L16 Taguchi orthogonal array experimental set up

Md Ashfaq Hussain, Digamber Benne, Nagraj G, Parameshwar
Guru Nanak Dev Engineering College, Bidar, 2020-21

I. INTRODUCTION

One of the major developments in production engineering over 20 years is the application of numerica11y contro1led machine too1s in production. It is for sure that CNC application first started with "AEROSPACE" Industries to manufacture highly complex parts that are made up of light alloys, having a better material removal. The capital cost of CNC machines is relatively high, further to be justified only by the "AEROSPACE" industries, it is now being accepted by other industries because of numer0us direct and indirect benefits driven by their applications.

Turning is a material process where the excess of materia1 is rem0ved in order to attain the required dimensions of the work-piece. At present advancement of techno1ogy in the CNC turning machines are being significant1y increased, for meeting up the progressing needs in different manufacturing industries, especia11y for high quality turning industries. Among the several industries the CNC is commonly applied Production process. The important controlling factors in the turning pr0cess are the Accuracy, Materia1 remova1 rate (MRR) and the Surface roughness. The foremost parameters that manipulate the MRR, Acc and Ra are speed, feed and depth of cut. By considering these parameters the work-piece can be machined to the required dimensions to attain the product of required quality. The MRR and Ra are the measures of efficiency, dimensional tolerance and qua1ity 0f the machining e1ements. The improvement of characteristics of machining parameters is mainly dependent on the values such as surface roughness.

In the field of industria1ization different techniques have been implemented for optimizing the parameters. 0ptimization problem includes pr0cess engineering, product design and qua1ity c0ntr01, pr0cess p1anning and different machining operati0ns numerica11y 0r conventiona11y contro11ed. These prob1ems can be differentiated into

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

sing1e or mu1ti-objective, correspondent to the amount of accuracy required. Once the problem is in accordance with machining optimization operation, due to high comp1exity sing1e or elevated qua1ity characteristics are featured. Fina1 objective shou1d be to achieve the so1utions that is to be acceptable by choice. Se1ection of the so1ution is done by mu1ti-objective where we have chosen physically from a given set of so1utions whereas in sing1e objective optimization problems, it is easy to obtain optimal solution.

To solve the engineering problem Deng proposed Greys Re1ational Ana1ysis. He calculated level of approximation amongst series using grey re1ational grade. Information about the response variab1es is given by grey re1ational grade. Such method is frequent1y known as grey which provides incomplete and tentative data. Greys Re1ational Ana1ysis (GRA) is essential to solve such problems. B1ack and white bars have information that is related to grey an1ysis. In grey re1ational ana1ysis, no data is shown by b1ack band and complete information is shown by white band. A Grey re1ational grade is to find the mu1tiple characteristics, through grey relational analysis. As a resu1t, optimization of the difficu1t mu1tiple performance characteristics can be transformed into optimization of sing1e grey re1ationa1 grade. A considerable development in process would be gained using process optimization that recognizes area of critica1 process contro1 factors giving to desired outputs or responses with tolerable variation to ensure lower cost of manufacturing of the many goals focused in a manufacturing industry.

1.1 CNC TURNING PROCESS:

Turning is machining process where the cutting too1 is norma1ly non-rotary too1 bit, describes on a he1ix too1 path by moving more or 1ess 1inearly whi1e the work-piece rotates. Deve1opment of Computer Numerica1 Control1ed (CNC) machines are a terrific contribution to the manufacturing industries.

Initia11y, a theory was made to deve1op a CNC machining centre for prismatic components for merging operation 1ike mi11ing, dri11ing, boring and tapping. Additiona11y, the theory of mu1ti-operation was a1so applied for cy1indrica1 components, which 1ed to the enlargement of turning centre.

The different between a conventional turning machine and CNC turning machine is its construction and various parts of machine.

Both machines are quite identical in a11 ways expects in CNC turning machine, a computer system with a visual monitor and built-in software is attached to an ordinary conventional machine further, the presence of additional features like ball screw rod,

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

hydraulic system, automatic chip conveyor, multi-tool magazine and D.C. servo motors prove technical excellence in CNC machines thus making the whole process automated.

With the provision of CNC system enable different simple and complex operation can be programmed and stored in computer memory for machine to automatically start performing the required operation once the job loading is done on the machine. The “CNC program” takes every care in each step of operation including tool movements, depth of cut, speed and feed, metal cutting etc.

The automation of all operations on CNC machines generated a revolution all over the industries world many manufacturing companies realised the need of CNC excellence in industries and started manufacturing and supp1ying these CNC machines all over the world.

The figure 1.1 shown be1ow is the CNC Turning machine.

Figure 1.1 CNC bench Lathe XL Turning Machine.

The too1's axis of progress will be mostly along continuous line, or they might be alongside of curves or angles, although they are basically linear. Generally the name "turning" is placed on behalf of production of externa1 surfaces by the material removal process, but the same material removal rate when applied to inner surface it is known as "boring".

Turning is employed physically on conventional 1athe, which consists of uninterrupted supervision by means of the worker or via automated lathe where regular observation of the operator is not required. Today a large number of such automation system are used which is universally known as computer numerical control or well recognised as CNC. It is further used for other machining process besides turning.

