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Retraction

Retracted: Thermal Straightening Control System for Variable-Section Automotive Leaf Springs Rolling Based on IoT Edge Computing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets 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 own 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. Sun, "Thermal Straightening Control System for Variable-Section Automotive Leaf Springs Rolling Based on IoT Edge Computing," *Journal of Advanced Transportation*, vol. 2022, Article ID 4100843, 12 pages, 2022.

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Research Article

Thermal Straightening Control System for Variable-Section Automotive Leaf Springs Rolling Based on IoT Edge Computing

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With the rapid development of social economy in recent years, people's living standards are also improving. The use of automobiles is becoming increasingly frequent, and people's requirements for the safety, comfort, and energy saving of automobiles are also getting higher. This paper mainly studies the thermal straightening control system after the rolling of variable-section automotive leaf springs through edge computing based on the Internet of Things. This paper presents the basic concepts of IoT edge computing and the role they play in various aspects. The percentage of IoT development trends in 2011 was 6.7%. By 2020, the development trend percentage of IoT reached 68%, an increase of 61.3%. It can be seen that the development of the Internet of Things is very rapid. It can be seen that the straightening accuracy of the thermal straightening control system based on edge computing after the rolling of variable-section automotive leaf springs reaches 78%, and it is 29% higher than the traditional system straightening accuracy, which is only 49%. The safety of the thermal straightening control system of the variable-section automotive leaf spring after rolling based on edge computing reaches 95%, which is 33% higher than the safety of the traditional system. The thermal alignment control system for variable-section automotive leaf springs after rolling based on the edge computing of the Internet of Things is not only safer than the traditional system but also much higher in comfort and alignment accuracy than the traditional system. It can be seen that the thermal straightening control system for variable cross section automotive leaf springs after rolling based on IoT edge computing is more conducive to the development of the automotive industry.

1. Introduction

The emergence of the Internet of Things is the result of human society entering the information age and the prosperity and development of the market economy. Its essence is the inevitability of human liberation and production development. At the same time, the Internet of Things has expanded to all aspects of society, gradually affecting people's way of life and bringing continuous change and progress to human society. Edge computing hardware and services, which is the processing and storage source for many of these systems, can help solve this problem. For example, edge gateways can process data from edge devices and then send only relevant data back through the cloud, reducing bandwidth requirements. Or, if real-time applications are required, it can send data back to the edge device.

The Internet of Things has received great attention from countries all over the world and is actively developing around the world. The Internet of Things not only promotes the prosperity of the global information industry but also promotes the healthy and sustainable development of society and economy, and it greatly improves people's work efficiency and living standards.

The innovations of this paper are as follows: (1) the theoretical knowledge of the Internet of Things and edge computing is introduced, and edge computing is used to analyze how the edge computing of the Internet of Things plays a role in the research on the thermal alignment control system after the rolling of variable-section automotive leaf springs. (2) Analyze the thermal straightening control system after the rolling of the traditional variable-section automotive leaf spring and the thermal straightening control system based on the Internet of Things and edge computing, and through experiments, it is found that the thermal alignment control system based on the Internet of Things and edge computing has higher performance in all aspects.

2. Related Work

As people's economic level is getting better, people have increasing requirements for all aspects of automobiles. Wu et al. found that traffic accidents occur increasingly frequently with the popularity of automobiles. The system monitors the status of the surrounding vehicles in real time. Therefore, it is possible to predict potential accidents and provide first aid immediately after the accident. Although the system proposed by this scholar sounds very intelligent, he did not describe the system in detail, nor did he explain how to establish the intelligent vehicle safety system [1]. Automatic lighting, according to Dahou et al., is a good complement to modern car technologies and helps to increase vehicle safety. In comparison to previous systems, the technology also helps to reduce energy use. He presented a new automatic lighting architecture that would replace the old mechanical system based on stepper motors with a new lighting system that would be extremely useful for traffic management and work. Although the scholars explained how to build the system, no specific experiments were performed to prove the feasibility of the system [2]. Yan et al. found that the car-following model based on the optimal speed can be easily applied to the traffic system composed of intelligent networks, however, the sudden speed change of the preceding vehicle will degrade the control performance of the following vehicle. To facilitate stability analysis and controller design, he proposed a feedforward compensator for compensation. Although the scholar proposed a method to solve the problems he mentioned, he did not mention the experimental objects and experimental data to verify the reliability of this method [3]. Kiatiwat found that most accidents with four-wheeled vehicles were because of faulty braking systems. The manual method of applying brakes is often dangerous because it can lead to accidents. Hence, it is necessary to automatically adjust the brakes electronically to mitigate accident problems. Therefore, his goal is to design and develop an intelligent, electronically controlled vehicle braking system called "Intelligent Reversing Brake System" that supports the shock system. The scholar's idea is very good based on the security point of view, however, he did not introduce how to build the system in detail, nor did he propose the advantages of the system [4]. Lin et al. found that edge computing and the Internet of Things are closely related, The Internet of Things and computer service devices deployed at the network's edge are closely related, and they can be utilized to improve user experience and service resilience in the case of failure. Edge computing can deliver faster response and improved service quality for IoT applications, thanks to its distributed architecture and proximity to end users. The scholar, on the other hand, did not explain what the relationship between edge computing and the Internet of Things is, or how they can work together to improve services [5]. To reduce the amount of data gathered by the Internet of Things and enhance the processing speed of big data, Xue et al. recommended that the data collected from the Internet of Things be reduced through the use of a technique called data compression. Xue et al. proposed to reduce the data collected from the Internet of Things through the compressive sensing sampling method. To solve the problem of high computational complexity of compressed sensing algorithm, he adopts the multiobjective optimization particle swarm optimization algorithm. Although the scholar proposed a specific method to solve this problem, he did not explain whether the method is suitable for solving this problem [6]. Singh et al. found that to realize the broad vision of ubiquitous computing underpinned by the "Internet of Things" (IoT), application- and technology-based challenges must be overcome to support widespread data connectivity and sharing. However, usually people rarely consider the security and privacy issues that arise during the use of IoT. Although the scholar described some problems in the Internet of Things, he did not propose corresponding methods to solve them [7]. Yang et al. found that the Internet of Things (IoT) is ubiquitous in people's daily life. However, while bringing benefits, it also exposes people to large risks from the loss of privacy and security concerns. Although the scholar knows that the use of the Internet of Things not only brings benefits but also brings security and privacy issues, the scholar does not describe how to solve the security and privacy risks [8].

