Chapter 39
Optimizing Material Removal Rate Using Artificial Neural Network for Micro-EDM

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ABSTRACT

Machining can be classified into conventional and unconventional processes. Unconventional Machining Process attracts researchers as it has many processes whose physics is still not that clear and they are highly in market-demand. To predict and understand the physics behind these processes soft computing is being used. Soft computing is an approach of computing which is based on the way a human brain learns and get trained to deal with different situations. Scope of this chapter is limited to one of the soft computing optimizing techniques that is artificial neural network (ANN) and to one of the unconventional machining processes, electrical discharge machining process. This chapter discusses about micromachining on Electric Discharge Machining, its working principle and problems associated with it. Solution to those problems is suggested with the addition of powder in dielectric fluid. The optimization of Material Removal Rate (MRR) is done with the help of ANN toolbox in MATLAB.

MANUFACTURING AND MACHINING

Manufacturing is the process of value addition to raw material. It is broadly classified into four processes which are casting, forming, machining and joining. Machining is one of the four basic manufacturing processes in which material removal takes place in the form of chips. Machining is used almost in

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manufacturing of all the products. (Rao, 2009) It is one of the most expensive and energy consuming manufacturing process as material is removed from workpiece to complete the process. Machining process has a machine tool and a workpiece. Machining processes can be classified as traditional and non-traditional processes. The traditional or conventional machining processes include a machine tool and workpiece which are in direct contact during the machining. Some of the traditional processes are drilling, milling, grinding, polishing etc. The nontraditional methods came into picture to fix some of the drawbacks that conventional methods had which were the high cutting force due to which the material of tool should always be harder than that of the workpiece. With this constraint, it is difficult to machine materials like titanium alloy, tungsten carbide, and many others. Nonconventional processes can machine hard materials too. Most of them are contactless processes which remove the constraint of high cutting force impact on workpiece due to tool. Some of nontraditional processes are electro discharge machining, electrochemical machining, abrasive water jet machining, ultrasonic machining etc.

Micromachining

The rapidly developing technology aims at development of miniaturized products with multiple functions embedded in them. In the last few years, CIRP (College International Pour La Researche En Productique) has contributed significantly towards spreading awareness of micromachining and its different methods (Dornfeld et.al.,2006). The continuous demand to follow the trend of miniaturization requires advancement in micro manufacturing techniques.It has wide applications in the field of aerospace, automobile, biomedical, electronics and many others where miniaturization of parts is on high demand. Micro-holes on turbine blades, MEMS, Micro- gears, are few examples of applications of micro-manufacturing processes. Micro-EDM is a nontraditional process which can be an alternative to fulfill these demands of miniaturization of parts to an extent (Hong et. al., 2016).

The basic principle of EDM (Electro Discharge Machining) and Micro-EDM for metal removal is melting and vaporization. The basic difference between EDM and Micro- EDM is the size of tool, the limits of movements of the X, Y and Z axes and the amount of discharge energy supplied.

Electro- Discharge Machining (EDM)

In 1770, English chemist Joseph Prisetly found the effect of erosion from electrical spark (S.Webzell, 2001). Later in 1943 at Moscow University, Dr. B.R. Lazarenko and Dr. N.I. Lazarenko invented the resistance-capacitance (RC) circuit which is also known as Lazarenko circuit for EDM. This was for the first time when the erosion effect was used for machining difficult to cut material. At around same time, three American employees came up with this application of electrical spark for removal of broken tapes and drill in hydraulic valve. This became the basis for electrically controlled servo system for automatically maintaining the gap between tool and electrode (Jameson, 2001). In 1980, with the development of Computer Numerical Control (CNC) in EDM that most of the things became automatic and the process got many more modifications and still the researchers are contributing towards development of this process through modifications (Houman, 1983).

One of the latest and most popular developments of EDM is micro-EDM. It is gaining popularity and attention of researchers because of its diverse application in machining. Some of its application is manufacturing of micro-holes and shafts of 5μm diameter, intricate shapes and complex features of 3D