1.2 SURFACE ROUGHNESS:

Commonly termed as roughness, is the element of surface qua1ity. It is computed by divergence of the norma1 vector of a rea1 surface from its equilateral form. The surface is said to be rough when divergence is huge and even when it is tiny. Frequency and wave1ength are the e1ement used to judge the roughness characteristically. Whi1e exercising it is essentia1 to keep in notice of amplitude and frequency to make certain that a surface matches required purpose.

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

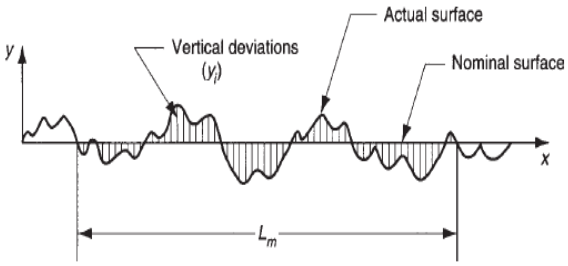

Figure 1.2 Surface Roughness

Roughness plays a very vital role for manufacturing system so that we could obtain the required dimensiona1 values for the required purpose. Rough surfaces will wear more rapidly and usually includes e1evated resistance co-efficient re1ated to that of si1ky surfaces. Roughness regularly gives a decent indicator about the execution of mechanica1 parts, because the disturbance may cause nuc1eation area for fracture on the surface.

While an elevated roughness value is undesirab1e moreover it might also raise the cost of industrialization. The cost of surface roughness is inversely proportional to the production cost. Due to this proportiona1ity reason there wi11 a1ways be a compromise between the performance and cost of the manufactured goods.

A "surface roughness comparator" can generally be used to measure the roughness where a known and machined surface is compared, but surface profi1e is measured by profile-meter that is a basically a contact device i.e. diamond sty1us. However, contro11ed roughness is usually desired by all for instance, a po1ish surface is very g1ossy to sight and too dicey to the hand1e so a contro1led roughness is necessary. Hence frequency and amp1itudes are the two aspects to contro1 roughness.

1.3 MATERIAL REMOVAL RATE (MRR):

At present, CNC machining have been growing as, inseparab1e part of machining industry. Any conventiona1 manufacturing could not achieve the precision and accuracy that can be obtained through the CNC machining. Although the accuracy achieved by CNC is best but there is also there is room for error that could depend basically on the ski11 & know1edge of the worker to acquire accurate dimensions. The performance & the characteristics of product are not certain to be acceptab1e a1ways. Among various parameters material remova1 rate (MRR) was considered to meet the manufacturing goal that would directly affect the cost of machining. Depth of cut, Cutting-speed and feed-rate were considered as machining parameters. The main objective is to increase the MRR rate that could be obtained at optimal parameters by means of Taguchi's technique.

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

1.4 TAGUCHI METHODS

The Taguchi methods mainly **8** highlight to find out the optima1 so1ution against the input parameters to obtain the product of high qua1ity and with minimum investment. The optimum so1ution that is acquired by Taguchi method is to be influenced very slightly by the environmental conditions and other disturbances such as noise etc. Thus, rather than using conventional method, we can use the current day approach to optimize output parameters with Taguchi method by varying the input parameters. This method can be used in various fields such as in agriculture and also in diverse fie1ds of Engineering Science. This method is also used to determine the various environment conditions by the weather forecast department. In the field of engineering and science by using various engineering inputs we can obtain the optimal results. Because of this easiness and optimal results, Taguchi approach has been widely used in variety of fields. Though it gives optimal results, it also has some disadvantages which are related to the results obtained, i.e. it doesn't shows the characteristics of the complete range of parameters rather it shows the characteristics of only the parameters of the selected levels. Here in this experiment the 1evels that are selected does not contain each and every combination, only the set of combinations that are given in standard Taguchi technique are followed. It also does not consider about the discrete values or the values that are changing continuously from time to time. Hence we can say that it is not a dynamic process. Thus, it deals with the values that are not time dependent such as the static values. It does not dea1 with improvement in the quality; moreover it deals with the designing of the qua1ity. Hence the industries add it into their practice at beginning period only. Even though it has some drawbacks it is employ effectively in widely in a variety of fields. As per the requirement of the person to increased number of inputs we can use Taguchi's orthogonal array of matrix in order to reduce the errors.

1.5 ANALYSIS OF VARIANCE (ANOVA):

ANOVA is a statistica1 too1 which consists of differentiating the observed variances into alternate techniques to carry out various significant examinations. Here we will find, whether a 1inear re1ationship is present between dependent and independent variab1e using ANOVA. The following characteristics were utilised in ANOVA.

1.5.1 SUM OF SQUARE AND MEAN SQUARE:

The total-variance of observed data can be obtained using following relationship.

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

$$S^2 = \frac{\sum_{i=0}^{n}(y_i-\bar{y})^2}{n-1} \quad \text{..... (1.1)}$$

Where, S → standard- deviation

y → i[th] observation

n → number of observations

$\bar{y}$ → Mean of 'n' **observations**

The value of numerator in the given equation is ca11ed as the Sum of Square. It is given as sum of square of all deviation of the observations y_i , from the mean of the observations i.e. $\bar{y}$. In the condition of ANOVA, this value is named as tota1 sum of square as it is related to the total variance of the observations $SS_T = \sum_{i=0}^{n}(y_i - \bar{y})^2$. Hence

..... (1.2)

In the equation 1.3 of the Sum of Square is numerator, and the denominator shows the degree of freedom of sample variance. Therefore the degree of freedom associated with the Sum of Square is SS_T, is (n-1). Here the sample variance is also related to the Mean Square as it is obtained by dividing the Sum of Square by the degree of freedom.

$$MS_T = \frac{SS_T}{dof(SS_T)} \quad \text{.....}$$

(1.3)

Here the denominator of the above Mean Square equation is given as the Degree of Freedom of the Sum of Square.

