To Improve Process Parameters Of Wire Edm At Minar Indusrty Using Anfis

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Abstract: Electrical discharge machining (EDM) is machining process that is suitable for machining very hard materials that are electrically conductive. In this process the material is removed by series of repeated electrical discharges, produced by electric pulse generators at short intervals in dielectric fluid medium. Thus, the electrical parameters are the main process parameters. The aim of this research is to investigate and predict the influence of the electrical parameters: peak current (I), pulse duration (Ton) and pulse off (Toff) on the surface roughness (SR),Cutting time (CT). Adaptive Neuro-Fuzzy Inference System (ANFIS) as one of the effective soft computing methods. In this research, a set of experimental data was obtained with different levels. The measured values have been used to train the ANFIS system to find minimum error. The results indicate that even with the complexity of the EDM process, the Adaptive Neuro-Fuzzy Inference System (ANFIS) was found to be adequate in predicting response variable with high accuracy.

Keywords: Wire-EDM, Fuzzy inference, Artificial neural network, ANFIS.

I. INTRODUCTION

The history of EDM techniques goes as far back as the 1770's when it was discovered by English scientist, Joseph Priestly. He noticed in his experiments that electrical discharges had removed material from the electrodes. Although it was originally observed by Priestly, EDM was imprecise and riddled with failures. During research to eliminate erosive effects on electrical contacts, the soviet scientists decided to exploit the destructive effect of an electrical discharge and develop a controlled method of metal machining. In 1943, soviet scientists announced the construction of the first spark erosion machining. The spark generator used in 1943, known as the Lazarenko circuit, has been employed for several years in power supplies for EDM machines and improves form is used in many application. Commercially developed EDM techniques were transferred to a machine tool. This migration made EDM more widely available and a more appealing choice over traditional machining processes [3].

Wire electrical discharge machining (WEDM) is an electrothermal machining process for conductive materials. A metal wire electrode with de-ionized water is used to machine metal by the heat produced from electrical sparks. WEDM is able to machine complicated and precision parts for hard conductive materials WEDM is used to machine variety of materials for modern tooling applications. Besides that, WEDM is used to machine modern composite materials[1].

WEDM is a complex machining process controlled by a large number of process parameters. Any slight variations in one of the process parameters can affect the machining performance measures such as surface roughness and cutting rate. The most effective machining strategy is determined by identifying the different factors affecting the WEDM process, and seeking the different methods of obtaining the optimal machining condition and performance [2].

1.2 Literature review

Ibrahem Maher , A. D. Sarhan , M. Hamdi, et al. study concludes that the peak current and pulse on time are the most significant parameters affecting the cutting speed, surface roughness and heat affected zone. The wire tension has minor effect on the cutting speed and heat affected zone but it has great effect on the surface roughness. ANFIS was successfully used to develop an empirical model for modeling the relation between the predictor variables (Ton, IP, and WT) and the performance parameters (CS, Ra, and HAZ). ANFIS model with gbellmf is accurate and can be used to predict cutting speed, surface roughness, and heat affected zone in wire electric discharge machining operation.[4]

Mahapatra and Patnaik [7] made an attempt was made to determine the important machining parameters for performance measures like MRR, SF, and kerf separately in the WEDM process. Taguchi's experimental design method is used to obtain optimum parameter combination for maximization of MRR, SF as well as minimization of kerf. In order to optimize for all the three objectives, mathematical models are developed using the non-linear regression method. This study evaluates the performance measures with equal importance to weighting factors since higher MRR, SF and low kerf are equally important objectives in WEDM application. In future, the study can be extended using different work materials, and hybrid optimization techniques.

Huang and Lio [6] proposed that grey relational analyses could be applied to determine the optimal selection of machining parameters for WEDM process. Based on Taguchi quality design concept, an L18 mixed orthogonal array table was chosen for the experiments. Moreover, the optimal machining parameters setting for maximum metal removal rate and minimum surface roughness could be obtained by approach.

