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Enhancing Stud Arc Welding Technique Vai Utilizing FuzzyLogic Approach (FLA)

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Abstract

A fuzzy logic approach (FLA) application in the process of stud arc welding environment was implemented under the condition of fuzziness input data. This paper is composed of the background of FLA, related research work review and points for developing in stud welding manufacturing. Then, it investigates thecase of developingstud arc welding process on the controversial certaintyof available equipment and human skills.Five parameters (welding time, sheet thickness, type of coating, welding current and stud shape) were studied.A pair of parameter was selected asiteration whichis welding current and welding time and used for verification corresponding with tensile strength as output results and this willconsider it as schema for other cases.The testing result in the case of crisp (exact) value verifyingied the uncertainty value of some criteria selected which open the concept to make the decision making process for some advance cases without implementation. This paper applied the proposed methodology using Matlab program, the graphic user interface (GUI) fuzzy tool box for the case study of screw DABOTEKSTUD welding machine, for 6 mm diameter stud. The sheet materials are (K14358 and K52355) according to (USN standards, and the stud materials are (54NiCrMoS6 and 4OCrMnMoS8-6) according to (DIN standards).This given information is very inevitable for the conventional crisp determination of the tensile stress for the particular specimens experimented and also for verifying the tensile test value estimate in the case of changing to a fuzzy value for two of the input variables.

Keywords: *Stud Arc Welding,Fuzzy Logic Approach, Fuzziness, Crisp,GUI.*

1. Introduction

Stud arc welding is a widely used operation in mechanical structure, where high tensile strength with minimum variation is required. The variation of tensile strength affects the cost of stud welding unit operations such as rework and time consume. These are often limiting steps in mechanical manufacturing processes; therefore, significant cost reduction can be realized by producing the stud welding joint having reliable tensile strength (JibsonJ 1997)[1].

Usually, to find the influence of controlling parameters on welding process a large number of experiments needed. In order to avoid this, fuzzy logic approach FLA methods can be used as a decision making process for the adequate solution of experiments. The Classical method of experiments emphasizes prediction of future behavior of experiments from empirical model while running a fraction of full factorial of the combination parameters which are very sophisticated.

The variation in the stud arc process, may be due to any or a combination of a selective five sources. So some of these source are srelated to machine, measurement, method, material, manpower, stud, sheet, power supply, and environment, etc. For this study of stud arc welding the effect of manpower on variation is limited because the machine is operating in a semiautomatic process, also the experiments wear executed onsort of or semi laboratory environment. Problem identification is very important for any industrial experiment. One of the most used methods for identifying the problem is brainstorming. Brainstorming is an activity that promotes team participation, encourages creative thinking and generates many ideas in a short period of time. For an investigation into the possible causes of the undesirable variability in the stud welding process, a cause-and-effect diagram that lists several suspected causes of this variability is shown in Figure (1)[7].

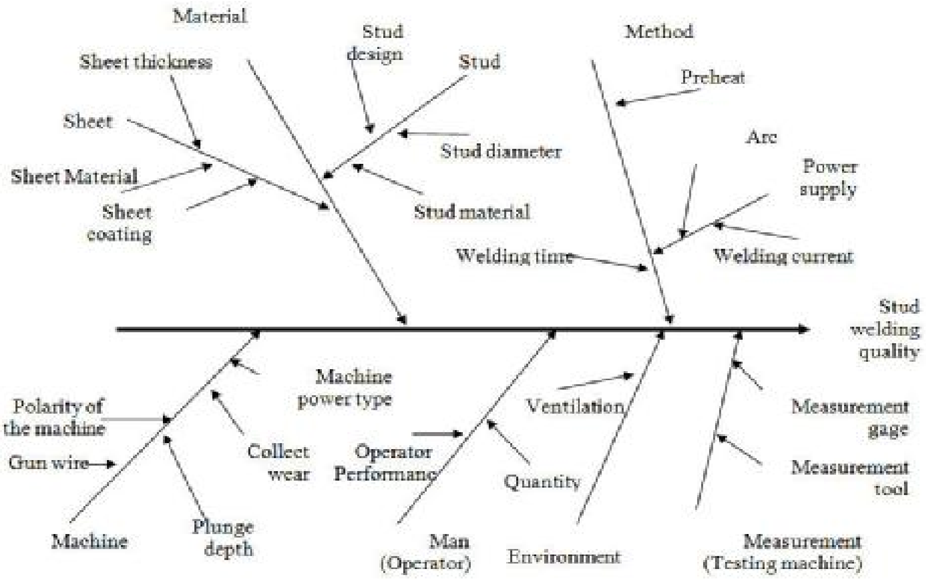

Fig. 1. Control Factors of Stud Welding Cause-and-Effect Diagram.

