ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Optimization of MIG welding parameters using Artificial Neural Network (ANN) and Genetic Algorithm (GA)

Amit Kumar[*1], Dr.R.S.Jadoun[2], Ankur Singh Bist[3]
Govind Ballabh Pant University of Agriculture & Technology, India

Abstract

There are many mathematical models by which we can control the quality of weld properties in welding. We can use neural network which express some relationship between input and output. Now a days neural network is very useful tool by which we can interrelate input and output parameters compare it with that of the value which is given by the neural network and we can optimize the value. An artificial neural network and genetic algorithm is use to optimize the parameter. An Artificial Neural Network is a mathematical model inspired by biological neural networks. Here we are using ANN model for MIG (metal inert gas welding) welding. Two dissimilar type of work piece (stainless steel grade 304 and stainless steel grade 316) was taken and the welding experiment was performed and the result was analyse by using artificial neural network and genetic algorithm and it was find that ANN was given the batter result argon was taken as shielding gas and experiment was done on full factorial. Genetic Algorithm (GA) used to optimize the value of output. And it is concluded that Artificial Neural Network (ANN) successfully integrated as other regression model.

Keywords: Welding, Neural, Genetic algorithm.

Introduction

There are lot of mathematical model by which we can control the quality of weld. Artificial neural network (ANN) can be used in optimization of welding parameter. The area of Artificial NeuralNnetwork is very vast it can be used in various field in today generation. It is used in agriculture, welding technology, group technology, soil water conservation etc. Artificial neural network play a very important role to develop model which express the interrelationship between input and output parameter

Experiment procedure

Material

The MIG welding done on the 3 mm sheet of dissimilar material of stainless steel of grade 304 and stainless steel of grade 316. The chemical composition of the base material is presented in Table 1. The experiments are conducted on the plate of dimension 100mmx50mm sheet and butt welding done on the sheet.

Shielding

Argon gas was used for shielding purpose. Which is use to prevent it to atmospheric contamination. Other gas like co_2 not used for stainless steel because they react with the metal and forms a layer on the metal surface and there is chance of corrosion.

Butt welding

The experiment are conducted on the 3mm thick sheet of stainless steel of grade 304 and stainless steel of grade 316 and electrode of stainless steel of grade 309L was used the chemical composition is given in the table the butt welding was performed on the work piece. Experiment are conducted on full factorial in which 3 input parameter are taken and 27 sample of work piece are taken for observation. Argon used for shielding gas to prevent the welding from the atmospheric contamination.

ANN architecture

A neural network consists of an interconnected group of artificial neurons, and it is very important and useful tool for develop models which express the interrelationship between input data and output data. There are so many benefits of ANN in the Engineering design and GT (group technology) because it can store a large set of parameter In most cases a neural network is an adaptive system that changes its structure during a learning phase. Learning of Neural network is very important we have to learn

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

to the ANN. Neural networks are used to model complex relationships between inputs and outputs or to find patterns in data.

Neural networks are similar to biological neural networks in that functions are performed collectively and in parallel by the units it is very important point because the biological neurons are perform the function in parallel artificial neural network are not work accurately like biological neuron, rather than there being a clear delineation of subtasks to which various units are assigned. The term "neural network" usually refers to models employed in statistics, cognitive psychology and artificial intelligence. Neural network models which emulate the central nervous system are part of theoretical neuroscience and computational neuroscience. Neural network models in artificial intelligence are usually referred to as artificial neural networks (ANNs); these are essentially simple mathematical models defining a function or a distribution over or both and but sometimes models are also intimately associated with a particular learning algorithm or learning rule[2]. A common use of the phrase ANN model really means the definition of a *class* of such functions (where members of the class are obtained by varying parameters, connection weights, or specifics of the architecture such as the number of neurons or their connectivity). Artificial neural networks proved useful in a various of real application that deal with highly interactive and complex processes [10].

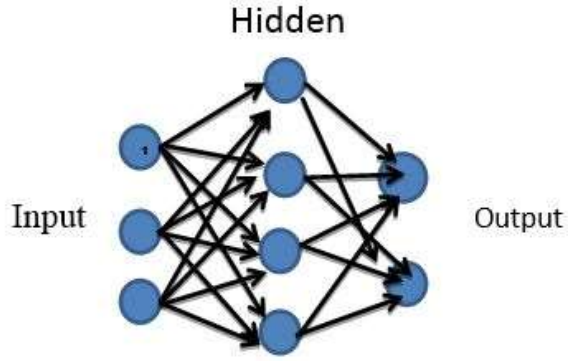


Fig 1 Diagram of neural network

.

