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THE APPLICATION OF INTELLIGENT ROBOTS AND DEEP LEARNING IN THE CONSTRUCTION MANAGEMENT PLATFORM SYSTEM OF CONSTRUCTION ENGINEERING

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Abstract. In order to solve the problem of duplicate data entry between construction management platform systems in construction engineering, the author proposes to apply RPA intelligent process robots to replace manual data collection, operation, entry, and verification. The design of the system is divided into overall architecture, instruction program loading process, human-machine interaction system level services, and other levels. An end-to-end procedural instruction transmission control method is adopted, establish a low-level control command output module for the online calibration system of the flight path, using a basic service architecture system, implement human-machine interactive control of the online calibration system for flight paths on the B/S architecture system. Build a record controller module for the inspection trajectory correction of RPA intelligent process robots, and perform feedback control during the trajectory correction process in LOG-CONTROL-BLOCK, using the RPA feedback correction algorithm, achieve adaptive correction and error feedback tracking of the inspection trajectory of RPA intelligent process robots. Implement calibration system development and design in an integrated DSP (Digital Signal Processing) information processing platform. The experimental results show that good economic benefits have been achieved through application, and the problem of duplicate data entry between the employer's IFS system and the ENPOWER document management system has been solved, greatly reducing error rates and personnel costs. It can replace manual data collection, entry, verification, and business operations; It has the characteristics of low error rate, low cost, high accuracy, compliance, and 24/7 standby; In 2021, 108000 yuan was saved, in 2022, 432000 yuan was saved, and in 2023, 432000 yuan was saved, demonstrating the labor hour cost savings achieved by utilizing RPA intelligent process robots.

Key words: Intelligent robots, Construction engineering, Construction management platform

1. Introduction. Traditional project management work is greatly influenced by the professional qualities and abilities of management personnel. If the management knowledge reserve of management personnel is not rich and lacks project management experience, it may be difficult to implement job responsibilities in engineering practice, increase the quality and safety risks of construction projects, and threaten the life safety of construction personnel. In addition, the construction site environment is relatively complex and diverse, and the cultural level of construction personnel is generally low, they usually lack awareness of safe and civilized construction, do not pay attention to the standardization of operations, and fail to use safety protection facilities reasonably, when a sudden unexpected event occurs, one is at a loss and loses the best opportunity to escape, not only will construction be delayed, but once casualties occur, their families will be in a state of disaster[1]. There are numerous high-rise buildings in the city, and the amount of construction work is larger and the complexity is higher. Traditional project management models are no longer applicable, in order to avoid safety accidents, strengthen the construction process and site management, and use intelligent technology is imperative[2].

With the advent of the information age, the application of information technology in the construction industry has become more and more common, with the help of the Internet of Things, BIM, cloud computing, Big data, artificial intelligence and other technologies, smart site systems are built, develop safety management strategies based on the characteristics of construction projects and the specific situation of the construction site, and make timely adjustments based on the relevant information obtained, storing information in the cloud breaks the limitations of outdated and outdated management, and aligns with the full lifecycle management of buildings, the smart construction site system consists of multiple layers, including perception layer, transmission layer, processing layer, etc., it can process and analyze the collected project information at corresponding levels, providing project management personnel with strong data support for decision-making[3]. Relying on the smart

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Fig. 1.1: Intelligent construction site personnel management system

construction site system, we implement smart supervision, coordination, and training to ensure the organic coordination of progress, quality, safety, and environmental management. By practicing the concept of safe and civilized construction, the project management system has been comprehensively reformed.

At present, the smart construction site system has become an important auxiliary tool for construction project management. During the construction phase of the project, the smart construction site system has played a significant role. The application process is to use sensors and video monitoring devices to monitor the operation of construction machinery, transfer the attendance information of construction personnel to the smart construction site system, and the personnel located in the management and command center will combine the video and image information to order the quality and safety responsible person to promptly rectify the hidden dangers and reduce the probability of safety accidents[4]. Ensuring the personal safety and vital interests of construction personnel is the fundamental goal of construction project management, given the low professional quality and poor safety protection awareness of some construction personnel, utilize the smart construction site system for training, assessment, salary management, and other aspects, reflecting the concept of smart management. One is to specially build a database to store the basic information of all construction personnel, and issue smart cards to construction personnel, smart cards must be used for entering and exiting the construction site, as well as for construction and consumption activities within the site, it is strictly prohibited to use others' smart cards under false names[5]. The second is for construction personnel to enter the safety education and training section of the smart construction site system to learn safety knowledge, learn about the causes of safety accidents and their own job responsibilities, participate in safety knowledge assessments online, and obtain certificates to participate in construction after passing the assessment. The third is to distribute exclusive safety helmets to construction personnel, which can automatically locate the positions of construction personnel and record the operation time as a basis for attendance, when construction personnel take off their safety helmets for a period of time or suffer severe impacts, the safety helmets will emit an alarm signal. The fourth is that the smart construction site system can calculate the wages payable based on the attendance status and salary standards of construction personnel, ensuring that the interests of construction personnel are not infringed, as shown in Figure 1.1.