Shandilya et al. conducted an experiment in order to Modeling and analysis of surface roughness in WEDC of SiCp/6061 Al MMC through response surface methodology. The WEDC parameters servo voltage, pulse- on time, pulse-off time and wire feed rate were varied to study effect on the quality of cut in SiCp/6061 aluminum MMC using surface roughness as response parameter. The mathematical relationship between WEDC input process parameters and surface roughness was established to determine the value of surface roughness mathematically. To identify the significant factors for WEDC process, analysis of variance (ANOVA) was employed.[11]

V. L. Bhambere, S. S. Khandare et al. presents the modeling of WEDM process for the complex shape. Two models were developed for predicting the material removal rate for manufacturing the complex shape punches. We have used response surface methodology for developing mathematical regression equation. The Artificial Neural Network with MLP was aslo designed for predicting the MRR. The values predicted by RSM and ANN model are compared with experimental values and the average percentage error is also calculated. IT is observed that values predicted with both the models are approximately same as the experimental values. the average percentage error is 1.28643% and -0.36829% for ANN and RSM model respectively.[8]

The paper has presented the use of the adaptive neuro-fuzzy inference system method based on the full factorial experimentation for predicting surface roughness and WLT in the WEDM process. Normalisation, feature reduction and ANFIS tests were performed to predict the desired performances. As a result, this approach can greatly improved the process responses such as surface roughness and WLT in the wire electrical discharge machining process.[10]

Jaskarn Singh et al. in the study, it is found that all of the input parameters significantly affect the Wire EDM process. Among the significant factors pulse on time, pulse off time and peak current has the maximum influence on the entire process. Wire feed, wire tension and water pressure has the minimum effect on the process. Therefore it is essential to optimize the process parameters to achieve the desire results. So here are some points which always kept in mind during research work on WEDM process parameters

- The Surface Roughness can be improved by decreasing both pulse duration and discharge current.
- The new developed high cutting speed wires can increase the production rate by a significant amount as compared to generally used brass wire and zinc coated wire [5].

2. DETAILS EXPERIMENTAL

2.1. Material

The material used in this experiment is EN24 rod shape size 30mm dia 45cm long. EN 24 Steel is a popular grade of hardening alloy steel due to its excellent machinability .EN24 is used in components such as gears, Shafts, studs and bolts .It is high tensile steel renown for its wear resistance property and also where high strength properties are require.This is used in aircraft, automotive and general application for example propeller or gear shafts, connecting rods.The chemical composition of workpiece material is given in table 1.

Table 1: Chemical Composition of the EN24 Material.

element	C	Si	Mg	Ph	Cu	S
Wt%	0.30-0.45	0.10-0.35	0.50-0.80	0.4	1.3	0.040

2.2Experimental Procedure

The experiments were conducted on Electronica china made model. The Brass wire with 0.8mm diameter is used in the experiment. The 3 input parameter (current,Ton,Toff) current in ampere with 2 level i.e 4& 5 ampere Toff is the time in second for which current is kept off with 2 level i.e 3 & 5 second and Ton is the time in second for which the current is allow to flow from 6 to 11 second from this 3 input parameters the 2 output CT is the cycle time to cut the 5mm slab and RA is the surface roughness of that slab is obtained 20 experiments. The surface roughness (Ra) was determined with Mitutoyo Surftest (SV-514) Machine. **Table 2: Output obtained from the Experiment**

	input parameter			Actual output	
Exprt no	current(I)	Toff(sec)	Ton(sec)	CT(min)	Ra(micron)
1	4	3	6	7.59	2.59
2	4	3	7	7.7	2.39
3	4	3	8	7.26	2.35
4	4	3	9	7.22	2.31
5	4	3	10	7.065	2.36
6	4	3	11	6.745	2.31
7	4	5	6	7.51	2.58
8	4	5	7	7.27	2.46
9	4	5	8	7.17	2.7
10	4	5	9	7.04	2.85
11	4	5	10	6.52	2.63
12	4	5	11	6.49	2.6
13	5	3	6	7.26	2.48
14	5	3	7	7.16	2.64
15	5	3	8	7.04	2.57
16	5	3	9	6.51	2.07
17	5	3	10	6.32	2.64
18	5	3	11	6.35	2.31
19	5	5	6	7.55	2.5
20	5	5	7	7.54	2.19
21	5	5	8	7.34	2.71
22	5	5	9	7.16	2.1
23	5	5	10	7.09	2.19
24	5	5	11	6.59	2.74

2.3 Adaptive neuro-fuzzy inference system (ANFIS)

The adaptive network based fuzzy inference system (ANFIS) is a useful neural network approach for the solution of function approximation problems (Buragohain & Mahanta, 2008). An ANFIS gives the mapping relation between the input and output data by using hybrid learning method to determine the optimal distribution of membership functions (Ying & Pan, 2008). Both artificial neural network (ANN) and fuzzy logic (FL) are used in ANFIS architecture (Avci, 2008). Such framework makes the ANFIS modeling more systematic and less reliant on expert knowledge (Sengur, 2008a; Übeyli, 2008). Basically, five layers are used to construct this inference system. Each ANFIS layer consists of several nodes described by the node function .The input so present layers are obtained from the nodes in the previous layers.