3. IoT Edge Computing and the Concept of Thermal Alignment Control System for Variable-Section Automotive Leaf Springs

The performance of the thermal alignment control system of the variable-section automotive leaf spring is directly related to the driving comfort and handling stability of the vehicle. This system not only improves the quality of the suspension system but also adopts a few suspension systems with variable-section panel springs that can improve the ride comfort of the vehicle under the premise of ensuring the antiload capability [9]. The structure of the leaf springs will not change, and the friction between the leaf springs will directly affect the rigidity of the leaf spring front suspension system. Moreover, the layout of the leaf spring front suspension system has a great influence on the changing characteristics of the front wheel alignment parameters, thereby affecting the operation and stability of the vehicle [10]. The application of variable section automotive leaf spring is shown in Figure 1.

As shown in Figure 1, the mass of the vehicle suspension system composed of multiple leaf springs is relatively large, accounting for about 6% to 10% of the total vehicle mass. The leaf springs are designed to meet the requirements of lightweight ride comfort that has become a trend in leaf spring development [11].

The Internet of Things has broad industry application requirements, and industries, such as transportation, security, logistics, retail, electricity, finance, environmental protection, and medical care will become key areas of

Internet of Things industry applications. The property of the Internet of Things itself to communicate information has subverted people's understanding of the sender and receiver of information in the past, and the new way of life and production it brings will have a large impact on human society [12]. The application of the Internet of Things is shown in Figure 2.

As shown in Figure 2, IoT has also been applied to the construction of smart security, smart energy, smart home, and smart cities [13].

This article compares the development of the Internet of Things from 2011 to 2020, as shown in Figure 3.

As shown in Figure 3, the development of the Internet of Things will eventually bring convenience to people's lives. It can not only reduce production costs but also improve the use of resources. The demand for informatization continues to expand, creating the most suitable environment for the development of the Internet of Things.

The Internet of Things itself is a powerful tool that integrates various technologies, combines people's management experience, and solves problems encountered in the production process and life [14]. The Internet of Things integrates wireless sensor technology and relies on communication networks to realize information-based comprehensive services that assist production and improve the quality of life. The structure of the Internet of Things is shown in Figure 4.

Figure 4: to realize the function of Internet of Things perception control, the connection between things must overcome the limitations of location and capacity and use the development of intelligent Internet of Things and application research in the field of communication to perceive and exchange information. The high-speed processing of the vast data created by the Internet of Things is the foundation for reaching this goal.

The increasing growth of smartphones around the world has accelerated the development of mobile terminals and "edge computing." The development of the Internet of Things and the edge computing system has followed the intelligent society with the interconnectedness of all things and the awareness of all things. The mobile edge computing network mainly includes three parts, which are as follows: intelligent mobile terminal, MEC service node, and core network. The MEC server is arranged near the base station, and then the base station and the MEC server are connected, where the dotted line represents the control plane and the solid line represents the user plane [15]. Base stations with MEC computing capabilities can provide powerful computing capabilities for mobile applications and reduce processing delays. The base station can not only process the user's request but also transmit the user's request to the remote data center. The mobile edge computing network is shown in Figure 5.

As shown in Figure 5, leveraging faster network technologies, such as 5G wireless networks and edge computing systems can create real-time applications faster, such as autonomous vehicles, artificial intelligence, robotics, and more. As a popular technology, edge computing is also widely used in the commercial field [16].

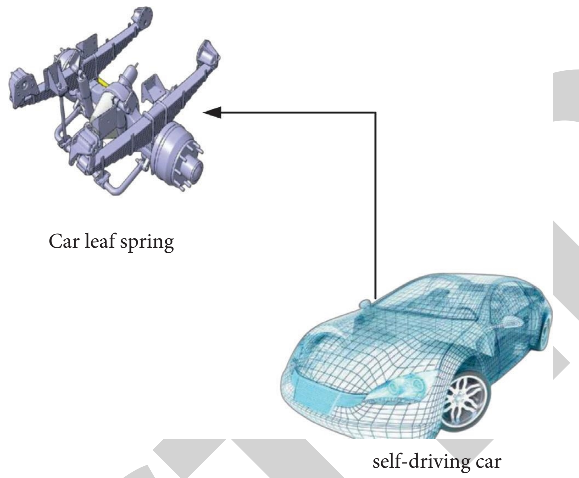

Figure 1: Application of variable section automotive leaf springs.

4. The Theoretical Model of Edge Computing and Delay Based on IoT

4.1. IoT-Based Edge Computing. The advantage of edge computing is that the data can be processed and saved faster to develop more efficient real-time applications. Using edge computing models, it is possible to provide more efficient services for applications, such as driverless cars, smart cities, and even automated systems [17]. Although the cost of edge computing microprocessors has continued to decrease and the performance has greatly improved, they are still more expensive than cheaper microprocessors. It makes low-end microprocessors more suitable for mass production.

4.1.1. Local Model Based on Edge Computing. To be more realistic, the computing power of each mobile device is different here. Calculate the time of the local execution of the task using formula (1).

$$t_v^u = \frac{d_v}{f_v^u}. \tag{1}$$

The energy consumption curves are drawn under specific rolling stock material specifications, rolling mill and bearing types, roll diameter and roll surface conditions, and various process system conditions. With the delay and energy consumption models of computing tasks, an overall load model of computing tasks when executed on the local CPU can be established, as given by formula (2).

$$K_v^u = \lambda_v^t t_v^u + \lambda_v^e e_v^u, \tag{2}$$

where the coefficients λ_v^t and λ_v^e, respectively, represent the weights of the task delay and energy consumption of the mobile device n in the offloading decision. The two coefficients satisfy the following relationship, as in formula (3).

$$\begin{cases} \lambda_v^t + \lambda_v^e = 1, \\ \lambda_v^t \geq 0, \\ \lambda_v^e \geq 0. \end{cases} \tag{3}$$

