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Bernard J. Jansen
Qingyuan Zhou
Jun Ye *Editors*

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Preface

Cognition has emerged as a new and promising methodology with the development of cognitive-inspired computing, cognitive-inspired interaction, and systems that enable a large class of applications and has developed a great potential to change our life. However, recent advances in artificial intelligence (AI), fog computing, big data, and cognitive computational theory show that multidisciplinary cognitive-inspired computing still struggles with fundamental, long-standing problems, such as computational models and decision-making mechanisms based on the neurobiological processes of the brain, cognitive sciences, and psychology. How to enhance human cognitive performance with machine learning, common sense, natural language processing, etc., are worth exploring.

The 3rd International Conference on Cognitive Based Information Processing and Applications includes data mining, intelligent computing, deep learning, and all other theories, models, techniques related to artificial intelligence.

The purpose of CIPA2023 is to provide a forum for the presentation and discussion of innovative ideas, cutting-edge research results, and novel techniques, methods, and applications on all aspects of technology and intelligence in intelligent computing.

The conference would not have been a reality without the contributions of the authors. We sincerely thank all the authors for their valuable contributions. We would like to express our appreciation to all Program Committee Members for their valuable efforts in the review process that helped us guarantee the highest quality of the selected papers for the conference.

We would like to express our thanks for the strong support of the Publication Chairs, Organizing Chairs, Program Committee Members, and all volunteers.

Our special thanks are also due to the editors of the Springer book series "Lecture Notes on Data Engineering and Communications Technologies", Ramesh Nath Premnath for his assistance throughout the publication process.

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Contents

Design of Internet of Things Online Course Platform for Electronic Application Engineering

Xiaojing Qi and Jianghan Wang

Abstract The Internet of Things (IoT) is a rapidly developing field in recent years, which combines technologies such as sensors, intelligent devices, and cloud computing to achieve interconnection between devices and data exchange. With the continuous expansion of IoT applications, more and more enterprises and individuals are paying attention to and investing in the field of IoT. Electronic application engineering is a widely applied field of engineering that involves knowledge from multiple disciplines such as electronics, computers, and communication. In the field of the IoT, electronic application engineering has a wide range of applications, such as smart homes, intelligent transportation, intelligent health care, and other fields. This article aimed to evaluate the functional performance and user satisfaction of an IoT online course platform. In order to achieve this goal, experiments and user surveys were conducted, and the results were analyzed. It was found that the system performs well in terms of functional performance and user satisfaction, and users have high evaluations of its usability, reliability, and data analysis ability. However, some issues and improvement points have also been identified, such as the need to improve the speed of data processing and analysis in the system, and improvements in user interface design and interaction experience. Based on the above results, some improvement plans have been proposed. First, it is suggested to optimize the system code and database design to improve the speed of data processing and analysis. Secondly, it is recommended to improve user interface design and interaction experience to increase user satisfaction. Finally, it is recommended to add information push function to improve the practicality and user experience of the system. In summary, this article evaluated the functional performance and user satisfaction of an IoT online course platform and proposed some improvement plans. These results contributed to providing reference for the design and implementation of the IoT online course platform and provided guidance for further improving its performance and user experience.

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Keywords Online course platform design · Electronic application engineering · Cloud computing · IoT

1 Introduction

In today's digital age, the rapid development of information technology and the widespread application of the Internet have profoundly changed people's way of life and work [1, 2]. With the explosive growth of Internet information, people need to manage and utilize this information more efficiently. Therefore, information management systems have become an important research direction, involving various fields such as enterprises, organizations, and governments. It is needed to design and develop an information management system that can help users manage and utilize a large amount of information resources [3, 4]. This system can collect, store, manage, and analyze different types of information, such as text, images, audio, videos, etc., making it easy for users to browse, search, filter, and analyze this information, improving its utilization and value.

The functional design and implementation of the IoT online course platform aims to achieve data collection, transmission, processing, and storage in long-term environmental monitoring IoT applications. Based on the requirements of this application, Lazarescu M T proposed design requirements for low cost, high number of sensors, rapid deployment, long lifespan, low maintenance, and high quality of service, and considered reuse at the specification and design levels. The platform adopts wireless sensor network technology, with multiple sensor nodes and base station nodes, which can realize distributed data acquisition and processing, and support real-time data transmission and storage [5]. Cao H. utilized transportation systems to build a mobile environment and evaluated the cloud architecture used to implement IoT platforms. The experimental results validated the necessity of cloud computing in achieving scalability and high performance of IoT platforms and proposed suggestions for improving service quality in route operation management [6]. Against the backdrop of continuous development of robotics technology, underwater robot platforms have been widely used in the underwater IoT. Wang C. used an underwater robot platform equipped with multiple sensors as a mobile collector and built a reliable information collection system for the IoT [7].