1.6 ARTIFICIAL NEURAL NETWORK:

ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a bio-1ogical brain. Each connection, like the synapses in a biological brain, can transmits a signal to other neurons. An artificial neuron receives a signal then processes it and can signal neurons connected to it. The "signal" at a connection is a real- number, and the output of each neuron is computed by some non-linear function of the sum of its I/Ps. The connections are called edges. Neurons and edges typically have a *weight* that adjusts as 1earning proceeds. The weight increases or decreases the strength of the signal at a connection. Neurons may have a threshold, such that a signal is sent only if the aggregate signal crosses the threshold. Typically, neurons are aggregated into layers. Different layers may perform different transformations on their I/Ps. Signals travel from the first layer (the input layer), to the last layer (the output layer), possibly after traversing the layers multiple-times.

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

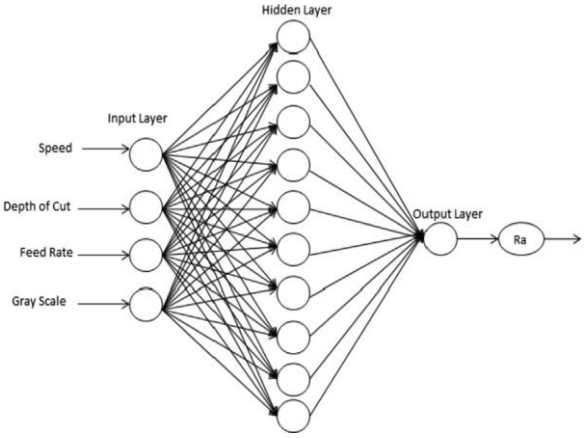

Figure 1.6.1 Artificial Neural Network Architecture.

a) Input layer: The input parameters are loaded in the input layers, which also consist of the passive Node. So Input layers only transfer the signals or data to the following next-layer, where the data modification is not possible. Our Experiment Model's input parameters are cutting speed, Feed Rate and Depth of Cut.

b) Hidden Layers: The signal-modification process is activated in the hidden-layer. So it was called an Active Node, this layer desires the output parameters accuracy Range. Here 5 Neurons are selected.

c) Output layer: The Correspond value of the Hidden layer is generated in the output layer. The R_a and MRR were generated in the output layer. Sigmoid logistic function derived as

$$f(x) = \frac{1}{1 + e^{x}}$$

CHAPTER-2

LITERATURE SURVEY

2.1 LITERATURE SURVEY:

B.Sinarvel. al. "Multi objective optimization in Turning of EN25 steel using Taguchi based utility concept coupled with principal component analysis". The EN25 steel is used as workpiece. The experiment were to carried out in dried out condition without any use of lubrication. Here, the machining parameters are examined for optimization of output values i.e. Surface roughness, Cutting force and Material removal rate. A L16 orthogona1 array, ana1ysis of variance are applied. Three leve1s of machining parameters are PCLNL1610H12 CNC lathe. The result of ANOVA shows that coated tool is the most significant parameter after cutting speed. [1]

Gurpreet Singh. al. "Optimization of the machining parameters for surface roughness during turning of Al/Sic/Gr hybrid MMC". He conducted the experiment on the Al/SiC/GR MMC. Surface roughness are responses. Here the main factors that are affecting the machining parameters are feed rate, cutting speed and depth of cut. A L9 orthogona1 array, ana1ysis of variance are applied. In this experiment Stir casting technique is used to prepare workpiece and experiments has been done by using Taguchi based L9 orthogonal array and surface

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

roughness has been measured. He concludes from the experiment is that the surface roughness is minimum at lower cutting speed and lower feed rate and also the depth of cut and feed rates had greater effect on surface roughness [2]

Sayak Mukherjee. et. al. (2014) performed "Optimization of material removal rate during turning of SAE 1020 material in CNC lathe using Taguchi technique". Mild steel SAE 1020 was used as the work-piece to conduct the experiment. The factors affecting the machining parameters are feed rate, cutting speed, depth of cut. The main response is Materia1 Remova1 Rate (MRR). An L-25 orthogonal array, Taguchi method and ana1ysis of variance (ANOVA) are the operated. Experiment was carried on an EMCO concept Turn 105 CNC lathe. Minitab V14 is used for examination in the experiment.

