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Intelligent Equipment Automation Technology

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I. INTRODUCTION

A summary of domestic and foreign research related to the topic selection, the theoretical and practical significance of the topic selection

A. Topic Significance

With the comprehensive progress of the prevention and control of the pneumonia epidemic caused by the new corona virus infection, a large amount of medical waste is generated every day. Medical waste is a special type of hazardous waste, and the issue of medical waste disposal has become a focus of attention around the world. my country lists it as No. 1 hazardous waste in the "List of Hazardous Wastes". Different from ordinary domestic waste, medical waste contains a large amount of bacteria, viruses and chemical agents, which are highly infectious, biologically toxic and corrosive, soil and air pollution will cause direct or indirect harm to the human body, and may also become a new source of epidemic disease. Strengthening the standardized management and harmless treatment of medical waste is of great significance in terms of environmental protection and disease prevention and control. In response to the new pneumonia epidemic, huge infectious wastes have been generated, mainly including: cotton balls, cotton swabs, drainage tampons, gauze and other dressings, disposable hygiene products after use, disposable medical supplies, discarded quilts and other medical waste. This kind of infectious waste is closest to the virus, and it carries a large amount of active virus after being discarded. Therefore, it is necessary to be safe and shorten the time during the collection and transportation process. The storage requirements are also relatively high. city transport. How to ensure that such infectious waste can be treated efficiently, quickly and harmlessly will provide a strong guarantee for controlling the spread of this epidemic and preventing the second spread of the epidemic.

B. Research Status Abroad

The research on waste incineration process control technology in foreign countries began earlier, so it has developed relatively well, such as expert system real-time control, fuzzy control, neural network control and simulation intelligent control [2-8]. There are many advanced cases abroad, such as Tanaka's ACC control system (Japan), alspa-p320 open automatic control system (France) and sigma combustion control system (Belgium) [8-13]. Alstom of France has built its alspa-p320 system in many regions and countries, including about 140 self built and cooperative incineration plants, more than 245 production lines, 5-50t / h incineration lines, and the heat generated by incineration of waste is up to 6000-21000kj / kg [14]. At present, most of the control systems of the combustion furnace are based on PID control. This control method is mainly used in the waste combustion with finer sorting and stable calorific value, which can basically meet the control requirements of the combustion furnace.

Founded more than 20 years ago and located in Antwerp, sigs company in Belgium is a technology-based enterprise. It has built about 50 incineration plants in South Korea, Europe and the United States. At the same time, it is a rare company with more cooperation with Asia. One of the reasons for the company's long-term prosperity is that they have created their own waste incineration technology.

At present, PID control method is applied to incinerator, and the unstable control effect is a major problem [16-19]. With the continuous development of waste incineration, the requirements for waste incineration effect are higher and higher. The traditional control method cannot meet the needs of actual combustion system control. Expert control system, neural network control system and other methods based on fuzzy control are gradually introduced into the incinerator control system, which has played a better control effect.

C. Domestic Research Status

At present, the incinerators of most row incinerators in China are imported from abroad, and the construction cost is relatively high. When China first started to implement waste incineration, incinerators were mainly imported from Japan and Europe.

The main brands in Japan include Mitsubishi Martin reverse push grate, Japanese shipbuilding, teddy bear and jiefuyi, while the brands in Europe mainly include Noel kerz stepped forward push grate, city-2000 inclined reciprocating grate and reciprocating forward push grate, Among them, the widely used brands in China are siges in Belgium and Tian Xiong in Japan.

For example, Shenzhen Energy Co., Ltd. and Bao'an waste power plant use Belgian sigma system, while Zhongshan power plant and Changzhou waste power plant also use Belgian sigma system. The ACC system made by Tian Xiong is used in Zhangjiagang waste incineration plant and Tianjin TEDA Shuanggang[20-24]. Compared with foreign countries, China's waste incineration industry is not developed and started relatively late. Zhu Lihong and others [25] are employees of Chongqing Tongxing waste treatment company. The plant itself introduces the German inclined exhaust furnace. In order to work more efficiently, Zhu Lihong and others optimized and changed the pusher speed, waiting time and load setting value of the incinerator, so that the incinerator can work more efficiently.

Tang Wei et al. [26] found that the nonlinearity in the incineration process of incinerator will cause the instability of working conditions. At the same time, due to the complex working process of incinerator, there are often deviations in the incineration process. Therefore, they studied the application of fuzzy control system in the operation of incinerator, which can effectively control the combustion temperature of incinerator after being put into practical application. Hua Xinfeng et al.

