

## *Retraction*

# **Retracted: Research on Energy-Saving Optimization of Rural Houses in Specific Regions Based on Internet of Things**

## **Security and Communication Networks**

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

## **References**

- [1] Y. Yang, X. Liu, and C. Tian, "Research on Energy-Saving Optimization of Rural Houses in Specific Regions Based on Internet of Things," *Security and Communication Networks*, vol. 2021, Article ID 9256764, 7 pages, 2021.

## Research Article

# Research on Energy-Saving Optimization of Rural Houses in Specific Regions Based on Internet of Things

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With the expansion of social energy use, the optimization of residential energy conservation has become urgent and important. The research on rural housing in areas with hot summers and cold winters started late and is relatively backward in terms of housing energy saving, which greatly hinders the sustainable development of rural areas. The application of the Internet of Things technology helps to provide a stable technical guarantee for energy-saving optimization. Therefore, this paper takes the energy-saving optimization design of rural houses in hot summer and cold winter areas based on the Internet of Things technology as the research theme. This article first takes H rural area as the research object and analyzes the climatic conditions of the place, that is, the typical characteristics of hot summer and cold winter. Then, the intelligent temperature acquisition system is designed, and the working process and main hardware modules of the system are introduced. This text combines GPRS and Internet of Things technology, designs the temperature control system, and carries on the test to the system operation effect. The test results show that during the heating period in January, before and after the temperature control system controls the room temperature, the maximum relative error between the set temperature value and the actual temperature value is 0.49 and 0.27, respectively. It can be seen that the intelligent temperature energy-saving control system can collect the indoor temperature in real time and can well control the heating equipment.

## 1. Introduction

In recent years, rural housing construction has entered a period of rapid growth, but due to the negligence and blindness of rural housing construction, there are many problems in energy-saving technology in rural housing [1, 2]. In rural areas with hot summers and cold winters, there are widespread problems of high energy consumption and environmental pollution in heating and cooling equipment [3, 4]. With the widespread attention and application of the Internet of Things technology in rural residential energy saving, it not only saves energy and improves air quality but also improves the indoor environment of rural residential buildings in hot summer and cold winter areas, which has important practical significance [5, 6].

Regarding the research on the Internet of Things technology and architecture, many scholars have conducted

multiangle discussions. For example, Hildayanti and Machrizzandi have studied the application of the Internet of Things in the smart home environment and integrated ecosystem [7]; Tan et al. use the Internet of Things technology research studies on the extraction of urban sound information from smart city residential areas [8]; Xing L designed and studied the intelligent energy-saving supervision system of urban buildings based on the Internet of Things [9]. It can be seen that there is still a relative lack of research on residential energy efficiency in rural areas in my country. There are few comprehensive studies on the Internet of Things technology, residential energy saving, and residential environments that are warm in winter and cool in summer. Therefore, this article is based on the Internet of Things technology in rural areas in hot summer and cold winter. Research on residential energy-saving optimization design has reference significance for practical applications.

Based on the related technologies of the Internet of Things, this paper studies the energy-saving optimization of rural residential buildings in hot summer and cold winter areas. This article first takes H rural area as the research object and analyzes the climate conditions in the area. Based on this, this article designs an indoor temperature acquisition and control system for this area. Finally, this article verifies the system, mainly to verify the room temperature control performance. Through the research of this article, it is helpful to better tap the potential of residential energy saving, improve energy utilization and heating quality, and reduce heat waste, which has high application value.

## 2. Survey Design

*2.1. Investigation on the Status Quo of Rural Housing in H Area.* In order to obtain more comprehensive data, this survey mainly focuses on offline visits.

*2.2. Questionnaire Design.* The questionnaire is divided into two parts: the first part is the basic information of the investigator and does not involve personal privacy issues; the second part is a survey of the current living environment.

*2.3. Questionnaire Distribution and Collection.* Considering that the object of this study is rural residential energy saving, the selection of the object of the investigation is mainly aimed at rural residents. A total of 569 paper questionnaires were recovered, excluding those questionnaires handed in incomplete or randomly. The valid data were 547, and the data validity rate was 96.13%.