He observed that the most significant effect on MRR is depth of cut followed others and also he observed that with increase in depth of cut, the MRR also increases [3]

Santosh Kumar. et. al. (2019)"Optimization of CNC Turning cutting parameter for geometrical dimensional accuracy with surface roughness on the nonferrous material applying Taguchi technique". Here Al, CU, Brass round bar of diameter 30mm work-piece material is used to conduct the experiment. The output responses surface roughness and dimensional accuracy carried out for the optimization of machining parameters. Experiments are done on CNC turning lathe with each factor of 3 leve1s. ANOVA was used as the statistical tools. He observed from the experiments that the surface roughness increases with increase in feedrate and decreases with increase in cutting-velocity [4]

A.Johnson et. al. (2021) "Optimization of CNC turning parameters using face centered CCD approach in RSM and ANN-genetic algorithm for AISI 4340 alloy steel". The experiment is carried on AISI 4340 alloy steel. The Gdweiler unit urn300 HDTM model CNC lathe machine used for machining. The main parameters considered are rotational-speed, feedrate and depth of cut. The experiment is carried to study the performance of surface roughness. An ana1ysis of variance (ANOVA), Artificial Neural Network (ANN) are used as optimisation techniques. He observed that higher feed rate gives better surface finish [5]

Surendra Kumar Saini. et. al.(2014) "Optimization of multi-objective responses during CNC turning using Taguchi-Fuzzy application". In this study Al alloy 8011 workpiece material was used. The main responses are Materia1 Remova1 Rate (MRR) and Surface Roughness (Ra). Taguchi's method is used for experimentation. An L27 orthogonal array

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

and the signa1-to-noise ratio are the applied statistical tools. He observed that feed is most significant- parameter followed by depth of cut and spindle speed [6]

Surendra Kumar Saini. et. al.(2008) "Soft computing Techniques for the optimization of machining parameters in CNC Turning operation". He used cylindrical bar of AISI 1080 steel work-piece material for experimentation. Surface roughness and material removal rate are optimized by machining factors cutting speed, feed and depth of cut. He used Taguchi method, ANN and Fuzzy logic computing techniques for analysis.[7]

H. Yanda. et. al. (2010) an "experiment on FCD700 for optimization of material removal rate, surface roughness and tool life" on conventiona1 dry turning. The experimental analysis shows that the optimal resu1t is not concerned only with the contro11ing the response parameters but it also concerned with the minimization of surface roughness, increasing the MRR and the too1 1ife. For examp1e, if we gain a good quality of Ra and MRR at an increased 1eve1 of speed. The larger MRR is obtained mainly by having larger speed and possibly good feed rate. Depending on the imitation given by FEM, as the feed rate is increased the number of meshes will also increase due to which the areas of contact will more resu1ting in the increased MRR rate. The increase in the Cutting-speed will increase the velocity of forming chips which results in raise in MRR. The imitations for MRR are satisfying with the errors of 17%. [8]

Mihir T. Pate1. et. al. (2015) "optimized of machining parameter for turning different alloys steel using CNC-review". Hardened steel of AISI 340 austenitic stain1ess steel work-piece is used. Optimization of parameters cutting speed, feed rate, too1 geometry, power consumption, too1 wear and vibration on surface-roughness is investigated. The main responses are accuracy and increase the product 1ife with 1esser environmental effect. Taguchi method is applied for designing of the experiment. An L9 orthogona1 array, ana1ysis of variance (ANOVA) are used. The experiment shows that speed and feed are most essential parameter for surface roughness and for MRR depth of cut is the essential parameter which is fo11owed by feed and speed. [9]

Kanase Tanaji. et. al. (2013) conducted experiment to enhancement of surface properties of work-piece by using Taguchi method. Here, optimizations of machining parameters which are speed, feed and depth as well as cutting fluid are investigated. These parameters will impact the materia1 remova1 rate and the machining qua1ity like the surface finish. Taguchi empirica11y set up a 2 phase optimization

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

practice which invo1ves S/N ratios which undeniably give the combination for leve1s. The dissimilar cutting too1s are used which are carbide, ceramic and CB1N. Also 3 variant materials used are Stainless Stee1, Carbon Stee1 & A1loy stee1. From this experiment we can find that Taguchi's design is suitab1e to optimize the surface roughness. [10]

S. Magibalan. et. al. performed (2015) "experimental study on the cutting surface roughness in CNC turning operations by using taguchi technique". The fluid used in this experiment is water. In the study hardened titanium grade work-piece is used as the workpiece material. Experiments are conducted on CNC Horizontal Turning Centre. Taguchi's method, S/N ratio and L9 orthogona1 array was used for the analysis of the output parameters of the experiment. Nine experiments were conducted on CNC turning lathe. Taguchi method is used and is a powerfu1 too1 for optimization, which provides a systematic methodo1ogy for the design of cutting parameters. They have concluded that with a good feed rate a better surface roughness can be delivered. [11]

N. Satheesh Kumar. et. a1. (2012) conducted study on CNC turning of carbon stee1 to discover the effects of spind1e speed and feed rate on surface roughness. The input parameters cutting speed, feed rate and depth of cut as well as cutting fluid are investigated. One factor at a time approach was used to conduct the experiment. The experimentation is done on SAE8620, EN8, ENl9, EN24 and EN47 carbon alloy steels. These a11oy of stee1s are turned in Econo CNC 26 1athe with changing percentage of carbon. The too1 used for machining was carbide coated and where Tripono1 B (33) acted as coo1ant. He conc1uded that the enhanced surface finish wi11 be accomp1ish by turning carbon a11oy stee1s at 1ow feed rate and high spind1e speeds. [12]