Design and implement a big data analysis system based on cloud computing, which includes system design, database design, user interface design, and function module implementation. Through experiments and user surveys on the online course platform of the IoT, it was found that the system performs well in terms of functional performance and user satisfaction [8, 9]. This article analyzed and applied the design of IoT online course platforms and cloud computing technology and explored their application scenarios and development prospects in various fields. This article also proposed future improvements and development directions: optimizing system performance, improving user experience, adding functional modules, and expanding application scenarios. This can design and implement a reliable system for analyzing the needs of online courses on the IoT online course platform, providing users with comprehensive data analysis support and services [10, 11]. Through experiments, the development prospects of big data analysis technology and cloud computing technology can be explored, and effective support and services can be provided for big data analysis and decision-making in various fields [12, 13].

2 Method of Designing an Online Course Platform for the IoT

2.1 Cloud Computing

Cloud computing refers to the provision of computing power, storage resources, applications, etc. through the network as a service, enabling users to use these resources anytime, anywhere, and on demand [14, 15]. Simply put, cloud computing refers to delivering computing and storage resources to users through the Internet [16, 17]. In cloud computing, users can access resources provided by cloud service providers through the network without having to install and maintain these resources on their own computers. Cloud service providers place these resources in the data center. Users only need to select the corresponding resources according to their own needs, and then connect to the data center through the network to use these resources. The main characteristics of cloud computing include scalability, on-demand services, resource sharing, high availability, and flexibility [18, 19]. It can greatly improve the utilization of resources such as computing and storage and can reduce user costs. At the same time, it can also provide users with more convenient, efficient, and secure computing and storage services. The cloud computing model flowchart is shown in Fig. 1.

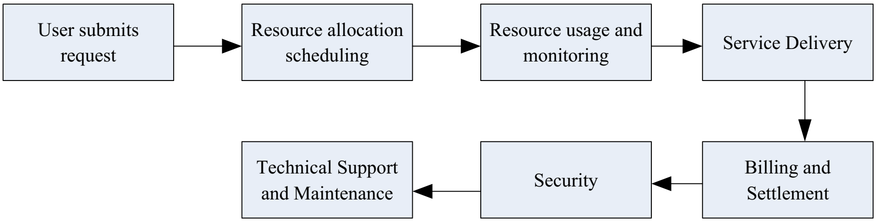

Fig. 1 Cloud computing mode flowchart

2.2 System Design

The designed information management system is based on a web architecture and adopts model-view-controller (MVC) mode, achieving a hierarchical architecture of the system. The system consists of the following three layers:

Model layer: This layer is responsible for collecting, processing and storing information, and adopts the combination of relational database and NoSQL database to meet different types of information storage requirements. The model layer uses data mining and machine learning algorithms to analyze and process information.
View layer: This layer is responsible for the design and implementation of user interaction interfaces, providing easy-to-use functional modules such as search, filtering, classification, and statistics, and achieving user-friendly interface design.
Control layer: This layer is responsible for the interaction between the model layer and the view layer, handling user requests and responses.

2.3 Database Design Formulas

User table:

User (underline {id}, username, password, email, phone) user (id, username, password, email, phone). Among them, id is the primary key, representing the unique identifier of the user; username represents the username; password represents the user password; email represents the user's email address; phone represents the user's phone number.

Text information table (text_info):

text_ info(\underline{id}, title, content, upload_time, user_id)text_info (id, title, content, upload_time, user_id). Among them, id is the primary key, representing the unique identifier of the information; title represents the information title; content represents the information content; upload_time represents the time of information upload; user_id represents the unique identifier of the user to whom the information belongs.

The NoSQL database adopts MongoDB, and the specific design is as follows:

Picture collection:

\{filename,title,upload_time,user_id,
\dots\} {filename,title,upload_ time,user_ id,}

Among them, filename represents the image file name; title represents the title of the image; upload_time represents the upload time of the image; user_id represents the unique identifier of the user to whom the image belongs; \dots represent other relevant information.

