

Analysis the Effectiveness of Cryogenic Treatment through Roughness and Temperature Prediction Using Bonn Technique

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ABSTRACT

Surface roughness is one of the major factor affecting the work piece surface finish in face milling operation. The main criteria discussed on this paper is to predict the ideal cutting performance of cryogenic treatment tool in surface roughness optimization. The surface roughness in machining process is generally formed by the irregularities in cutting tool properties like strength, hardness, toughness etc. For the optimization process, the cutting tool is initially subjected to cryogenic treatment for the improvement in the tool property. The cryogenic treatment is cold treatment process at low temperature to increase the material property. In this paper, the face milling operation processed out in the cryo treated tool which can lower the surface roughness of the machined material. For the validation of the machined work carried out in this paper is verified theoretically by the developing a foreboding prototype by Bat Optimization based artificial Neural Network (BONN) technique using a real time experimental data. The gathered outcome is executed in mathematical modelling using Mat lab and the result shows that cryogenic treatment tool is more efficient than untreated tool with higher cutting accuracy and tool life. Thus, the bat algorithm coupled with artificial neural network is a dynamic and specific method in advancing the overall least possible method for surface roughness prediction in face milling operations.

Keywords: *Face Milling Tool, Optimization, Artificial Neural Network, Bat Algorithm, BONN Technique.*

Introduction

The optimization of tool property is the main process followed in the manufacturing field. Today the manufacturing firms focussed on minimization of error in the material machining and by increasing their product quality and surface finish. Surface roughness is the important factor of determining the product quality and it plays an important role in material strength, hardness and surface finish F. Pusavecaet al. [1]. The manufacturers improve their product quality by introducing suitable material treatment and coatings for improving the material efficiency on machining. The roughness of the material is formed by the wear capacity, lubrication, and poor strength of metals N.R. Abburiet al. [2]. For lower the surface roughness the machining process need an upgradation by improving the tool property on manufacturing. While manufacturing in milling machine the surface roughness is the challenging factor arise these days A.D. Jayal et al. [3]. Thus effective treatment on metals such as surface coating, heat treatments and lubrication is followed in the industry to improve the surface quality of metals. Cryogenic treatment is a metal treatment process carried out in machining field for improving the cutting metal properties. The treatment is done by the metal is subjected to cool at cryogenic temperature of below -190°C in liquid nitrogen. After reaching the cryogenic temperature the metal possess better material properties such as strength, hardness etc. The cryogenic treatment is suitable with cutting tools like high-speed steel (HSS) tools, carbides, ceramics, CBN, PCBN and coated tools. This manufacturing techniques guarantees the cutting tool properties even after re-machining. Researches on cryogenic treatment also getting higher and it proves this process of manufacturing can increase the efficiency of the tool materials Molinari et al. [4]. The other material improvements like coatings over tools and lubrication technique can also been followed to improve the surface roughness of the machined material. The cutting tool which are generally used for machining purposes are high-speed steel tools. In recent research the technique is used for machining materials such as cemented carbides, cermets and ceramics are generally used to manufacture materials at high cutting speeds and metal removal rates with performance reliability. In early years while machining, the tool and work piece produce more heat, particularly HSS tools. But there is an increase in cryogenic treatment in production field and proves that it can improve the material property P.G. Benardos et al. [5]. By analysing previous researches it shows cryogenic treatment can decrease the temperature of tool and by improving the surface quality of machined material. The neural networks are

the predictive method for the optimization process. The neural networks process with input layers, hidden layers and output layers. The structure of neural network is a typical to biological neural system which consist of neuron. The neuron are the feed data to the neural system Hamid Beigyh et al. [6]. Thus artificial neural network also similar to biological neural system where the data are in form of inputs and neurons acts as weights in the network for the processing of outputs Hill, Tim et al.[7]. The rest of this paper are the recent analysis on cryogenic treatment is discussed in section 2. The proposed methodology on surface roughness optimization is explained in section 3. The experimental result and discussion and conclusion are discussed in section 4 and 5.