*2.4. Questionnaire Analysis.* Use SPSS software to make statistics and analysis of reliability, validity, and correlation of questionnaire data.

## 3. Experimental Results and Analysis

*3.1. Monthly Average Relative Humidity and Average Rainfall.* The meteorological parameter data of rural H area come from the "Meteorological Parameter Table of H Area," and the results are shown in Table 1. The relative humidity in March and April was 35.4% and 33.6%; the relative humidity in July and August was 70.2%, 65.3%; the average rainfall in July and August was 181 mm and 141 mm.

Looking at Figure 1, we can find that the relative humidity is low in March and April, and the relative humidity is high in July and August. It can be seen that the climate in this area is characterized by low summers and dry winters.

*3.2. Analysis of Indoor Thermal Environment.* The monthly maximum temperature and monthly minimum temperature in rural H area are shown in Table 2. The minimum temperature in January is  $-7.7^{\circ}\text{C}$ , and the maximum temperature in August is  $37.7^{\circ}\text{C}$ .

It can be seen from Figure 2 that the monthly average temperature in this region is the lowest in January and the

TABLE 1: Monthly average relative humidity and average rainfall.

Month	Relative humidity (%)	Average rainfall (mm)
1	37.6	4
2	38.5	6
3	35.4	11
4	33.6	46
5	45.8	34
6	50.6	70
7	70.2	181
8	65.3	141
9	66.4	45
10	59.2	29
11	45.3	15
12	38.7	4

highest in July. The place belongs to a typical temperate monsoon climate; that is, summer is hot and rainy, and winter is cold and dry.

## 4. Energy-Saving Optimization Design of Rural Houses in Hot Summer and Cold Winter Areas Based on Internet of Things Technology

### 4.1. Intelligent Temperature Acquisition System Design

*4.1.1. Overall System Design.* The hardware part of the system is mainly composed of a single-chip microcomputer as the control core, and the peripheral circuit includes a temperature acquisition module, a GPRS module, a liquid crystal display module, which are used to collect indoor real-time temperature data and complete the temperature data transmission through the GPRS module. The collected temperature data is then processed through the software part, which is mainly composed of three parts: client, database, and server.

*4.1.2. System Workflow.* The system takes STC89C52 single-chip microcomputer as the core, and the core of STC89C52 is the MCS-51 chip. This chip has many functions and the highest operating frequency is 35 MHz. Connect the STC89C52 single-chip microcomputer to the temperature acquisition module, LCD liquid crystal display module, GPRS communication module, and so on.

First of all, the single-chip microcomputer controls the temperature and humidity sensor, and the temperature signal is transmitted from the digital temperature sensor to the single-chip microcomputer through a single bus. After the single-chip data processing, the current temperature information is sent to the LCD screen.

Then, the single-chip microcomputer sends the collected data to the server through the router through the GPRS module and stores the temperature data in the database in real time.

Finally, the server pushes the received data to the client through the communication protocol and displays the intuitive temperature data on the client's web page, allowing users or administrators to understand the indoor