2. Crisp Factor Levels and Fuzziness Range of Factor Setting

Determining the membership function of selected factors from brainstorming is a major concern to many researchers in industries. Abrainstorming session suggested using five factors with particular two pairs of them in the fuzziness / defuzziness method. After determining the number required for each factor, it is needed to specify the fuzziness range of operation for each control factor. It is usually best to experiment the largest range feasible, so that the variation inherent in the process does not mask the factor effects on the response.

The crisp membership function for welding time and welding current are shown in Table (1), and the list of the rest three factors taken into consideration on the traditional crisp method experimental were changed in the conventional test to obtain the tensile stress values, see Table(2).

This action was taken to get more measurement of tensile test which was already verified as exact. The same concept was established with two of the inputs to verify the result as in the crisp case when taken the range for these particular two variables, so that for the fuzzy approach the selected factor Table (1) was chosen as a keystone for the huge amount of constrain like those in cause and effect diagram control factors which are shown in Figure (1).

Table 1,
Welding Time/Current Membership Function

	Range	
Time:	0.15 - 0.2 – 0.25 – 0.3 – 0.35	unit in second
Welding current:	350 – 450	unit in Amp

Table 2,
Other Factors

Factors	**Unit**	**Range**
Sheet thickness	Mm	1.6 – 3.175
Type of coating K52355 - K14358	Mm	0.3 - 0.75
Stud shape	None	Small stud - Flange stud

Once the factors were decided, the membership function for each factor was selected. Selection of membership function depends on how the outcome (tensile strength) is affected and verification the different member and that was achieved by taking six values within the factors shown in Table (3) and acquiring the tensile test result in the crisp case, for example the set of (0.15s time, 1.6 mm sheet thickness, 350 Amp welding current, 0.3 mm coating type, small stud shape) will generate (175.73, 288.70, 284.39, 359.99, 190.70) N/mm² respectively.

Table 3,
Stud Arc Welding Tensile Strength.

Factors				**Tensile strength N/mm²**			**Mean N/mm²**
Time	175.73	213.23	143.66	195.09	210.50	155.60	182.302
Sheet thickness	288.70	251.20	330.40	284.99	225.90	300.70	280.315
Welding current	284.39	198.56	225.89	245.87	276.24	263.54	249.082
Type of coating	359.99	420.50	428.42	300.03	387.38	367.54	377.310
Stud shape	190.70	245.87	235.90	298.46	164.33	289.46	237.453

3. Fuzzy logic Programming Methodology

Fuzzy logic is a logical system, which is an extension of multivalued logic. However, in a wider sense fuzzy logic (FL) is almost synonymous with the theory of fuzzy sets, a theory which relates to classes of objects with non-sharp boundaries in which membership is a matter of degree. (mathwork2010)[6].

However, using the GUI guide user interface to obtain the number of input and output and inference engine domain containing the membership function curve that concurrently describe the behavior of each variable corresponding with rule that reflect stud welding machining demand for this case study, the carrying out of the following steps are inevitable Figure (2).

Step 1 (input): For the welding current theGaussian function (gaussmf) [5] was used, two of them representa single value as shown in Figure (3).

Step2 (input): For the welding time the trapezoidal function (trapzmf) [5] was used, three of them represent a single value see Figure (4).

Step3 (output): For tensile strength the triangular function (trimf) [5] was used, three of them on representsa single value see Figure (5). (For coated type in fuzzy range the value of its tensile stress was ignored to get more accuracy and it did not affect the manipulation as checked on its availability in crisp case).

