Weld Quality Prediction Using Artificial Intelligence Technique

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ABSTRACT

Decision-making process in manufacturing environment is increasingly difficult due to the rapid changes in design and demand of quality products. To make decision making process online, effective and efficient artificial intelligent tools like neural networks are being attempted. Usually, the desired welding parameters are determined using traditional methods like welder's experiences, charts and handbooks (preferred values) which are simple and inexpensive. But this does not ensure that the selected welding parameters result in satisfactory welding and this method is not applicable to new welding process. To overcome this problem, various methods of obtaining the desired output variables through models to correlate input variables with output variables have been developed. Fractional factorial techniques, Mathematical modeling, curvilinear regression equations, linear regression equations, response surface methodology, finite element modeling, grey-based Taguchi method and sensitivity analysis were used to model SAW process. These methods are limited in application due to difficulties in modeling, time consuming and cumbersome. Due to the inadequacy and inefficiency of the mathematical models to explain the nonlinear properties existing between the input and output parameters of welding lead to the development of intelligent modeling techniques. Precise simulation and analysis of the process needs attention which helps to predict the wide variety of process parameters to set the factory floor in real time. The type of artificial intelligence capable of responding to changes in the automated manufacturing environment, and having the ability to capture vast manufacturing knowledge is Adaptive Neuro Fuzzy Inference System (ANFIS). It is becoming widely used in all aspects of manufacturing process to assist humans. Realizing that matter, ANFIS a state of the art artificial intelligent method, has the possibility to enhance the prediction of weld quality to find the best combination of independent variables which is welding current (I), speed (S) and welding voltage (V) as the input variables in order to achieve desired weld quality. Thus, the main objectives of this project is to develop ANFIS model to predict weld quality.

Keywords : *Submerged arc welding, Weld quality, Adaptive Neuro Fuzzy Inference System (ANFIS).*

1. INTRODUCTION

Submerged Arc Welding is a widely used industrial arc welding process needs a better prediction and monitoring of its parameters to produce consistent weld quality. Weld quality plays an important role as it improves material strength, hardness and toughness of the product. Quality of a weld product is evaluated by different parameters like weld bead geometry, deposition rate, hardness etc. These characteristics are controlled by weld parameters like welding current, welding speed, arc voltage and electrode stick out. In order to attain good quality, is necessary to set the proper welding process parameters [1]. Researchers attempted many techniques to establish SAW process. The effects of welding variables upon

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bead shape and size [2], bead width and height [3, 4] , dilution and bead geometry [5] , weld deposit area [6], element transfer behavior and weld-metal chemistry [7] in submerged-arc welding was explored. Also the effect of increasing deposition rate on bead geometry [8] and flux component on softening temperature was examined [9] for submerged arc weld. Investigations were done to analyze the effect of welding parameters on chemical composition and mechanical properties [10], heat affected zone [11] and bead geometry [12] of submerged arc weld.

2. REVIEW OF TRADITIONAL METHODS

Like other methods, the quality of welds in submerged arc welding is directly affected by weld bead geometry which includes the bead height, width and penetration. In this regard, the proper adjustment of input parameters is an unavoidable necessity in order to achieve the welding with desired geometric properties due to the vastness and variety of involved parameters. The experimental methods based on the trial and error were usually used in the past in order to determine the optimal levels of adjusting parameters, but in recent years, the theoretical approaches such as statistical methods, response levels, approaches for designing the experiments and neural network have been considered [13]. Since that compared with other methods, using the regression analysis and artificial neural network lead to the models, which generally resulted in more accurate findings, are more cost-effective and precise despite obtaining from a small number of experimental tests, predicting the weld bead geometry by the mentioned methods has become an active field for research. In this regard, Yang, L.J.et al. have applied the regression equations in electric arc welding [14]. Kim, I.S et al. have been attempted in establishing the relationship between the adjusting parameters and weld bead geometry in robotic COR2R arc welding by using the linear and nonlinear regression equations, Lee and Um (2000) modeled the Gas Metal Arc Welding (GMAW) process by using the multiple regression analysis and neural network[15]. Moreover, while some of the researchers have applied the neural network and fuzzy logic in order to control the arc welding processes [16]. J.S. Son et al. have predicted the weld bead geometry and bead penetration in Shielded Metal Arc Welding (SMAW) process by neural network[17]. P.K. Sarkar et al. have applied the neural network for investigating the effects of adjusting parameters on submerged arc welding process [18]. Serdar, K et al. have optimized the submerged arc welding based on the weld bead geometry by using the mathematical modeling and regression analysis [19].

3. BRIEF OUTLINE ABOUT ANFIS

Adaptive neuro-fuzzy inference system is a fuzzy inference system implemented in the framework of an adaptive neural network. By using a hybrid learning procedure, ANFIS can construct an input-output mapping based on both human-knowledge as fuzzy if-then rules and approximate membership functions from the stipulated input-output data pairs for neural network training. This procedure of developing a FIS using the framework of adaptive neural network is called an adaptive neuro fuzzy inference system (ANFIS). There are two methods that ANFIS learning employs for updating membership function parameters: 1) back propagation for all parameters (a steepest descent method), and 2) a hybrid method consisting of back propagation for the parameters associated with the input membership and least squares estimation for the parameters associated with the output membership functions. As a result, the training error decreases, at least locally, throughout the learning process. It applies the least-squares method to identify the consequent parameters that define the coefficients of each output equation in the Sugenotype fuzzy rule base. The training process continues till the desired number of training steps (epochs) or the desired root mean square error (RMSE) between the desired and the generated output is achieved. This study uses a hybrid learning algorithm, to identify premise and consequent parameters of first order Takagi-Sugeno type fuzzy system for predicting surface roughness in ball end milling.

4. CONCLUSION

Proposed ANFIS is based on first order surgeon-fuzzy inference system. developed to predict weld bead width in SAW process. It could be extended with more welding parameter such as type of flux width & depth of flux layer, polarity & type of current voltage &their effect in weld bead width. the predication accuracy is better in ANFIS model than ANN model.

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