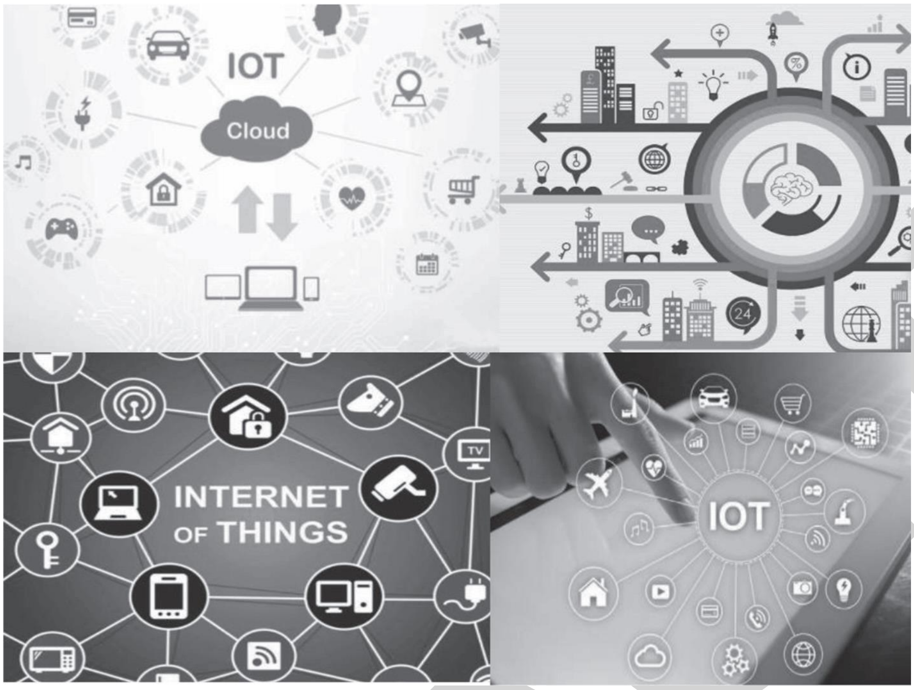

Figure 2: Applications of the internet of things.

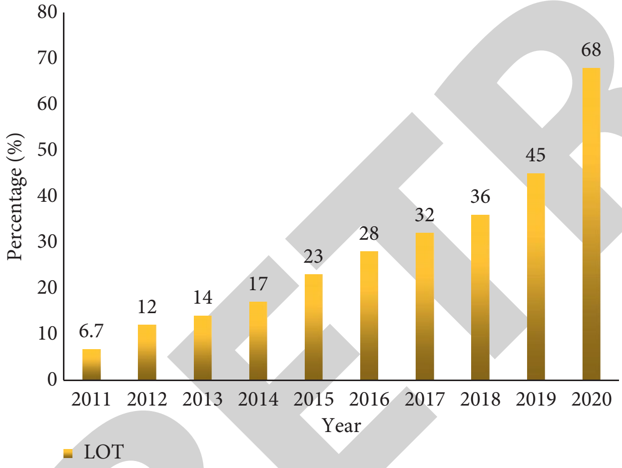

Figure 3: Development of IoT 2011–2020.

When λ_v^t is larger, it means that the mobile device n is more concerned about the delay of the computing task at this time and is more sensitive to the delay. When T_v is larger, it means that the power of mobile device n is low at this time. To increase the usage time of mobile devices, more attention is paid to the energy consumption of computing tasks. In this way, users can appropriately select the weight coefficient according to their specific situation at that time [18].

4.1.2. MEC Server Computing Model Based on Edge Computing. The goal of reliable low-latency communication is less than 1 millisecond of communication delay between the end user and the server, and the MEC server computing model can help achieve this goal. Edge computing tasks need to go through three steps to be finally completed: task uploading, cloud execution, and result return [19]. Like most studies, the influence of the result return on the whole analysis process is ignored because the calculation result is relatively small. In the task uploading stage, the mobile device n needs extra delay and energy consumption to complete the task offloading [20]. The mobile device first needs to select a channel to upload the data of the computing task and obtain the delay time of uploading task as shown in (4):

$$t^a_{v,\mathrm{off}\,(a)} = \frac{b_v}{\gamma_v(a)}. \tag{4}$$

Among them, b_v represents the amount of data that the mobile device needs to upload at this time, and $\gamma_v(a)$ represents the data rate of the channel selected by the mobile device n. When a mobile device uploads a computing task, the TU module needs to consume a certain amount of energy, as shown in formula (5).

$$e^a_{v,\mathrm{off}\,(a)} = \frac{q_v b_v}{\gamma_v(a)} + L_v. \tag{5}$$

Among them, q_v represents the transmit power of the mobile device n, and L_v represents the extra energy that the mobile device needs to consume after transmitting certain data. This part of the extra energy consumption is a common phenomenon in all mobile devices.

When the mobile device n successfully uploads the computing task to the MEC server, the process of computing task execution begins. The MEC server can be expressed as formula (6).

