Volume : 1 | Issue : 3 | December 2011 ISSN - 2249-555X

Research Paper Engineering

A Review On The Applications Of Fuzzy Logic Technique Related To The Engineering Applications

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ABSTRACT

The extremely hard and tough materials are ideal materials for parts with micro-holes and have been widely used as dies and cutting tools in automotive, aerospace and woodworking industries due to its superior wear and corrosion resistance. In this study, the review of work done by various researchers has been done. The modeling and simultaneous optimization of multiple performance characteristics such as material removal rate and surface roughness of hard and tough materials using the fuzzy logic and taguchi's quality loss function has been done. In recent years, fuzzy logic has been used in manufacturing engineering for modeling and monitoring. This work deals with the review of various papers related to optimization and modeling of Electrical discharge machining process. EDM is a manufacturing process by which tool cuts the required shape into the work piece within a dielectric fluid. Short duration discharges are generated in a liquid dielectric gap which separates the tool and work piece. The material is removed with an erosive effect of the electric discharges from tool and work piece.

Keywords : Fuzzy, Modeling, Optimization, Machining

Introduction

Fuzzy logic is an effective tool for dealing with complex nonlinear systems. Fuzzy logic is based on imprecision and is similar to the way people make decisions based on imprecise and non numerical information. Fuzzy logic modeling is based on mathematical theory combining multivalued logic, probability theory and artificial intelligence methods. Fuzzy modeling is based on fuzzy set theory in which the linguistic statements are expressed mathematically and corresponds to the analysis of a human expert. The meaningful linguistic statements are selected for each variable and expressed by appropriate fuzzy sets like low, medium and high. The input and output variables are fuzzified and represented by means of membership functions [1-3]. The concept of fuzzy reasoning for three input one output fuzzy logic unit is described as follows. The fuzzy rule base consists of a group of IF-THEN statements with three inputs x_1,x_2,x_3 and one output y; that is,

Rule 1: if x_1 is A_1 and x_2 is B_2 and x_3 is C_1 then y is D_1; else

Rule 2: if x_1 is A_2 and x_2 is B_2 and x_3 is C_2 then y is D_2; else

Rule 3: if x_1 is A_3 and x_2 is B_3 and x_3 is C_3 then y is D_3; else

Rule n: if x_1 is A_n and x_2 is B_n and x_3 is C_n the y is D_n;

A_i, B_i, C_i, and D_i are fuzzy subsets defined by corresponding membership functions; that is μ_A, μ_B, μ_C and μ_D. Eighteen rules were developed based on experimental conditions. By taking max-min compositional operation, the fuzzy reasoning of these rules yields a fuzzy output[4]. Suppose that x_1,x_2 and x_3 are the three input variables of the fuzzy logic unit, the membership function of the output of fuzzy reasoning can be expressed as: The membership functions can be of different forms like triangular, trapezoidal, Gaussian, sigmoid etc. In this study, triangular and trapezoidal membership functions are considered. The triangular shaped membership function for input is specified by three parameters {a,b,c} as follows:

$$triangle(x;a,b,c) = \begin{cases} 0, & x \le a \\ \dfrac{x-a}{b-a} & a \le x \ge b \\ \dfrac{c-x}{c-b} & b \le x \ge c \\ 0, & c \le x. \end{cases}$$

By using min and max, an alternate expression for the proceeding equation is

$$triangle(x;a,b,c) = max\left(min\left(\frac{x-a}{b-a}, \frac{c-x}{c-b}\right), 0\right)$$

Where a, b, c stand for the triangular fuzzy triplet and determine the x coordinates of the three corners of the underlying triangular membership function.

Literature review

Design and tuning of a fuzzy logic controller for micro-hole electrical discharge machining

Electrical discharge machining (EDM) is commonly used in the micro-hole manufacturing process. Pulse generations in the EDM process are highly stochastic and complicated. The difficulty of using mathematical models to precisely describe the EDM process renders the commonly used proportional integral derivative (PID) controller less competitive in preventing the undesired arc and short circuit pulses for efficient EDM processes [5,6]. Adaptive control of the EDM process has been studied since the late 1970s The adaptive control strategy is able to detect and react to EDM status changes by continuously adjusting system responses based on feedback information. Gain scheduling, which uses local linear controllers to collectively perform global nonlinear process control by scheduling gains at different operating conditions, is a common adaptive EDM process control method.