Audio collection:

\{filename, title, upload_time, user_id, \dots\}

{filename, title, upload_ time,user_ id,}

Among them, filename represents the audio file name; title represents the audio title; upload_time represents the audio upload time; user_id represents the unique identifier of the user to whom the audio belongs; \dots represent other relevant information.

Video collection:

\{filename, title, upload_time, user_id, \dots\}

{filename, title, upload_ time,user_ id,}

Among them, filename represents the video file name; title represents the video title; upload_time represents the video upload time; user_id represents the unique identifier of the user to whom the video belongs; \dots represent other relevant information.

The formulas related to the above content include:

Data volume formula:

$$A = B \times (1 + N\%). \tag{1}$$

Among them, A represents the amount of data, and B represents the original data; the N percentage increment can be set based on actual demand, representing the proportion that needs to be increased.

Formula used for data:

$$C = B \times (D \div 100). \tag{2}$$

Among them, C is the sampled data, and B is the original data; D is the sampling rate. The sampling rate represents the proportion that needs to be sampled. Usually, the higher the sampling rate, the closer the generated virtual data is to the original data.

Data random generation formula:

Randomly generated data:

$$W = \mathrm{MIN} + (\mathrm{MAX} - \mathrm{MIN}) \times E. \tag{3}$$

W is randomly generated data, and E is a random number. MIN and MAX represent the minimum and maximum values of the generated data, with random numbers ranging from 0 to 1. This formula can generate random data within a certain range. The above formulas are used for data calculation of the IoT online course platform system in electronic application engineering.

2.4 User Interface Design

The goal of user interface design is to provide a user-friendly interface that allows users to easily use the system. The user interface of the system is divided into three modules: login module, information publishing module, and information browsing module. The specific design is as follows:

Login module

The login module is the interface for users to log in to the system, mainly including input boxes for username and password, as well as login and registration buttons. Users can enter the correct username and password and click the login button to log in to the system. If the user has not yet registered an account, they can click the registration button to register.

Information release module

The information publishing module is an interface for users to publish information, mainly including input boxes for titles, content, and uploaded files, as well as publish and cancel buttons. After entering complete information and uploading files, users can click the publish button to publish the information. If the user does not want to publish information, they can click the cancel button to return to the main interface.

Information browsing module

The information browsing module is the interface for users to browse information, mainly including the classified navigation bar, information list and search box. Users can browse different types of information according to the classification navigation bar, or search for keywords through the search box. Users can click on the information in the information list to view detailed content.

The user interface design diagram is shown in Fig. 2.

