Review of Optimization and Modeling of Laser Machined AISI 304 Material Using MATLAB.

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Abstract- This review paper says fuzzy logic system, artificial neural fuzzy interface system and genetic algorithm can be used to predict the output results according to the given inputs by using MATLAB. By using these modules the systems can be built to approximately predict the result.

Key Words- Fuzzy logic, ANFIS, Genetic algorithm

I. Introduction:

A. Fuzzy Logic System

Fuzzy Logic is a logic or control system of ANN-valued logic system which uses the degrees of state **"**degrees of truth" of the inputs and produces outputs which depend on the states of the inputs and rate of change of these states. It was developed in 1965, by Professor Lofti Zadeh, at University of California, Berkley. Generally, it's a method of reasoning Also, it has an approach to decision making in humans. As they involve all intermediate possibilities between digital values YES and NO. Fuzzy logic starts with and builds on a set of user-supplied human language rules. The fuzzy systems convert these rules to their mathematical equivalents. This simplifies the job of the system designer and the computer, and results in much more accurate representations of the way systems behave in the real world.

Fuzzy Logic system can be used in automotive systems, for applications like 4-Wheel steering, automatic gearboxes etc. Other applications include Hi-Fi Systems, Photo-Copiers, Humidifiers etc. A Fuzzy Logic System is flexible and allow modification in the rules.The systems can be easily constructed.

B. Artificial Neural Fuzzy Interface System:

Neuro fuzzy refers to the combination of artificial neural network and fuzzy logic system in the field of artificial intelligence which was proposed by Jang in 1993. The main objective of manufacturing industries is to produce low cost, high quality products in short time. The selection of optimal cutting parameters is a very important issue for every machining process in order to enhance the quality of machined products and reduce the machining cost. In recent years, the trend of modeling the machining processes using artificial intelligence techniques of artificial neural fuzzy interface system is rising. The technique is used for the prediction of machining parameters and to enhance manufacturing automation. This research is used to predict the surface roughness, kerf top width, kerf bottom width, dross height and striation using laser power, cutting speed and gas power as input parameters. AISI 304 material is used as sample for the prediction of the given machining parameters.

C. Genetic Algorithm:

The GA is coded using software suite Matlab, assisted by the Parallel Computing toolbox. The basic idea is to imitate the natural selection and survival of the fittest that exist sinthegenetics of the species. A synthesis of GA principles, applications and examples can be find in literature. The general principle of GA is to assess the best configurations among a starting random population of configurations, keep the best (those meeting best the objective function or fitness), and then cross and must ate them to get a new child population of the same size, and soon. Genetic algorithm(GA), one of the superior and most applicable optimization methods is conceptualized around the ever evolving techniques of optimization. GA comes with the advantage of locating a global optimum point and does not reflect the deterrent so the gradient method viz. concavity, continuity, and drivability of the objective function.

II. Literature Review:

[1] Hashmi et al. [1999] studied fuzzy logic based selection of machining parameters. Fuzzy-logic principles have been applied for selecting cutting conditions in machining operations. The materials data used for theoretical calculations were for medium-carbon leaded steel (BHN 125-425) and free-machining carbon wrought steel (BHN 225-425). A fuzzy model has been developed for carrying out these calculations.All of the calculations for both materials were done manually and equations expressing cutting speed as a function of hardness were obtained for different cases. The technique is demonstrated to be an effective way to present a large volume of experimental data in a compressed form. The results presented show a very good correlation between the Machining Data Handbook's recommended

cutting speed values and those predicted using the fuzzy logic model. The strategy and action of the skilled machine tool operator for selecting the cutting speed and depth of cut can be described by the fuzzy set theory. The relationship between a given material hardness and the cutting speed can be described and evaluated by the fuzzy relation.

