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Development of the Intelligent Judgment System for the Welding Efficiency

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Abstract: To improve the welding quality of the robot, monitor the welding accuracy and optimization of the parameters in the welding process, create an intelligent welding quality judgment system based on the Fuzzy Neural Network Control Technology, perform continuous optimization of the welding quality database and improve the efficiency of welding defect detection. This paper explains the technical approach of developing smart judgment framework, employing fuzzy control theory combined with BP neural network to recognize welding defects and optimize process parameters for welding operation. Through integrating different features into the fuzzy neural network, seam classification accuracy will exceed 90%, and the experimental results indicate that the proposed method of optimizing welding parameters and enhancing welding efficiency is successful and feasible. Introduction of the intelligent control theory described by expert method and fuzzy control as well as neural network and its implementation status in the management of welding processes. It addresses the creation trend of smart control technology in the welding process.

Keywords: Fuzzy neural network, welding quality, intelligent judgment system, welding defect, welding process parameters

INTRODUCTION

Welding quality entails the service life and safety of the whole product so the examination focuses on welding efficiency. The welding process in industry varies in time and at the same time it is unstable and is non-linear. A welding quality intelligent judgment program was built to direct the continuous optimization of the grinding and spraying process database and to provide subsequent location information and repeated process parameters to address the problem of robot welding quality inspection and welding process parameter optimization.Thiseliminates manual checks and arbitrary decision making, thereby increasing the efficiency and consistency of the whole cycles of welding[1], [2].

There is currently little research on computer-aided process welding systems at home and abroad. Expert systems, blurred regulation and neural networks are the main research fields. They have benefits, and hassles. The expert system is excellent at logical reasoning, but the learning rate is poor and it is difficult to meet the control criteria of the fast time-varying system. Fuzzy control is longer than that of the fussy processing of information and decision making, Yet precision control of complex objects is not sufficient[3].

Neural network shared storage information has good self-organization with self-learning capabilities, but it also needs to improve learning speed and avoid local optimization. Through expanding intelligent control science, neural networks, expert systems and blurred control have begun to penetrate and integrate with each other, and intelligent control technology has been applied in welding. Such as combining neural network with fuzzy control, combining expert system with neural network, and implementing fuzzy expert control systems. The use of expert systems as adaptive units and the use of fuzzy computation as a decision unit and the use of neural networks as compensation units are generally believed to be the most effective approaches for the development of intelligent controls. The combination of the three makes the control system more flexible, self-learning, self-organizing and increased control of quality. Actually, the expert method is primarily used in arc welding process control for deep penetration and melt width control, arc stability control, weld seam tracking, and expert information optimization of

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design parameters; fuzzy and its composite control is mainlyused in the arc stability control and neural network are combined for melting distance, penetration depth and weld seam tracking. The neural network utilizes its learning feature to mainly apply penetration and melting width detection and then integrates the blurred controller to complete quality and location tracking of the welding[3], [4].

The system developed by the above multiple smart control methods is shown in Table I below. For example, a selection system of welding materials developed jointly by the Colorado School of Mines and the American Welding Institute. An expert system for the prediction of defects was developed. Artificial neural networks and blurred control techniques are used to achieve robot welding efficiency and weld power. Some research merged neural network modeling and blurred control to create a closed loop control system for automatic spot-welding resistance[5].

Table 1: Development Status of Welding System at Home and Abroad

The name of the welding system	System developer
NEWCS	**General Digital Industries**
Camtech 1000 and Adaptitech 1000	Adaptive technologies
Weldexcell	AWI & NIST
Expert system for control of welding parameter	NKK
Weldplan	Toyo Engineering Corp
Weld Assit	Hobart Brothers Co
MIG Expert	Institute de Souduxe
Aluminium alloy welding process designation expert system	Harbin institute of technology
SMAW expert system	Tianjin University

Figure 1: Intelligent Welding Robot

The galvanized steel spot welding quality prediction model is known as the non-destructive test method for spot welding robot quality monitoring. Many researchers use the empirical data to train the multi-layer self-organizing feature mapping network without guidance; some researchers also use finite-element calculation model data, process parameters and rigidity of thin-wall welded box girder are used to train multi-stage BP network samples, and thin-line network training is used to create the rigid prediction spot welding box girder model with electric thin-wall.

Although the above welding process method will improve efficiency, the welding judgment results and the welding process parameters are not coupled with each other. As shown in Fig. 1, the system uses laser tracking to guide welding robot. The sensor uses lasers to communicate with the robot, so that the robot can monitor and scan digitally and weld flexibly. The welding quality judgment system will feed back the post weld quality information into the system and define the welding process parameters and finally output the optimum welding process parameters through the BP neural network for optimization design purposes.

METHODOLOGY

Welding defects, including volume defects, surface defects and dimensional defects, are the subject of inspections in intelligent judgment systems. Volume defects include voids and slag inclusions; surface defects include grooves, undercuts, welds, and surface cracks; linear defects include slag, incomplete penetration, unfused and cracks. This paper's smart judgment method pertains to the type of non-destructive testing. It automatically stores test data compared to destructive testing, and is not easy to miss[6][7].

Parameters for the input and output are shown in Fig. 2. The fuzzy neural network algorithm is being used to classify the defects in welding, and the process of understanding the intelligent judgment system for

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welding efficiency is analyzed. Intelligent welding process parameters and surface quality information are designed to provide optimized welding process parameters according to the data information after welding (welding process parameters, welding location information, molten pool state information, and welding quality information). This reduces the quality of welding errors, guarantees system stability and provides continuous grinding and painting process calibration[8].