Step 4: The data could be entered in term of numerical symbols or simply adjust the line (move by using computer mouse) from the guide user interface screen see Figure (6).

Step 5: The case of defuzziness output could be numerically recognized or from the surface of 3D dimension see in Figure (7).

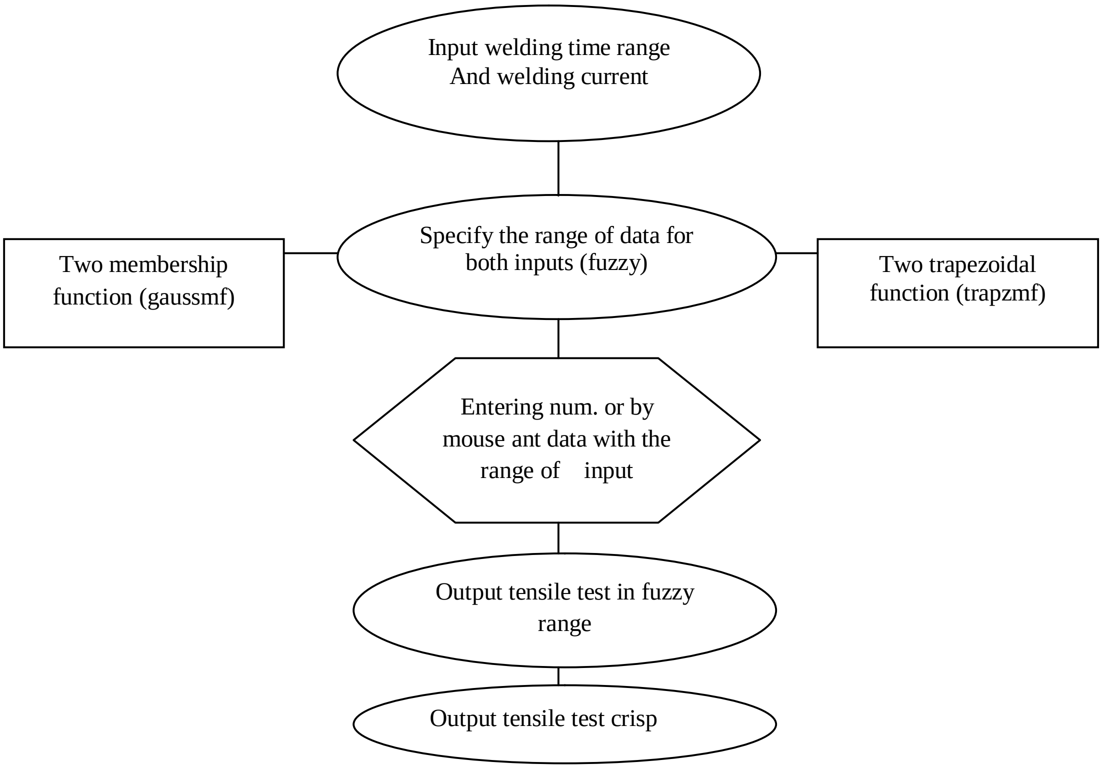

Fig. 2. Fuzzy Reasoning Methodology Steps.