[2] David et al. [2015] studied a fuzzy logic system for selection of non-traditional sheet metal cutting processes. This work presents a methodology for the selection and comparison of non-traditional sheet metal cutting processes as a new structure of selection by means of an expert system. The model is generated from a knowledge base acquired from diverse experts, and the use of fuzzy logic techniques. With a simple input of the parameters of a piece, the system offers the most appropriate cutting options (based on the requirements of the piece) allowing a non-expert user selecting the most appropriate process with emphasis on a predefined priority: finish, cost or time. The selection process consists of four base algorithms that measure the attributes of each process as a dependent indicator of the other processes, that is, a pre-selection that considers (1) the process capability to cut a material-thickness relation, (2) the speed that can be achieved with this relation, (3) the inherent complexity of the piece to be cut, and (4) the process tolerance. Results of experiments under three different approaches prove that the expert system here presented accurately prioritizes the most convenient cutting processes. The three different approaches: expert vs system on finished parts, process vs process, and experts vs system for cutting options, proved that the MSPC system, using diverse techniques including fuzzy logic, is able to accurately prioritize the most convenient cutting processes; in 92% of the analyzed cases the system coincided with the first option of the expert, and those which did not coincide, the selection provided by the system was supported according to the requirements and the given priority.

[3] Chong et al. [2011] studied fuzzy logic system for prediction of laser cutting quality. In laser cutting, the surface quality and metallurgical characteristics of the end product is what matters the most in terms of laser cutting quality. Thus, an attempt has been carried out to develop an expert system using fuzzy logic model to predict the effect of carbon dioxide (CO_2) laser cutting quality based on laser cutting parameters onto 1 mm thickness of Incoloy alloy 800. The predicting fuzzy logic model is implemented on Fuzzy Logic Toolbox of MATLAB using Mamdani technique. A set of training and testing consists of 125 data used in the fuzzy logic model are arranged in a format of three input parameters that cover the power, assist gas pressure and cutting speed, and two output parameters which are the surface roughness and dross inclusion. The relationships between experimental results, fuzzy logic model and statistical results for both training and testing performance exhibited a good correlation. Based on the results of the study, it shows that the proposed fuzzy logic model can be used to predict the surface roughness and dross inclusion of carbon dioxide (CO_2) laser cutting process. In this study, the present Mamdani fuzzy expert model has been developed to predict the surface roughness and dross inclusion as output parameters for a given laser cutting parameters such as laser power assist gas pressure and cutting speed as input parameters in a CO_2 laser cutting process. The model was trained with input and output experimental data using Fuzzy Logic Toolbox of MATLAB. The prediction results and statistical values were used to evaluate the FL model. The results of the proposed FL model compared to the experimental results obtained from the training and the testing were found to be quite satisfactory. Hence, it is concluded that the proposed FL model is a suitable and practical technique that can be effectively used in the prediction of carbon dioxide (CO_2) laser cutting process with minor error rates.

[4] Author Dalibor et.al (2016) predicted the heat affected zone using ANFIS technique. The input parameters were laser power, cutting speed and gas power. The experimental specimen was made of Glass Fibre Reinforced Plastic Composite. It was found that the cutting speed has the highest influence on HAZ and gas power has the lowest influence on HAZ.

[5] Vlastimir et.al (2016) experimented water jet assisted underwater laser cutting process using ANFIS technique. The input parameters were laser power, cutting speed and water-jet speed representing the output parameters as top kerf width, bottom kerf width, kerf width ratio, striation depth and dross area per unit length. The best prediction was observed for bottom kerf width and the worst was for dross area per unit length. This is due to the high non-linearity in dross area during water jet assisted underwater laser cutting process. [6] Gerardo et.al (2016) used ANFIS model to estimate the surface roughness of tungsten-copper alloys in micro-machining process.

