Chapter 15
Artificial Neural Network Training Algorithms in Modeling of Radial Overcut in EDM:
A Comparative Study

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ABSTRACT

This chapter describes with the comparison of the most used back propagations training algorithms neural networks, mainly Levenberg-Marquardt, conjugate gradient and Resilient back propagation are discussed. In the present study, using radial overcut prediction as illustrations, comparisons are made based on the effectiveness and efficiency of three training algorithms on the networks. Electrical Discharge Machining (EDM), the most traditional non-traditional manufacturing procedures, is growing attraction, due to its not requiring cutting tools and permits machining of hard, brittle, thin and complex geometry. Hence it is very popular in the field of modern manufacturing industries such as aerospace, surgical components, nuclear industries. But, these industries surface finish has the almost importance. Based on the study and test results, although the Levenberg-Marquardt has been found to be faster and having improved performance than other algorithms in training, the Resilient back propagation algorithm has the best accuracy in testing period.

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INTRODUCTION

Due to the increasing trend of using lightweight, lean, and compact components in recent years, there has been growing interest in the advanced and tailor-made materials, with better properties such as high strength, high stiffness, good damping capability, low thermal expansion, higher fatigue characteristics. Besides, components made with these materials demands stringent design and close tolerances during manufacturing. The traditional manufacturing processes are unable to cope up the challenges exhibit by these advanced materials owing to the improved mechanical properties (Abbas, Solomon, & Bahari, 2007; Ho & Newman, 2003). They are hard and 'difficult to machine', strict high precision, higher surface quality standards lead to increase the scrap and rework that leads to increase the machining price. For the last seven decades, electrical discharge machining (EDM) has been extending inimitable capabilities to ma- chine "difficult to machine" materials with desired shape, size and required dimensional accuracy. It has been impressively applied for machining in the advance industries like automotive, medical, aerospace, consumer electronics and optoelectronic industries development. In the past, with the continuing advances of technology, there has been a significant enhancement in EDM technology also, to improve productivity, accuracy and the versatility of the process. The key interest in the active research was to choose the optimal setting of the process parameters in such a way that accuracy should increase and, concurrently, overcut or gap, tool wear and surface roughness should reduce (Pradhan, 2012; Anitha, Das, & Pradhan, 2012; Pradhan & Kumar, 2012). Moreover, a process can be identified better when a model replicates its behavior by its vital parameters. The factors that are significant for the system are to be recognized and different aspects of the process are to be correlated while constructing the model. It is expensive, unpractical or impossible to experiment directly with the process so a good model can be cost-effective to predict the actual process very closely (Das & Pradhan, 2014; Jena, Pradhan, Das, Acharjya, & Mishra, 2014; Pradhan & Das, 2015).

Experimental Setup and Procedure

To collect the data experiments were performed using a CNC Electrical discharge die sinking machine set up "Electronica Electraplus PS 50ZNC" presented in Figure 1. A pure copper electrode (99.9% Cu) of a diameter of 30 mm was used to machine the AISI D2 Tool steel, the photographic view of the specimen is depicted in Figure 2, and a commercial grade EDM oil (specific gravity = 0.763, freezing point= 94°C) was used as dielectric fluid, the power supply was linked with the tool electrode (Tool: positive polarity, work piece: negative polarity). Dielectric was pumped through the tube electrode laterally as shown in Figure 3, for effective flushing of machining debris from the working gap region with a pressure of 0.4 kgf/cm^2. Work piece material was initially circular bar of diameter 100 mm and was cut into specimens of thickness 10 mm. the top and bottom faces of the work piece were ground to make it flat and good quality surface finish before experimentation. the bottom of the cylindrical electrode was polished by a very fine grade emery sheet before each experimental run. every treatment of the experiment was run for 15 minutes and the time was measured with a stopwatch of accuracy 0.1s. The work piece as well because the tool was detached from the machine, clean and dried up, to form it free from the dirt, trash and dielectric. They were weighed, before and after machining, on a precision electronics balance (maximum capacity = 300 g, precision = 0.001 g). The diameter of the cavity machined on work piece was measured by a tool maker microscope (make: Carl Zeiss, Germany) with an accuracy of 1 μ m.

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