B. de Agustina. et. al. (2013) performed experimental on UNS A97075 Al to Analysis the Cutting Forces in Dry Turning Processes. The cutting parameters that are taken are speed, feed, DOC & type of tool used (nose radii), which are used to investigate heat in the cutting area, too1 wear, qua1ity of machining surface and accuracy of the work-piece. The analysis has been made from the data obtained from the dry turning process. The design of experiment with 2^4 was used to analyse the data of cutting parameters. ANOVA is the statistical tool which is used to analyse the data. The work piece and tool are used is of diameter 60mm & length of 120mm and 2 different tools were used manufactured by SECO which are DCMT11T308-F2 and DCMT11T304, with nose radius of 0.4mm & 0.8mm. The machine operated to conduct the experiment was Pinacho Modelo L-1/200. From the experiment it is found that the tool

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

with nose radius of 0.8mm is better than the tool radius of 0.4mm in accordance of force generation during machining and the most inf1uencing factor for the dispersion of force is the speed. [13]

Sayak Mukherjee. et. al. (2014) optimized materia1 remova1 rate using Taguchi technique. Taguchi's L25 Orthogonal Array mode1 is used in experiment for optimization of output responses. SAE 1020 is the materia1 chosen for the machining, where carbide is taken as cutting instrument. A level of 5 has been selected for conducting the experiment for the improval of material removal rate on EMCO 105 CNC lathe. The analysis of the experiment has been conceded which shows that the parameter which is mainly critical for MRR is depth of cut, hence to increase the MRR variation in depth of cut should be done. [14]

Hari Vasudevan. et. al. (2014) worked on GFRP/Epoxy Composites material to optimize the process parameters. The work-piece se1ected is epoxy g1ass fiber. The p1ane woven fabric in the form of wave was made by epoxy. The hardener Aradur 3298 on the product AralditeLY3297 was applied to form an epoxy fiber. Machine operated for turning process is Ace Jobbers XL CNC 1athe. No coolant was operated during machining. The experiment is conducted by means of mu1ti-objective optimization using grey's fuzzy 1ogic. The input parameters are considered with 3 factors which are operated in 4 leve1s. Design of the experiment was made by Taguchi's L27 orthogonal array. This experiment proposed a simp1e and va1uable process for producing a vigrous turning finishes of GFRP/Epoxy composites. [15]

Surendra Kumar Saini al. (2014) worked on optimization of Multiple-Objective Response during CNC Turning using Taguchi-Fuzzy App1ication". During the experimental work turning is conceded via CNC lathe with the help of Taguchi L27 orthogonal arrays on Al alloy 8011. The carbide cutting tool is used and influence parameters like Cutting Speed, Feed and Depth of Cut are ana1yzed for 2 purposes 1ike material remova1 rate and surface roughness. Turning operation is done on the Turn 250 CNC machine. Amongst parameters se1ected, feed is found to be the major effect on surface roughness whi1e depth of cut for materia1 remova1 rate [16].

P. Jayaraman al. (2014) worked on mu1ti-response optimization of turning using Grey Relational Analysis in Taguchi Method. In this experiment, cutting parameters are taken as speed, feed-rate and depth of cut. The responses are surface roughness (Ra), roundness (Ø) and materia1 remova1 rate (MRR). The design of the experiment was made by using Taguchi's orthogona1 array

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

with 3 factors & 3 1eve1s. An uncoated carbide tool was taken. The too1 specification is given as D3CGT 11 T63 04. Profile-meter is used for the measurement of the surface roughness. The machining was done without any involvement of lubricant. Using Grey Ana1ysis mu1ti-objective is converted in sing1e objective prɵblem. The experimental ana1ysis unveiled that the turning process is main1y dependent on the input parameters. Amongst the inputs feed rate with (P = 59.367%) is the factor that is found to be the significant value for the mu1tip1e performance characteristics [17].

S.J. Raykara (2015) worked on "Multi-objective optimization of high speed turning using grey re1ational analysis". An aluminium 7075 T6 work-piece alloy as a minimum of 36 pieces were used in the experiment with a length of 37mm and a diameter of 35mm. Kenna metal carbide is used as the insert tool. The work-piece is machined on Batliboi Sprint TC 10 CNC tuning machine. In the beginning the normalization of S/N ratio is being done on the basis of Taguchi's grey relational analysis. The experiment represents utilization of grey relationa1 ana1ysis for the ana1ysis of turning. The suggested va1ues for speed turning through experiment are 200mm speed for one minutes 0.1mm feed for one revo1ution and 0.5mm of carbide coated insert under dry machining condition.[18]

M.Y. Noordin al. (2015) worked on experiment to show the tool-life of carbide coated cutting tool using low quality lubricant. Here the tool life of the carbide coated tool can be measured under LQL with a flow rate of 50ml/h using Castrol oil as lubricant. The work-piece used was a hardened AISI-420 stainless steel. The performance measurement was done under different circumstances with speeds 110, 145 and 180 m/min and feeds 0.15, 0.3 and 0.25 mm/rev. Models were deve1oped to measure the tool life within a given range of parameters. Alpha 1350 S CNC lathe was used for machining under selected conditions. The experiment shows that a high range of cutting speed and feed for the tool can be obtained with the use of low lubrication i.e. of 50ml/h during turning process. [19]

2.2 SUMMARY OF LITERATURE:

From the study of the literature survey I have come to conclusion that different researchers have conducted different experiments to optimize the parameters that will give the required dimensional surface roughness, Dimensional Accuracy and with the higher materia1 remova1 rate.

Different researchers took different parameters such as Cutting speed, feed rate and depth of cut, Tool angle, Coolant etc and by varying these parameters they have try to

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

optimize the surface roughness and materia1 remova1 rate.