[27] solved the problem of unstable output variables through the construction of the model, so that the temperature of the incinerator becomes very stable during the incineration process. Zou baochan et al. [28] believed that the incineration object of the incinerator is very complex, so the reaction in the incinerator is also diverse.

They gave an optimized artificial intelligence control method. In order to control the reaction in the incinerator in real time, they found that this intelligent control method has strong robustness and can control the incinerator well through modeling, calculation and experiment, Is a method that can be implemented.

D. Existing Problems

To sum up, at present, many predecessors have studied the automatic control system of large and medium-sized waste incinerators and achieved good benefits in application, but the waste incineration technology is not perfect, especially the research on the incineration process control of medical waste incinerators is not many, and the existing waste incinerators still stay as long as the waste is incinerated, with less consideration of environmental pollution factors.

Combined with the characteristics of large and medium-sized waste incinerators and smallsimple incinerators, the design requirements for medical waste incinerators are as follows:

1) During medical waste incineration, the furnace body temperature shall be kept above the decomposition temperature of harmful substances.

2) Aiming at the instability of medical waste combustion, the control system can control the furnace temperature within a certain range.

II. MAIN CONTENTS OF THE RESEARCH

Due to the limitations of PID control in realizing the stability of waste incinerator temperature, and fuzzy control is a control that imitates human thinking mode for reasoning and has strong adaptive ability, a fuzzy controller can be constructed to realize more effective control of the controlled object with unstable parameters such as waste incinerator temperature.

Therefore, based on the fuzzy theory, this paper studies the temperature control system of waste incinerator. The specific research contents are as follows:

1) This part also introduces the research significance, content and methods, and briefly introduces the current situation of waste incineration at home and abroad.

2) This paper introduces the existing medical waste gasification incinerator in the laboratory, including the introduction of some systems of the project and the description of process flow functions, and determines the main factors affecting the stability of furnace temperature.

3) The fuzzy control technology, fuzzy controller and the principle of fuzzy control system are introduced. Aiming at the problems existing in the traditional incineration control system, a fuzzy controller is designed, and the optimization method of combustion control mode is proposed. This part studies the problem of fuzzy control of combustion system, how to determine fuzzy language and membership function, how to establish fuzzy control rules and corresponding fuzzy decision-making.

4) The combustion system of waste gasification incinerator with fuzzy control algorithm is simulated and verified, and the simulation results are analyzed in detail. The system is applied to the actual gasification incinerator, and the real-time data of the incineration system based on fuzzy control is collected and compared with the data of PID control system.

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III. MAIN PROBLEMS TO BE SOLVED AND RESEARCH APPROACHES AND METHODS (EXPECTED IDEAS AND TECHNICAL ROUTES)

The research scheme of this project adopts the research method of combining theoretical research, simulation experiment and experimental verification. The research technology route is shown in Figure 1:

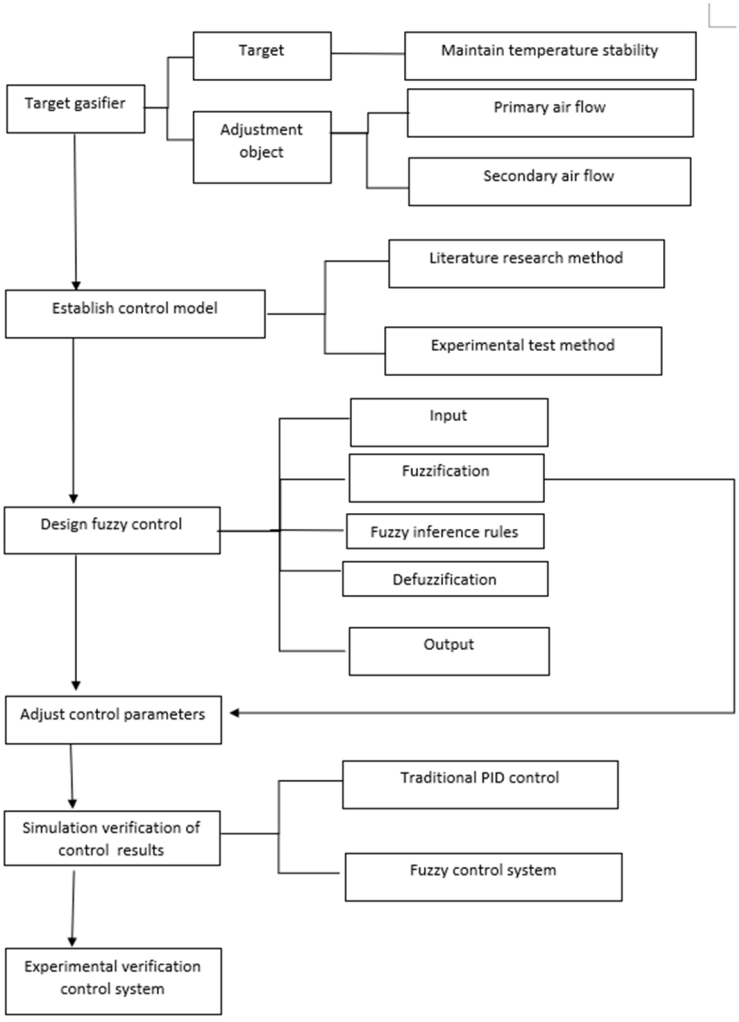

Figure 1 Research Technology Route

1) In order to determine the control object, it is necessary to study the control process of waste incinerator. This paper analyzes the technical characteristics of incinerator, the principle of incinerator, the composition of incinerator system, the evaluation standard of incineration treatment effect, the difficulties of incinerator temperature control in incinerator control system, and the relationship between temperature and various incineration parameters. During the incineration process, the furnace temperature of the incinerator control system needs to be maintained at a high and stable level. Only in this way can the waste gas treatment achieve harmless treatment as far as possible. To maintain the temperature at a high and stable level, it is necessary to accurately control the furnace temperature.

2) The mathematical model of the controlled object is of great significance for analyzing the system characteristics and designing the system control scheme. Establish the mathematical model of the control object. In order to make the mathematical model highly fit with our research object, when adjusting the model parameters, the experimental test method is proposed to provide data support to improve the accuracy of the model. The mathematical model of control system enables the mathematical expression to describe the input and output variables of control system and the relationship between internal variables. The relationship between system variables can be expressed through differential equation, difference equation, transfer function, pulse transfer function and state space expression to ensure the accuracy of simulation results.

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3) This subject plans to use fuzzy control to realize the stability of furnace temperature. The combustion process of waste incinerator is a strongly coupled multi input and multi output nonlinear system, and its dynamic characteristics change greatly with the change of operating conditions. The dynamic characteristics of each link are very different, and there are uncertainties such as inertia, lag, nonlinearity, time-varying, working environment and interference, so it is difficult to obtain an accurate mathematical model. However, skilled operators can often effectively control the combustion process of incinerator. When the operator controls the controlled object, he mainly accumulates operation experience through continuous learning. These experiences include his understanding of the characteristics of the controlled object and the control strategy, performance index and criterion under various conditions. Then, according to these experiences, a set of fuzzy and effective control rules expressed in natural language are established to control the controlled object, which is the so-called fuzzy control strategy.

4) After making the control strategy for the first time and putting it into the control model for operation, there will generally be deviations between the control results and expectations. At this time, we need to go back and adjust the control parameters in the control strategy to make the output of the control system meet our expectations.

5) After adjusting the control strategy, it is necessary to analyze whether the overshoot of the control system meets the design requirements or leads to the divergence of the control system by inserting interference signals during the operation of the control system. At the same time, we also need to compare the traditional control system and analyze their advantages and disadvantages.

6) The optimized control strategy is applied to practice. Through the actual experiment, compare the previously used control methods, judge whether the control strategy is effective, and complete the final step of designing the control system.

This subject plans to use fuzzy control method to realize the accurate control of furnace temperature at a high and stable level.

Fuzzy control is a control method based on fuzzy set theory, fuzzy language variables and fuzzy logic reasoning. It is a common intelligent control method reflecting people's thinking. It is mainly used in the control system with complex and variable controlled objects, which is difficult to establish mathematical model or has strong nonlinear system. Different from the traditional control system which depends on the system behavior parameters, the fuzzy controller depends on the operator's experience.