[7] Mohammad et al. [2016] analyzed that the Friction-stir-welding (FSW) is a solid-state joining process where joint properties are dependent on welding process parameters. In the current study three critical process parameters including spindle speed (N), plunge force (F), and welding speed (V) are considered key factors in the determination of ultimate tensile strength (UTS) of welded aluminum alloy joints. A total of 73 weld schedules were welded and tensile properties were subsequently obtained experimentally. It is observed that all three process parameters have direct influence on UTS of the welded joints. Utilizing experimental data, an optimized adaptive Neuro-fuzzy inference system (ANFIS) model has been developed to predict UTS of FSW joint. For comparison, optimized artificialneural network (ANN) models were also developed to predict UTS from FSW process parameters. By comparing ANFIS and ANN predicted results, it was found that optimized ANFIS models provide better results than ANN. This newly developed best ANFIS model could be utilized for prediction of UTS of FSW joints. In the current investigation, an ANFIS model has been developed utilizing weld process parameters to predict UTS of FS welded aluminum alloy joints. The optimization process involves testing different combinations of four input variables (rotational speed, welding speed, plunge force, and empirical force index) and varying ANFIS parameters to

obtain a model with minimum error (RMSE and MAPE). For comparison, the artificial neural network (ANN) approach was also utilized to develop a model with a similar experimental data set. Among the four input variables, EFI was observed to have strong correlation with UTS compared to other parameters. EFI was formulated from an experimental investigation and found to be non-linearly correlated with the three critical process parameters (N, V, Fz). The developed best ANFIS can be used for and incorporated into an optimization model for further optimization studies.

[8] Samarjit et al. [2014] considered various applications of ANFIS such as student modeling system, medical system, economic system, electrical and electronics system, traffic control, image processing and feature extraction, manufacturing and system modeling, forecasting and predictions, NFS enhancements and social sciences. This review study indicates mainly three types of future development directions for NFS methodologies, domains and article types: (1) NFS methodologies are tending to be developed toward expertise orientation. (2) It is suggested that different social science methodologies could be implemented using NFS as another kind of expert methodology. (3) The ability to change and learning capability is the driving power of NFS methodologies and will be the key for future intelligent applications. The experimental results of this category are highly encouraging and suggest that an adaptive neuro fuzzy approach is viable for developing many more forecasting system like as price prediction, weather prediction etc. Manufacturing and system modeling using NFS is proved to be one of best techniques in industry. Articles those presented antilock braking system using neuro fuzzy controller could emphasize computational simplicity as one of its' prominent features According to the survey on NFS in the last decade, we can conclude that research interest has been diversified in this Electrical and Electronics field as well as in technique also. When some researchers working with transformer current then another's are working with electrical drives, control system, wind firm etc. In 2010 it is seen that they concentrated mostly on T2FLS. That means application of proposed approach is getting modified due to time. Some research work can be done in electronics system such as, electronics circuit, laboratory, television, VLSI, electronics manufacturing systems etc. for future work, an also in electrical system such as, power plant, machines electrical manufacturing system etc.

[9] V Chengal Reddy et al.[2018]analysed that the paper gives profound learning into improving process parameters to upgrade dimensional and surface quality in the laser processing minimizing scale producing process by optimized process parameters. However, it is additionally essential to recognize which ones effects the resultant way of highlight measurements and surface while fulfilling target material removal rates and effectiveness. Consequently, this work will add to a comprehension of the relations between process parameters and nature of the last geometrical elements. Keeping in mind the end goal to locate an arrangement of laser handling parameters that provisions the favored micro - channel measurements for a particular application under specific preparing imperatives, predictive models can be utilized. A few statistical and numerical methodologies have been used to judge and upgrade distinctive laser producing forms including Design of experiments (DOE), RSM and GA.

III. Conclusion:

This paper is based on literature review of artificial neural network, fuzzy logic interface, artificial neural fuzzy interface system and genetic algorithm methodologies and applications. We can conclude that a number of the above methodologies are tending toward expertise orientation. Proposed domains are used to find out application area and article types are defined to categorize papers of different context. These domains can actually help us to explore applications in new unknown areas. It can be asserted that some social science, technological field, real life applications could be implemented by using these domains. Integration of qualitative, quantitative and scientific methods and integration of these domains and its methodologies may broaden our horizon on this subject.

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