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AUTOMIZING PULSED CURRENT TIG WELDING PROCESS USING REGRESSION

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ABSTRACT

Machine Learning is the fast emerging technology which is poised to dominate in almost all walks of life. Machine Learning not only analyses data, but also predicts future responses/actions aimed towards greater results. Artificial Intelligence will be the prime support system for human resources, human actions and performances in all areas of application. In TIG welding process it is easy to control heat input into parent materials and weld formation, to improve arc stability, to reduce thermal distortion and to achieve fine grains in the weld zone. In TIG welding, because of the cyclic variation of heat input, the weld pool volume and its fluid flow field and the temperature distribution change periodically. In this paper the effect of tungsten inert gas welding process has been studied. Input parameters such as peak current, base current, pulse frequency and pulse on time are taken to predict the tensile strength, hardness and grain size. We use machine learning linear regression to predict the output.

KEYWORDS: Machine learning, Linear Regression, TIG Welding process, Artificial Intelligence

1. INTRODUCTION

Pulsed current tungsten–inert-gas welding is widely used in manufacturing important structures and products because it has quite a few advantages and practical benefits. With this process, it is easy and convenient to control heat input into parent materials and weld formation, to improve arc stability, to reduce thermal distortion and to achieve fine grains in the weld zone. The weld pool configuration and the temperature profile around the pool are in a quasi-steady state under the action of constant current arc welding. However, in pulsed current TIG welding, because of the cyclic variation of heat input, the weld pool volume and its fluid flow field and the temperature distribution change periodically. During the action of the pulse current, Ip, the temperature in the work piece rises and the dimension of the pool grows, whereas during the action of the base current, I_b, the temperature falls, the pool solidifies, and the dimension of the pool is decreased. Conventional arc pulsation involves using the power supply to rapidly alternate the weld current from a high to a low value. In some cases, materials and weld joints that are difficult to weld with a nonplused arc may be welded using a pulsed arc technique. Arc pulsation involves four welding parameters: peak current, background current, pulse width, and pulse frequency. These parameters affect arc

force and stability and the resultant weld speed and quality. This is a tedious manual time consuming process. Costly rare materials are wasted and consume time, effort and money.

Machine learning is employed in almost every field nowadays. Starting from the recommendations based on our interest to filtering systems in our email inbox everyone is somewhere dependent on one or several of the machine learning systems. With internet becoming more personalised, machine learning is very popular and is the key component of the future. Machine learning is making the system to act without being explicitly programmed that is allowing the computer to learn automatically. The various applications includes video surveillance, e-mail spam filtering, online fraud detection, virtual personal assistance like Alexa, automatic traffic prediction using GPS and many more.

Machine learning algorithms are broadly classified into supervised and unsupervised algorithms. Supervised learning is a method in which we train the machine using data which are well labelled or the problem for which answers are well known. Then the machine is provided with new set of examples and the supervised learning algorithm analyses the training data and comes out with predictions and produces a correct outcome from labelled data. Unsupervised learning is the training of machine using information that is neither classified nor labelled and allowing the algorithm to act on that information without guidance. Reinforcement learning approach is based on observation. The network makes a decision by observing the environment. If observation is negative, the network adjusts its weights to be able to make a different required decision the next time.

2. RELATED WORKS

Ahamed [2] developed an automated system to analyse and classify wheat seeds using k-means clustering algorithm. A higher confidence level and faster classification rate is achieved. Haroon [3] performs seed classification using Weka tool. Multifold cross validation is employed. L. Lin and et al [4] introduced a method based on fuzzy theory by considering the characteristics of wheat seed which helps in recognition the seed type. Tabu search method employed. M. R. Neuman and et al [5] developed a workstation assisting in cereal grain inspection for classifying purposes video colorimetry methodology is proposed to help measuring color of cereal grains. The classification of chickpea seeds varieties was made according to the morphological properties of chickpea seeds, by considering its 400 samples which includes its four varieties; Kaka, Piroz, Ilc and Jam [6]. A machine vision composed with the established neural network architectures could be used as a tool to attain better and more impartial rice quality evaluation according to the business point of view [8].

3. PROPOSED WORK

3.1. Dataset

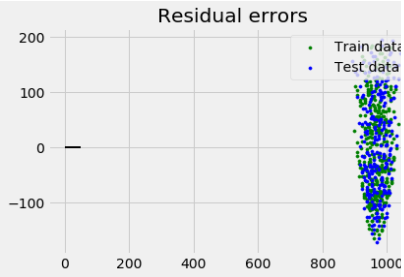
The TIG welding Dataset consists of Input parameters peak current, Base current, Pulse frequency and pulse on time. The output parameters are Tensile Strength, Hardness and Grain size. Around 625 data were collected and network model is developed to fit the data and predict the output parameters for given new values of input.

Peak Current	Base Current	Pulse Frequency	Pulse On Time	Tensile Strength	Hardness	Grain Size
60	20	0	35	790.55	607.29	151.41
60	20	0	40	807.64	545.25	191
60	20	0	45	809.73	534.57	200.45
60	20	3	50	796.82	575.25	179.76
60	20	3	55	768.91	667.29	128.93
60	20	3	35	928.77	410.67	261.63
60	20	6	40	944.61	348.63	301.22
60	20	6	45	945.45	337.95	310.67
60	20	6	50	931.29	378.63	289.98
60	20	9	55	902.13	470.67	239.15

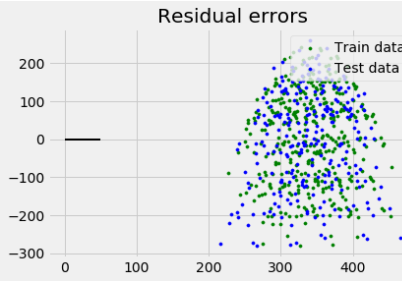
Table 1: Sample from Dataset

3.2 Regression

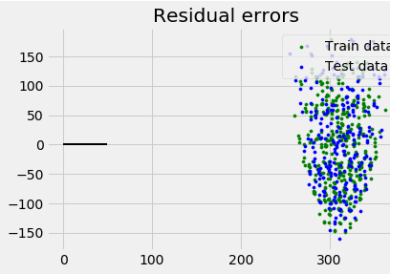
Here we use Linear regression which is a statistical approach to develop a model which represents relationship between a dependent variable that is the output with a given set of independent variables (Input Parameters). Since we have multiple inputs we use multiple linear regression to model the relationship between four inputs and an output by fitting a linear equation to observed data. Three output models developed for Tensile strength, Hardness and Grain size. A regression line that gives the minimum error between the predicted values and observed values is found. The Residuals are the errors shown in Table (2). Root mean squared error (RMSE) and Co-efficient of determination (R^2 score) are used to evaluate the model. Scikit-learn is a machine learning library for python. It consists of various inbuilt algorithm like Linear regression, support vector machine, Random forest, Decision trees, K-nearest neighbour and more. In order to make predictions we use LinearRegression.



Tensile Strength



Hardness



Grain Size

Table(2): Residual Errors for outputs Tensile Strength, Hardness and Grain size

4. CONCLUSION

This work proposes TIG welding output parameter predictions using multiple linear regression. A built-in method for linear regression is employed using the Scikit-learn library. Using the four Input parameters peak current, Base current, Pulse frequency and pulse on time we predict the output parameters Tensile Strength, Hardness and Grain size separately by regression. The TIG welding dataset is used to train a regression model and to find a best fit line.

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