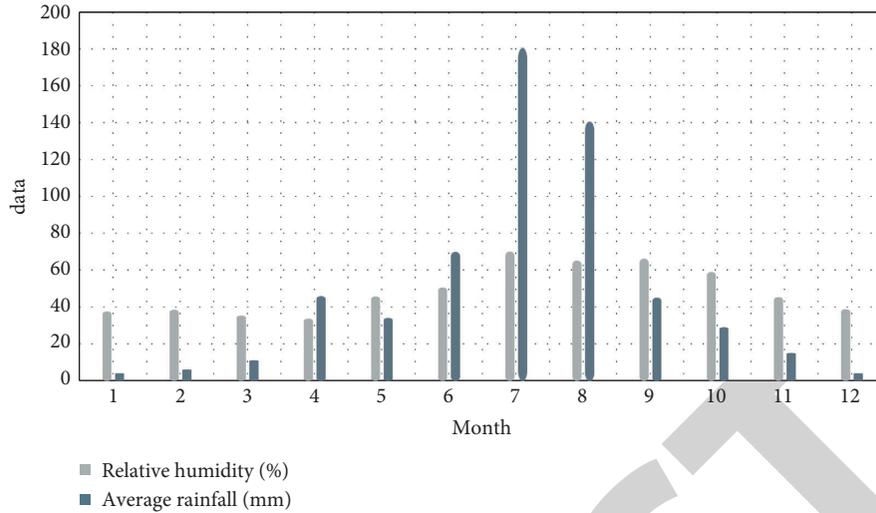


FIGURE 1: Monthly average relative humidity and average rainfall.

TABLE 2: Monthly maximum and minimum temperature.

Month	Maximum temperature	Minimum temperature
1	3.2	-7.7
2	6.7	-5.4
3	13.1	1.2
4	21.2	9.6
5	27.6	15.7
6	32.7	20.3
7	34.6	23.4
8	37.7	26.7
9	27.4	16.5
10	21.3	9.8
11	12.2	2.7
12	5.1	-6.7

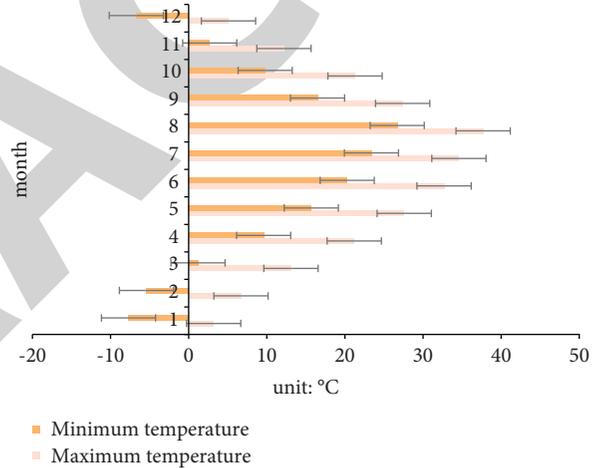


FIGURE 2: Monthly maximum and minimum temperature.

temperature changes in a day through mobile electronic devices in real time.

#### 4.1.3. System Module Hardware Design

(1) *Temperature and Humidity Sensor Module.* The system adopts DHT11 temperature and humidity sensor, which can be used in an environment of 0~50°C, 20%~90% relative humidity (RH), and 3~5 V working voltage, and the accurate value of detecting humidity is about 5% RH, and the accurate value of detecting temperature is 2°C, which meets the temperature control index of rural houses.

(2) *Pressure Sensor.* In the heating system, the measurement of the heating water pressure parameter is essential, and the heating pressure directly affects the heating quality. The system selects the pressure sensor to measure the pressure sensor of the heating pipe water. Taking into account the measurement medium and the measurement requirements, the system selects the QBE2002-P40 sensor to measure the pipe water pressure, and the collected pressure signal becomes a recognizable current signal of 4 mA~20 mA. The

working temperature of this type of sensor is -45~125°C, and the compensation temperature is -20~85°C.

(3) *Communication System Design.* Among many networks, the communication system is used to transmit network communication coordinates, manage network node data, store and modify network node information, and provide routing information for nodes in the connection section. According to the changing characteristics of rural residential climate environment, FFD controller is selected, which can realize different functions by writing different codes.

The intelligent temperature and energy-saving control system is far away from the main control room, and wiring is difficult. If the wiring is used outdoors, it will be affected by sunlight and rain, which will shorten the life of the outdoor signal transmission line and make it difficult to maintain. Therefore, the communication system uses GPRS wireless communication. GPRS uses “packet switching” for data transmission. It uses a voice service channel very similar to GSM, adding SGSN and GGSN to GSM. In this system, the

data is transmitted to the main control room, and the main control room feeds the data back to the heating management department, and then the management department can perform heating distribution and scheduling according to the on-site situation.