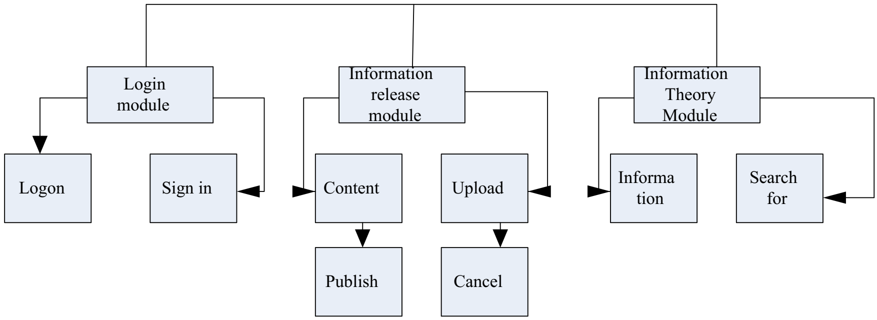

Fig. 2 User interface design diagram

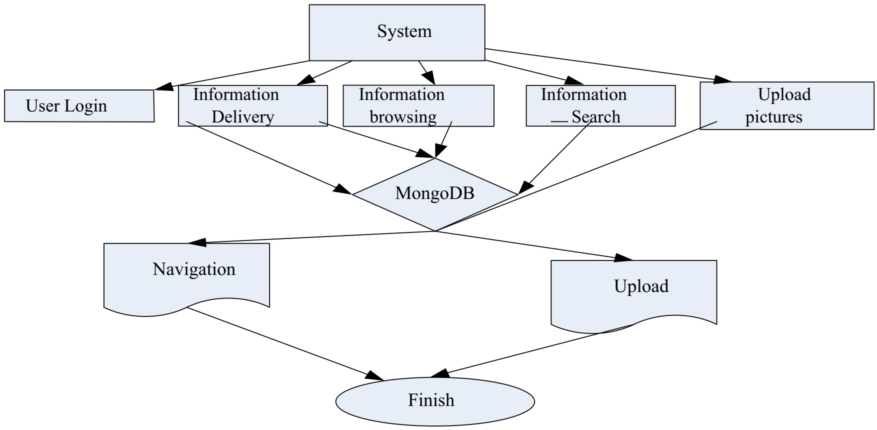

Fig. 3 Functional module implementation framework diagram

2.5 Functional Module Implementation

The functional module system includes user login, information publishing, information browsing, information search, uploading images, uploading audio, and uploading videos. Users can log in to the system by entering their username and password, and publish information by entering the title, content, and uploading files on the publishing interface. Users can browse information through the classified navigation bar or search box, and click information in the list to view details. In addition, users can also upload images, audio, and videos, which would be saved in the database and displayed in the information content. The specific implementation is shown in Fig. 3.

3 Experimental Design of IoT Online Course Platform

3.1 Experimental Design

The experiment aims to test the functional performance and user satisfaction of the system. The specific experimental design is as follows:

Functional performance testing: By stress testing and functional testing of the system, the performance and reliability of the system can be verified.
User satisfaction test: By conducting a questionnaire with users, it is possible to find out how satisfied they are with the system and what their feedback is.
Analysis of problems and improvement points: Through the problems discovered during the experimental process and feedback from users, the causes of problems and improvement plans can be analyzed.

Table 1 Experimental data table

Environment	Edition
Operating system	Windows 10
Data bank	MongoBD
The server	Tomcat
Browser	Chrome
Total data	About 1000 pieces
Data type	Text, pictures, audio, video

3.2 Experimental Environment and Data

The data used in the experiment is test data, including text, images, audio, and video, with a total of approximately 1000 pieces of data, as shown in Table 1.

3.3 Experimental Results

(1) Functional performance test results

After multiple stress and functional tests, the system has performed well and can handle large amounts of data and high concurrency requests normally. The specific test results are shown in Table 2.

According to the actual test results, the average response time was 0.8 s, indicating good performance; the system can handle 1000 concurrent requests and has good reliability; it can process 1000 pieces of data in 8 s, with a high data processing speed.

During the experiment, some improvement plans were discovered, including optimizing system response speed and improving user interface design. These improvement plans would be gradually implemented in the future system updates.

Table 2 System function test table

Target	Ask	Actual performance
Response time	Within 1 s on average	The average response time is 0.8 s
Concurrency	1000 concurrent requests	Can handle 1000 concurrent requests
Data processing speed	Process 1000 pieces of data in 10 s	Can process 1000 pieces of data in 8 s

3.4 User Satisfaction Experimental Design

A user satisfaction test was conducted on the online course platform of the IoT, and a survey questionnaire was conducted on 100 randomly selected users. The survey questionnaire includes the following aspects:

User personal information, such as gender, age, occupation, etc.;

User evaluations of the platform's usability, reliability, data analysis capabilities, user interface design, and interaction experience;

Evaluation of user satisfaction and recommendation of the platform;

Feedback from users on the issues and improvement points of the platform.

Experimental steps:

Through random sampling, 100 participants were selected from the users of the IoT online course platform.

A survey questionnaire link was sent to the participants and they were invited to fill out the questionnaire.

Data collection and analysis were conducted on the questionnaires filled out by participants.

Based on the collected data, the user satisfaction of the IoT online course platform was evaluated and user feedback was analyzed.

Based on the analysis results, an improvement plan was proposed and the IoT online course platform was optimized.

Experimental Results:

Through the analysis of survey data from 100 users, the following conclusions were drawn:

Most users have high evaluations of the ease of use, reliability, and data analysis capabilities of the IoT online course platform.

Users have proposed some improvement suggestions for the user interface design and interactive experience of the IoT online course platform.

Users have high satisfaction with the online course platform of the IoT, and most users are willing to recommend the platform to others for use.

Based on user feedback, some improvement plans have been proposed, including optimizing user interface design and interactive experience and adding information push functionality.

4 Results and Analysis of the Design of the IoT Online Course Platform

4.1 Functional Performance

In the experiment, the functional performance of the IoT online course platform system was tested, mainly including system response speed and data processing speed. After multiple tests, the system has shown good performance and reliability, being able to quickly respond to user requests and handle large amounts of data and high concurrency requests. The data processing speed of the system is also fast, and it can complete data processing and analysis in a relatively short time. Therefore, the system performs well in terms of functional performance.