Welding

Welding is a process of joining of two metals (can be similar of dissimilar) with the application of heat with pressure with or without filler rod. Sometime filler metal is required.In today's technology welding technology is used in every branch of industries, mechanical industries etc.

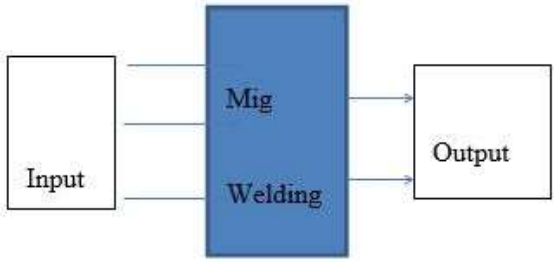


Fig 2 Input–output parameters of MIG Welding process.

Input parameters:-

1. Welding voltage
2. Welding speed
3. Welding current

Output parameter:-

1. Ultimate tensile stress
2. Many different energy sources can be used for welding purpose including a gas flame, an electric arc, a laser, Ultrasound, an electron beam etc. While often an industrial process, welding can be performed in many different environments, sometime vacuum is used, open air can also used ,sometime welding performed in under water and in outer space it can also be done in vacuum also. With the help of welding technology we can get strength up to 100%. It is very easy to weld most of the material at any direction welding equipment can be transported at the work place easily. It is very easy to use welding equipment as compared other processes like casting.

Welding optimization techniques

Now a day artificial neural network and genetic algorithm (GA) are widely used for optimization purpose so the purpose of our study is to analysis the process of welding using these techniques of soft computing

Table 1 Welding parameters levels.

Parameters	Level 1	Level 2	Level 3
Voltage (volt)	100	110	120
Current amp	16	18	20
Velocity (cm/min)	40	45	50

Methodology

Artificial neural network (ANN) used for classification and genetic algorithm (GA) used for optimized to data.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

Table Experimental Data collection

S.No.	Curr. (A)	Vol. (V)	TS (cm/min)	UTS (MPa)
1	100	16	40	715.76
2	100	16	45	725
3	100	16	50	656
4	100	18	40	710.43
5	100	18	45	730.65
6	100	18	50	650.45
7	100	20	40	650
8	100	20	45	670
9	100	20	50	600.67
10	110	16	40	755
11	110	16	45	756.89
12	110	16	50	687.32
13	110	18	40	738.43
14	110	18	45	751.67
15	110	18	50	680.43
16	110	20	40	678.33
17	110	20	45	703.23
18	110	20	50	589.92
19	120	16	40	726.67
20	120	16	45	716.67
21	120	16	50	671.75
22	120	18	40	678.33
23	120	18	45	688.33
24	120	18	50	623.33
25	120	20	40	673.33
26	120	20	45	681.67
27	120	20	50	571.73

Normalization of data done by the formula= Xi/ X max
Where Xi is value at i[th] column and X_{max} is max value in that column.

Table 2 Normalized data

Current	Voltage	Travel Speed	UTS
0.833	0.8	0.8	0.946
0.833	0.8	0.9	0.958
0.833	0.8	1	0.867
0.833	0.9	0.8	0.939
0.833	0.9	0.9	0.965
0.833	0.9	1	0.859
0.833	1	0.8	0.859
0.833	1	0.9	0.885
0.833	1	1	0.794
0.917	0.8	0.8	0.998
0.917	0.8	0.9	1.000
0.917	0.8	1	0.908
0.917	0.9	0.8	0.976
0.917	0.9	0.9	0.993
0.917	0.9	1	0.899
0.917	1	0.8	0.896
0.917	1	0.9	0.929
0.917	1	1	0.779
1	0.8	0.8	0.960
1	0.8	0.9	0.947
1	0.8	1	0.888
1	0.9	0.8	0.896
1	0.9	0.9	0.909
1	0.9	1	0.824
1	1	0.8	0.890
1	1	0.9	0.901
1	1	1	0.755

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

Table 3 Training data

S.No.	Current	Voltage	Travel Speed	UTS
1	0.833	0.8	0.9	0.958
2	0.833	0.8	1	0.867
3	0.833	0.9	0.8	0.939
4	0.833	0.9	1	0.859
5	0.833	1	0.8	0.859
6	0.833	1	1	0.794
7	0.917	0.8	0.8	0.998
8	0.917	0.8	1	0.908
9	0.917	0.9	0.8	0.976
10	0.917	0.9	0.9	0.993
11	0.917	0.9	1	0.899
12	0.917	1	0.8	0.896
13	0.917	1	1	0.779
14	1.000	0.8	0.8	0.960
15	1.000	0.8	0.9	0.947
16	1.000	0.8	1	0.888
17	1.000	0.9	0.8	0.896
18	1.000	0.9	0.9	0.909
19	1.000	1	0.8	0.890
20	1.000	1	0.9	0.901
21	1.000	1	1	0.755