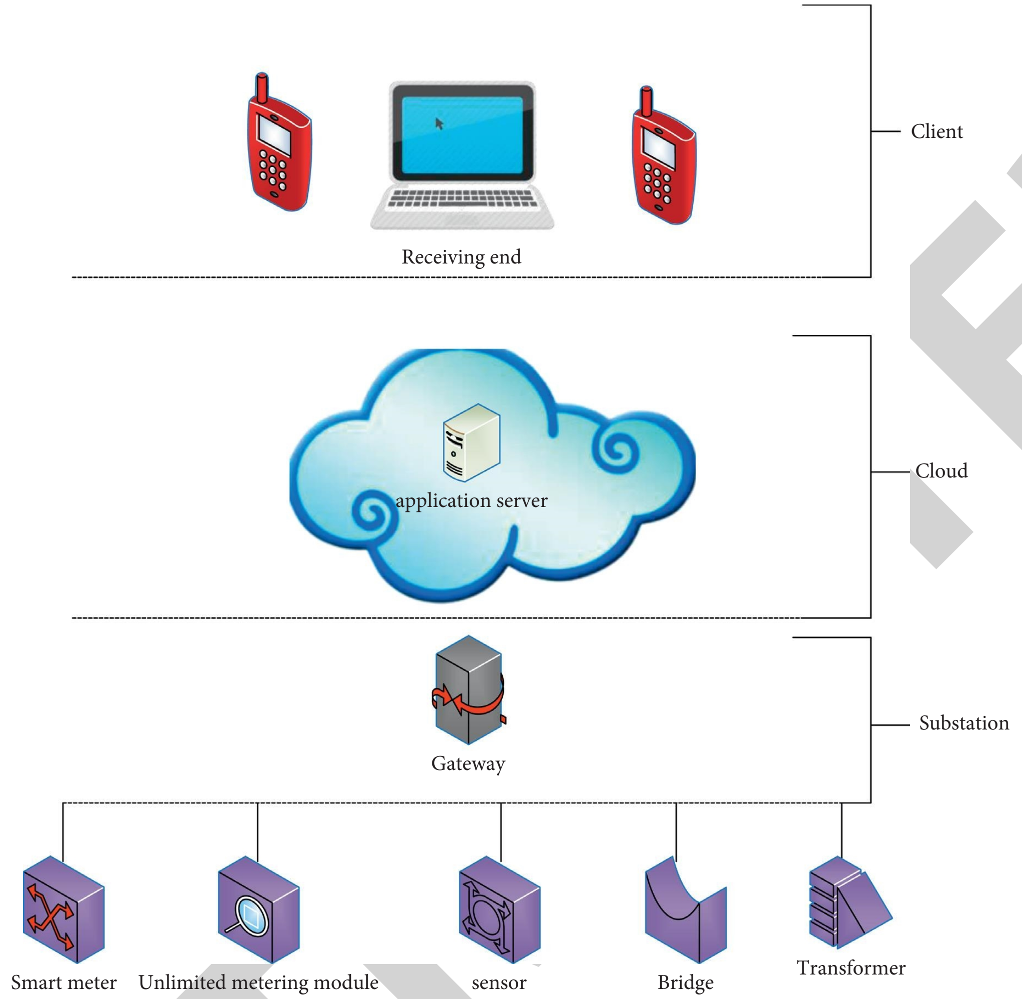

Figure 4: The structure of the Internet of Things.

$$t^a_{v,\text{exe}} = \frac{d_v}{f^a_v}. \tag{6}$$

When the computing power of the MEC server cannot meet the computing needs of all users, the user's computing task needs to be decided in the second stage on the MEC server. If the second-stage decision waits at the MEC, the execution time can be expressed as formula (7).

$$t^a_{v,\text{exe}} = \frac{d_v}{f^a_v} + t_{\text{wait}}, \tag{7}$$

where t_{wait} represents the queuing delay because of insufficient MEC computing resources, and $t_{\text{wait}} = 0$ when MEC computing resources are sufficient.

4.1.3. Center Server Computing Model Based on Edge Computing. If the second stage chooses to offload to the central cloud server for execution, then the overall delay can be expressed as formula (8).

$$t^c_v = t^c_{v,\text{off}} + t^c_{v,\text{exe}} + t^c_{v,\text{down}}. \tag{8}$$

Among them, $t^c_{v,\text{off}}$, $t^c_{v,\text{exe}}$, and $t^c_{v,\text{down}}$, respectively, represent the time when the task is uploaded from the MEC to the central cloud server executed on the central cloud server, and the result is uploaded from the central cloud server to the MEC.

To sum up, in this paper, the overall load of computing tasks when executed on the server can be obtained as formula (9).

$$K^s_v(a) = \lambda^t_v\left(x_v \cdot t^a_{v|a|} + (1 - a_i) \cdot t^c_v\right) + \lambda^e_v e^a_v(a). \tag{9}$$

Here, the coefficients λ^t_v and λ^e_v have the same meaning as the local computing load model, and x_v is the decision result of the second stage.

4.2. Theoretical Model of Time Delay in No-Fault Condition and in Fault Condition. In the edge computing architecture, MEC devices are deployed in IoT scenarios in a scattered manner, and their computing and storage capabilities are relatively weak. Therefore, to support delay-sensitive services in IoT scenarios, it is necessary to comprehensively consider the computing and communication resources of MEC devices and cloud servers. Therefore, this paper

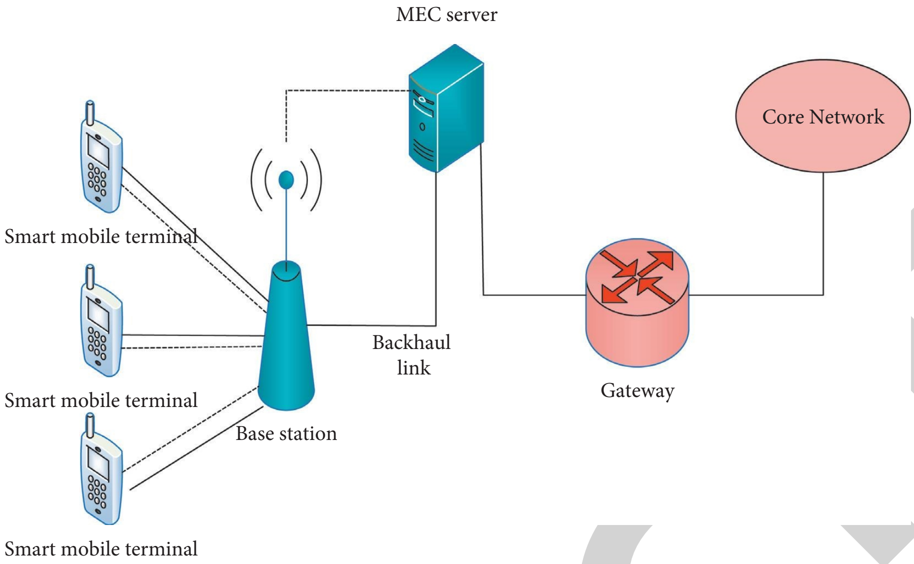

Figure 5: Mobile edge computing network.

analyzes the service response delay with or without faults in the edge computing architecture [21]. Latency refers to the time it takes for a packet to travel from one end of a network to another. It includes sending delay, propagation delay, processing delay, and queuing delay. In the computer network, it is an important performance indicator, which means that the sender sends data, and the sender receives the confirmation from the receiver.

Set the number of edge computing layer MEC devices to 4 parts [22], as shown in Table 1.

As shown in Table 1, the computing speed of the fourth edge computing layer MEC device is the fastest, at 80%. The data transmission speed is also the fastest at 84%, and the packet loss rate is only 0.0079. It can be seen that the fourth edge computing layer MEC device is the best.