Related Work

In face milling operation the surface roughness is generally occurred due to the improper machining of cutting tool. These deformation occurred when the milling tool is subjected to low hardness and toughness Razfar, Mohammad Reza et al. [8]. For the improvement of milling tool hardness the tool is subjected to cryogenic treatment. The cryogenic treatment is a cold treatment practiced in cutting tools for improving the tool properties on machining S. Thamizhmanii et al. [9]. Recent researches were conducted on various tools for example coated tungsten carbide the cryogenic treatment is employed to improve the strength of adhesion on coated material Mahdi Koneshlo et al. [10]. For further reference the cryogenic treatment is carried out to find the wear behaviour in orthogonal turning is mentioned. The manufacturers are making their product stabilize in the market by introducing new metal technology in their product production Paolo Baldissera et al. [11]. Other alternative method of metal treatments like coatings over metals, lubrication systems etc, are also developed Simranpreet Singh Gill et al. [12]. The cutting fluids also have major role in removal of surface roughness in the machining process but the use of cutting fluids are hazardous to environment and machining with cutting fluid is very costly than conventional machining Konstantinos-Dionysios Bouzakis et al.[13]. For considering the environmental impacts the use of cutting fluids are eliminated by developing metal treatments in metals for optimizing surface roughness A. Shokrani et al.[14]. The cryogenic treated tool is introduced for machining difficult materials like tungsten alloys which are widely used in aerospace, nuclear and in defence due to its productivity loss, low surface quality and poor cutting tool life E.O. Ezugwu et al. [15]. When machining Inconel 718 the tool wear is reduced by cutting fluids which is a conventional method in machining. The new era of manufacturing arise and treatments on metals are also implemented S. Zhang et al. [16]. The cryogenic treatment on tungsten carbide for machining of tungsten alloy is taken for the reference Zhang. S, Li. J. F, Deng. J. X et al. [17]. Machining the tungsten carbide with cryogenic treatment and

it shows the deep treated tool is more effective than untreated tool Adem Çiçek et al. [18]. The material roughness is carried out by neural network which is a prediction method of finding best optimum value in the network design. The algorithm are effective method in prediction of surface roughness in the neural network Kaan Yetilmezsoy et al. [19]. Some of the prediction algorithms are artificial bee colony, genetic algorithm, bat optimization, harmony search algorithm which are used for the prediction process in the neural networks. The algorithms is a step procedure for solving a problem and it starts with initialized input processed and ends with particular outputs. While some algorithms uses randomized values for the prediction of outputs these algorithm uses random inputs for getting outputs such algorithms are generally mentioned as randomized algorithm. The bat optimization is an optimization algorithm for the prediction of surface roughness in the neural network A. H. Gandomi et al. [20]. The early researches results that the proposed algorithm and system is an efficient method in optimization of surface roughness in face milling operation.

Proposed Methodology

In machining process surface roughness is the common factor occur on the workpiece due to the improper working of metal. The roughness of material is decreased by limiting the working temperature of material. The increase of milling tool hardness can improve the surface roughness and there by an adaptive treatment on metals called cryogenic is implemented on the milling tool. The cryogenic treatment can improve the material properties like toughness, thermal conductivity, tensile strength etc. The input parameters are introduced on the artificial neural network for the processing of output. Artificial neural network is a predictive method for the prediction of output by using weights. The neural network uses backpropagation algorithm for the processing of network design. The error occur on the neural network can be predicted and adjusted by bat optimization algorithm, this algorithm will adjust the weights in the neural network for the network prediction. This paper briefly explains the optimization of surface roughness in face milling. In this paper the experiment is carried out by the workpiece made of Aluminium 6351 alloy and cutting tool is made of molybdenum M2 grade. Thus cryotreated tool is introduced on the milling process to improve its properties. The experiment starts initially with untreated tool where the roughness and temperature value is analysed. Then cryotreated tool is introduced on the machining where the roughness and temperature value is noted. Thus obtained value is compared with neural network design by feeding the input parameters in the neural network and output is verified. In this paper Bat Optimization based artificial Neural Network (BONN) technique is used for the optimization process. By comparing the treated and untreated tool experiments the cryotreated tool is

effective in machining and it can lower the roughness and temperature of the cutting material. Thus the surface roughness is optimized and temperature is controlled to increase life span of cutting tool. The modelling will be undertaken by Mat Lab and process performance is compared with analysed algorithms and experimented results will be plotted in forms of graphs.

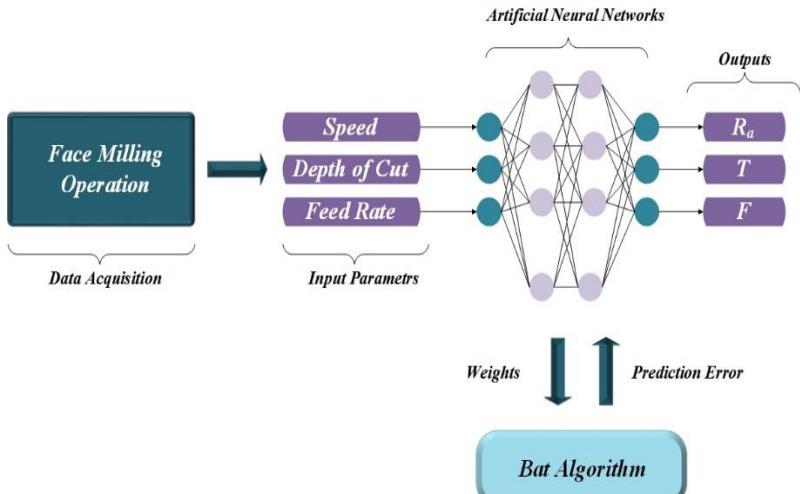


Figure 1: Data flow for the optimization in face milling by using artificial neural network and Bat Algorithm.