With the development of artificial intelligence control technology, the types and complexity of robots have increased, and robots have been applied in various fields. In auditing, artificial intelligence robots are used to process bills and reports during the auditing process, improving the intelligence level of auditing.In the process of auditing robot operations, due to factors such as the irregularity and uncertainty of the robot's job interface, the robot's trajectory tracking and control ability is not good. Therefore, it is necessary to conduct online calibration of the audit robot's inspection trajectory, combined with environmental parameter recognition and obstacle avoidance processing, to improve the robot's inspection and control performance.Studying the optimization design method of online calibration system for audit robot inspection trajectory is of great significance in improving the inspection ability of audit robots.

2. Literature Review. At present, there are multiple separate information systems in the project, such as NC (financial shared software), OA (office automation), ENPOWER (nuclear power multi project management system), IFS3. o (construction management information system), and other heterogeneous databases. To develop various API interfaces, WCF (Windows communication development platform), Web Service (remote call technology across programming languages and operating systems) to rebuild and achieve automation processing, it is not only costly, but also costly, And the development cycle is long. At this point, RPA technology has a powerful advantage in connecting these system interfaces. When using RPA intelligent process robots to simulate manual operations, they do not need to modify the original system, but directly imitate human behavior for operation, with good confidentiality. Especially in the processes of data extraction, input, filling out forms, and extracting structured and semi-structured data from various systems, RPA robots can be developed to achieve automation operations without making any program changes to the original system.At this time, RPA technology has powerful advantages in connecting these system interfaces. The RPA intelligent process robot does not transform the original system when simulating the manual operation, but directly imitates human behavior, with good confidentiality. In particular, RPA robots can be developed to extract data, input, filling in forms, and extracting structured and semi-structured data from various systems, and automatic operation can be realized without any program changes to the original system.

The construction industry is one of the pillar industries in China, playing a very important role in the development of the national economy and the employment of the people. In 2016, the national construction industry enterprises (referring to qualified general contracting and professional contracting construction enterprises, excluding labor subcontracting construction enterprises) had a total output value of over 19 trillion yuan, an increase of 7.09% compared to last year, the proportion of its increment to the national GDP is 6.66%, and the number of people employed in the entire construction industry exceeds 50 million, accounting for 6.68% of the total number of employed people in society. However, China's construction industry still has outdated technology and extensive management, resulting in serious waste of resources, building an ordinary residential building can result in up to 40in 2016, the profit margin of China's construction industry is still very low. At present, the industrialization level of China's construction industry is very low, and many construction methods, processes, and skills in the construction process heavily rely on the on-site construction operations of construction workers, which are greatly influenced by human factors and the environment, this is an important factor contributing to the unfavorable situation of low quality and low profits in China's construction industry. In current construction, although a large number of mechanical equipment have been involved, more processes still rely on manual work, which is inefficient and time-consuming. On the other hand, the issue of worker health and safety is also an important obstacle to the development of China's construction industry. Construction workers are always exposed to dangerous and deadly external environments. In 2015, 43 construction workers in the UK died at work, accounting for 30% of the total number of deaths in various industries throughout the year. In the same year, 937 construction workers in the United States were fatally injured during construction, accounting for 19.37% of the total number of fatal work-related injuries in the country. In China, from 1997 to 2014, there were an average of over 2500 fatal accidents occurring at construction sites every year. Based on global statistical data, the average casualty rate of the construction industry is 2-3 times that of other industries. Despite improvements in recent years, the casualty rate of construction workers is still very high. Moreover, the working environment of construction workers is extremely harsh, with dust and loud noise, which seriously affect the physical and mental health of on-site personnel in engineering projects, bringing health hazards to them. The large number of workers and imperfect management systems on the construction site have also brought many safety hazards, seriously restricting the healthy development of the construction industry.