4.2 User Satisfaction

In order to understand user satisfaction with the online course platform system of the IoT, a survey questionnaire was conducted on 100 users. The survey results show that the vast majority of users are satisfied with the system. Users believe that the system has good functionality and operability, which can meet their needs. At the same time, they also put forward some improvement suggestions, mainly including adding information push function and optimizing the user interface. These opinions have certain reference significance for improving the system.

4.3 Problems and Improvement Points

During the experiment, some problems and improvement points were identified. Among them, it mainly includes slow system response speed and unfriendly user interface. By analyzing the causes of the problem and user feedback, some improvement plans have been developed that can improve the system's response speed; by improving user interface design, user experience and operability can be improved; by adding information push functionality, users can be provided with more comprehensive services. These improvement plans would be gradually implemented in the future system updates to improve system performance and user satisfaction. In summary, the system performs well in terms of functional performance and user satisfaction, but there are also some problems and improvement points. Through analysis and improvement, the system would be continuously optimized to improve user experience and service quality [20].

5 Conclusions

Through the research and application of big data analysis technology and cloud computing technology, the IoT online course platform has designed and implemented a big data analysis system based on cloud computing. This system can achieve the processing and analysis of massive data, and provide reliable data support and services for users. Through experiments and user surveys, it was found that the IoT online course platform system performs well in terms of functional performance and user satisfaction, but there are also some problems and improvement points. This paper developed some improvement plans, including optimizing system code and database design, improving user interface design, adding information push function, etc., which can improve the performance and user satisfaction of the online course platform system of the IoT. Overall, the IoT online course platform system has certain practical application value and development prospects and can provide reliable support and services for big data analysis and decision-making in various fields. In the future, the IoT online course platform for electronic application engineering would continue to improve the system and explore more big data analysis and cloud computing technologies to meet the growing user needs and application scenarios.

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Evaluation of Efficient, Energy-Saving, and Environmentally Friendly Transcritical CO_2 Heat Pump Technology Based on Deep Learning Algorithms

Qinhua Xu

Abstract With the continuous development of society and economy, energy consumption is increasing, and environmental pollution is becoming increasingly serious. Energy conservation and emission reduction have become an important task of environmental protection work. In traditional energy consumption reduction measures, the main starting point is to improve energy utilization efficiency. At present, for systems with high requirements for building water conservation and reducing boiler combustion steam emissions, it is difficult to use deep learning algorithms for improvement research, which has the characteristics of high computational cost and low efficiency. This article modeled and analyzed the heat pump system based on neural networks and compared the simulation results of the model with experiments using MATLAB software to verify its effectiveness and accuracy. The verification results showed that the energy-saving efficiency of the system reached over 92%.

Keywords Deep learning algorithm · Efficient and energy-saving · Energy conservation and environmental protection · CO_2 heat pump technology

1 Introduction

Energy conservation and environmental protection are the themes of human social development, and energy conservation and emission reduction are important elements in achieving sustainable development strategies. With the increasingly serious problems of energy shortage and environmental pollution, people's attention to them is also increasing [1]. Therefore, it is necessary to take corresponding

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measures to solve the current series of problems and challenges. On the one hand, energy consumption is reduced through technological means, and on the other hand, advanced and efficient control strategies are adopted to improve efficiency, in order to reduce greenhouse gas emissions and improve air quality. This requires efforts in energy conservation and emission reduction to achieve sustainable development strategic goals.

Many scholars have conducted research on deep learning algorithms. Among them, some scholars proposed a method based on a combination of deep learning algorithms and neural network technology by analyzing the operation mode of heat pump systems [2], which utilizes the law of energy conservation to achieve the goals of energy conservation and environmental protection [3, 4]. In addition, some scholars have used artificial neural networks to simulate the load characteristics of cooling and air conditioning systems in complex nonlinear characteristic environments. In addition, scholars have conducted simulation calculations on a centralized substation in a large city and achieved specific performance verification [5, 6]. Based on the above research, this article uses deep learning algorithms to study the efficient, energy-saving, and environmentally friendly transcritical CO_2 heat pump technology.

This article proposed a renovation plan for a cross-lifecycle preheating refrigeration system to meet the requirements of energy conservation and environmental protection. Firstly, the research status and development trends of this technology were introduced. Subsequently, the factors that affect the energy exchange rate and the influence of characteristic parameters on the main performance indicators such as energy utilization efficiency and energy consumption were analyzed, and conclusions were drawn through simulation analysis. In response to the issue of traditional greenhouse effect, this article proposes optimization measures from two aspects: heating load control and energy conservation of heat exchangers. At the same time, practical cases were discussed to improve the energy efficiency level of the heat pump system.