The data flow in fig 1 shows the optimization of surface roughness in face milling operation is carried out by three input variables (such as speed V_s , feed rate of work piece v_f , depth of cut a_p). The inputs are feed to artificial neural network for analysis with obtained data, if error creates that will change in prediction which can be adjusted by weights. An algorithm function is used to change weights which is based on bat inspired algorithm. Thus the surface roughness and on work piece can be predicted and the tool piece temperature is controlled by cryogenic treatment and artificial neural networks based on bat algorithm.

Experimental procedure and data collection

The experiments were carried out in horizontal conventional milling machine with maximum spindle speed of 5,000 rpm and maximum feed of 30 m/min. This milling machine has a 17.5kW spindle motor and is equipped with a 30 collect cutting tool holder. The machining work piece is made of Aluminium

6351 alloy with dimensions of 40mm (length) x 40mm (width) x 40mm (height). Cutting experiments were carried out by material made of molybdenum M2 grade is used. The mechanical properties of molybdenum steel are plotted in table below. The values of machining parameters were selected based on recommendation of SECO tools category. The diameter of cutting tool is 63 mm with six teeths with clearance angle of 26 degree is used. The cutter tools were from SECO category as based on molybdenum stainless steels.

Table 1.Mechanical Properties of Molybdenum

Mechanical Properties	Metric/Imperial
Atomic number	42
Atomic weight	95.6
Crystal structure	BCC Structure
Lattice constant ‘a’	3.1470 Å
Density	10.22 g/cm ³
Melting Temperature	2623 oC
Thermal Expansion coeff	4.8 x 10-6 / K at 25 oC
Thermal Conductivity	138 W/m at 20 oC

Molybdenum forms as two times of carbide with iron and carbon as tungsten but when comparing molybdenum has half the atomic weight of tungsten. As a result molybdenum can be substituted for tungsten on the basis of almost one part of molybdenum can be even up weight for two parts of tungsten. The melting point of the molybdenum steels is slightly lower than tungsten steels, so the steel can withstand high temperature while machining. The Molybdenum type high-speed tool steels are tougher than the Tungsten type high-speed tool steels but the surface hardness is slightly lower. Allowance for this reduced surface hardness is partially accomplished by the addition of tungsten and to a lesser extent and vanadium to the molybdenum composites. It is the main reason for the popularity of the tungsten-molybdenum grades (like M2, M3, and M4): they afford good surface hardness, which is so desirable in high-speed tool steels.

Surface Roughness Measurements

On early days the surface roughness of material is measured by either vision or by touch. By the past years the development of technology arise and various test experiments were developed. For the experiment process Pertho-meter M1 instrument is used for the surface roughness measurement. The experiment starts with introducing the Pertho meter probe to the workpiece surfaces. In the roughness affected part, the probe reciprocates and produce vibrations. The coils used in the instrument which transforms the vibrations in to electrical

signals. The obtained signals are graphically mentioned and plotted by graphs. In this experiment small portions of workpiece piece surfaces taken for the measurements and the values are tabulated and noted as surface roughness R_a . The initial velocity for the roughness measurements taken as 0.5mm/s and length as 2.5mm respectively.

Experimental Design

The experiment for face milling is carried out in two types of cutting tools one is untreated M2 steels and the other one is cryotreated M2 steels. The parameter induced on the milling operation are cutting speed, feed rate, depth of cut. The experiment is conduct initially on untreated tool with test levels of cutting speeds 180, 250,355 rpm, feed rates are, depth of cut is randomly chosen as 20 mm/min and 0.3 mm and temperatures obtained are 32.5° , 35.9° , and 35.6° . While in cryotreated tool the input parameters are same as above and the temperature in machining is lower as 32.5° , 33.9° , 34.6° respectively. By comparing the two tests the cryotreated tool form lower temperatures in machining than untreated tool.