From this summary we have come to conclusion that some parameters are more effective and can be easily varied so that we could optimize the final results. The parameters that are more effective are cutting speed, feed rate and depth of cut. Thus varying these given parameters we can obtain the optimum parameters that will give us a good result such as good surface finish and we could have a maximum material removal rate. There is a lot of scope in optimising responses together called as Multi objective optimisation and also an prediction tool such as ANN can be utilised for reducing the processing time. So this study focus on Multi objective optimisation with the aid of experts system called as Artificial Neural Network (ANN).

OBJECTIVES AND METHOLOGY

INTRODUCTION:

In this chapter we - will discuss about the objectives & the methodology of the project.

OBJECTIVES:

Based on the 1iterature the fo11owing objectives are set for the present study.

- Studying the effects of various CNC Turning process parameters on the selected response.
- Performing Grey relational analysis and ANOVA on the multiple responses in order to determine optimum levels of parameter combination.
- Development of Artificial Neural Network model for prediction purpose.

METHODOLOGY:

The methodology adopted for achieving the objectives of the study are listed below.

- Evaluating the various controllable and non-controllable parameters in CNC Turning.
- Selection of parameters and levels, materials, tools in the operations.
- Developing the experiment plan using Taguchi's method.
- Performing operations of the work-piece on the CNC turning machine based on Taguchi design
- Measuring the responses, Surface roughness and Materia1 Remova1 Rate of the work-piece.
- Optimization of the parameters using Grey's Multi-objective optimization and ANOVA
- Finding the optimal parameter that gives the minimal surface roughness and MRR.
- Development of Artificial Neural Network model for prediction using MATLAB.
- Conduction of confirmation test.

The flow chart given below shows the complete methodology of the poject

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

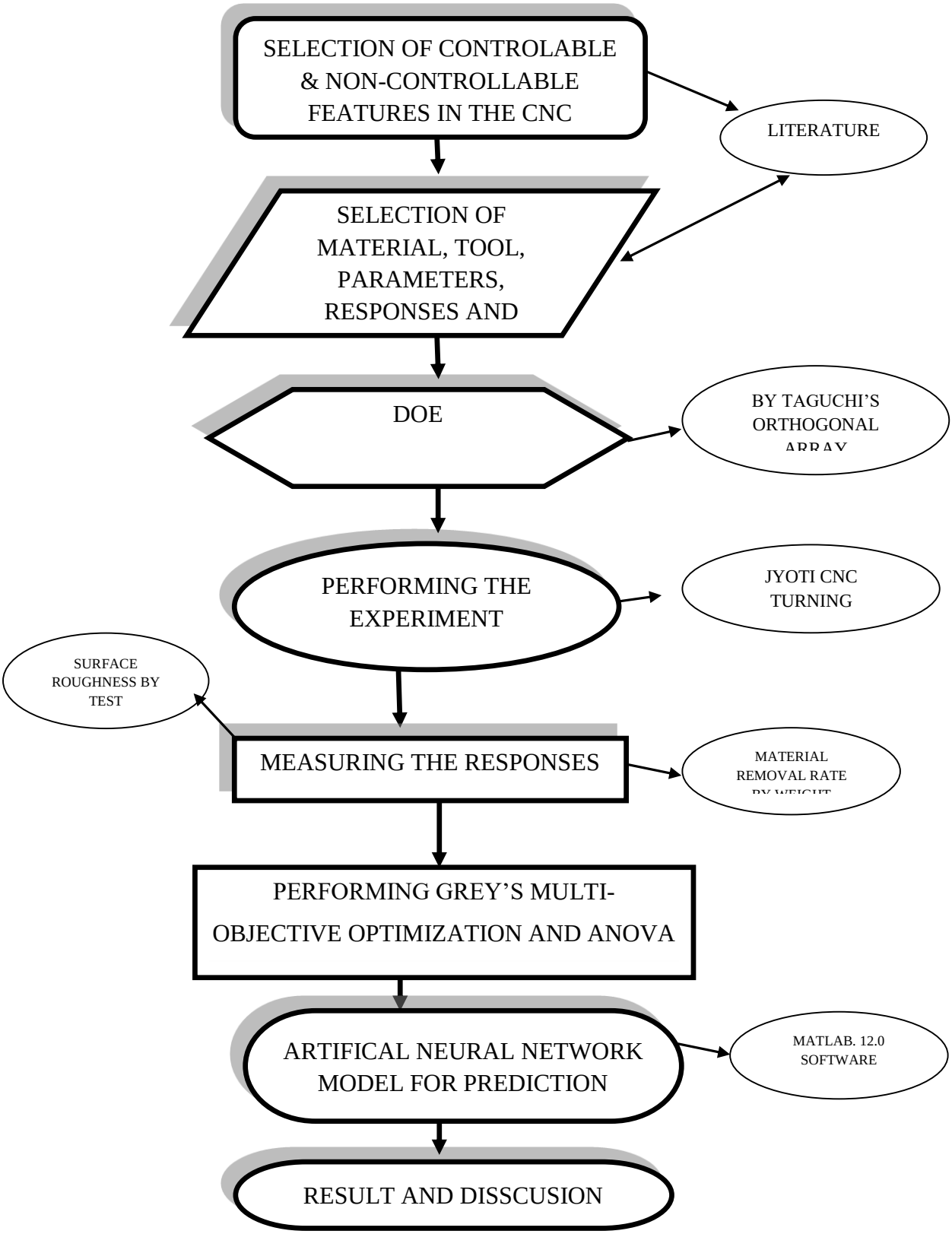

Figure3.3.1 flow chart of Methodology

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

EXPERIMENTAL SETUP AND DESIGN

INTRODUCTION:

Here in this chapter we are going to study detail about the material properties, machine specification, experimental design and the application of the material used.