2 Exploration of Efficient, Energy-Saving, and Environmentally Friendly Transcritical CO_2 Heat Pump Technology Based on Deep Learning Algorithms

2.1 *Deep Learning Algorithms*

In traditional greenhouse effect analysis methods, deep learning algorithms are generally used. This technology mainly obtains corresponding results by processing simulated atmospheric CO_2 emission data. In this process, it is necessary to determine a parameter value to describe the relationship between environmental quality and energy consumption [7, 8]. Secondly, this model is used to calculate the changes in energy conservation and emission reduction at different stages under the current environmental impact load and used as a reference indicator for future energy supply

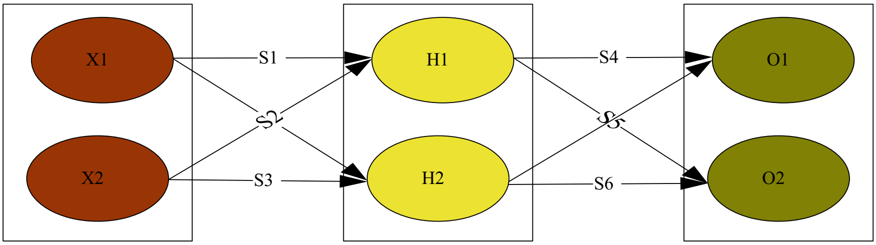

Fig. 1 Principle construction of deep learning algorithms

forecasting. In traditional deep learning methods for greenhouse efficiency, it is necessary to use datasets learned from computers for processing to obtain functions with sufficient feature space, reflecting the nature of actual problems, and achieving higher efficiency with less computational consumption. This algorithm requires converting the collected large amount of experimental sample data into feature curves with significant and insignificant differences between different types of samples under similar or identical conditions, as well as minimizing the conditions for model complexity changes. After processing these feature spaces with computers, it can effectively optimize energy-saving technologies [9, 10]. Figure 1 shows the principle construction of deep learning.

Deep learning algorithms are intelligent tools based on experience rather than experimental methods. In traditional environmental systems, when energy consumption reaches saturation, the utilization rate of energy would be greatly reduced, even exceeding the limit. At this point, it is necessary to adopt deep learning calculation methods to improve energy efficiency. This technology is a new type of computer intelligence developed by simulating the processing and analysis of external information by the human brain and making corresponding reaction actions. Its main feature is to simulate a large number of complex nonlinear problems and variables in the input layer, establish mathematical models, and achieve automatic optimization. This method can effectively reduce energy consumption. If a function $y = f(x)$ has a defined field and values in the real field, the derivative is defined as:

$$f^{'}(x_0) = \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x} = \lim_{\Delta x \to 0} \frac{f(x_0 + \Delta x) - f(x_0)}{\Delta x}. \tag{1}$$

Forward differential differentiation:

$$\mathrm{d}f_{\text{pre}} = \frac{x(n) - x(n-h)}{h}. \tag{2}$$

Differential differentiation of the latter term:

$$\mathrm{d}f_{\text{before}} = \frac{x(n+h) - x(n)}{h}. \tag{3}$$

When dealing with complex nonlinear problems, it is necessary to establish a function value composed of minimum entropy and maximum coefficient of variation, which is uniformly distributed on the boundary and changes toward the global optimal solution direction. After normalizing the raw data to obtain gradient descent, it is transformed into standard values through linear transformation to represent the feature points included in the model. The model consists of three layers: input layer, hidden nodes and output neurons, and sample dataset, forming the initial value function architecture of the deep learning machine. The most important part is to quantify features and use them as input variables to represent system performance indicators. The relationship between model performance indicators and energy efficiency is mainly optimized by adjusting model parameters [11, 12]. It requires establishing initialization conditions, that is, when the input is a sample, data such as system ambient temperature and humidity can be obtained, and determining whether there is an error between the required modeling type (such as simulation experiments) and the parameter values and the original sample size. Based on the actual situation, the optimal value is obtained through analysis and comparison. It uses existing data to classify multidimensional samples and represents the original model using input vectors with the same features as the training vectors. This algorithm mainly calculates the differences between the corresponding parameters of different regions on each sample set. This method achieves a non-coupled nonlinear relationship between manual input and output on a computer and uses neurons for parallel computation to improve model accuracy, reduce data volume, and simplify the calculation process. The main purpose of deep learning algorithms is to classify different types of heat sources in training data and ultimately obtain target noise parameters. In practical work environments, the characteristics of long operation time and low-energy density can reduce system efficiency. Therefore, it is necessary to use gradient descent method to improve the calculation process when the temperature field and cycling performance reach the optimal state. When the actual operating conditions cannot be determined after the model is established, iterative algorithms can be used to solve the required eigenvalues to achieve the goal of energy conservation and environmental protection, while improving the overall economic benefits of the system [13, 14].