4.2.1. Service Response Delay in the Case of no Fault.

In the IoT scenario, taking the path planning of an industrial robot with laser navigation as an example, there are a lot of data processing operations in the path planning process. Firstly, the robot can use sensors to collect path data in real time, and the collected path data needs to be processed in real time efficiently, as shown in Figure 6.

As shown in Figure 6, if all path data is uploaded to the cloud server for processing, it will cause a large transmission delay and cannot provide real-time path planning services. In the edge computing architecture, the collected real-time path data will be offloaded to the MEC device. The cloud server performs fast distributed computing, and the final path planning result is returned to guide the robot's actions.

When the devices and links in the edge computing architecture are fault-free, the intelligent terminals and users at the infrastructure layer first send low-latency and highly reliable service requests to their connected MEC devices. This MEC device is considered the master MEC device. Therefore, in the edge computing architecture, the total service response delay t in the case of no fault can be expressed as formula (10).

Table 1: Situation table of four-edge computing layer MEC devices.

Parameter type	1	2	3	4
Calculation speed (GHz)	60%	65%	76%	80%
Data transmission speed (Mbps)	65%	67%	80%	84%
Packet loss rate	0.0213	0.0256	0.0201	0.0079

$$t\left(A_i, B_C\right) = \max\left\{\frac{B_i}{A_C} + W_i + L_j\right\}. \tag{10}$$

Among them, B_i/A_C represents the calculation delay of MEC device W_i processing subtask B_i, and (A_i, B_C) represents the communication delay between the MEC devices B_i and A_C.

The communication delay $W_{v,j}$ of the computing node B_i/L in the edge computing architecture can be expressed as formula (11).

$$W_{v,j} = \frac{B_i}{L} \times \frac{T_{\text{succ}}\left(1 + p_{ei}\right)}{1 - p_{ei}}. \tag{11}$$

Among them, B_i is the subtask sent by the master MEC device $W_{v,j}$ to the slave MEC device p_{ei}, and L represents the length of the data packet. T_{succ} represents the successful transmission delay of a packet. Assume that the data transmission rate of each link is r_i. The calculation is shown in formula (12).

$$T_{\text{succ}} = \frac{L}{r_i}. \tag{12}$$

$W_{v,c}$ 13:

$$W_{v,c} = \frac{B_c}{r_c} \times \frac{1 + p_{ec}}{1 - p_{ec}}. \tag{13}$$

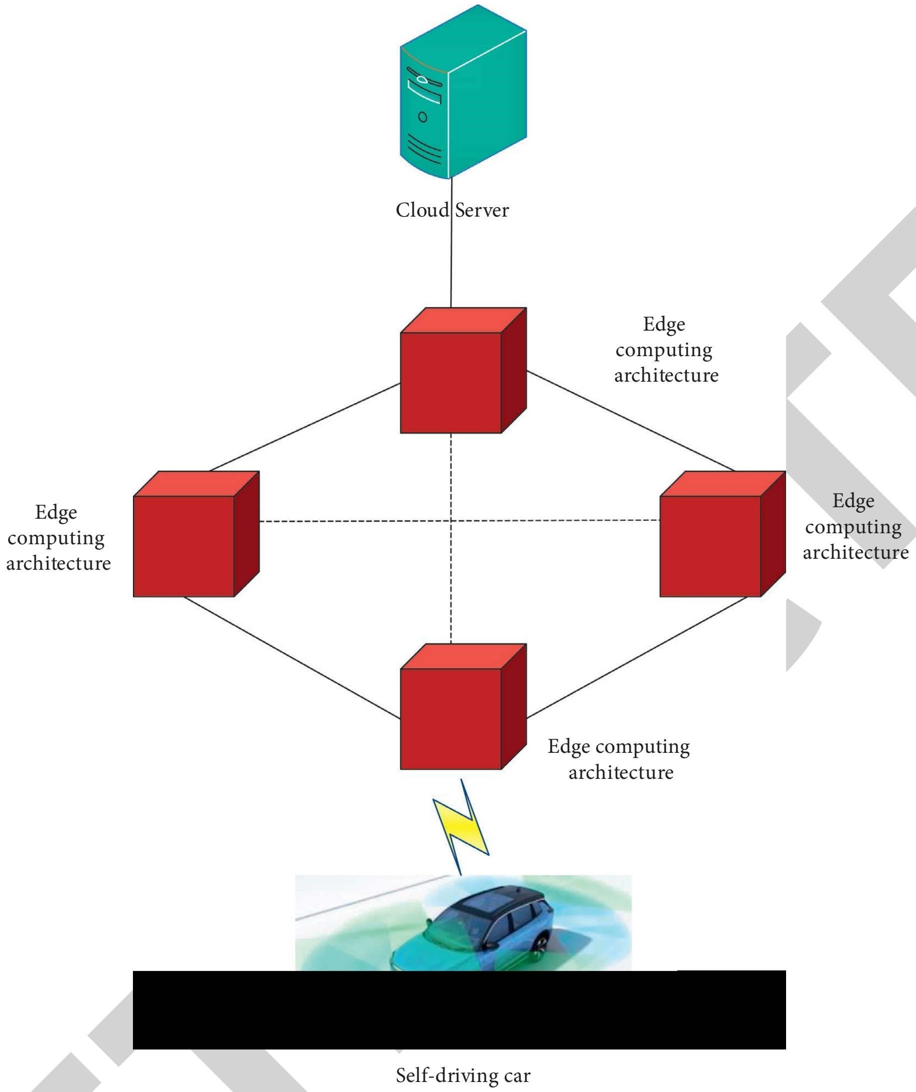

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Figure 6: Edge computing in automotive applications.

Among them, B_c is the subtask sent by the main MEC device $W_{v,j}$ to the cloud server C.