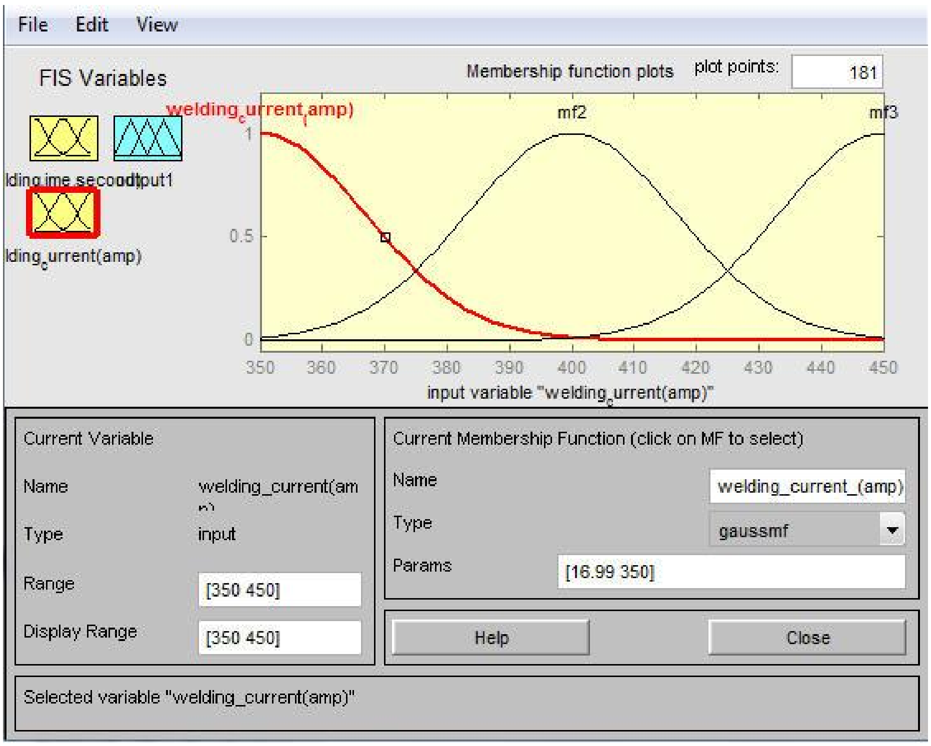

Fig. 3. Welding Current Membership.

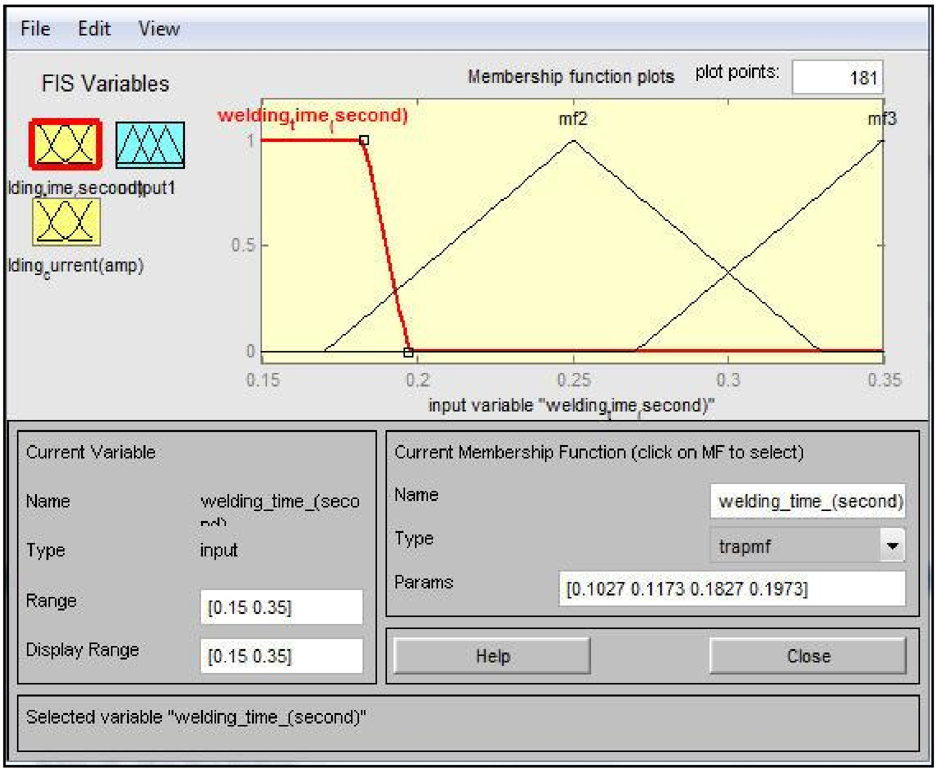

Fig. 4. Welding Time Membership.