The control idea of fuzzy control system is:

a) The physical quantity to be monitored is converted into accurate digital quantity through the sensor and analog-to-digital converter. After the accurate input is input into the fuzzy controller, it is converted into the membership function of the fuzzy set. This step is called the fuzzification of the accurate quantity. Its purpose is to convert the input of the sensor into a variable format that can be understood and operated by the knowledge base.

b) According to the experience of experienced operators or experts, formulate fuzzy control rules and carry out fuzzy logic reasoning to obtain a fuzzy output set, that is, a new fuzzy set membership function. This step is called the formation and reasoning of fuzzy control rules. Its purpose is to use fuzzy input values to adapt control rules, determine the degree of adaptation for each control rule, and combine the outputs of those rules through weighted calculation, The output control fuzzy set is obtained.

c) According to the membership function of the output fuzzy set obtained by fuzzy logic reasoning, find a representative accurate value as the control quantity with an appropriate method. This step is called the defuzzification method of fuzzy output quantity. Its purpose is to summarize and combine the distribution range into the output value of a single point and add it to the actuator to realize control.

Structural design of fuzzy controller:

The structure design of fuzzy controller is to determine the input variables and output variables of fuzzy controller. What kind of variable should be selected? It is necessary to deeply study what information experienced operators mainly use in the process of manual control to control the controlled object to approach the expected target.

In the process of manual control, the information that people can obtain can generally be summarized as error, error change and error change rate.

Therefore, error, error change and error change rate can be taken as the input variables of fuzzy controller, and the change of control quantity can be taken as the output variables.

Generally, the number of input variables of fuzzy controller is called the dimension of fuzzy control. Because one-dimensional fuzzy controller only adopts deviation control, its dynamic control performance is poor, which is generally used for the first-order controlled object. Two dimensional fuzzy controller has better control effect than one-dimensional fuzzy controller, and is easy to be realized by computer. At present, it is widely used.

Theoretically, the higher the dimension of the fuzzy controller is, the finer the control is. However, the higher the dimension is, the more complex the fuzzy control rules become, and the implementation of the control algorithm is very difficult.

Basic principle of fuzzy control system:

The basic principle block diagram of fuzzy control system is shown in Figure 2. Workflow: the sensor detects the actual output value of the controlled quantity, compares the error value with the given input value, and then sends it to the fuzzy controller through a / D conversion (analog-to-digital conversion). The error is fuzzified by the fuzzy controller, fuzzy reasoning and anti fuzzy processing. The output control quantity is sent to the actuator through D / a conversion (digital to analog conversion) to control the control object, so that the control quantity changes according to the change of the set value, so as to achieve the ideal control effect.

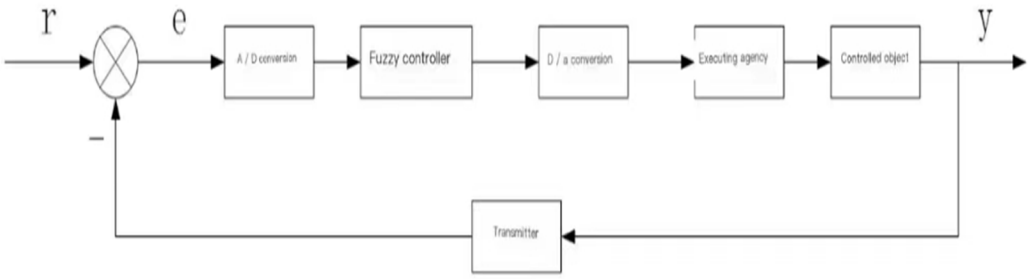

Fig. 2 basic principle block diagram of fuzzy control system

Fuzzy control system can be generally divided into five parts:

1) Fuzzy Controller: the core part of fuzzy control system uses fuzzy mathematics knowledge representation and rule-based reasoning language controller.

2) Input And Output Interface: the fuzzy controller obtains the digital signal from the controlled object through the input interface, and converts the digital signal determined by the fuzzy controller into analog signal through the output interface to control the controlled object.

3) Actuator: mainly composed of electric or pneumatic actuator.

4) Controlled Object: it can be a device or a production, social, biological or other state transfer process. These controlled objects can be deterministic or fuzzy, univariate or multivariable, linear or nonlinear, and have strong anti-interference.

5) Transmitter: it is composed of sensor and signal conditioning circuit. Sensor is a device that converts the controlled object or controlled quantity into electrical signal. Its accuracy has a great impact on the accuracy of the whole fuzzy control system.