To reduce the service response delay in formula (13), it is necessary to comprehensively consider the communication and computing capabilities of MEC devices and cloud servers and find a set of optimal task allocation methods $\{B_1, B_2, \ldots, B_n\}$ to unload tasks to minimize the objective function. The objective function is the target form that is pursued by the design variables. Hence, the objective function is the function of the design variable, which is a scalar. Therefore, the minimum service response delay model in the case of no fault is as shown in formula (14).

$$\min \max\left\{\frac{B_i}{A_v} + W_v L_j\right\} i, j = 1, 2, \ldots, n. \tag{14}$$

4.2.2. Service Response Delay in Case of Failure. In this paper, to successfully process services even under fault conditions and improve system reliability, a task redistribution and retransmission computing task offloading strategy is proposed. When the MEC device is faulty or the link is interrupted, the average service response delay T_a in the edge computing architecture is shown in formula (15).

$$T_a = \prod_{v \in V^I} \left(1 - P_i\right)\left(\frac{B_i}{A_{vi}} + \frac{B_i\left(1 + p_{ei}\right)}{r_i\left(1 - p_{ei}\right)}\right). \tag{15}$$

In formula (15), $V = \{v_1, v_2, \ldots, v_k\}$ is the set of MEC devices, V^T is the set of normal MEC devices, $V^T - v$ is the set of faulty MEC devices, and p_{ei} is the probability that subtasks cannot be successfully processed on this MEC device as formula (16).

$$T = \max\left\{\frac{\delta_i \text{Task}}{C_{vi}} + W_v, m_j\right\} + \frac{\text{Task}_{\text{pre}}}{C_c}. \tag{16}$$

This paper presents a practical coding genetic algorithm (RCGA-CO) for solving constrained optimization problems. This method is used to obtain the optimal offloading strategy of computing tasks, reduce the business response delay in fault-free and faulty states, and improve the reliability of model processing. A genetic algorithm begins with a population that represents the problem's possible solutions, and a population is made up of a set number of individuals encoded by genes. The real coding genetic algorithm improves the genetic algorithm's local search ability and makes the local control search of continuous functions easier.

The fitness function chosen has a direct impact on the genetic algorithm's convergence speed and ability to locate the best solution. Because the genetic algorithm is based solely on the fitness function and searches using the fitness of each member in the population, it does not employ external information in its evolutionary search. Different from the traditional real-coded genetic algorithm, since the optimization problems in this paper are all constrained optimization problems, the fitness function of the RCGA-CO algorithm is calculated as formula (17).

$$f(A) = \begin{cases} t(A), A \in F \\ t(A) + h\sum t_i(A) + \xi(A, g), A \in S - F \end{cases}. \tag{17}$$

Among them, h is the penalty factor, ${}_{i}(A)$ is the constraint violation value of the nonfeasible individual to the j^{th} constraint, $\xi(A, g)$ represents the additional heuristic value for nonfeasible individuals from the execution of the algorithm to the g^{th} generation, and the expression of $\xi(A, g)$ is formula (18).

$$\xi(A, g) = \mathrm{Worst}(g) - \min\left\{t(A) + h\sum t_j(A)\right\}. \tag{18}$$

In formula (18), $\mathrm{Worst}(g)$ records the feasible individual with the maximum fitness value obtained by the algorithm after the evolution of the g generation, and its expression is formula (19).

$$\mathrm{Worst}(g) = \max\{\mathrm{Worst}(g-1), \max t(A)\}. \tag{19}$$

The redistribution and retransmission mechanism ensures that the service can be completed in time and correctly under the fault condition, thereby enhancing the reliability of the system and reducing the service response delay under the fault condition.

5. Experiment and Analysis of Traditional and Edge Computing-Based Thermal Straightening Control System for Variable-Section Automotive Leaf Springs after Rolling

5.1. Experiment and Analysis of the Thermal Straightening Control System after the Rolling of Variable-Section Automotive Leaf Springs. The key and technical problem of the hot straightening control system is the control of the automatic rolling process. Although the traditional algorithm can control better, for the variable section leaf spring with large slope, there is always overshoot. In this paper, an improved algorithm edge computing method is proposed, and the control effect has been greatly improved. The control block diagram is shown in Figure 7.

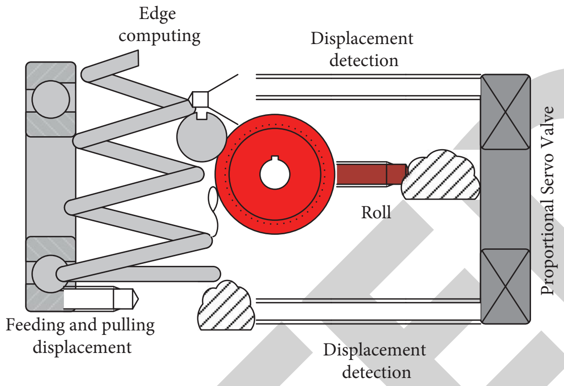


Figure 7: Control block diagram of variable section automotive leaf spring.

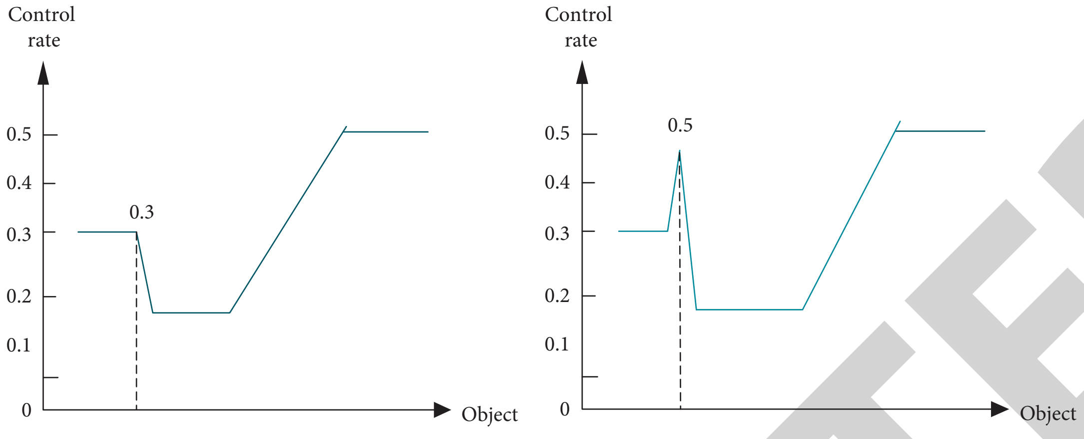
As shown in Figure 7, Hyundai cars are committed to improving safety and comfort while ensuring basic performance, such as driving and braking. The curves of the program rolling without and with inflection point control are shown in Figure 8.