Zhou.L believe that intelligent manufacturing is the theme and main direction of the development strategy of "Made in China 2025", and the application of industrial robots is an important direction of intelligent manufacturing. In the coming years, industrial robots will be widely used in various enterprises, which will inevitably require a large number of high-tech industries. Industrial robots are high-tech products in modern society, playing an important role in the process of economic development, especially in the manufacturing industry. Industrial robot technology is widely used in automated production lines, greatly improving industrial production efficiency. Replacing manual labor for various complex production operations to achieve industrial production automation. Analyze the current application of industrial robots in automated production lines, explore their future development direction, in order to better serve the manufacturing industry [6]. Wei, H. H conducted a bibliometric analysis of publications related to the application of social network analysis in the field of engineering construction management to describe existing research activities and determine future directions in this research field. These publications were retrieved from the China National Knowledge Infrastructure Database. There has been a significant increase in the knowledge system of using social network analysis in the field of engineering construction management. Out of 513 retrieved literature, 98 relevant literature related to the application of social network analysis in the field of engineering construction management was selected for research and analysis through reading abstracts. Through a comprehensive analysis of keywords and relevant literature, it can be found that the application of social network analysis in the field of engineering construction management is mainly studied from the perspectives of stakeholders, construction projects, and workers [7].

In order to solve the problem of duplicate data entry between construction management platform systems in construction engineering, the author proposes to apply RPA intelligent process robots to replace manual data collection, operation, entry, and verification. The design of the system is divided into overall architecture, instruction program loading process, human-machine interaction system level services, and other levels. An end-to-end procedural instruction transmission control method is adopted,establish a low-level control command output module for the online calibration system of the flight path, using a basic service architecture system, implement human-machine interactive control of the online calibration system for flight paths on the B/S architecture system. Build a record controller module for the inspection trajectory correction of RPA intelligent process robots, and perform feedback control during the trajectory correction process in LOG-CONTROL-BLOCK, using the RPA feedback correction algorithm, achieve adaptive correction and error feedback tracking of the inspection trajectory of RPA intelligent process robots. Implement calibration system development and design in an integrated DSP (Digital Signal Processing) information processing platform.

3. Intelligent Process Robot Based on RPA Technology.

3.1. Research Content and Objectives.

(1) Research content. After research and analysis, the nuclear power project takes the construction of ”smart nuclear power” as an opportunity to research new generation information technologies such as RPA technology, OCR, artificial intelligence, etc. on the basis of the existing nuclear power multi-project management system, ultimately, a set of intelligent process management platforms with nuclear power project management characteristics will be formed, achieving intelligent control of project document management, budget data, item warehousing, and other processes, replacing personnel automation for process operations.

(2) Business pain points. The project of China Nuclear Power Fifth Company has deployed a nuclear power multi-project construction management system, which can basically cover all businesses during the construction phase of nuclear power projects, however, there is no data interface between the nuclear power multi-project management archive management system (EN-POWER) and the employer’s construction management system (IFS3.0), there is a large amount of data re recording work, which not only increases labor costs and low work efficiency, but also cannot guarantee accuracy[8]. At the same time, there is a significant amount of data guidance work in the areas of construction budget data, financial reimbursement, and construction task sheet data backfill. Therefore, there is an urgent need to use more intelligent methods to solve this problem.

(3) Research objectives. Based on the analysis of the above issues, nuclear power projects take the construction of ”smart nuclear power” as an opportunity to investigate and research new generation information technologies such as RPA technology, OCR, artificial intelligence, etc. on the basis of the existing nuclear power multi-project management system, ultimately, a set of intelligent process management platforms with nuclear power project management characteristics will be formed, achieving intelligent control of project archive management, budget data entry, item management, and construction process management processes, this will replace personnel in automatic file merging, naming, authorization, entry, uploading attachments, distribution, and archiving of the entire process automation management, and replace manual automatic operation and data entry business[9].

1. Having the characteristics of low cost, low error rate, high accuracy, compliance, and 24/7 work III;
2. Implement cross platform automated operation between ENPOWER and IFS3.0 systems;
3. Implement automated input of ENPower budget data and item arrival data;
4. Replacing personnel to automatically execute repetitive business processes, saving labor costs;
5. Automated execution of procedural operations to improve work efficiency; Reduce the workload of technical personnel, enable technical personnel to focus more on creative work;