Existing research basis:

A set of 1ton/daymedical waste gasification incinerator has been developed in the early stage of the laboratory, as shown in Figure 3.

Figure 3waste gasification incinerator

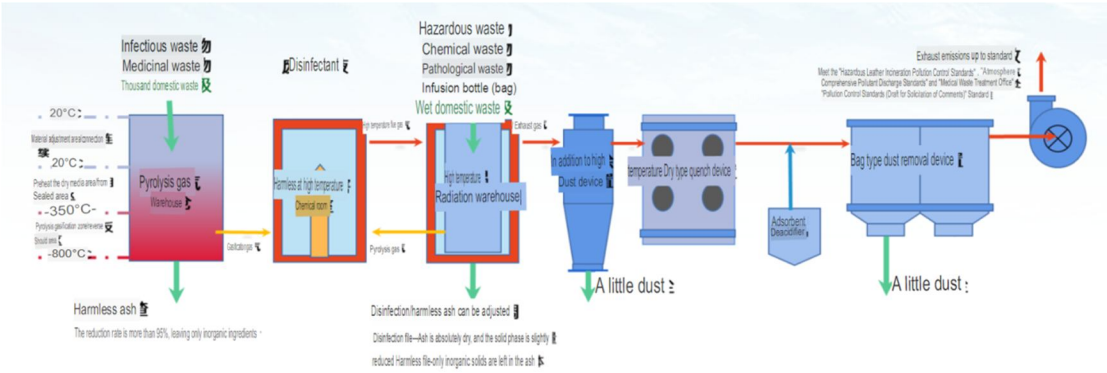

Fig. 4 Medical waste gasification incinerator process route

As shown in Figure 4, The dry material undergoes a gasification reaction in the temperature environment of 300~850℃ in the gasification incinerator tank. With the complete gasification and decomposition of organic matter in the material, bacteria, viruses, biochemical substances and organic pollutants are completely decomposed at high temperature to form gasification gas. Through the smokeless high temperature oxidation module above 950℃, it is further oxidized and decomposed into CO2 and H2O at high temperature. This module strictly controls the reaction temperature above 950℃, which ensures the complete decomposition of dioxin and the full combustion of the solid-phase gasification gas. High temperature flue gas is formed as a heat source for indirect carbonization of wet materials. Make the waste go through a series of processes of drying, pyrolysis and carbonization (500~650°C) in the reactor to achieve reduction and harmless treatment. The pyrolysis gas generated in this process is also harmless through the smokeless device. chemical and heat recovery. The temperature of the gas after the carbonization jacket heat exchange and cooling is 550 ℃ ~ 600 ℃, and the temperature is reduced to below 250 ℃ within 1s by the dry quench cooling device, and then the residual organic pollutants and HCl, HCl, Acid oxides such as SO2, and eventually particulates are controlled by an integrated baghouse. During the process, a small amount of harmless slag and carbon compounds produced by the gasification incineration module and the pyrolysis carbonization module are discharged from the ash outlet.

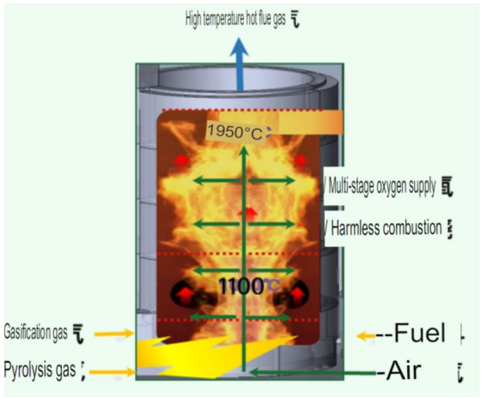

Fig.5. Harmless treatment unit

As shown in Figure 5, harmless treatment process adopts the layered combustion process to realize the incineration of exhaust in an efficient and energy-saving way. A central air distribution pipe is set in the furnace, and the air distribution pipe is provided with a blowhole at a certain height, which can make the air form a multi-layer air curtain perpendicular to the air distribution pipe in the furnace cavity. The medical waste is smouldering beside. The unburned particles go with the hot gas flow into the bottom of harmless treatment unit, reach each air curtain and burn with oxygen, and finally burn out. The exhaust gas is led out by the exhaust fan for dust reduction treatment, and then directly discharged into the atmosphere. The existence of the central distribution pipe can keep the high temperature in the incinerator without combustion supporting fuel. The air introduced by the fan can be preheated at the bottom of the incinerator. The temperature of the air curtain increases layer by layer with the height, and the temperature of the top layer in the incinerator can reach 1100 ℃, which can effectively inhibit and decompose toxic and harmful substances such as dioxins.