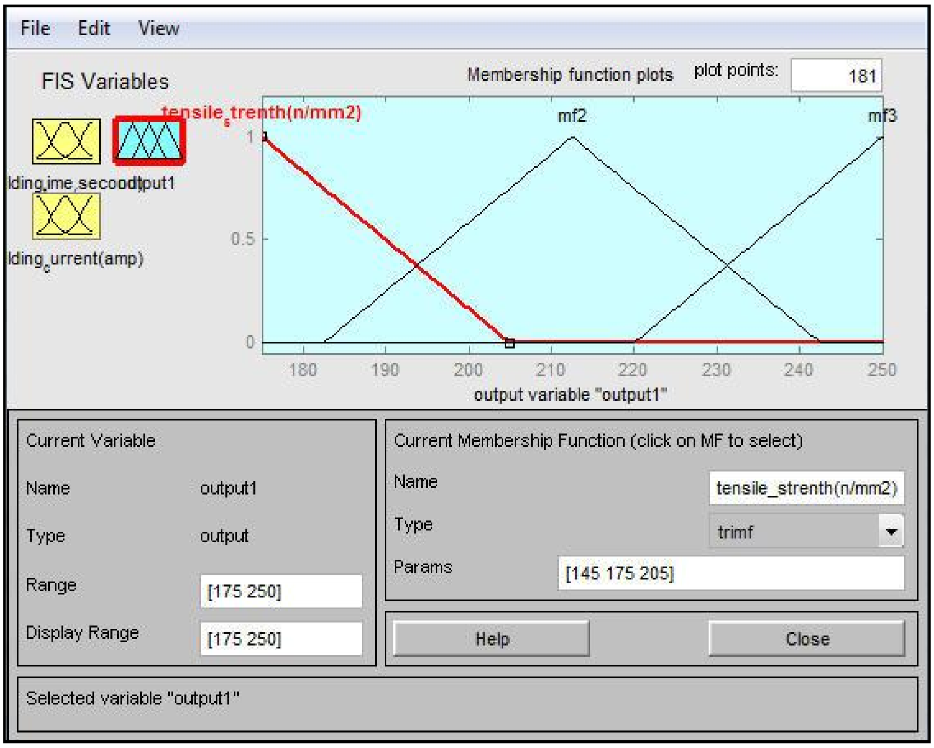

Fig. 5. Tensile Strength Membership.

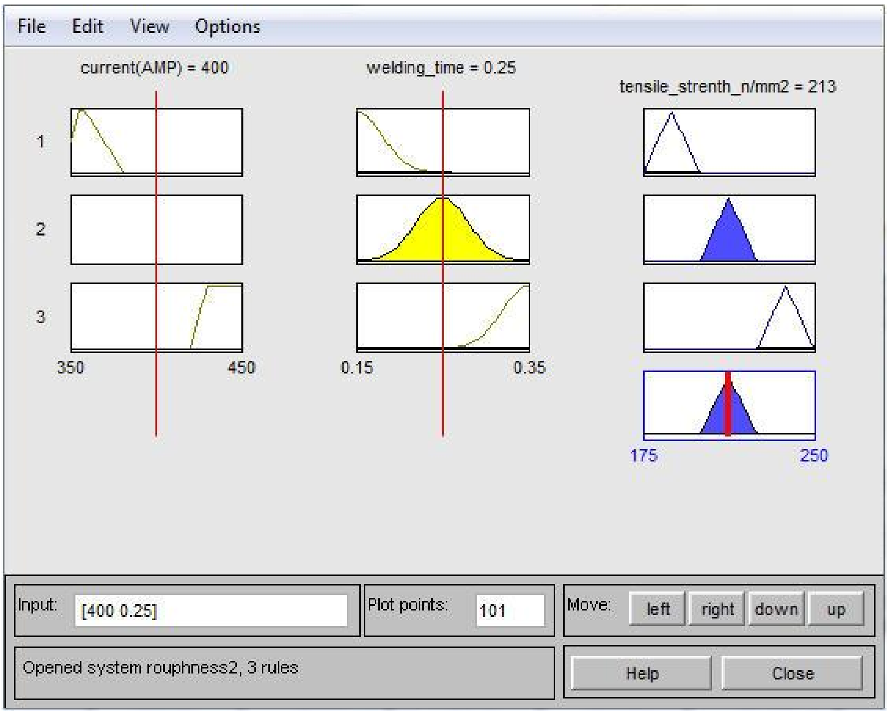

Fig. 6. Defuzziness Input/Output Interface.