As shown in Figure 8, it can be seen that the control rate of the curve inflection point rolled by the program without edge calculation is 0.3, while the control rate of the curve inflection point rolled by the program with edge calculation is 0.5. The control effects of the two algorithms for the oblique line segment and the straight-line segment are the same, however, for the control at the inflection point, the improved edge computing algorithm is better than the general algorithm. Practice has proved that the equipment has reliable performance, convenient operation, high rolling precision, and fast rolling rhythm, and is very popular among users.

In this paper, a comparison is made between the traditional variable-section automotive leaf spring after rolling the thermal straightening control system and the edge computing-based intelligent variable-section automotive leaf spring thermal straightening control system after rolling, as shown in Table 2:

As shown in Table 2, this paper mainly compares the straightening function, safety, energy consumption, and comfort of the traditional and edge computing-based variable-section automotive leaf springs after rolling in thermal straightening control system. Through comparison, it is found that the straightening accuracy of the traditional variable-section automotive leaf spring after rolling in the thermal state straightening control system is 49%, the safety is 73%, and the comfort is 62%. The traditional thermal straightening control system of the variable-section automobile leaf spring after rolling not only has poor straightening function and general safety but also produces a lot of energy consumption, and the comfort is not good. The thermal straightening control system for variable-section automotive leaf springs after rolling based on edge computing proposed in this paper has the following two advantages:

(1) Save energy. According to the actual side bending of the reed, the correction range is automatically adjusted. Since the distance between the cold and hot clamping points can be adjusted to the maximum, the required straightening force is small.



(a)

(b)

FIGURE 8: Curves of programmed rolling without and with inflection point control. (a) Curve of programmed rolling without inflection point control. (b) Curve of programmed rolling with inflection point control.

TABLE 2: Comparison table of two kinds of variable-section automotive leaf springs after rolling hot straightening control system.

	Straightening function (%)	Energy saving (%)	Energy consumption (%)	Comfort (%)
Tradition	49	73	59	62
New type	78	86	20	95
Difference	29	13	39	33

TABLE 3: System utility table for two-tier processing architecture with the same system power consumption.

Method	Object	System power consumption	System utility	Operation hours	Efficient (%)
Two-tier processing architecture	1	50	78	2.3	59
	2	100	65	2.5	54
	3	150	48	2.7	48
	4	200	36	2.9	45

TABLE 4: System utility table for three-tier processing architecture with the same system power consumption.

Method	Object	System power consumption	System utility	Operation hours	Efficient (%)
Two-tier processing architecture	1	50	86	2.1	73
	2	100	83	2.2	72
	3	150	79	2.3	75
	4	200	80	2.4	70

(2) High straightening accuracy. The deformation monitoring device set at the lower end of the equipment can accurately control the bending amount after straightening within a reasonable range.

5.2. Experiments and Analysis of Two-Layer Processing Model and Three-Layer Processing Model of Mobile Edge Network. In this chapter, the three-layer processing model of mobile edge network and the two-layer processing model of the mobile edge network are used as comparison models, as shown in Tables 3 and 4.

As can be seen from Table 3, the system power consumption of the two-layer task processing architecture is between 50–200, and the system utility drops from 78% to 36%, with the regular increase of system power consumption, the system utility of the two-layer task processing architecture is gradually decreasing, and the running time is also increasing, which brings about the increase of the two-layer task processing architecture.

As can be seen from Table 4, with the regular increase of system power consumption, the system utility of the three-layer task processing architecture does not change much and is always around 80%. The running time has not increased much, and the work efficiency of the model of the three-tier task processing architecture has not changed much. Therefore, it can be known that the increase of system power consumption has little effect on the system utility of the three-layer task processing architecture.

Then, this paper investigates and compares the system power consumption difference between the same system utility, as shown in Figure 9.

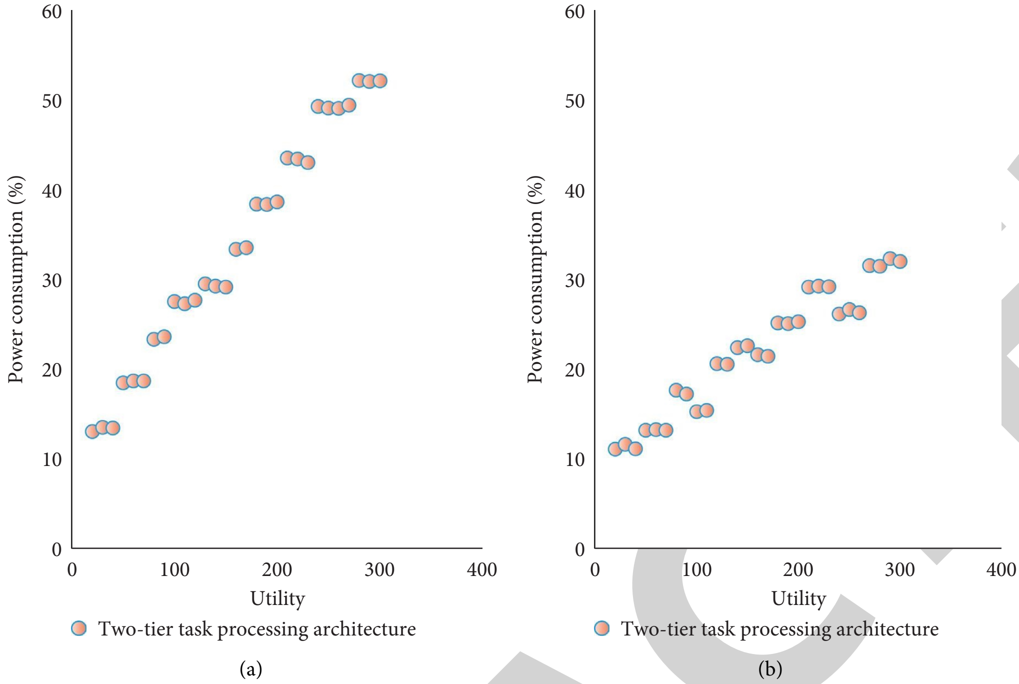


FIGURE 9: System power consumption for three-tier processing architecture and two-tier processing architecture at the same system utility. (a) System power consumption of two-tier processing architecture. (b) System power consumption of three-tier processing architecture.