IV. EXISTING PROBLEMS

1) The existing harmless treatment process is controlled manually. During incineration, workers need to observe the temperature in the furnace and adjust the fan speed at all times.

2) During manual operation, the temperature in the furnace fluctuates more than ± 100 ℃, with large deviation.

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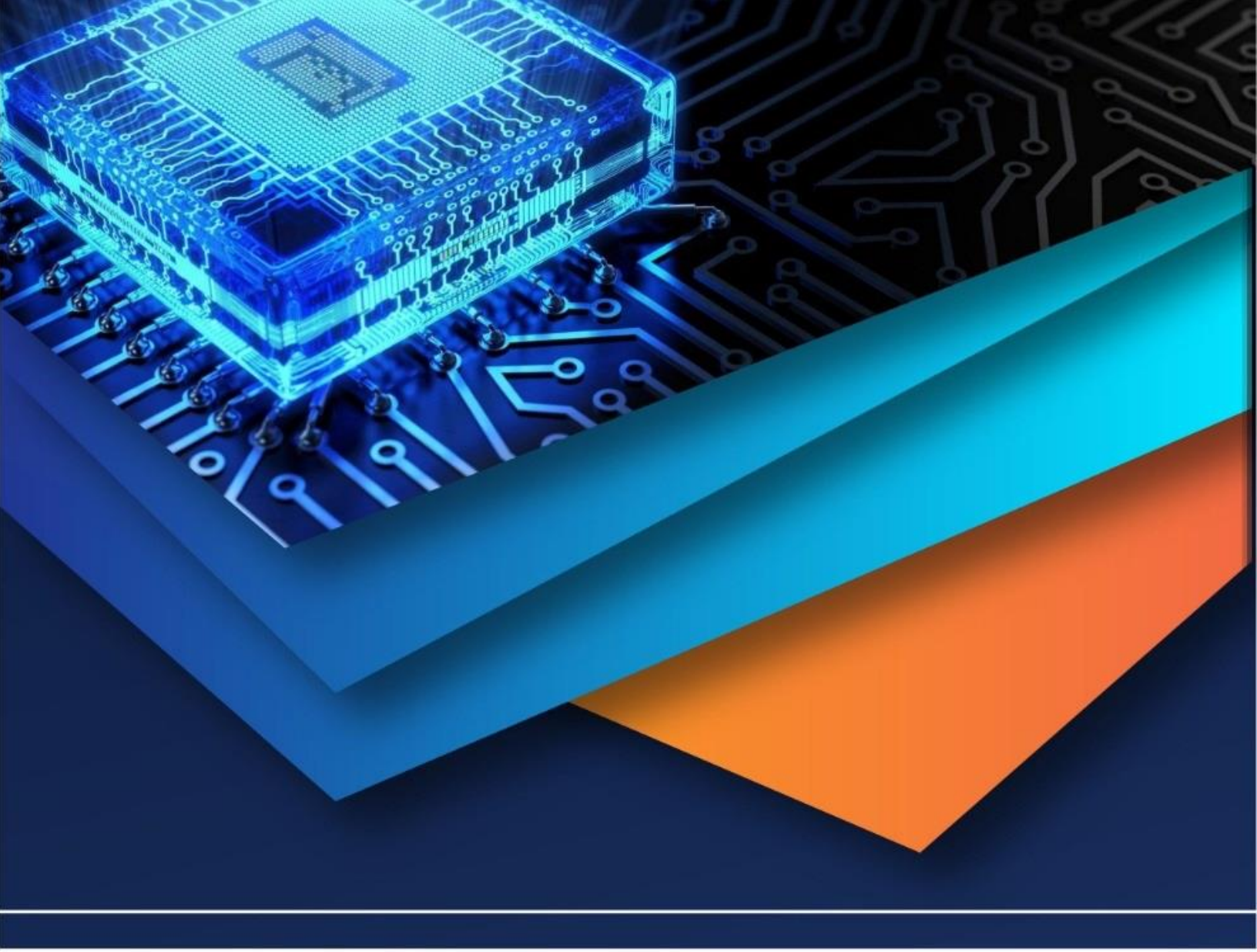

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