Cryogenic Treatment on Metals

The metal treatment is a growing innovation followed in the manufacturing field. The development of cryogenic treatment is implemented in the past years. The awareness of the new treatment rises in the recent years which can form higher efficiency on operation. The newly implemented cryogenic treatment is used in this paper, the cryogenic process is a cold treatment process on metals. The metal is subjected to slow cooled at cryogenic temperature in the liquid nitrogen at -196°C and remain at room temperature. After the process the metal form low distortion and harder than before. Cryogenic treatment is initially done with cutting tools made of stainless steels for wear reduction on the metals. Researches were carried out on cryogenic treatment on metals like tungsten carbide and molybdenum steels. Thus the researches proves that cryogenic treatment is an effective method in metal treatments. In milling operation the roughness of the metal formed by the poor cutting of metal in the machining process. The main factors affecting surface roughness are wear, strength and hardness of cutting tool. Due to the improper machining of cutting tool and the parameters in machining such as speed, depth of cut and work feed can cause surface roughness on the workpiece. By suitable metal treatments the roughness of the metal can be lowered and thus it improve the surface quality of the metal. The paper determines the cause of roughness in the machining process, the use of low hardened cutting tools in machining process is generally cause surface roughness in workpiece. The use of lower hardness and strength of cutting tools in machining the temperature formed by milling will be higher which results in breakage of cutting tool.

Excess of temperature in machining affects both the cutting tool and workpiece. The cryogenic treatment on cutting metal is introduced to improve the tool properties like hardness and strength in milling operation. Thus cryogenic treatment promote the cutting metal to lower the temperature and surface roughness in the machining process.

Bat algorithm

Bat algorithm is a bat inspired metaheuristic optimization algorithm developed by Xin-She Yang in 2010[21]. Metaheuristics technique is a new method for optimization in recent years, more and more different metaheuristic algorithms have been proposed, such as harmony search, artificial bee colony, genetic algorithm and ant colony algorithm. The bat inspired algorithm is also a metaheuristic algorithm based artificial neural network for the optimization of surface roughness. The bat algorithm is based on the echolocation behaviour of micro bats with pulse rates and loudness. The bat algorithm is the algorithm for global optimization. The concept of bat algorithm is related to bat which flies with a random velocity u_i at Position y_i with a frequency or wavelength variation and loudness l_i . Thus the bat search and finds its prey by changing its frequency, loudness and pulse emission rate r . The bat algorithm is proved earlier when comparing with other most well-known algorithms such as harmony search and ant colony algorithm. In this paper bat algorithm based back propagation algorithm is used for solving surface roughness in face milling operation.

Distance at location function,

$$y_i^t = y_i^{t-1} + u_i^t$$

Velocity function,

$$u_i^t = u_i^{t-1} + (y_i^{t-1} - y_*)\varphi$$

Frequency function,

$$\varphi = Q_{\min} + (Q_{\max} - Q_{\min})\beta$$

Where,

φ, β [0, 1] = random vector drawn at uniform distribution.

(Q_{\max}, Q_{\min}) = randomly assigned frequency which is drawn uniformly.

y_i^t = iteration 't' at location in dimensional search 'd'.

y_ψ = the current best solution exists.

Bat Algorithm Objective Function for Optimization

- Initialize Bat population size and Bat Optimization Neural Network (BONN) Structure
- Load the training data
- If error obtained stop the criteria
- Pass the bat weights to neural network
- Back propagation neural network processed using the weights initialized by Bat algorithm
- The sensitivity of one layer is determined from its previous layer and the valuation of the sensitivity will starts from network last layer and turns back.
- Update weights and applied in the neural network
- Calculate the error in the network. Minimize the error by adjusting neural network parameters using Bat algorithm
- Generate Bat Preys (y) by selecting random target preys i.e.,
$$Y_i = Y_j$$
- Evaluate the fitness of the prey, Chose a random prey i
If
 - i. $Y_j > Y_i$, Then
 - ii. $y_i \leftarrow y_j$
 - iii. $Y_i \leftarrow U_j$
- End if
- Bat update the weight at each iteration until the neural network is combined.
- End While.

Artificial Neural network

An artificial neural network is pre-programmed computational prototype based on natural neural network of human brain. Neural network is an important data quarrying tool for classification and clustering. The neural network is generally composed of three layers (input, output and hidden). Each layer have separate number of nodes. The input layer are connected to hidden layer, thus input data are feed to hidden layer for processing. From the hidden layer the nodes are connected to output layer. The connection between each layer denotes the weight adapted on nodes. Thus artificial neural network works based on natural neurons and these neurons receive signals through synapses located on the dendrites or membrane of the neuron. When the signal received are high (which pass a certain threshold), the neuron is activated and emits a signal through the axon. The received signals are sent to another

synapse to activate other neurons. The complexity of real neurons is highly hypothetical when modelling artificial neurons. In general the inputs which are multiplied by weights and then computed by mathematical function which actuate the activation of the neurons. Another function computes the output of the artificial neurons.