*4.2. Design of Intelligent Temperature Energy-Saving Control System.* On the one hand, the rural residential indoor temperature control system must take into account the hysteresis of indoor temperature rise and fall and timely control the indoor temperature to keep the indoor temperature at an appropriate level. On the other hand, it must ensure the safe and reliable operation of the system to minimize energy consumption.

The structure of the intelligent heating and energy-saving control system is mainly composed of three parts: GPRS communication network, terminal equipment, and supervision center. The supervision center is composed of servers and workstations. Its functions are to store and process collected data, display operating status, perform control operations, manage alarm systems, and publish information through the network. The communication method adopted by the communication network is GPRS wireless communication. The terminal equipment includes the automatic control equipment of the heating station and the one-time data collection instrument and electric valve of the pressure and temperature on the spot.

*4.2.1. GPRS Heating Geographic Information System.* Through the geographic information system software interface, it can display the relevant landmark buildings of rural residential areas, heating companies, heat source plants, heat exchange stations, tube wells, underground pipe network distribution and direction, heating coverage area and user distribution, etc. In the system interface, click on the relevant area to query and reflect the operating status of the heating equipment in the area, which is convenient for observing the temperature of residents.

*4.2.2. Acquisition Control System.* Install temperature transmitters and pressure transmitters on both sides of the heating network pipe to measure the temperature and pressure of the water supply and return. A flow meter is installed on one side of the heating network pipe to detect the flow of water supply; and on the other side, a solenoid valve is installed to control the flow of the water supply to adjust the heat. Collect field pressure, flow, temperature, and other data through the data collector, and adjust the heating parameters through the control strategy and algorithm of the programmable controller to ensure the safe and stable operation of the system.

*4.2.3. Host Computer Monitoring System.* The upper computer monitoring system mainly completes the function of real-time data collection. The operation of the heating system is closely related to parameters such as the flow and pressure of the hot water in the pipeline. The management of

the control system requires a monitoring center to monitor the temperature, pressure, flow, circulation pump, and make-up pump of the primary and secondary pipelines. According to the change of parameters, appropriate control measures shall be taken. The various hot water working condition parameters and operating procedures of the heat exchange station are displayed on the host computer system in real time. The host computer monitoring system facilitates management and operators to view and coordinate heating parameters to ensure heating quality.

*4.2.4. Lower Computer Control System.* The lower computer is composed of three parts: MGC touch screen, Siemens PLC, and GPRS module. The program design of the lower computer control system includes the design of the self-checking program of the boot system failure and the design of the heating mode selection program. This control system first performs system fault self-check, and when a fault is detected, the machine enters the fault mode to report an error. After the fault self-check procedure is completed, the system starts to collect temperature, pressure, and heat measurement and select heating according to the climate conditions in rural areas mode for heating, preheating 2 hours in advance before using heat, so that the indoor temperature basically rises to a comfortable temperature.

*4.2.5. Analysis of Control Plan.* The quality of indoor temperature control performance reflects the quality of heating effect, so temperature control performance is an important indicator to measure heating. The indoor temperature is affected by a variety of uncertain factors and is difficult to control. It has the characteristics of large inertia and hysteresis, and it is difficult to establish an accurate mathematical model. Traditional control methods such as two- or three-position control and PID control are difficult to meet the requirements of indoor temperature control and cannot meet the effects of high control accuracy, excellent transition process, and high comfort. Therefore, according to the characteristics of indoor temperature changes and fuzzy based on mathematical principles, a fuzzy controller for controlling indoor temperature is designed.

The establishment process of the fuzzy controller: first determine its input and output variables, and determine the domain, quantified parameters, and membership functions, then fuzzify it and formulate fuzzy control rules, and finally, perform defuzzification processing [10, 11].

This article chooses the current error rate EC and the predicted error E between the temperature at the next moment and the set temperature as the input of the controller and the opening U of the valve port as the output.