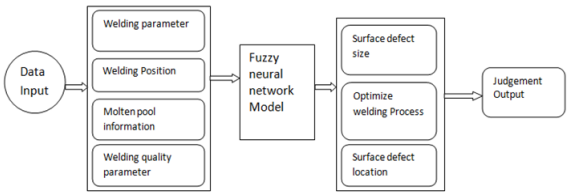

Figure 2: Intelligent Judgement System Input and Output

The above information regarding welding data is obtained via the visualization system. As illustrated in Fig. 3. Weld Vision System visualizes welding pools and welds by means of a high dynamic spectral camera imaging system that clearly shows the welding state during welding and the torch position and welding through the imaging system. The picture of welding is shown in Fig. 4. It solves the problems which are hard to observe and difficult to monitor when the welding equipment is in operation and increases welding device reliability. The system can be mounted on any highly compatible automatic welding equipment. Video and analysis of the welding process of the welding process help to track production process and traceability of quality[3][7].

Figure 3: Weld Bead Visualization System

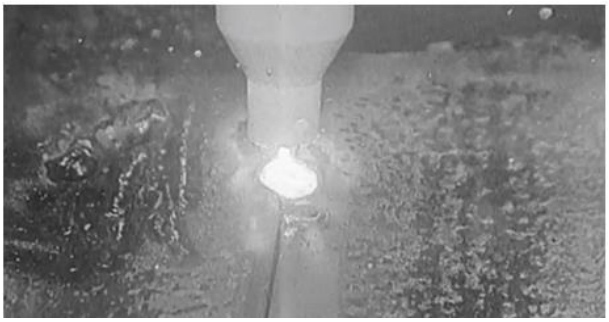

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Figure 4: Welding Image Acquisition

The investigational route of the intelligent judgment system for welding quality is shown in Fig. 5, The weld bead visualization system is used to collect the weld surface's real-time image to detect the weld image, including image preprocessing, image standardization processing, image edge detection and segmentation; the welding features were then extracted using Principal Component Analysis (PCA) data dimension reduction and welding feature extraction techniques to create a standard weld libra. A method to extract the appearance of a weld based on image processing techniques, compared to a standard feature library of weld appearance. Use contour tracking to determine the features of the welding flaw problem and integrating the welding process database; eventually, an intelligent judgment model is studied based on the fuzzy neural network to define the welding surface image function and

welding process parameters. Bydefining the BP neural network, the defect location of the digital image and the edge detection of the weld is obtained, and the factors which have the greatest influence on the weld defects are obtained. It is possible to use the fuzzy rule network to create a fuzzy rule base of defect parameters, and the defect detection data is used as a fuzzy neural network.The model examines the results, decides where the welding defects are located in the digital image, and effectively increases the precision of intelligent welding defect detection. Not only does the program promote continuous improvement of the welding process database but it also provides precise location information for subsequent grinding operations.

Fuzzy neural network application:

Neural network and fuzzy theory are two important directions of study in intelligent systems of judgment. Using neural networks to model the human brain's neural structure and think about roles of prediction, learning and classification. Given the great advantages of neural networks in nonlinear approximations, nonlinear mapping capabilities and efficiency of fault tolerance do not need predetermined sample data, and accurate predictions can only be made by training the sample data. There are many neural network models, and the system uses the neural network model that is commonly used in BP neural network modal.Even though BP neural network does have good ability to adapt to changes in the environment, the data performance is lacking. The design of fuzzy sets, membership functions, and fuzzy rules in fuzzy systems is based on empirical knowledge which is subjective. Introducing the learning process into the fuzzy system so that the fuzzy system can adjust and improve membership function and fuzzy rules through continuous learning, which is the Fuzzy system's direction of growth. The most important feature of fuzzy control is to represent the control experience and knowledge of the expert as the rules of language control, and then use those rules to govern the system[9].

Fuzzy control has developed from a simplistic process of fuzzy control to the current phase of self-improving fuzzy control. In the simple fuzzy control system the control decision tables and rules are assumed based on experience. The control process rules have no function to change and no learning capability. Hence it is often less effective to monitor more complex unpredictable structures.It is difficult to meet the high precision of system control by integrating the learning process into the fuzzy system, so that the fuzzy system can change and develop membership function and fuzzy rules through continuous learning, which is the evolutionary path of the fuzzy system. To develop the intelligent decision system's knowledge representation and learning ability, the ability to convey information in conjunction with fuzzy theory, and the ability of neural networks to self-learn[10].

CONCLUSION

The following conclusion has been made after the study:

- The intelligent judgment framework for welding quality will improve the performance evaluation of welding process parameter and surface quality and provide guidelines for the continuous correction of subsequent processes.
- The system may improve the quality of process design and provide scientific basis for management of enterprise enhancement and standardize processes.
- The integration of neural network and fuzzy completely exploits both of the advantages and improves system recognition accuracy and response speed and improves the smart judgment system.
- Fuzzy neural network stability analysis in the weld seam tracking phases is still in the theoretical stage and further research is needed.

With enhancing the precision of the welding technology in real time control and improving the accuracy of welding defect identification and the benefit of deep learning technology in welding process control and welding defect are becoming

increasingly apparent and which this system shortcoming was. With the constant advancement of science and technology, in particular the development of technology, automatic control theory, microelectronics technology and power electronics technology, welding technology continues to absorb the advanced results of related disciples and the degree of automation and intelligence is constantly improving, which is especially in the field of the neural networks. The application of the intelligent control theory in the welding process and the acquisition of higher welding quality.

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