The back propagation algorithm is one of a most popular artificial neural network algorithm. It is a method of training artificial neural networks used for coincidence with the optimization methods. The methods calculates the inclination of a loss function considering all the weights in the neural network. It is then feed to the optimization method which in turn update the weights in an attempt to minimize loss function. The backpropagation algorithm can work with multiple input unit in which several self-reliant variables are involved. In this experiment backpropagation based artificial neural network is used for the improvement of tool piece by cryogenic treatment and surface roughness in workpiece material.

- Objective function for bat $f(y)$, $y = (y_1, \dots, y_d)^T$
- Initialization of bat population y_i ($i = 1, 2, \dots, n$) and u_i
- Define the pulse frequency Q_i at y_i
- Initialize pulse rate r_i , loudness l_i
- While ($t < \text{Max number of iteration}$)
 - Generate new solutions by updating frequency, velocities and location or solutions.
 - if ($\text{rand} > r_i$)
 - Select the best solution.
 - Generate a local solution from the best solution selected.
 - End if
 - Generate a new solution Bat generate new solution and fly randomly.
 - if ($\text{rand} < l_i \& f(y) < f(Y_p)$)
 - Accept the new solutions.
 - Increase of pulse rate r_i and by reducing loudness l_i
 - End if
- Rank the bats and select the current best solution Y_p
- End While
- process results and visualization.

Figure 2: Pseudo code for BAT algorithm

Modelling of Proposed BONN technique

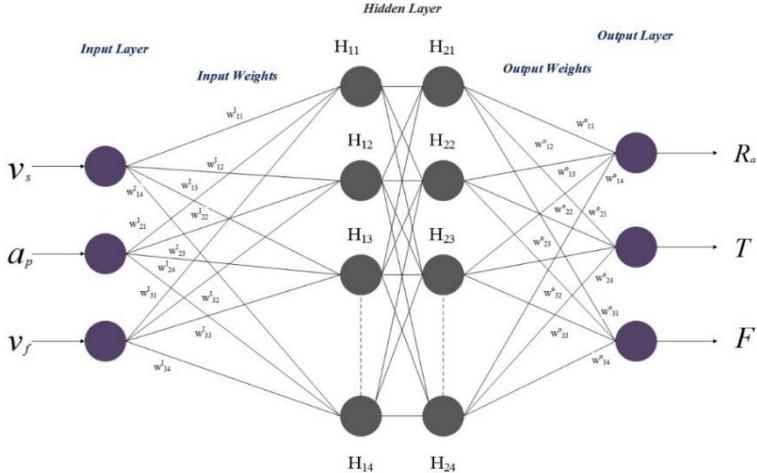


Figure 3. Proposed structure of artificial neural network

In this paper the artificial neural network for consists of four input layer (such as speed , feed rate of work piece , depth of cut , eight hidden layer and two output layers. Each input node is connected with eight hidden layer for processing and each output layer is also connected with hidden layer for the execution of output. Thus the input is feed to hidden layer and processed by functions (Transig) and output data R_a, T and F is executed.

Mathematical Modelling using Artificial Neural Network

The artificial neural networks by BONN technique for optimization purposes are discussed as below.

Input function

The basic input function for the evaluation of artificial neural network is explained in Equation (1) as below.

$$X_i = H_1 G'_{11} + H_2 G'_{21} + \dots + H_n G'_{n1} \quad (1)$$

In Equation (1) X_i is the basic input function for the neural network, H_i is the input data in the neural network. G'_{11}, G'_{21} is the input weight acting on each node of neural network for the optimization. G'_{n1} , is the n^{th} no of input weights acts on nodes in neural network.

$$X_i = \sum_{i=1}^M H_i G'_i \quad (2)$$

In Equation (2) X_i is the sum of input evaluated in artificial neural network, M is the total no of hidden layer in neural network, i is defined as the i^{th} number of inputs for neural network. H_i , denotes the sum of inputs in neural network and G'_i defined as sum of weights with hidden layers acting on input nodes in neural network for the optimization process.

Transig function:

This function in neural network is for training the network design for optimization. It is done by the given input datas, the function is defined in Equation (3) below.

$$T_j = \frac{1}{1 + \exp\left(-\sum_{i=1}^M H_i G'_i\right)} \quad (3)$$

In Equation (3) T_j is the transig function for training neural network. It is equal to the inverse exponential sum of input function. Where, H_i denotes the sum of inputs in neural network. G'_i , denotes the sum of weights with hidden layers acting on all nodes in neural network for the optimization.

Output function

The output function shows the sum of input function to the weights with hidden layer acting on the output layer which is defined in Equation (4)

$$X_k = \sum_{j=1}^N T_j G''_k \quad (4)$$

In Equation (4) denotes the X_k as the output function in neural network, T_j is the transig function for training neural network. G''_k is the weights with the hidden layer acting on each output node for the optimization.