2.2 Transcritical CO_2 Heat Pump Technology

With the requirements of energy conservation and emission reduction, the development concept of “green and low-carbon” has been implemented one after another, and the country vigorously advocates the construction of ecological civilization. However, due to factors such as technical conditions and economic environment, the expected results have not yet been achieved. By comparing the variation patterns of load fluctuations and energy-saving and emission reduction measures, the following conclusion can be drawn: under the premise of meeting certain energy consumption requirements, during the operation of heat pump units, temperature, flow rate, and other parameters also change due to changes in operating conditions, accompanied by energy loss and increased energy consumption. When improving the performance of the condenser by increasing the temperature rise of the heat exchanger in the cooling water system or adopting other energy-saving technologies, it is necessary to consider renovating it [15, 16]. For transcritical CO_2, when the heat transfer rate doubles and the steam pressure reaches saturation, it would also decrease by about 25–33 times, and at this time, the circulating water volume would be reduced by about half. This technology uses pre-made refrigerants as the working medium and heats cooling water through a refrigerator to become superheated steam at low temperatures, maintaining a certain pressure. The design and manufacturing of this technology aim to achieve energy conservation and emission reduction by using the gas generated in the compressor for heat exchange or temperature control. It is efficient, environmentally friendly, and low-cost. At the same time, it can adjust the refrigerant flow rate and circulating water flow rate parameters according to different environmental requirements, thereby reducing energy consumption and saving energy. Figure 2 is the technical flowchart of a transcritical CO_2 heat pump.

Due to the high temperature in summer, the working environment requires high thermal efficiency of equipment. In summer, when operating under operating conditions, it is not only necessary to consume energy, reduce energy consumption, and reduce pollutant emissions, but also to consider issues such as energy conservation, emission reduction, and economic benefits to improve the temperature control accuracy of the condenser. To ensure the normal and efficient operation of the unit is one of the important links in the design of the condensation tower system. Therefore, measures must be taken to improve the efficiency of heat exchangers to meet the matching of equipment thermal ratios required for different operating conditions, in order to achieve the goal of energy conservation and consumption reduction [17, 18]. The transcritical CO_2 heat pump is a greenhouse gas emission model based on