Artificial intelligence, such as neural networks and fuzzy logic, has been successfully applied to further advance EDM process control].

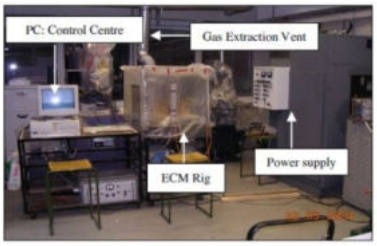
2.2. A neuro-fuzzy approach to generating mold/die polishing Sequences

Mold and die materials are usually polished under high speed rotation of an abrasive wheel or stone such as Al2O3. The manufacture of mold depends on various process and material

variables like the tools, techniques, molding materials, polishing materials, mold surfaces, its geometry rquirements, polishing pressures and polishing times, etc. There is no absolute standard. Fig. 2 illustrates the experimental method for the polishing mechanism. Our group has constructed this device for determining the tool/work piece pressure. In the present design, the abrasive stone does not rotate and only the variance in pressure is seen.

2.3 Towards next generation Electrochemical machining controllers: A fuzzy logic control approach to ECMGap conditions in ECM are random in nature due to the variable state of the electrolyte condition and the machining process itself is subject to various practical complications (e.g. debris in the gap causing sparking) that affect machining performance[15-18]. Creating a fuzzy logic controller will serve two purposes: (1) to investigate the concept of integrating fuzzy logic into the experimental ECM drilling rig; and (2) to investigate the potential of fuzzy logic control (FLC) to ensure higher levels of machining performance through inter-electrode gap control.

Figure 1 : Towards next generation electrochemical machining controllers:A fuzzy logic control approach to ECM



2.3.1The ECM drilling rig

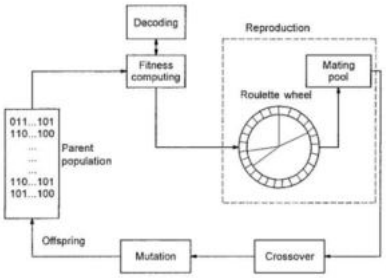
The following section presents three annotated pictures to enable the reader to gain an appreciation for the ECM drilling rig.

Fig. 1 presents a picture of the whole ECM drilling rig, the major parts are identified as the control PC, the power supply and the ECM rig. Fig. 2, presents a more detailed look at the ECM rig machining chamber.

2.4 Forward and reverse mappings of electrical discharge machining process using adaptive network-based fuzzy inference systemTo automate this process, inputoutput relationships are to be known in both forward as well as reverse directions. In forward mapping, the outputs are expressed as the functions of input variables, whereas in reverse mapping, the input variables are represented as the functions of the responses [19-21]. It is important to mention that it may be necessary to determine a set of inputs corresponding to a set of desired outputs. Experimentation Experiments have been conducted on Die Sinking EDM machine (refer to Fig. 1) having a maximum current capacity of 50 A, 28 pulse-on-time and 12 pulse-off-time settings[22-24]. Experiments are carried out in the reverse polarity (that is, tool andwork-piece have been connected to the positive and negative terminals,respectively).

Mild steel work-pieces of 30.0 mm diameter and 6.0 mm thickness have been machined using copper tool, and paraffin oil is used as dielectric medium. For each sample, machining is done for 1 min. Weights of the work-pieces have been determined.2.5 An adaptive neuro-fuzzy inference system (ANFIS) model for wire-EDM

Figure 2 : Genetic synthesis of fuzzy logic controllers in turning logic



Mild steel work-pieces of 30.0 mm diameter and 6.0 mm thickness have been machined using copper tool, and paraffin oil is used as dielectric medium. For each sample, machining is done for 1 min. Weights of the work-pieces have been determined.2.5 An adaptive neuro-fuzzy inference system (ANFIS) model for wire-EDM

Rapid progress in the manufacturing technology has stimulated the application of non-traditional machining (NTM) processes in modern machining to economically machine materials that are usually difficult to machine with the conventional tools [25-26]. Wire electrical discharge machining (WEDM) is one of the most widely applied NTM process for machining and shaping hard, fragile and difficult-cutting in the tool and die industry process

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