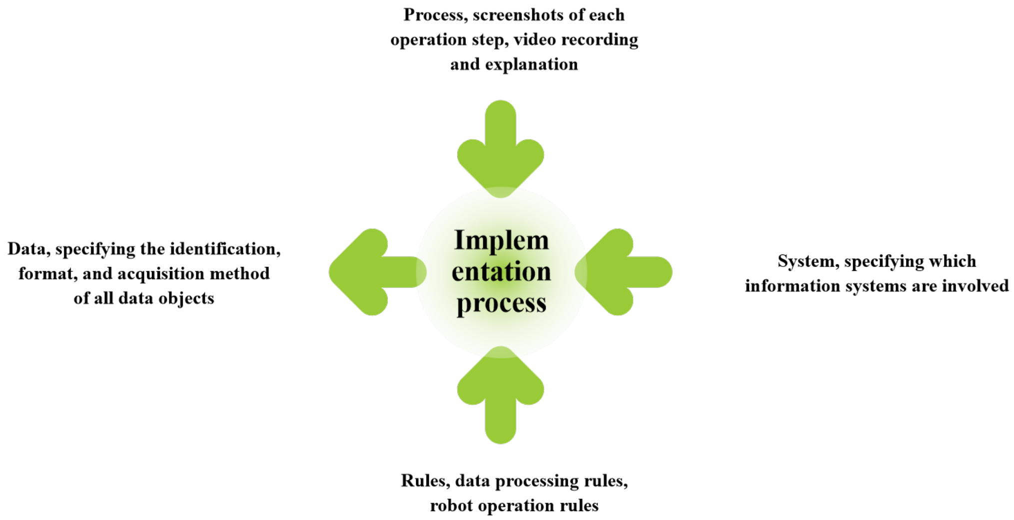

Fig. 3.1: RPA study technical route

6. Seamless connection with ENPOWER for data integration; Assist in Digital transformation of the project [10].

3.2. Technical Proposal and Application.

(1) Design Platform and Research Methods. The nuclear power project uses UiBot as the design platform for intelligent process robots; The main research Technology roadmap is shown in Figure 3.2:

1. Sort out and analyze the workflow of various existing information systems, and mine application points; Transform highly repetitive and relatively fixed processes into "intelligent process robots" to achieve automation;
2. By designing a platform, we can develop and implement "intelligent process robots" from a technical perspective, by simulating mouse, keyboard operations, and data interaction during human-computer interaction in specific scenarios, computers can independently operate and complete work tasks[11];
3. Deploying the developed "intelligent process robot" into the actual working environment, computer users can start the intelligent process robot automatically with just one click, and monitor the robot's operation status, if problems occur, they need to handle them in a timely manner.

(2) Introduction to the functional modules of the R&D platform. The research and development platform for intelligent process robots based on RPA technology consists of designers, runners, AI integration platforms, and intelligent process robots. The process robot equipment and management platform are shown in Figure 3.3:

1. Designer: Mainly used for developing "intelligent process robots", and can also run and debug RPA robots; Mainly designed to meet the needs of users in developing and designing process robots for different scenarios, helping users easily complete the design work of machine process automation;
2. Runner or controller: After RPA development is completed, users use the runtime platform to run the built robot; When it is necessary to run "intelligent process robots" on multiple computers, these "software robots" can be centrally controlled, such as unified distribution and setting of startup conditions[12];
3. AI integration platform: Providing intelligent process robots with various AI capabilities required for executing process automation; Through OCR character recognition, Natural language processing, image recognition and other AI technologies, the process processing capability and efficiency are further improved.

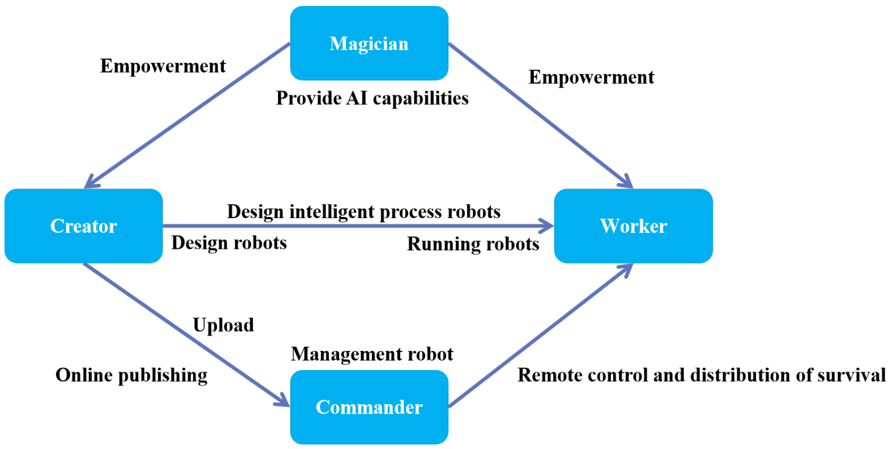

Fig. 3.2: Intelligent process robot design and management platform

3.3. Technological innovation and progressiveness . In order to solve the duplicate data entry work between the IFS and ENPower systems, the Nuclear Power Project Department of CNNC No.5 Company, by researching and developing RPA technology, we greatly reduce the error rate of personnel entering data and reduce project personnel costs. Instead of technical personnel, we automatically perform the entire process of file merging, naming, authorization, input, uploading attachments, distribution, and archiving, saving labor costs[13]; Solved the problem of duplicate entry of design file data in the document management system of the contracting party (IFS3.0) and the nuclear power multi-project management system (ENPOWER). Its main innovation points are as follows:

(1) Management Innovation.