As shown in Figure 9, with the increase of system utility, the system power consumption of the two-tier processing architecture is also slowly increasing, and the increase is larger, and the upward trend is also rapid. According to the analysis, the two-tier processing architecture consumes a lot of power as the system utility increases. The power consumption of the system grows when the utility of the three-tier processing design improves, although the increase is relatively tiny, around half that of the two-tier processing architecture. It demonstrates that the three-tier processing design consumes extremely little power. When the study is combined, it can be shown that the three-tier processing architecture system consumes less power than the two-tier processing architecture system. As a result, the three-tier processing design is preferable. At the same time, in edge computing in the current scenario, the computing power of edge devices is limited. Therefore, the complexity of the three-tier processing architecture also needs to be considered when generating the decision model so that it can run normally on devices with weak computing power.

Therefore, in this experiment, it is decided to set the number of iterations to 10 to ensure that the model will not lose its applicability while achieving the desired accuracy. On the other hand, this choice can also improve the computing speed of the overall system. This paper compares and tests the three-layer processing architecture, decision tree, and Bayesian based on edge computing, which are all common classification algorithm models. Therefore, this paper uses these methods for comparative testing, as shown in Table 5.

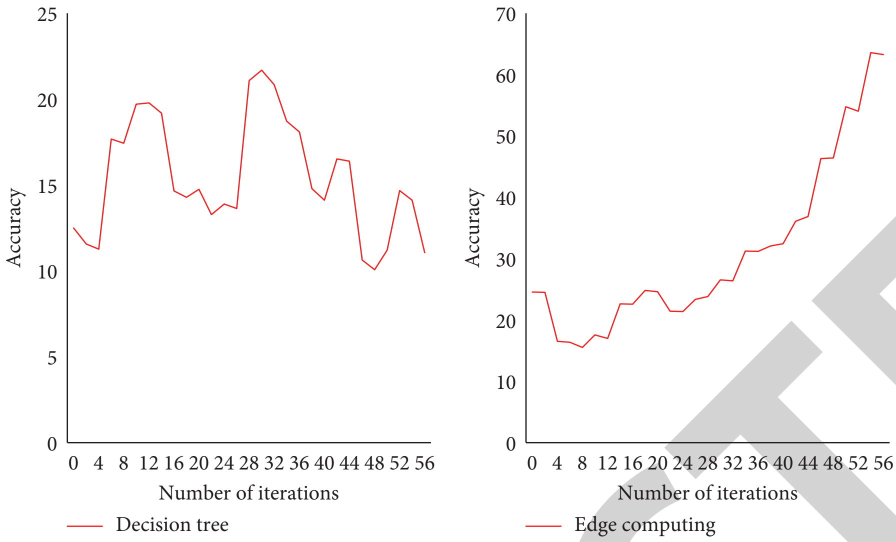
As shown in Table 5, the computing speed of the three-layer processing architecture based on edge computing is 78%, the accuracy rate is 67%, and the running time is 7.8 seconds. The operation speed of the decision tree is 75%, the accuracy rate is 65%, and the running time is 7.7 seconds. The Bayesian operation was 52% faster, 35% accurate, and took 7.9 seconds to run. Therefore, it can be known that the computing speed and accuracy of the three-layer processing architecture and decision tree based on edge computing are higher than those of Bayesian computing.

TABLE 5: Three-tier processing architecture, decision tree, and Bayesian comparison test table based on edge computing.

Method	Calculating speed (%)	Accuracy (%)	Operation hours
Edge computing	78	67	7.8
Decision tree	75	65	7.7
Bayes	52	35	7.9

Through the analysis in Table 5, this paper compares the classification accuracy of the three-layer processing architecture based on edge computing and decision tree and abandons Bayesian. The classification accuracy and computing speed of the three-layer processing architecture and decision tree based on edge computing are higher than the Bayesian classification accuracy and computing speed, as shown in Figure 10.

As shown in Figure 10, the classification accuracy of the decision tree fluctuates high and low, and it is not stable. Overall, the accuracy rate is still relatively low, with the continuous increase of the number of iterations, although the classification accuracy of the three-layer processing architecture based on edge computing decreased at the beginning, it quickly increased, and it has been showing a



(a) (b)

Figure 10: Classification accuracy of edge computing-based three-tier processing architecture and decision tree. (a) Classification accuracy of decision tree. (b) Classification accuracy of three-tier processing architecture based on edge computing.

steady upward trend. Therefore, it can be known that the classification accuracy of the three-layer processing architecture based on edge computing is not only stable but also in a state of rising. The classification accuracy of the three-layer processing architecture based on edge computing is clearly much more stable than that of the decision tree.

6. Discussion

This paper analyzes how to research the thermal straightening control system after the rolling of variable-section automotive leaf springs based on IoT edge computing. It explores the method of designing the thermal straightening control system after the rolling of the variable-section automobile leaf spring and discusses the importance of the thermal straightening control system after the rolling of the variable-section automobile leaf spring through experiments.

The research and analysis of the time-delay theoretical model is actually a good foundation for the research on the thermal straightening control system after the rolling of the variable-section automobile leaf spring in the experimental part of this paper. Through experimental analysis, this paper shows that in today's rapidly developing social context, almost every household has its own car. At this time, the importance of the safety and comfort of the car is self-evident, and the research on the thermal alignment control system of the variable-section automobile leaf spring after rolling is to further improve the performance of the car.

7. Conclusions

This paper mainly studies the development of the Internet of Things and edge computing and applies it to the design of the thermal straightening control system after the rolling of the variable-section automotive leaf spring. This paper first briefly expounds why the hot straightening control system after the rolling of the variable-section automobile leaf spring should be studied, which is for the safety of the car and the driver and for saving energy. This paper introduces the theoretical knowledge of the Internet of Things and edge computing in detail and briefly introduces the importance of the thermal straightening control system after the rolling of the variable-section automotive leaf spring. In the method part, this paper gives a specific description of edge computing. In the experimental analysis part, this paper, firstly, gives a general explanation of the schematic diagram of the thermal straightening control system after the rolling of the variable-section automobile leaf spring. Then, a comparative analysis is made between the traditional and edge computing-based thermal straightening control systems for variable-section automotive leaf springs after rolling. Finally, it is found that the thermal straightening control system of variable-section automotive leaf spring after rolling based on edge computing not only has higher straightening accuracy than the traditional system but also saves a lot of energy. Experimental results show that based on the edge computing of the Internet of Things, it is of great significance to study the thermal straightening control system of the variable-section automotive leaf spring after rolling.

Data Availability

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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