Purelin function

The Purelin function is generally a transfer function to calculate the hidden layer output from its total input which is explained in (5) as below.

$$Z = X_{out} \times 1 \quad (5)$$

Where, Z is the desired output in neural network, X_{out} is the output combined with hidden layer to the inputs. The final output of the neural network is sum of the output hidden layers to the weights acting on each output node which is explained in Equation (6) as below.

$$Z_k = \sum_{j=1}^N T_j G''_{jk} \quad (6)$$

The Equation (6) denotes Z_k is the actual output of neural network, T_j is the input transig function for train neural network. G^o is the net weights acting on the output layer in neural network.

Surface Roughness

Surface roughness in material is defined as the quality of machined surface is characterized by the accuracy of the material after manufactured determined by dimensions. Every machining operation characterised by requirements on tool roughness and surface finish. The surface roughness for the optimization is explained in Equation (7) as below.

$$R_s = \frac{1}{l} \int [v_s + v_f + a_r] dx \quad (7)$$

These parameters were recognised is in the form of finely spaced micro distortion left by the cutting tool. Each type of cutting tool discard its own individual pattern so it can be identified. This type of pattern is called as surface roughness. In Equation (7), R_s is the surface roughness of the material, v_f is the feed rate of workpiece, v_s is speed, a_r is the depth of cut and l is the sample length for roughness optimization. This paper determines the artificial neural network, which consists of four input units and two output units. The hidden layers for the processing of artificial neural network which consists of eight layers. It is generally called as forward pass of artificial neural network. The input layer is connected by each node in the hidden layer which is multiplied with weights. The output of the neural network is obtained by the weights adapted on the output layer. Thus the equation for obtaining output function is explained in Equation (8) as below.

$$Z_k = \sum_{j=1}^N \frac{G^o}{1 + \exp\left(-\sum_{i=1}^M H_i G'_i\right)} \quad (8)$$

In equation (8), N is the total no of input layer for the optimization, M is the total no of hidden layer, i is the number of inputs, j is the no of hidden, k is the no of outputs get after processing hidden layer, G^o is number of weight for the output layer multiplied by hidden layer for the output, G' is the weight for the input layer multiplied by hidden layer for the processing to get output. The operation of hidden layer is of nonlinear transformation for the outcome and this process is repeated for the output function. Thus the output layer values is analysed with the initial values and check for error rate on neural network is calculated which is plotted in equation (9) as below.

$$\lambda_k = \frac{1}{2} (z - z_k)^2 \quad (9)$$

λ_k is defined as the k^{th} error occur on the artificial neural network, z and z_k is the desired output and actual output on the neural network. The error occur on the network node is transmitted forward to the hidden layer which is called forward pass of artificial neural network.

Weight Optimization by Bat algorithm

For the weight optimization artificial neural network uses bat algorithm to train the neural network. The node weights is optimized by using bat algorithm, each input node represent a set of weights for the neural network. Thus the population is generated initially by this phase. The solution shows the weights which are given in Equation (10) as below.

$$y_i = y_1, y_2, \dots, y_n \quad (10)$$

The fitness function is calculated by Equation (11)

$$\text{fit}_i(y_i) = \begin{cases} \frac{1}{1 + f_i(y_i)} & \text{if } f_i(y_i) \geq 0 \\ 1 + \text{bat}(f_i(y_i)) & \text{if } f_i(y_i) < 0 \end{cases} \quad (11)$$

Fitness Evaluation Phase

The employed bats search prey by change its frequency, loudness and pulse emission rate r . Thus the location of the nearby prey is stored in the bat memory. After that it evaluates the fitness of the nearby prey.

Bat Optimization

The Bat Optimization is employed in the paper for the weight updating on each iteration of the optimal output. The update of weights by using bat optimization algorithm is explained in Equation (12) as below.

$$G'_i = [G_i^{t-1} + (Y_i^{t-1} - Y_\Psi) w_i] \quad (12)$$

Where G'_i and G_i^{t-1} denotes the weights of neural network at the time interval t and $t-1$, Y_i^t and X_i^{t-1} denotes the position vectors of the bats at time interval t , $t-1$ and Y_Ψ stands for the current global best solution. The local

search is carried out in the initial population, which is illustrated in the following Equation (13) as below.

$$Y_i^t = Y_i^{t-1} + \beta_{i,j} l^{At} \quad (13)$$

Where, $\beta_{i,j}$ denotes a random number between -1 and 1 , l^{At} denotes the loudness value at time interval t . These updated bats are included in the fitness evaluation Equation (11), and the fine fitness function is chosen as the optimized value.

Experimental Result and Discussion

The proposed system for the analysis is implemented in the working platform of Mat lab with the following system specification.