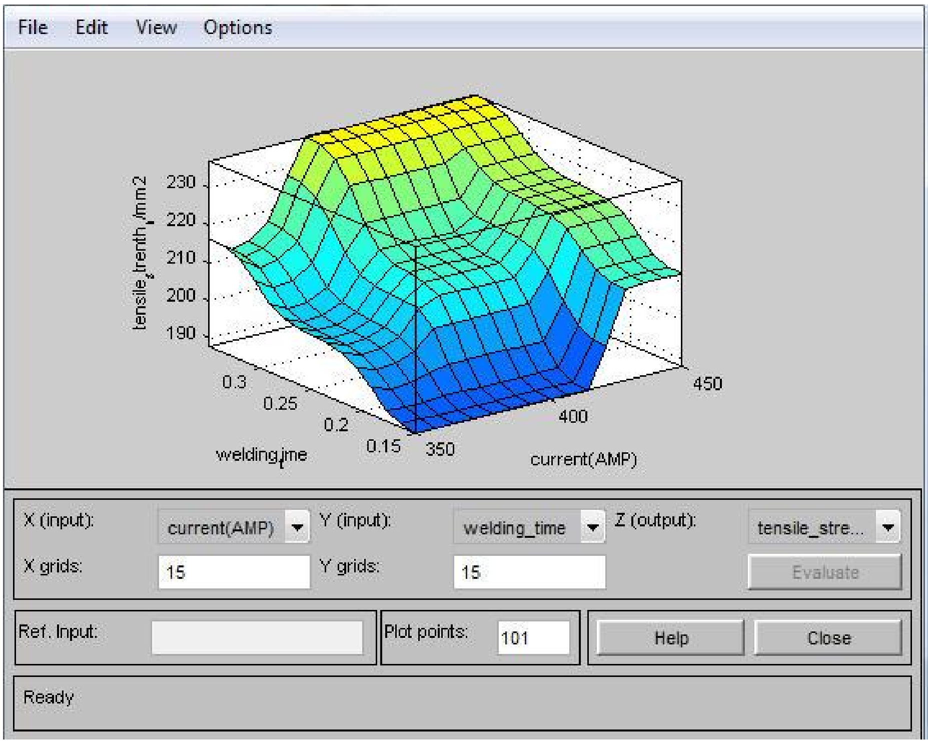

Fig. 7. Three Dimension Surface Viewing.

4. Discussion and Conclusion

After interpreting the results of the analysis, it is advisable to ensure that the experimental conclusions are supported by the data in both the crispness and the fuzzy cases. The confidence interval of each set of variables range is the varianceof the estimated result inthe in between value or simply in the fuzzy condition.

So that the result inthe tensile stress to be reasoning distributed was selected in the range of (l75 to 250) N/mm²which is already verified in the crisp or conventional method. The confirmation experimental is used to verify whether the predicated output responseonthe tensile stress based on the same levels of the combination of factors (variables) range and here two of which could called main factors entered with no exact value and that could be localized for whole welding environment where this could show extreme benefits for others more sophisticated cases with the lackof some processes information. If conclusive results are obtained from the confirmation run, a specific action on the process may be taken for improvement.

A confirmatory run/experiment (or follow-up experiment) is necessary in order to verify the results from the statistical analysis (for future work). This is to demonstrate that the factors and levels chosen for the influential do provide the desired results. The insignificant factors should be set at their economic level during the verification run/experiment. However, observations with some out of range data for the general experimental essentially for the crisp situation and continuing in the particular range the fuzzycondition and this could be seen as a flow:

1. **Welding:** Time this factor strongly effects on tensile strength measure. The mean value of tensile strength in levels (0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, and 0.5).
2. **Sheet Material:** This factor explicitly affects the welding process and the mechanism of joint product where it has a wide range of levels.
3. **Stud Material:** This factor also effects in the stud welding process, the different value of tensile strength varies from one level to another.
4. **Sheet Thickness:** Increasing sheet thickness; a thicker sheet is stiffer during mechanical testing and this minimizes the peel characteristic of the tests and increases strength.
5. **Welding Current:** This factor has the smallest effect factor where the effect of tensile strength in the level range (350 ampere) is 278.73 N/mm² for an instant.

