RTDL, the computational node selects a satisfaction level of very poor. RTDL stands for Real-time Location system and Devices. whereas these technologies used to track and monitor the location and movements of individuals such as RFID, Wi-Fi and Bluetooth to provide accurate information.

For example, a set of fuzzy logic input variables {LT:0.7, NCP:0.4, RTD:0.5}, the following four rules can be obtained from the affiliation functions of the three variables:

`11`

$$\begin{aligned} R1 &= \{LT_L : 0.25, NCP_L : 0.2, RTD_N : 1\} \\ R2 &= \{LT_L : 0.25, NCP_N : 0.8, RTD_N : 1\} \\ R3 &= \{LT_N : 0.25, NCP_L : 0.2, RTD_N : 1\} \\ R4 &= \{LT_N : 0.25, NCP_N : 0.8, RTD_N : 1\} \end{aligned} \tag{1}$$

In the condition of fuzzy rules using the minimum value method to get the final fuzzy value, so the calculation node selection satisfaction level for better affiliation for 0.2 and 0.25; In this paper, we use the centre of gravity method to defuzzify, according to the obtained affiliation, using the horizontal line cut output affiliation function and remove the top, and then calculate the centre of gravity of the remaining shaded part area by formula (2). When locating a single facility, the center of gravity method takes into account the locations of existing facilities, the distances between them and the amount of cargo that needs to be transported.

$$NOS = \frac{\int \mu(x) x dx}{\int \mu(x) dx} \tag{2}$$

NOS stand for Not Otherwise Specified. The exact output value NOS of each candidate computing node can be obtained by the fuzzy logic algorithm, which is expressed as {NOS1, NOS2.... .NOSN}, and the candidate node with the highest value of {NOS1, NOS2.... .NOSN}, the candidate computation node with the largest value is selected as the computation task offloading node:

$$NOS_{\max} = \max\{NOS_1, NOS_2, ..., NOS_N\} \tag{3}$$

A fuzzy quantity is defuzzified to produce a precise value. The union of the output from each rule is taken into account when developing the resultant membership functions, which implies that the overlapped area of the fuzzy output set is counted as one, producing more results. The traditional logic block is capable of understanding exact input and producing a clear output, such as TRUE or FALSE.

4 ANALYSIS AND RESEARCH ON THE DEVELOPMENT MODEL OF AGING HEALTH INDUSTRY BASED ON INTELLIGENT FUZZY EDGE COMPUTING IN THE CONTEXT OF BIG HEALTH INDUSTRY

4.1 Algorithm Analysis of Fuzzy Edge Computing

This paper compares the fuzzy logic-based method for selecting offloading nodes for computing tasks with the following three schemes:

Local computing:All computational tasks are placed on local devices for execution without considering offloading.

Random algorithm:In the SDIIoT-EC network architecture, the execution location of computational tasks (local, edge and local cloud) is randomly assigned, and if assigned to a computational node, the computational tasks are randomly assigned to a particular computational node. Smart Data-Driven Internet of Things Edge Computing is the name of the network architecture. It is intended to manage the rising volume, diversity and velocity of data produced by IoT devices at the network's edge. The explanation is that dense computational tasks will take longer to complete and use more energy as a result. In addition, several algorithms are contrasted.

Minimising computational latency algorithm:Under the condition that the computational task latency constraint is satisfied, the computational node that takes the least time to execute the task is selected for task processing. A compute node offers the temporary memory, computing, networking, storage and memory that virtual machine instances can use. The parameters of the experimental scenario are shown in Table 1.

parameter	Setting value
Field equipment computing capacity	2GHz
Calculate task workload	Obey the uniform distribution between [0 ， 2] (unit: Mb)
Computing power of edge computing gateway	10(GHz)
Number of edge computing gateways	8
Computing capacity of local ECS	50GHz

Table 1: Experimental parameters.

The computational task execution times of local computation, Random algorithm, minimising computational delay algorithm and the algorithm in this paper are compared for different number of computational tasks. The number of computational tasks in the experiments is taken as 20, 40, 80 and 100 respectively, and the results are shown in Figure 3. From the figure, it can be seen that the execution time of the computational tasks gradually increases as the number of computational tasks increases. Compared with the local computing and Random algorithms, the algorithm in this paper has the smallest computational task execution time. However, the task execution time of the algorithm in this paper is slightly greater than that of the minimised computation delay algorithm compared to the minimised computation delay algorithm, as shown in Table 2. The worst-case scenario under which an algorithm can execute a statement in the lowest time possible. The execution time in this situation acts as an upper limit on the algorithm's temporal complexity.

Calculation task quantity (piece)	Local Computing	Random algorithm	Algorithm for minimizing computation delay	Algorithm in this paper
20	0.8	0.6	0.7	0.6
40	1.5	1.4	1.3	0.8
60	3.3	3.1	3.0	2.5
80	4.7	4.5	4.1	3.1
100	5.8	5.1	4.7	4.2

Table 2: Calculation task execution time comparison.