Processor	: Intel Core 2 Quad @ 2.5 GHz
RAM	: 3GB
Operating system	: windows 7
Mat lab version	: R 2014a version 8.3

The optimization process is used for selecting suitable weights with neural network. The algorithms are used for the prediction of values. The tool is subjected to face milling operation where the metal forms irregularities on the surfaces it is called surface roughness. The surface roughness is formed by the irregularities in cutting tool properties like hardness, strength and toughness. Thus the tool is cryotreated and it is subjected to milling operation, where the surface roughness on workpiece and temperature of cutting tool is lowered. The artificial neural network is drawn to predict the surface roughness adapted on the metal. The artificial neural network based on bat algorithm is used for the prediction operation. The bat algorithm is used to adjust weight in neural network for the prediction of datas. Thus the proposed system is analysed in the analysing software called Mat lab. The output performance is verified by using analysed results.

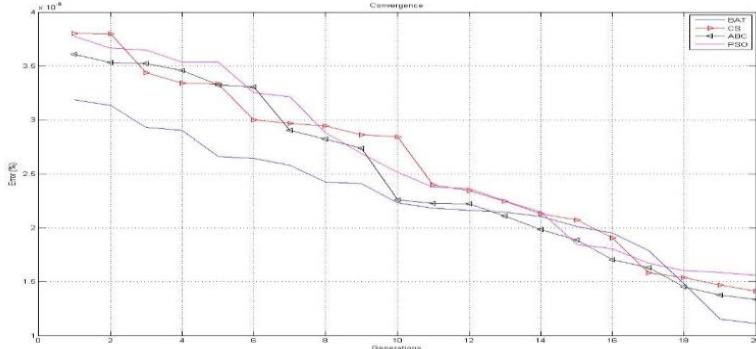


Figure 4. Iteration vs Error

The convergence graph is plotted for error prediction in artificial neural network. In this graph the error predicted by algorithms and the iteration starts from 1 – 20 and error from 1- 5. During iteration the bat has least error occurred in the neural network. In this paper bat algorithm uses weights to adjust error for the prediction of cutting tool property and surface roughness. While in comparison with similar optimization algorithm such as cuckoo search algorithm, artificial bee colony and particle swarm optimization the bat possess less error on the optimization methods. Thus bat algorithm is an effective error prediction method used in the artificial neural network for the optimization.

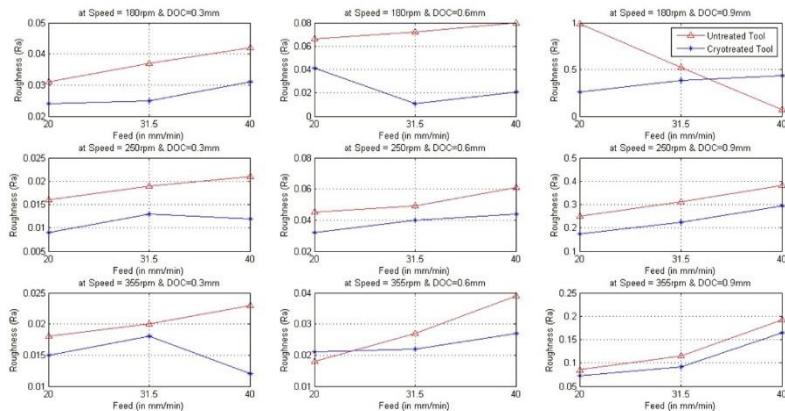


Figure 5. Roughness prediction of Cryotreated and Untreated tools in cutting tool

The roughness of tool is analysed based on speed, depth of cut and feed rate. The parameters for the roughness prediction by feed rate of cutting tool are 20, 315.5 and 40 mm/min, cutting speed of tool 180, 250 and 355 rpm and depth of cut are 0.3, 0.6, 0.9mm respectively. Initially untreated tool is introduced for the milling process with the cutting parameter of speed 180rpm, depth of cut 0.3mm and feed rate 20 mm/min, the untreated tool form roughness value of 0.031, while in cryogenic treated tool the roughness value obtained is lower than untreated tool of range 0.024. Then the metal tends to cryogenic treatment where the treated metal is tested to milling process which makes the roughness rate lower than before. In untreated tool the roughness of material is higher than cryogenic treated material. By comparing the graphs plotted, it shows the cryotreated tool is more effective method in machining process.