The domain expression of the fuzzy set taken by the error E is shown as follows:

$$X = \{-n, -n + 1, \dots, 0, \dots, n - 1, n\}. \quad (1)$$

The domain expression of the fuzzy set of the error rate of change EC is shown as follows:

$$Y = \{-m, -m + 1, \dots, 0, \dots, m - 1, m\}. \quad (2)$$

The domain expression of the fuzzy set of the control quantity  $U$  is shown as follows:

$$Z = \{-l, -l + 1, \dots, 0, \dots, l - 1, l\}. \quad (3)$$

Usually the value of  $n, m, l$  is 6 or 7.

The expression of the quantization factor is shown as follows:

$$K_e = \frac{n}{e_{\max}}, \quad (4)$$

$$K_{ec} = \frac{n}{ec_{\max}}. \quad (5)$$

The current error rate  $EC$  and the error  $E$  between the predicted temperature at the next moment and the set temperature are used as the input of the controller, and the opening  $U$  of the valve port is used as the output. The system uses an electric valve as a switching element, that is, to open to the maximum or minimum, and to ensure that it can be opened for a certain period of time, so the output of the controller is selected as open valve (KF) or close valve (GF [12]).

Combined with the control accuracy of the heating system and related historical data, the basic domain and fuzzy domain of the setting error  $E$  are both  $[-1, 1]$ , and the  $EC$  basic domain and fuzzy domain are both  $[-0.3, 0.2]$ ; quantified, the factor is 1; when the collected value exceeds this range, it will be processed as the boundary value. When the room temperature is lower than the room temperature setting value, that is, when the deviation between the measured room temperature and the set room temperature is negative, if the deviation tends to increase, in order to ensure that the room temperature reaches the set value as soon as possible, the valve should be opened; if the deviation shows a decreasing trend, in order to reduce the room temperature overshoot and not cause overheating, the valve opening and closing are determined according to the deviation change rate.

The output of fuzzy inference cannot be used directly and needs to be defuzzified. This paper selects the weighted average defuzzification method through comparative analysis.

The typical transfer function of the indoor temperature controlled object is shown as follows:

$$G_0(s) = \frac{K * e^{-\tau s}}{TS + 1}. \quad (6)$$

In formula (6),  $K$  is the magnification factor, which is related to the indoor static heat loss rate, and the value is 1. The pure delay time  $r$  and the time constant  $T$  of the controlled object depend on factors such as outdoor temperature, indoor people, and indoor equipment. For the control of indoor temperature, the room temperature needs a delay time after the valve port is activated to reach the given value. The system needs to set the value of the delay time  $r$  and the value of the time constant  $T$ .

TABLE 3: Indoor temperature curve on December 25.

Time	Set room temperature	Actual room temperature
22~24	18	21.5
0~2	18	20.6
2~4	18	20.3
4~6	18	22.4
6~8	21	22.6
8~10	21	22.4
10~12	21	23.7
12~14	21	22.8
14~16	21	22.6
16~18	21	22.4
18~20	21	22.5
20~22	18	21.7

This control method mainly adopts differential pressure control valve and electric control valve control. In addition to ensuring the isolated closed-loop control of the heat exchange station when the communication is abnormal, it can also realize the group control that executes the host computer command when the communication is normal and realizes the goal of system control.

## 5. Analysis of the Actual Operation Effect of the System

**5.1. Room Temperature on December 25.** The experiment takes H area as an example for analysis. First, the heating system is not adjusted. The heating time is set to 8 o'clock, the heating time indoor temperature is set to 21°C, the night antifreeze time is 22 o'clock, and the night antifreeze time temperature is set to 18°C. The set temperature and actual temperature data are measured every two hours. The recorded conditions of the set and actual temperature on December 25 are shown in Table 3.

It can be seen from Figure 3 that the indoor temperature is relatively high due to no temperature control operation. Especially in the unmanned phase at night, the indoor temperature is still above 20°C, and in the noon phase, the indoor temperature can reach as high as 23.7°C, causing a waste of heat.