Table: 4 Testing data

S.No.	Current	Voltage	Travel Speed	UTS
1	0.833	0.8	0.8	0.946
2	0.833	0.9	0.9	0.965
3	0.833	1	0.9	0.885
4	0.917	0.8	0.9	1.000
5	0.917	1	0.9	0.929
6	1.000	0.9	1	0.824

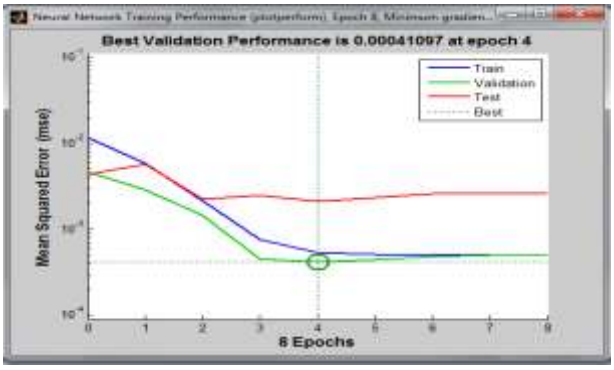


Fig.3 Best validation performance model 3-55-55-1

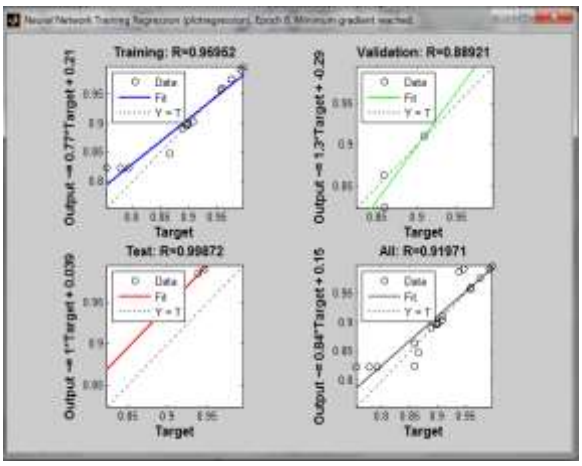


Fig.4 Plot of neural network training regression at 3-55-55-1Mathematical Model for UTS by Genetic Algorithm (GA)

A regression analysis has been used for developing the second order regression models for response UTS. In order to understand the effect of control factors on the responses, first order, second order and interactions between different control factors have been considered. The general equation for regression model may be given as-

$$y_j = b_0 + \sum_{i=1}^{n} b_i x_i + \sum_{i=1}^{n} b_{ij} {x_i}^2 + \sum_{i} b_{ij} x_i x_j$$

Where b's are coefficients.The final model for the UTS obtained as follows –

f = function f= UTS(x)

f = -(- 7883 + 69.9*x(1) + 148*x(2)+ 168*x(3)- 0.051*x(1)*x(2)- 0.475*x(2)*x(3)- 0.0708*x(3)*x(1)- 0.301*x(1)*x(1)-3.81*x(2)*x(2)- 1.76*x(3)*x(3));