1. Implement cross platform automated operation between ENPOWER and IFS3. o systems;
2. Implement automated input of ENPower budget data and item arrival data;
3. Replacing personnel to automatically execute repetitive business processes, saving labor costs;
4. Automated execution of procedural operations to improve work efficiency;
   Reduce the workload of technical personnel and make them more focused on doing creative work;
5. Seamless integration of ENPOWER data; Use AI technologies such as OCR and image recognition to help Digital transformation of nuclear power projects.

(2) Technological innovation.

① Visual programming technology

The original visual programming and source code programming can be switched at any time, making it simple and easy to use. Designers do not need advanced programming skills, by visualizing process views and rich source code command library views, the presentation of processes and process blocks can be achieved, effectively improving the efficiency of RPA process development[14].

② Business processing and software process intelligence

In RPA intelligent process design and daily office processes, it is often necessary to automate commonly used software such as Excel, Word, and browser, the use of RPA technology can achieve intelligent operation of these software. Meanwhile, RPA can perform repetitive and mechanical operations based on pre written scripts, replacing manual task processing with automated processing to improve work efficiency.

③ Simulate human-computer interaction

The RPA intelligent process machine mainly simulates the manual operation of users, such as data entry, character copying, pasting, mouse clicking, keyboard input, etc., and automatically processes the data conversion between tables, automatically adjusts the document format and article layout, automatically sends and receives emails, automatically opens the links of inspection web pages, Document retrieval,

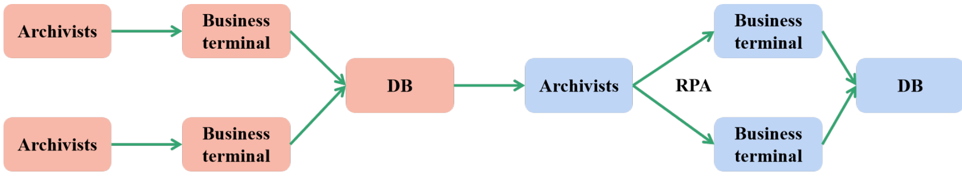

Fig. 3.3: The comparison of traditional working mode and RPA robot

collects data and other repeated operations. The comparison between its traditional work and RPA robots is shown in Figure 3.4.

④ Strong scalability and compatibility

Support custom plugins written in multiple programming languages such as Python, C/C++, C #, JAVA, etc., support custom commands, and support a multi-level developer ecosystem. At the same time, it has cross platform advantages, and the engine supports platforms such as Windows/Mac/Android. It is compatible with multiple PC and mobile devices, and supports various UI automation such as browsers, desktops, and SAP[15].

3.4. Design of online calibration algorithm for robot inspection trajectory. In order to achieve the design and research of the online calibration system for the audit robot's inspection trajectory, combined with the algorithm design and bus transmission design for the online calibration of the audit robot's inspection trajectory, a bus development design method is adopted, and the integrated DSP control is used to perform the online calibration and trajectory path tracking control of the audit robot's inspection trajectory from the input end to the output end. The overall structural model of the audit robot's inspection trajectory online calibration system is constructed,combining the hardware module design of the online calibration system for the audit robot's inspection trajectory with the MicroChannel expansion bus, the overall control of the audit robot's inspection trajectory online calibration system is carried out. Based on the audit robot's inspection control unit, a component functional modular development method is adopted to establish a human-machine interaction control module for the audit robot's inspection trajectory online calibration system, which is controlled by dynamic units, Implement the output unit conversion and overall structural design of the online calibration system for the audit robot's inspection trajectory.

In order to achieve the design and research of the online calibration system for the audit robot's inspection trajectory, combined with the algorithm design and bus transmission design for the online calibration of the audit robot's inspection trajectory, a bus development design method is adopted, and the integrated DSP control is used to perform the online calibration and trajectory path tracking control of the audit robot's inspection trajectory from the input end to the output end. The overall structural model of the audit robot's inspection trajectory online calibration system is constructed,combining the hardware module design of the online calibration system for the audit robot's inspection trajectory with the MicroChannel expansion bus, the overall control of the audit robot's inspection trajectory online calibration system is carried out. Based on the audit robot's inspection control unit, a component functional modular development method is adopted to establish a human-machine interaction control module for the audit robot's inspection trajectory online calibration system, which is controlled by dynamic units, Implement the output unit conversion and overall structural design of the online calibration system for the audit robot's inspection trajectory.

