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Predicting Material Removal Rate of Electrical Discharge Machining (EDM) using Artificial Neural Network for High I_{gap} current

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***Abstract*—This article presents a prediction of Material Removal Rate (MRR) in Electrical Discharge Machining (EDM) using Artificial Neural Network (ANN). Experimental data were gathered from Die sinking EDM process for copper-electrode and steel-workpiece. It is aimed to develop a behavioral model using input-output pattern of raw data from EDM process experiment. The behavioral model is used to predict MRR and than the predicted MRR is compared to actual MRR value. The results show good agreement of predicting MRR between them.**

Keywords—Electrical Discharge Machining(EDM),Material Removal Rate(MRR), predicting, Artificial Neural Network(ANN)

I. INTRODUCTION

Electrical Discharge Machining (EDM) is one of the earliest non-conventional or non-traditional manufacturing processes. EDM is widely used for making mold and dies and finishing parts for automotive industry, aerospace and surgical components[1]. EDM erodes a workpiece material by using precisely controlled sparks that occur between an electrode and a workpiece in the presence of a dielectric fluid. Material is removed from the workpiece by repetitive current discharges between two electrodes, separated by a dielectric liquid and subject to an electrical voltage. Two principle types of EDM processes are the die sinking and the wire cut EDM process. Die sinking type EDM machine requires an electrode to machine the workpiece. Wire cut EDM machine uses a continuous wire as the electrode to cut the workpiece. EDM has been widely used for producing mould and dies. EDM differs from most chip-making machining operations. The electrode does not make a physical contact with the workpiece while machining, thus avoiding chatter vibration.

Rajurkar[2] explained some future trends study in EDM such as: machining advanced materials, mirror surface finish using powder additives, ultrasonic-assisted EDM, control and automation. Other researchers conducted various investigations in process performance[3-8]. One of the field interests is to study the optimal selection of process parameters which will increase production rate considerably by reducing the machining time[9, 10]. An optimum selection of machining parameters for the best process performance is still uncertain since EDM process is a complex and stochastic process[11]. Determination of MRR has been reported by[9] where dimensional analysis technique is used to predict the MRR. In [12] Artificial Neural Network is used to predict the MRR for low I_{gap} current. In this paper, an artificial neural network as a behavioral model will be used to predict the MRR of EDM at High I_{gap} current.

II. APPLICATION OF ARTIFICIAL NEURAL NETWORK TO PREDICT MRR OF EDM

In the past two decades, neural networks have been shown to be highly flexible modeling tools with capabilities of learning the mathematical mapping between input and output variables for non linear systems. Artificial Neural Network (ANN) is an algorithm that imitates human being biological nervous systems. It has certain performance characteristics in common with biological neural networks[13]. The key element of this algorithm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working together to solve a specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. The main objective is to model EDM process for optimum operation representing a particular problem in the manufacturing environment where defining the optimization objective function using a smooth, continuous mathematical formula is not possible.

III. TRAINING THE EXPERIMENTAL DATA FOR ANN

Experiments were conducted in order to gather data for training or learning to the neural network purposes. The training data set includes a number of cases, each containing values for a range of input and output variables. The first decisions will be needed to make are: which variables to use, and how many (and which) cases to gather. The choice of variables (at least initially) is guided by intuition. Researcher's own expertise in the problem domain will give some ideas of which input variables are likely to be influential.

Experimental work for EDM process of [10] was conducted using copper electrode and steel workpiece materials. Experimental results of the material removal rate were recorded and presented in tabular form shown in Table I, Table II and Table III. A BP200 hydrocarbon mineral oil was employed as the dielectric fluid. "Open flushing" condition was applied to circulate the dielectric fluid between the electrode and the