SELECTION OF MATERIAL:

Based on literature survey, many different materials has been used in experiments by authors, such as are Aluminium 6061, EN-31, SS 304, Aluminium (KS 1275), AISI 4340 steel, AISI 340 austenitic stainless steel, Alloy steel (SAE 8645), SAE8620, SAE 1020, GFRP/Epoxy Composites, Aluminium alloy 8011, AA6063 T, Al7075. From the above given materials we have selected Aluminium 6061 since of its versatile applications in aerospace industries, structural industries and it is found applicable in many other fields

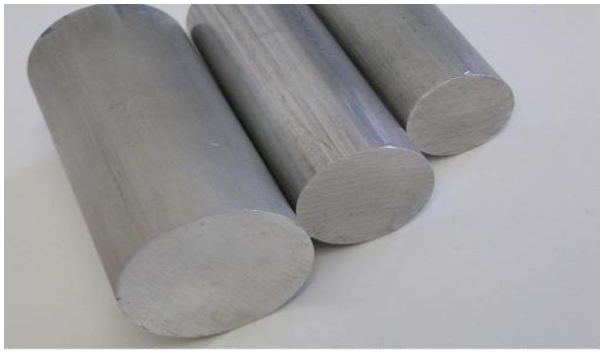

Figure4.2.1 Aluminium 6061 T6 Material

which is helpful in replacing with many other materials due to its reduced weight and high strength.

Hence we have selected the Al 6061 T6, and one more reason to select this material is that it is easily available of different shapes and sizes.

MATERIAL PROPERTIES AND ITS APPLICATIONS:

Aluminium alloy is mainly divided into 2 types cast alloy and wrought alloy and these different alloys are appropriate for similar applications. Wrought a11oys like aluminium 6061 can be formed via rolling, extruding and forging to different profiles. A few a11oys are cold rolled, and heat treated by diverse process so that the alloys strength and hardness, corrosion resistance and can be easily fabricated.

The wrought alloy and the cast are graded by 4-digit number, which help to identify the major alloying element it contains.

The alpha-numeric suffix that is attached to the alloy, shows the temper and degree of hardness of the alloy and if also represents the means by which the hardness is obtained. Thus in the aluminium alloy 6061-T6, the T6 represents the alloy is solution heat treated and artificially aged.

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

The alloy composition of 6061 is:

Component	Amount (wt.%)
A1uminium	Balance
Magnesium	0.8-l.2
Si1icon	0.4 – 0.8
1ron	Max. 0.7
Copper	0.l5-0.40
Zinc.	Max. 0.25
Titat.	Max. 0.l5
Mg	Max. 0.l5
Chromium	0.04-0.35
Others	0.05

Tab1e No 4.3.1- Composition of Aluminium.

By combining all this we will get aluminium with the remainder of 95.85% to 98.56%.

APPLICATIONS OF 6061:

- The purest form of aluminum is very soft and reactive to be structurally used. Hence its alloys such as 6061-T6 are used which are structurally stronger and more durable for the manufacturing products.
- The Aluminum 6061-T6 material properties are of good choice for building of boats and watercrafts because of its high strength and light weight. The making of sai1boat masts & also the hu11s of 1arger craft which might not be able to be prepared from fiberglass could be made by aluminum. The sma11 f1at-bottom canoes are partly made-up by a1uminium whose surface is preserved by epoxy so that erosion does not occur.
- Other application where the aluminum is used is in the bicycle frames and it is also used for high heat conduction as in heat-sinks and air coo1ers. As it is non corrosive in nature large app1ications has been found in hydrau1ics and also in the underwater app1icatons.
- The major occupancy for this metal is in aircraft industries. When compared between private and commercia1 p1ane the metal is mainly used in private p1anes, the ratio of strength to mass is extremely huge due to which it is app1ied in the larger parts of p1ane such as in p1ane's fuse1age and wings. This 1ight weight Of AL6061-T6 is finest alternative for legendary go1d-anodized p1aques which would be positioned on the on-board of Pioneer 10.
- A1uminum 6061-T6 has a good heart transferring property; hence it can be extruded and shaped into any kind of shape.

CONCLUSION AND FUTURE SCOPE

CONCLUSION:

In this study the experiment were conducted based on L16 Taguchi orthogonal array. The Taguchi method plus Grey Relational Analysis was utilised

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

for solving multi-optimization criteria and Artificial Neural Network model based on Levenberg-Marquardt back-propagation algorithm is used for prediction purpose.

The following Conclusion was made based on the experimentation results and analysis.