**5.2. Heating System Control Effect.** Since this system mainly detects the temperature control and energy-saving effects of the system, if the heating equipment can be accurately controlled, the waste of heat flow can be reduced. Therefore, temperature control will be implemented on January 5 and no temperature control will be implemented on January 7; comparing the relative error between the two indoor temperatures and the set value, the results are shown in Table 4.

Observing Figure 4, we can find that, in the heating period, after the room temperature is controlled, the maximum relative error is 0.27, and the minimum relative error is 0.12; before the room temperature is controlled, the maximum relative error is 0.49, and the minimum relative error is 0.14. During the antifreeze period, after the room temperature is controlled, the maximum relative error is 0.16 and the minimum relative error is 0.09; before the room

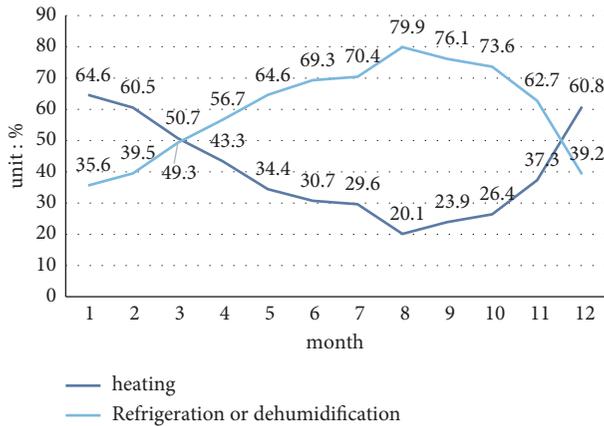


FIGURE 3: Indoor temperature curve on December 25.

TABLE 4: The error between the indoor temperature and the set value before and after heating system regulation.

Time	Time	Before control	After control
Antifreeze	22~24	0.21	0.16
	0~2	0.19	0.16
	2~4	0.17	0.12
	4~6	0.14	0.09
Heating time	6~8	0.14	0.16
	8~10	0.43	0.12
	10~12	0.42	0.14
	12~14	0.49	0.27
	14~16	0.24	0.26
	16~18	0.27	0.20
	18~20	0.17	0.13
	20~22	0.16	0.14

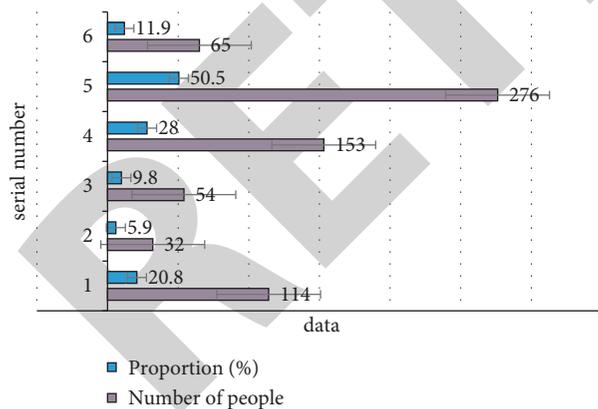


FIGURE 4: The error between the indoor temperature and the set value before and after heating system regulation.

temperature control, the maximum relative error is 0.21, and the minimum relative error is 0.17. It can be seen that the intelligent temperature energy-saving control system can collect indoor temperature in real time and perform good control, the occurrence of overheating is greatly reduced, and the indoor environment of the building is kept within a comfortable range.

## 6. Conclusions

With the improvement of living conditions, rural residents have an increasing demand for housing that is warm in winter and cool in summer. Therefore, it is of great practical significance to analyze and study the optimization of rural residential energy saving in hot summer and cold winter areas based on the Internet of Things technology. Through research, this paper has completed the following tasks: taking the H rural area with the characteristics of hot summer and cold winter as an example, the local climate change is investigated, and the temperature collection and control system is designed. Before and after the room temperature is controlled, the temperature value and the maximum relative error of the actual temperature value are only 0.27, which proves the feasibility of the system.

## Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

## Acknowledgments

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