$$ {}^{4}T_{5}^{-1}(q_i) = {}^{4}T_{7} \prod_{i=6}^{7} {}^{i-1}T_i(q_i) \tag{3.1} $$

Among them, ${}^{4}T_{7}$ is the 4th order equilibrium moment, and $T_i(q_i)$ is the average degree of freedom of the RPA intelligent process robot, q_i is the balance parameter of the robot's end pose, and the robot's end pose constraint control is used to establish an adaptive planning model for the inspection trajectory of the RPA intelligent process robot, combined with the center of gravity offset planning, the feedback constraint parameters for the inspection trajectory center adjustment of the RPA intelligent process robot are obtained as follows:

$$q_0 = [\alpha_0, \beta_0, \gamma_0]^T \equiv [\theta_1, \theta_2, \theta_3]^T \tag{3.2}$$

Among them, $\alpha_0, \beta_0, \gamma_0$ represents the coordinates of RPA intelligent process robot in the patrol Polar coordinate system, $\theta_1, \theta_2, \theta_3$ is the phase parameter of the RPA intelligent process robot's inspection trajectory space. When measuring distance and pose, the offset correction is performed based on the calibration method of the plane template, resulting in a pose offset of $q_1 = [q_1, ..., q_7]^T = [\theta_4, ..., \theta_{10}]^T$; By homogeneous transformation, the pose is transformed into the robot base coordinate system, and the fuzzy information parameters of the inspection trajectory of the RPA intelligent process robot are composed of n omnidirectional motion parameters, the dynamic distribution function of the calibration trajectory is:

$$\begin{aligned} minF(x) = (f_1(x), f_2(x), ..., f_m(x))^T \\ s.t. g_i \leqslant 0, i = 1, 2, ..., q \\ h_j = 0, j = 1, 2, ..., p \end{aligned} \tag{3.3}$$

Among them, $f_1(x), f_2(x), ..., f_m(x)$ represents the contour sensing output parameters for the inspection trajectory inspection of RPA intelligent process robots, respectively, is the dynamic torque of the robot's end pose, h_j is the calibration feature parameter for path correction, and q and p respectively represent the calibration object positions of the inspection trajectory of the RPA intelligent process robot, based on this, a center of gravity offset planning model for online calibration of RPA intelligent process robot inspection trajectory is constructed, represented as:

$$H(s) = \frac{e^{-\tau s}}{1 + G_c(s)G_0(s)} \tag{3.4}$$

Among them, $G_c(s)$ represents the main control parameter for the center of gravity shift of the inspection trajectory of the RPA intelligent process robot; $G_0(s)$ represents the expected pose parameters of the inspection trajectory of the RPA intelligent process robot, $e^{-\tau s}$ represents the dynamic error of the inspection trajectory of the RPA intelligent process robot, for solving constrained nonlinear optimization problems, based on the correction method of center of gravity shift, the calibrated dynamic parameter distribution model in the robot's base coordinate system is obtained as follows:

$$L = J(w, e) - \sum_{i=1}^{N} \alpha_i \int_{i=1}^{M} H(r)\{w^T \phi(x_i) + b + e_i - y_i\} \tag{3.5}$$

Among them, $J(w, e)$ is the inertia function of motion along the expected path, α_i is the distribution along the edge of the expected path, is the adjustment function of the path edge, and w is the dynamic feature point for angle symmetry adjustment, $\phi(x_i)$ is the compensation torque, b is the alternating feature point in the path edge, e_i is the path offset error, y_i is the motion direction adjusted by the robot according to the path, and a discrete spatial planning method L is used to construct the inspection trajectory control model of the RPA intelligent process robot, the output is:

$$\begin{cases} K_i(d) = \sum\limits_{r=1}^{t} \sum\limits_{q=1}^{k_2} (x_{ir} - x_{irq})(x_{ir} - x_{irq})^T B_{irq} \\ F_1 = W_i^T H_2 W + f_i(d) \times log(\frac{N}{n_i} + 0.01) \\ Co_{const} = \sqrt{\sum\limits_{i=1}^{n} \sum\limits_{r=1}^{t} \sum\limits_{p=1}^{k_1} [(x_{ir} - x'_{irp})(x_{ir} - x'_{irp})^T A_{irp}]^2} \end{cases} \tag{3.6}$$

Among them, t is the time sampling point, x_{ir} is the head torque, x_{irq} is the width required for the robot to swing, and B_{irq} is the extension direction of the path determined by the target point, A_{irq} is the directional