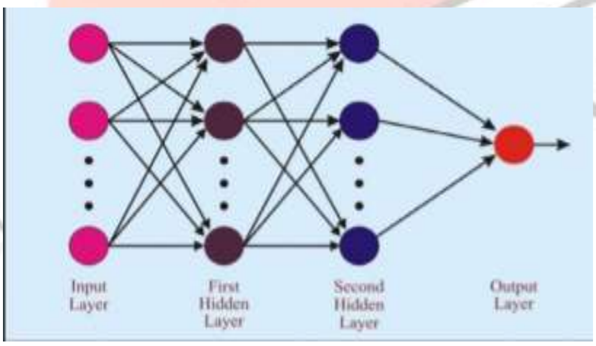

Fig 1. Architecture of Multilayer Perceptron (MLP)

Table 3: Comparison between CT and Ra values by Experiment and ANFIS

Actual measured		Predected value	
CT(min)	Ra(micron)	CT(min)	Ra(micron)
7.59	2.59	7.7325	2.4182
7.7	2.39	7.4572	2.4093
7.26	2.35	7.2071	2.4013
7.22	2.31	6.9897	2.3945
7.065	2.36	6.8077	2.3891
6.745	2.31	6.6592	2.386
7.51	2.58	7.7407	2.6478
7.27	2.46	7.4539	2.6386
7.17	2.7	7.183	2.6298
7.04	2.85	6.9393	2.622
6.52	2.63	6.7293	2.6152
6.49	2.6	6.5551	2.6096
7.26	2.48	7.3681	2.4064
7.16	2.64	7.1287	2.3987
7.04	2.57	6.9236	2.3921
6.51	2.07	6.7542	2.3866
6.32	2.64	6.6186	2.3823
6.35	2.31	6.5126	2.3789
7.55	2.5	7.5785	2.4132
7.54	2.19	7.3159	2.4048
7.34	2.71	7.0833	2.3973
7.16	2.1	6.8856	2.3909
7.09	2.19	6.7235	2.3857
6.59	2.74	6.5944	2.3815

Comparison of measured value and the predicted value is done .To evaluate the fuzzy model , the percentage error and the average percentage error is used.

$$PE = \frac{|measured\ value - predeced\ value|}{measured\ value} *100$$

$$APE = \frac{1}{m}\sum_{i=1}^{m} PE$$

where PE is the percentage error and APE is the average percentage error of the experiment.

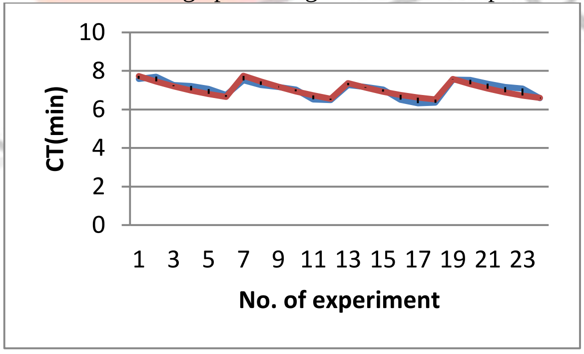

Fig.2. Measured versus predicted of CT

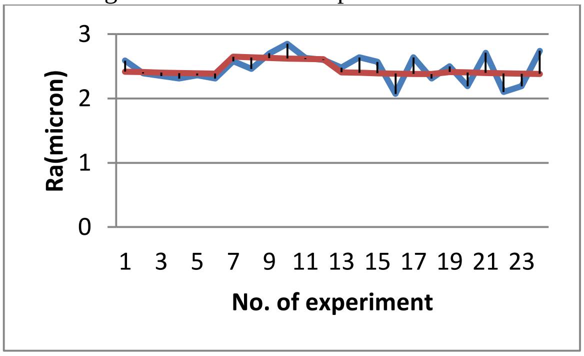

Fig 3.Measured versus predicted of Ra.

3.RESULT AND CONCLUSION

The validations have been conducted by comparing the measured and simulated values using ANFIS model. The results show that the average percentage error of the models for CT model is 3.53%, Ra is 3.59% These values show a high correlation in using the developed model for all the responses in the boundary of the design.

CONCLUSIONS

This study concludes that the peak current and pulse on time are the most significant parameters affecting the cutting speed, surface roughness. ANFIS was successfully used to develop an empirical model for modeling the relation between the predictor variables (I,Ton,Toff) and the performance parameters (CT,Ra). ANFIS model is accurate and can be used to predict cutting time, surface roughness, in wire electric discharge machining operation with average percentage errors 1.90, 3.59 respectively.

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