where

x(1) = Current

x(2) = Voltage

x(3) = Travel Speed

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

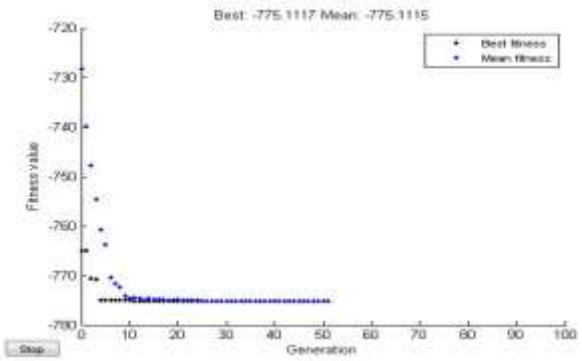


Fig.5 variation between Fitness value and Generation

Objective value(UTS): 775.1137 MPa

Current=109.641amp	**Voltage =16.001volt**	**Travel speed =43.362 cm/min**

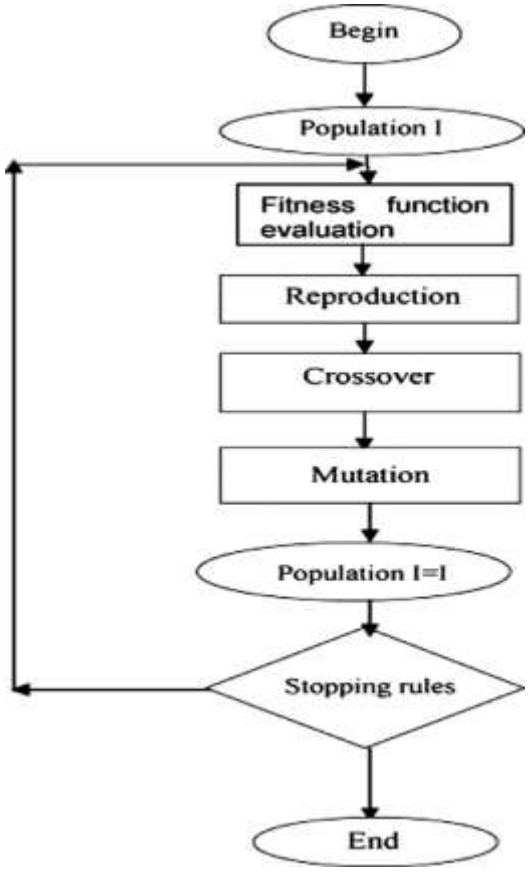


Fig 6:- General optimization procedures using a genetic algorithm ref Optimization of laser butt welding parameters with multiple Performance characteristics. [4]

Effect of Various Process Parameters on UTS

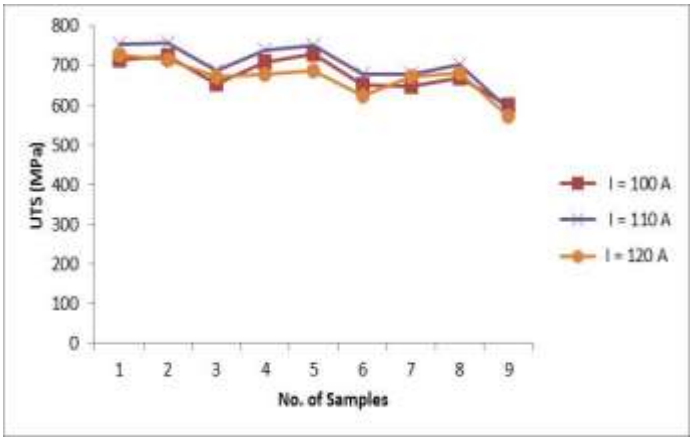


Figure 7. Effect of current on UTS

The graph shown in fig. 4.1 is plotted between current levels at 100A, 110 A, 120 A, and ultimate tensile strength. The voltage and speed level varies here from 16 V to 20 V and 40 to 50 cm/s. It is observed from the graph that the maximum possible values of strength are obtained with current at level 110 A. The value of strength obtained from the genetic algorithm is confirm that the optimum strength is obtained at current level 109.641A.

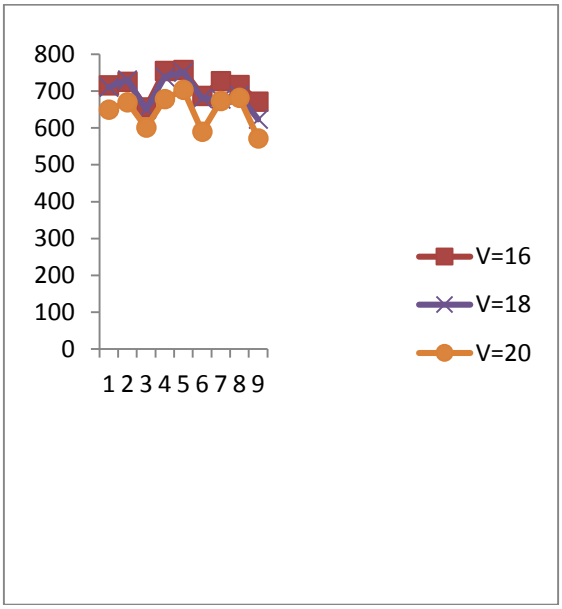


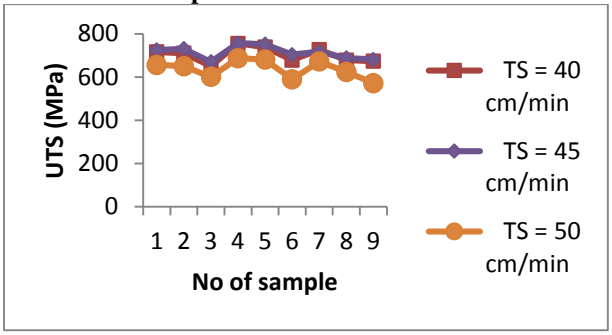
Figure 8. Effect of voltage on UTS

Here the value of voltage are kept constant at each nine experiment and the value of current and speed is varies from 100A to 120A and the 40cm/s to

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

50 cm/s respectively. The optimum value of strength is obtained at 18 V. Genetic algorithm also shown that the value of voltage for optimum output is comes out to be at 16.001 V.