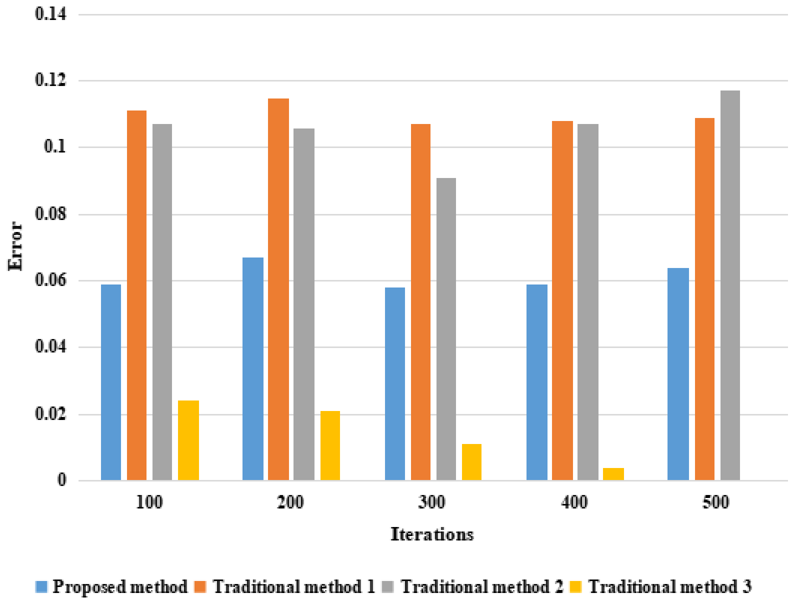

Fig. 4.1: Comparison of online correction error of intelligent robot inspection track

control parameter, W_i is the intersection point of the expected effective edge of the path, H_2 is the modeled parameter moving along the centerline of the path, and W is the alternating parameter between path edges, $f_i(d)$ is the mass of a single module, N is the target point selection parameter, n_i is the initial pose. Based on the above analysis, the RPA feedback correction algorithm is used to achieve adaptive correction of the inspection trajectory and error feedback tracking of the RPA intelligent process robot.

4. Application Achievements and Benefit Analysis. Feedback control during the trajectory correction process is carried out in LOG-CONTROL-BLOCK, using position sensors such as accelerometers and Doppler velocimeters (DVL) for data acquisition, the calibration system development and design were implemented in an integrated DSP information processing platform, and the results are shown in Figure 4.1. Analysis of Figure 4.1 shows that the error feedback performance of using this method for online calibration of RPA intelligent process robot inspection tracks is good, improving the accuracy of robot inspection[16].

The nuclear power project has been applied based on the conventional islands of Unit 1 and Unit 2 of the nuclear power plant, as well as some BOP engineering projects, with document, budget data, and item management as the entry points; Good economic benefits have been achieved through application, and the problem of duplicate data entry between the employer's IFS system and the ENPOWER document management system has been solved, greatly reducing error rates and personnel costs. It can replace manual data collection, entry, verification, and business operations; It has the characteristics of low error rate, low cost, high accuracy, compliance, and 24/7 standby; At present, the project has been applied in fields such as budget data and material management, with good application value and prospects[17,18]; It provides reference and guidance for the digital transformation work of similar nuclear power projects in the future, and its benefits in the construction of conventional nuclear power island projects are as follows:

RPA intelligent process robot, as a new software automation technology, is currently applied in nuclear power project documents, budget data, and item management; The application effect is good; through research and application, proved that RPA intelligent process robots can replace manual collection, input, verification of document data, and operation of business; Table 1 shows the labor cost savings after using RPA intelligent process robots.

5. Conclusion. Conduct online calibration of audit robot inspection trajectory, combine environmental

Table 4.1: The saved labor costs

Serial number	Year	New output value/10000 yuan	Cost savings /10000 yuan
1	2021	0	10.8
2	2022	0	43.3
3	2023	0	43.2
Three years of conservative calculation of the economic benefits generated			97.2

Note: After the above analysis, after the RPA intelligent process machine is put into use, it is expected to save 8 data or losers in the fields of budget data, item management and document management; cost (54 000 yuan / year 8 people) for 2 years + RMB 108,000 = RMB 0972,000.

parameter identification and obstacle avoidance processing to improve the robot's inspection control performance, and propose a design method for an RPA based audit robot inspection trajectory online calibration system. Establish an adaptive planning model of the audit robot's patrol path, use the Discretization space planning method to build the control model of the audit robot's patrol path, and use the RPA feedback correction algorithm to realize the adaptive correction and error feedback tracking of the audit robot's patrol path.The experimental results show that it has achieved good economic benefits through the application, solved the problem of repeated data entry between the employer's IFS system and the authorized document management system, and greatly reduced the error rate and personnel cost. It can replace manual data collection, input, verification and business operation; low error rate, low cost, high accuracy, compliance and 24 / 7 reserve; 108,000 in 2021,432,000 in 2022, and 432,000 in 2023. Through the application research of RPA intelligent process robot technology, we have promoted the transformation and functional improvement of nuclear power project information processes, and explored a path of information management with nuclear power characteristics; Making the information management of nuclear power projects increasingly "intelligent", while improving work efficiency and reducing management costs, it also breaks the data silos with the contracting party's system, exploring a new approach and method for subsequent digital transformation and intelligent project management; In the future, it will be promoted and applied in fields such as construction task orders, financial accounting, smart warehousing, and invoice verification, which has good application value and market prospects. It is hoped that the research on the application of intelligent site system can play a reference role in practical work and make a contribution to the innovation and development of the construction industry.