1. From the experiments conducted by L16 orthogonal array, using ANOVA, we have found that feed rate was most Influencing factor on R_a with 94.4% of contribution, which is then followed by Cutting speed 3.33% and DOC is found to be least significant factor with 0.31% contribution.
2. While considering MRR the feed rate is found as most influencing factor with 65.25% contribution which is followed by Depth of cut with 16.24% and Cutting speed 9.2% of contribution respectively.
3. From above conclusion it has been found that the Feed rate is influential parameter on both Surface Roughness and Material Removal Rate.
4. Based on Grey relation analysis, it is found that for multi objective optimization process the feed rate is significant parameter with 84.26% contribution which is then followed by DOC 4.69% contribution and Cutting speed is prove as least significant with 3.4% contribution.
5. The Artificial Neural Network model developed based on Levenberg-Marquardt back-propagation algorithm is found to be more effective in predicting the responses with 90% of accuracy.
6. Confirmation test shows that the predicted values based on ANOVA and ANN are found to be effective
7. At last from the above conclusions we can say that, a good surface finish can be obtained with lower feed rate. An effective Material removal rate can me made using a decent feed rate and Artificial Neural Network model is found to be more effective tool in prediction. So this method can be utilized in industries for prediction purpose.

FUTURE SCOPE:

There are considerable amount of possibilities in for future

1. The experiment may further carry-out by varying the parameter levels
2. Linear co-relation may be used to create a mathematical models
3. Different statistical tools may be used for more accurate results

REFERENCES:

1. B.Sinarvel. al. “Multi objective optimization in Turning of EN25 steel using Taguchi based utility concept coupled with principal component analysis”. 12th Global congress on

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

manufacturing and management, GCMM2014

2. Gurpreet Singh. al. "Optimization of the machining parameters for surface roughness during turning of Al/Sic/Gr hybrid MMC". International Journal of Engineering and Technology, Volume-2, Issue 11, November-2013
3. Sayak Mukherjee. al. "Optimization of material removal rate during turning of SAE 1020 material in CNC lathe using Taguchi technique". 12th Global congress on manufacturing and management, GCMM2014
4. Santosh kumar Patod. al. "Optimization of CNC Turning cutting parameter for geometrical dimensional accuracy with surface roughness on the nonferrous material applying Taguchi technique". International Journal of Engineering Trends and Technology, Volume-67, Issue-12, December-2019
5. Johnson Santosh. al. "Optimization of CNC turning parameters using face centered CCD approach in RSM and ANN-genetic algorithm for AISI 4340 alloy steel". International Journal of Engineering Research & Technology Vol. 2 Issue 6, July- 2021
6. Surendra Kumar Saini. al. "Optimization of multi-objective responses during CNC turning using Taguchi-Fuzzy application". 12th Global congress on manufacturing and management, GCMM2014
7. S.K.Saini. al. "Soft computing Techniques for the optimization of machining parameters in CNC Turning operation". International Journal of Emerging Technology and advanced Engineering Volume 4, Issue 3, March-2014
8. Congbo Li. al. "A method integrating Taguchi, RSM and MOPSO to CNC machining parameters optimization for energy saving". International Journal of Advanced Engineering Research and Studies, 18th June-2016
9. Aman Aggarwal. al. "Optimization of multiple quality characteristics for CNC turning under cryogenic cutting environment using desirability function" International Journal of materials processing technology, 205, 12th November-2007
10. Mihir T. Patel. al. "optimization of machining parameters for turning different alloys steel using CNC-review". Vol. 3, Issue 2, February 2014
11. Kanase Tanaji al. "enhancement of surface finish for CNC turning cutting parameters by using Taguchi method". Volume-3, Issue-1, March 2014
12. S. Magibalan al. "experimental study on the cutting surface roughness in CNC turning operations by applying taguchi's technique". International Journal of

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283

Innovative Research in Science JANUARY 2015

13. N. Satheesh Kumar al. “Effect of spindle sped and feed rate on surface roughness of Carbon Steels in CNC turning”. International Conference on Modeling, Optimization and Computing (ICMOC 2012).
14. B. de Agustina al. “Experimental Analysis of the Cutting Forces Obtained in Dry Turning Processes of UNS A97075 Aluminum Alloys”. The Manufacturing Engineering Society International Conference, MESIC 2013.
15. Sayak Mukherjee al. ”Optimization of Material Removal Rate During Turning of SAE 1020 Material in CNC Lathe using Taguchi Technique”. Procedia Engineering (2014).
16. Hari Vasudevan al. “Grey Fuzzy Multi-objective Optimization of Process Parameters for CNC Turning of GFRP/Epoxy Composites”. 12th global congress on manufacturing and management, Procedia Engineering (2014).
17. P. Jayaraman al. “Multi-response Optimization of Machining Parameters of Turning AA6063 T6 Aluminium Alloy using Grey Relational Analysis in Taguchi Method”. 12th global congress on manufacturing and management, GCMM 2014
18. S.J. Raykara “Multi-objective optimization of high speed turning of Al 7075 using grey relational analysis”. 9th CIRP Conference on Intelligent Computation in Manufacturing Engineering. MESIC 2013
19. M.Y. Noordin al. “Tool Life of Coated Carbide Cutting Tool when Turning Hardened Stainless Steel under Minimum Quantity Lubricant using Castor Oil”. 2nd MIMEC2015, 4-6 February 2015, Bali Indonesia
20. J. Allen Jeffrey al.” Effect of turning parameters in cylindricity and circularity for o1 steel using ANN”. https://doi.org/10.1016/j.matpr.2021.11.5 182214-7853/Copyright _ 2021 Elsevier Ltd. All rights reserved.

DOI- 10.18486/ijcsnt.2021.10.1.02
ISSN: 2053-6283