Effect of travel speed on UTS



Value of UTS is fined maximum between 40 to 45 and it is clear by the Genetic Algorithm that the optimum value of the travel speed is 43.362 cm/min at which the value of the Ultimate Tensile Strength is found775.1137 MPawhich is optimum value coming from Genetic algorithm.

Conclusions

In MIG welding process we use stainless steel of grade 304 and stainless steel of grade 316. Three parameters are taken as input parameters (welding voltage, current, and travel speed of welding) and one parameter is taken as output parameters(ultimate tensile strength). Data is classified by using Artificial Neural Network and optimized by using Genetic Algorithm successfully integrated. The developed Artificial Neural Network model is successfully integrated with optimization algorithms like Genetic algorithm to optimize the welding parameters. The optimized welding parameters given by the GA, the metal inert gas (MIG) welding joints were processed. Joints exhibit better quality. After performing the experiment we found that stainless steel grade 304 has better strength than stainless steel grade 316. Argon gas work satisfactory for stainless steel because we cannot used such gas which react with the work piece and form metal oxides.

References

1. Parikshik dutta, Dilip Kumar pratihar do modelling of TIG welding process using conventional regression analysis and neural network-based approaches. journal of Materials Processing Technology 184 (2007) 56–68
2. P. Sathiya ⇑, K. Panneerselvam, M.Y. Abdul Jaleel “Optimization of laser welding process parameters for super austenitic stainless steel using artificial neural networks and genetic algorithm” Materials and Design 36 (2012) 490–498
3. Sathiya P, Abdul Jaleel MY. Influence of shielding gas mixtures on bead profile and microstructural characteristics of super austenitic stainless steel weldment by laser welding. International Journal of Advanced Manufacturing Technology 2011;54:525–35
4. Sathiya P, Abdul Jaleel MY, Katherasan D, Shanmugarajan B. Optimization of laser butt welding parameters with multiple Performance characteristics. International Journal of Optics & Laser Technology 2011;43(3):660–73.
5. MATLAB neural network toolbox, The MathWorks Inc., Prentice- Hall, Engle- wood Cliffs; (1998).
6. Jean-Pierre Planckaert El-Hadi Djermoune a,, David Brie a, Francis Briand b, Frédéric Richard Modeling of MIG/MAG welding with experimental validation using an active contour algorithm applied on high speed movies
7. K. Manikya Kanti, P. Srinivasa Rao say in his paper “Prediction of bead geometry in pulsed GMA welding using back propagation neural network” journal of materials processing technology 2 0 0 (2 0 0 8) 300–30
8. Hakan Ates “Prediction of gas metal arc welding parameters based on artificial neural networks” Materials and Design 28 (2007) 2015–2023
9. Kamal Pal, Surjya K. Pal Study of weld joint strength using sensor signals for various torch angles in pulsed MIG welding CIRP Journal of Manufacturing Science and Technology 3 (2010) 55–65
10. sukhomay pal, Surjya k.pal, Arun k. samantaray “Artificial neural network modeling of weld joint strength prediction of a pulsed metal inert gaswelding process using arc signals” journal of materials processing technology 202 (2008) 464-474
11. Rakesh malviya, Dilip pratihar “Tuning of neural networks using particle swarm optimization to model MIG welding process” swarm and evolutionary computation 1 (2011) 223-235
12. Sathiya.p, K.Panneerselvam R Soundarajan”optimal design for laser beam butt

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

welding process parameter using artificial neural networks and genetic algorithm for super austenitic stainless steel" optics & technology 44 (2012) 1995-1914

13. Neural Network Toolbox™ User's Guide R2012b Mark Hudson Beale, Martin T. Hagan, Howard B. Demuth
14. Rakesh Kumar a, Ulrich Dilthey b, D.K. Dwivedi a,*, P.K. Ghosh c "Thin sheet welding of Al 6082 alloy by AC pulse-GMA and AC wave pulse-GMA welding" Materials and Design 30 (2009) 306–313