I hope to do better or make breakthroughs in the following areas in the future, so that the intelligent search robot system can better serve everyone and create a new situation for us to use the Internet.

The stability and real-time performance of the system. As the number of users continues to grow and the load on the system continues to increase, the system can still maintain its stable and fast characteristics.

The expansion of business seeks businesses with more business opportunities, linking actual business with virtual internet.

REFERENCES

[1] Guo, J. (2021). Research on the application of intelligent robots in explosive crime scenes. International Journal of System Assurance Engineering and Management, 14(2), 626-634.

[2] Chuanbao, W., Jin, H. E., Liang, L. I., & Yue, Z. (2021). Application of bim technology in the construction management of oil and gas field stations. Oil-Gas Field Surface Engineering,58(6),85-89.

[3] Khoso, A. R., Yusof, A. M., Chen, Z. S., Wang, X. J., & Memon, N. A. (2021). Embedded remote group environment through modification in macbeth-an application of contractor's selection in construction. Journal of Civil Engineering and Management,47(1),96-102.

[4] Cai, H. (2022). Building construction operation simulation based on bim technology and intelligent robots. Journal of Interconnection Networks,178(14),88-91.

[5] Varlamov, O. (2021). "brains" for robots: application of the mivar expert systems for implementation of autonomous intelligent robots. Big Data Research, 25(ahead-of-print), 100241.

[6] Zhou, L., Wang, F., Wang, N., & Yuan, T. (2021). Application of industrial robots in automated production lines under the background of intelligent manufacturing. Journal of Physics: Conference Series, 1992(4), 042050-.
[7] Wei, H. H., Zhang, Y., Sun, X., Chen, J., & Li, S. (2023). Intelligent robots and human–robot collaboration in the construction industry: a review. Journal of Intelligent Construction33(7), 9180002-9180002.
[8] Xie, J. Y. Y. (2021). Iot-based model for intelligent innovation practice system in higher education institutions. Journal of intelligent & fuzzy systems: Applications in Engineering and Technology, 40(2),98.
[9] Dahl, M., Bengtsson, K., & Falkman, P. (2021). Application of the sequence planner control framework to an intelligent automation system with a focus on error handling,18(74),88-93.
[10] Guo, Y. (2022). Research on the construction path of the target management system of the party building work in the tobacco industry. Journal of Higher Education Research, 3(4), 363-366.
[11] Xiong, W., Xiang, Y., & Meng, K. (2021). Exploration and practice of engineering management specialty in the teaching of innovative curriculum system construction. Francis Academic Press,978(18),587-589.
[12] Berco, V., Pfukani, N. S., & Hendri, D. P. (2021). Factors influencing the adoption of building information modelling (bim) in the south african construction and built environment (cbe) from a quantity surveying perspective. Engineering Management in Production and Services, 13(8),447-449.
[13] Feng, L., & Zhao, J. (2021). Research on the construction of intelligent management platform of garden landscape environment system based on remote sensing images. Arabian Journal of Geosciences, 14(14), 1-19.
[14] Yang, C., & Zhang, X. (2022). Research into the application of ai robots in community home leisure interaction. Journal of supercomputing,58(7), 78.
[15] C, J. H. A., & B, B. P. (2022). Study the path planning of intelligent robots and the application of blockchain technology. Energy Reports, 8(3), 5235-5245.
[16] Zhao, M., Mao, Y., Hen, Q., & Zhou, Y. (2021). Research on problems and countermeasures in the application of substation intelligent inspection system. Journal of Physics: Conference Series, 1983(1), 012084 (7pp).
[17] Banteng, B. S. D., & Uno, W. R. (2021). Application of time management systems in tardiness of the auditorium construction projects in the district bone bolango, gorontalo province. IOP Conference Series: Materials Science and Engineering, 1098(2), 022028 (4pp).
[18] Alhusban, M., Elghaish, F., & Matarneh, S. T. (2022). The application of ”deep learning” in construction site management: scientometric, thematic and critical analysis. Construction Innovation , 22(3), 580-603.

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