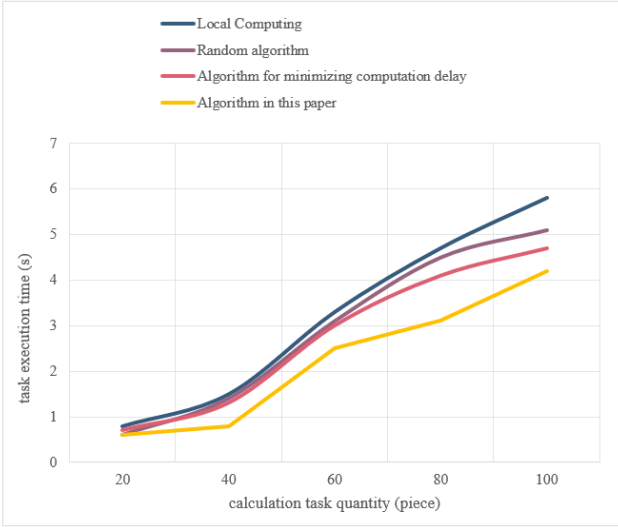

Figure 3: The impact of different computing tasks on computing task execution time.

4.2 System Function Analysis

The system can achieve remote monitoring of system data through WebUI and smart terminal APP. Remote monitoring refers to the capability of remotely observing machine condition, performance, and behavior. Devices consume real-time device data from IoT devices to determine each device's status and notify you. WebUI can display real-time monitoring information, including body temperature, heart rate and sleep data of smart wearable nodes, environmental temperature and humidity, air quality index, etc. uploaded by environmental sensing nodes, and can also remotely control desk lamp nodes, as shown in Table 3. In addition to the above functions, the smart terminal APP also has functions such as video dialogue. The client interface of the gateway can view the monitoring data in real time, and the signs column displays the body temperature and heart rate curves, as shown in Figure 4.

Time	temperature	heatrate
1:00	35	76
2:00	36	80
3:00	36	81
4:00	35	85
5:00	36	82

Table 3: Monitoring data.

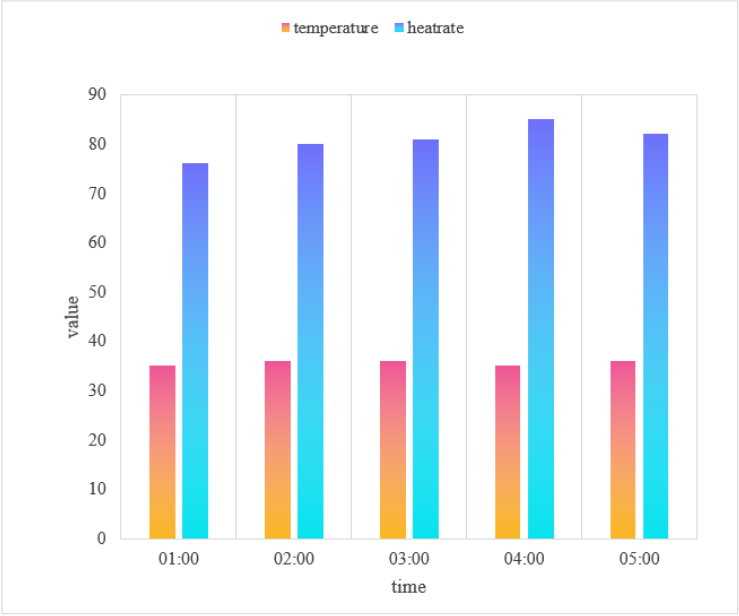

Figure 4. Monitoring of physical sign column.

5 CONCLUSIONS

With the progress of social civilisation and the continuous emergence of people's demand for healthy ageing, the trend of the healthy ageing market tide is gradually becoming obvious. Promoting the accelerated development of the health and elderly care industry into shape through scientific management, so as to actively and effectively solve the problem of unbalanced and insufficient development of the health and elderly care industry brought about by the ageing population, is not only a positive response to the ageing population, but also a realistic need to promote the prosperity and coordinated development of the economy in the context of an ageing society. In this paper, a caregiving system based on an edge gateway is designed and implemented, and a fuzzy logic-based method for selecting nodes for offloading computational tasks is proposed. However, this paper is not clear and mature enough in the formulation of certain ideas, and there are some deficiencies in the research and application of certain policies and theories, such as insufficient depth of research, insufficient understanding of policies, superficiality in response to certain issues, and insufficient understanding of management theories to guide practice with precision, etc. All these will be improved in the next research.

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ACKNOWLEDGEMENTS

Special Key Projects Entrusted by Chongqing Social Science Planning Think Tank in 2022 (Approval No.: 2022ZDZK42), Key Research Project of Chongqing Postgraduate Education and Teaching Reform in 2022 (Project No.: yjg222017), 2022 Chongqing Education Science "Fourteenth Five Year Plan" Key Project (Project Approval No. K22YD204071)

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