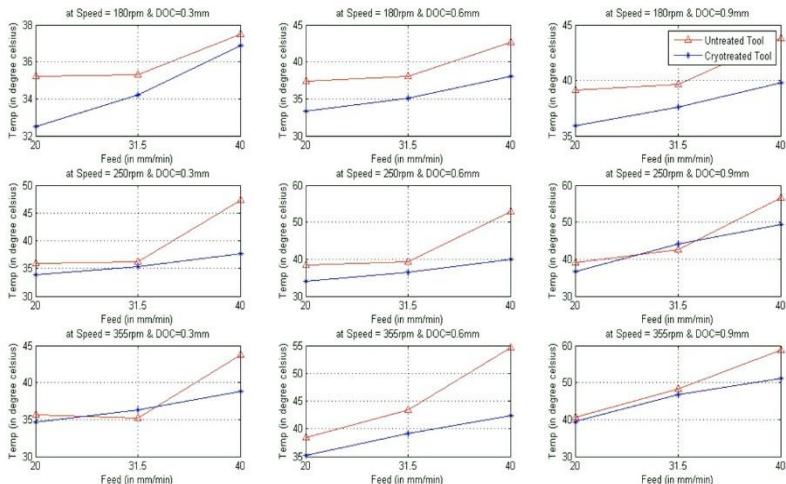


Figure 6. Temperature analysis of cryotreated and untreated tools in optimization

In this graph the temperature difference on untreated and cryotreated tools in face milling operation is plotted. The temperature of metal increases by applying feed, depth of cut and cutting tool speed in the milling operation. The feed rate of metal are in the range of 20, 31.5, 40 mm/min, cutting speeds are 180, 250, and 355 rpm and depth of cut are 0.3, 0.6 and 0.9 mm respectively. The initial parameter of speed 180rpm, depth of cut 0.3mm and feed rate 20mm/min, the temperature obtain at untreated tool is 35.2°C and in cryotreated tool is 32.5°C. When comparing the cryotreated and untreated metals, the cryotreated tool decreases the temperature rather than untreated. The increase of cutting tool temperature form surface roughness on workpiece

which brittle the cutting tool. Thus cryotreated tool can lower the temperature of material on the cutting tool and increase the life span of cutting tool.

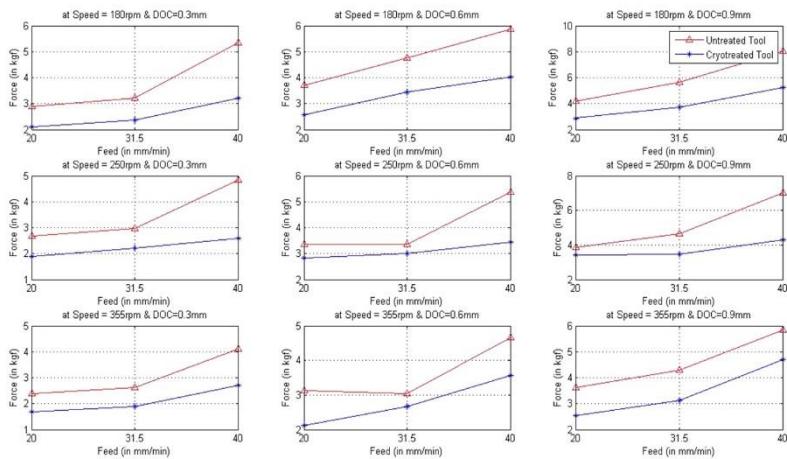


Figure 7. Force analysis in cryotreated and untreated tools

This graph determines the force applied for both cryotreated and untreated tool in the face milling operation is plotted based on the machining parameters. The parameters are feed rate of 20, 31.5, 40 mm/min, cutting tool speed of 180, 250, 355 rpm and depth of cut in the range of 0.3, 0.6 and 0.9 respectively. Initially the speeds of 180rpm, depth of cut 0.3 and feed rate 20 is applied the output force is low in cryotreated tools of range 2.1, but in untreated tools the force is higher than treated tools of range 2.89. By comparing these two parameters the cryotreated tool is more efficient in milling operation than untreated tools.

Conclusion

Cryogenic treatment on cutting tool is the main objective described in this paper. The treatment on metal is carried out to improve the tool property in machining process. The roughness is mostly occurred on the surface of the work piece by the improper machining of cutting tool. In this paper cryotreated tool is subjected to machining process, while machining the tool produces less roughness and temperature. While comparing with untreated tool, the cryotreated tool is more effective in machining. Thus data on cryotreated and untreated tool is tabulated and analysis process is carried out to find the optimized value of surface roughness and temperature by which the tool produces. For validating the better tool property on machining bat algorithm

based artificial neural network is used in this paper. The bat algorithm in neural network is used to modify weights in hidden layer for reducing prediction error to get output. Finally modelling and analysis is undertaken by Mat lab. In forthcoming optimization process the bat optimization algorithm can be replaced with other algorithms to get higher output data. By machining process and result analysis it shows the cryogenically treated tool is more effective in reduction of surface roughness and temperature, increase of tool life span, than untreated tool in face milling operations.

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