5. References

[1] JibsonJ."Advance Welding", John Wiley & Sons, 1997.

[2] Montgomery D.C" Design and Analysis of Experiments" Second Edition John Wiley &Sons, Inc., 2001.

[3] HU Ping, BO Jun (WeihaiCampus,Harbin University of Technology,Weihai,264200,China) ANew Stud Welder Bolt Welder in Generating Arc by Computer Auto-Detecting http://en.cnki.com.cn/Journal_en/C-C000 JLGY-2001-03.htm.

[4] 4- Arabshahi, P.; Marks, R.J., II; Seho Oh; Caudell, T.P.; Choi, J.J.; Bong-Gee Song; Jet Propulsion Lab., California Inst. Of Technol., Pasadena, CA + Arabshahi, P.+M Pointer adaptation and pruning of mini-max fuzzy inference and estimation IEEE Volume: 44 Issue: 9 ISSN: 1057-7130.

[5] L. A. Zadeh the adoption of fuzzy logic in the mathematics curriculum. .....Controllers, controllers for robot arc-welders, Stud., Vol. 12, 1980, pp. 11-23 (1965).

[6] Nabeel. K." Taguchi Experimental Design and Artificial Neural Network Solution of Stud Arc Welding Process "university of Baghdad college of engineering 2010.

[7] M. J. ARNEST Application to Arc Welding, in Industrial Processes," Int. J. General Systems, Controller," Int. J. Man-mach. Stud.7, pp.1-13. "In Proceedings of I EE.2007

[8] Samuel H. Huang and Hong-Chao Zhang Neural-expert hybrid approach for intelligent manufacturing: A survey (Elsevier)science direct Volume 26, Issue 2, May 1995, Pages 107-126

[9] Vahdani, Behnam; Hadipour, Hasan; Sadaghiani, JamshidSalehi; Amiri, Maghsoudextension of VIKOR method based on the interval value fuzzy set. Springer, February 24, 2010.

[10] SHI Bao-shan,LI . Fuzzy logic control strategy for submerged arc automatic welding of digital controllingCNKI: SUN: GWDZ.0.pp-04-038-2009.

تعظيم تقنية لحام القوس المسماري بواسطة الانتفاع من مقاربة المنطق المظبب

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الخلاصة

ان دراسة تطبيق لحام القوس المسماري باسلوب المنطق المظبب لمدخلات عملية اللحام اثبتت فاعليتها في تحسين ظروف عملية اللحام . في هذا البحث تم تطبيق اثر المنطق الظبابي في هذا المجال و التطرق لبعض البحوث المتعلقه بهذه العمليه ونقاط التطور و التعزيز لصناعة لحام القوس المسماري ثم مقارنة هذا مع تطبيق اللحام لحالة عملية بوجود عدم الدقة لمكينة او مهارة اللحام .

تم دراسة خمس نقاط اساسيه لمدخلات عملية اللحام وهي زمن اللحام وسمك لوح اللحام ونوع التغليف والجهد الكهربائي واخيرا شكل مسمار اللحام . لقد تم اختيار اثنان من المدخلات لتدخل باسلوب المنطق المظبب لتوليفة مجموع المدخلات وهي زمن اللحام والجهد الكهربائي للتيار المستخدم في عملية اللحام. وللتحقق من صحة النتائج تم مقارنة المخرجات في كلا الحالتين المظببة والتقليدية (القيمه الثابتة) ووجد هناك دقه وتصحيح للعمليه التصنيعيه بشكل عام. ونتيجه لذلك مكن هذا الامر من الحصول على عمليات اتخاذ قرار لبعض الحالات دون تنفيذها بشكل واقعي . تم استخدام برنامج الماتلاب واسلوب واجهات المستفيد للمحاكات ولهذا البحث تم استخدام ماركة معينة من المسمار وبمواصفة معيارية بسمك ٦ ملم للقطر ولوح معدني معياري عالمي مع التحقق من مجمل العملية التصنيعية من خلال فحوصات الشد لعينات مختاره ولكلا الحالتين القيمه الثابتة والمظببة لعملية اللحام .