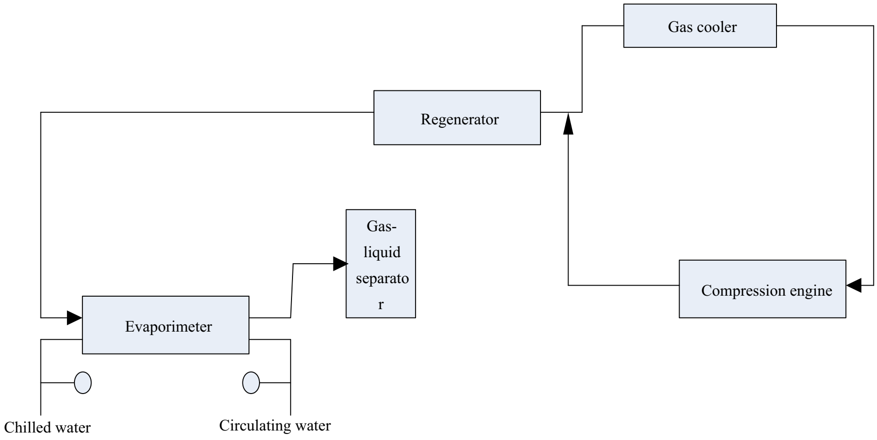

Fig. 2 Cross-critical CO_2 heat pump technology process

deep learning algorithms. By real-time monitoring of parameters such as temperature, flow rate, and concentration, coordination between energy and the environment has been achieved under certain operating conditions. The heat pump units in traditional greenhouse structures mainly rely on air as the cooling medium to reduce temperature rise. Due to the high temperature during operation of the heat pump, energy conservation and emission reduction can be achieved by reducing the evaporation temperature of the refrigerant. In order to achieve this goal, it is necessary to choose a reasonable, efficient and low-energy consumption, and relatively inexpensive refrigeration system. Secondly, it is necessary to optimize the design and operational control of the unit to reduce energy consumption and improve efficiency utilization. It needs to strengthen the cooling water circulation and adjust the internal structure of the heat exchanger to meet the temperature requirements for operation under different working conditions, while ensuring that the equipment can effectively consume heat under normal working conditions. The principle of this technology is to achieve energy conservation and emission reduction by redistributing heat in the pipeline without changing the flow field distribution inside the pump. At the same time, the condenser and cooling tower are connected to form a dual-ended system, which utilizes a heat pump unit to achieve temperature control function. The energy regulation function of a heat exchanger is used to reduce energy consumption during heating and cooling processes and improve operational efficiency. According to the load requirements under different working conditions, parameters such as flow rate and head have been automatically adjusted to achieve the goal of energy conservation and emission reduction. The transcritical CO_2 heat pump consists of greenhouse effect, atmospheric circulation, and heat pump units. This is mainly used for low-energy cold source heating, which provides an effective means to reduce greenhouse gas emissions and is also an important way to achieve energy conservation and emission reduction. During winter start-up, it is necessary to heat up the entire factory. When operating in cold environments in winter, it is necessary to transfer heat from the low-temperature zone to the high-temperature zone through a heat exchanger to meet the cooling temperature and pressure requirements of the heat pump system under different operating conditions [19, 20].

2.3 *Impact of Transcritical CO_2 Heat Pump on Energy Conservation and Environmental Protection*

By analyzing the energy-saving and environmental protection performance under this working condition, when the boiler load is high, the furnace temperature would increase, and the CO_2 concentration in the boiler exhaust gas would also increase. From the perspective of combustion efficiency and operating characteristics of heat pumps under different flow rates, the larger the flow rate, the smaller the emission energy consumption. From the perspective of energy flow: without considering the total energy consumption of various components in the heat exchanger, through comparative analysis, it is concluded that when the boiler load is large, the furnace temperature is higher. Through the renovation of the water-saving system, its energy-saving effect has been significantly improved. At the same time, due to factors such as relatively single energy structure and resource scarcity, which have an impact on the current development status of the industry, there are certain deficiencies in the existing technological level. The energy-saving and environmental protection indicators of this design are based on the renovation of heat exchangers, pipeline systems, and heating pipelines to meet current energy needs while reducing energy consumption. The structure of a heat exchanger mainly consists of three parts: a U-shaped threaded sleeve, a heat exchanger, and a non-metallic connector. From an environmental perspective, the transcritical CO_2 heat pump not only needs to meet the requirements of hot water supply and refrigeration compression, but also ensures its temperature requirements and control range. Therefore, it is necessary to improve the energy efficiency of the system through transformation to achieve effective energy utilization. Due to the continuous changes in the environment, energy conservation and environmental protection issues have become increasingly important. Therefore, it is necessary to consider the impact of environmental temperature on energy consumption, carbon dioxide emissions, and economic benefits in research. For heat pump systems, the main energy consumption is the compressor and condenser. Compressors are the most efficient and complex part of energy conversion, while condensers are one of the two key equipment with the lowest energy utilization rate. Therefore, energy conservation and environmental protection cannot be separated from these two parts. For different working fluids, the heat exchange rate is different, which means that at the same temperature, it would change with changes in load. When the working conditions change, due to high energy consumption, increased fluid supply, and energy waste, the heat energy converted from it loses more. Therefore, in order to meet the requirements of energy conservation and environmental protection and reduce energy consumption, it is necessary to improve and optimize the process design to improve the economy of system operation.

3 Experimental Process of Efficient, Energy-Saving, and Environmentally Friendly Transcritical CO_2 Heat Pump Technology Based on Deep Learning Algorithms

3.1 Framework of Efficient, Energy-Saving, and Environmentally Friendly Transcritical CO_2 Heat Pump Technology Based on Deep Learning Algorithms

In order to meet the requirements of energy conservation and environmental protection, this article uses deep learning algorithms to improve the new high-efficiency heat exchanger of heat pump systems by combining greenhouse effect and energy changes.