OPTIMIZATION OF TURNING PARAMETERS USING GENETIC ALGORITHM METHOD

SHAH IZWANDI BIN MOHD ZAWAWI

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University Malaysia Pahang

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.

Signature:
Name of Supervisor: MR MOHD FADZIL FAISAE BIN AB RASHID
Position: LECTURER
Date: 14 NOVEMBER 2008

Signature:
Name of Panel: MADAM SITI HARYANI BINTI TOMADI
Position: LECTURER
Date: 14 NOVEMBER 2008

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature:
Name: SHAH IZWANDI BIN MOHD ZAWAWI
ID Number: ME05022
Date: 14 NOVEMBER 2008

Dedicated to my beloved

"Family"

For their endless support in term of motivation,

supportive and caring as well throughout the whole project

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ABSTRACT

This study about development of optimization for turning parameters based on the Genetic Algorithm (GA). This method was demonstrated for the optimization of machining parameters for turning operation using conventional lathe machines. Currently, everybody has start realizing the importance of this new manufacturing optimization in order to improve the performance and its efficiency. The purpose of this project is to find the optimum parameters values for turning operations that will benefit such as reduces the machining time, improves their quality and productivity and also minimize the unit cost of the product. GA can be used in optimization problems such as scheduling, materials engineering , optimal control, and so forth. This approach has led to the important following discoveries such as GA has robustness, the balance between efficiency and performances for survival in many different environments. The machining parameters that been consider in this thesis are cutting speed, feed rate and depth of cut. The GA simulation are been develop to achieve the objective. The MATLAB software will be use to develop the GA simulation. An example to apply the Genetic Algorithm to the problem has been presented at the end of this paper to give more understanding picture from the application of the system and how its work. The result obtained from this simulation shown GA has a potential for improvements in order to optimize the turning parameters and minimize the unit production cost. The simulation based on Genetic Algorithm are successful develop and the optimum parameters values are obtained from the simulation.

ABSTRAK

Kajian ini menerangkan tentang cara mengoptimumkan parameter yang digunakan oleh mesin larik mengikut kaedah *Genetic Algorithm (GA)*.Sekarang ini,semua sedar akan kepentingannya untuk meningkatkan kemajuan dan kecekapan dalam bidang pembuatan baru.Tujuan projek ini dijalankan adalah untuk mencari parameter yang optimum yang akan memberi kelebihan seperti mengurangkan masa penggunaan mesin, meningkatkan kualiti dan produktiviti,dan juga menjimatkan kos produk itu.*GA* dapat digunakan seperti jadual,kejuruteraan bahan,optimal control dan banyak lagi.Penemuan ini menunjukkan *GA* satu kaedah yang kukuh,yang mengandungi kecekapan dan kemajuan yang dapat digunakan bagi banyak keadaan.Parameter yang digunakan dalam thesis ini ialah kelajuan mata alat,kadar potongan dan kedalaman potongan.*GA* simulasi dicipta untuk mencapai objektif yang di rancang.Perisian MATLAB digunakan untuk mencipta simulasi ini. Satu contoh masalah akan digunakan untuk menerangkan cara pengunaan kaedah *GA* untuk memberi kefahaman yang lebih jelas tentang kaedah ini dan cara kaedah ini berfungsi. Keputusan yang diperolehi daripada simulasi ini menunjukkan *GA* ada potensi untuk mencapai parameter yang optimum dan menjimatkan kos produk.Simulasi mengikut kaedah *GA* berjaya dicipta dan parameter yang optimum dapat diketahui dari simulasi ini.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEW

Nowadays, everybody has start realizing the importance of this new manufacturing optimization in order to improve the performance. Manufacturing optimization can be defined as a function of certain decision variables that give the maximum or minimum value of one or more objective functions subject to some resources or process constraints. [1]

In general, we are interested in robust search techniques that can easily apply to a wide variety of problems. Most traditional method is not robust because each of them is specialized to solve a particular class problem, that why so many different type of optimization exist. (For different problem, different algorithm must be applied).So we must make a research to know some robust search algorithm that can be applied to a wide variety of problems without much difficulty. [1]

The ultimate goal of all such decisions is either to minimize the effort required or to maximize the desired benefit. By understanding this concepts such how does it work, what important about this algorithm, the relationship between the genetic algorithms with the turning optimization are the success way in order to optimize the turning parameter.

1.2 PROBLEM STATEMENT

Firstly, the optimization of turning parameters is usually a difficult work where the following aspects are required like knowledge of machining, specification of machine tool capabilities is compulsory.

Secondly, the level of parameters is the main point because it will affect the surface of the work piece, it also to avoid from scratch marks or inaccuracies in the cut.

Finally, in a turning operation, the important task is to select a good combination of parameters level for achieving high cutting performance. Generally, this combination is hard to find.

1.3 OBJECTIVE

The objective of this project is to:

1. Develop genetic algorithm (GA) program to optimize the turning parameter.
2. Determine the optimum turning parameter that minimize the production cost

1.4 SCOPE OF THE PROJECT

1. This project will use genetic algorithm (GA) to optimize the turning parameter and minimize the production cost
2. This project will concentrate to the single turning process (not multistage tuning process).
3. The data are acquired from the related journals and papers (not from the experiment).
4. Not involve any experiment.

1.5 IMPORTANT OF STUDY

As a future engineer, it is important to know how to establish a machining optimization turning parameter with high quality material that will be produced in order to increase the profit to our company.

By understanding the concepts, it will be easy to develop and implement the suitable optimization procedures and algorithm for a wide variety of problem in the area of design and manufacturing.

This project also will increase the knowledge about the way to optimize the machining parameter in order to obtain the minimum production cost, maximum profit rate and minimum production time.

These optimization machining parameters is also prevent us from doing something that waste in production such as time and produce a better product.

1.6 SUMMARY

This chapter discussed about the project background such as the important of this manufacturing optimization and research in other to know which type of algorithm that can be applied to a wide variety problem. It is also described the problem statement of this project, the important to the study, the objective and the scope of the project (limitation of the project).

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION TO TURNING PROCESS

Turning is a form of machining of a material removal process, which is used to create rotational parts by cutting away unwanted material. The turning process requires a turning machine or lathe, work piece, fixture, and cutting tool. The work piece is a piece of pre-shaped material that is secured to the fixture, which is attached to the turning machine, and allowed to rotate at suitable speeds. [14]

The cutter is typically a single-point cutting tool that is also secured in the machine, although some operations make use of multi-point tools. The cutting tool feeds into the rotating work piece and cuts away material in the form of small chips to create the desired shape.

Turning is used to produce rotational, typically axi-symmetric. Parts that are fabricated completely through turning often include components that are used in limited quantities, perhaps for prototypes, such as custom designed shafts and fasteners.

Turning is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that turning can offer, it is ideal for adding precision rotational features to a part whose basic shape has already been formed. [14]

2.2 TURNING OPERATION

During the process cycle, a variety of operations may be performed to the work piece to yield the desired part shape. These operations may be classified as external or internal. External operations modify the outer diameter of the work piece, while internal operations modify the inner diameter. [14]

2.2.1 External operations

- Turning - A single-point turning tool moves axially, along the side of the work piece, removing material to form different features. These features are typically machined at a small radial depth of cut and multiple passes are made until the end diameter is reached.
- Facing - A single-point turning tool moves radial, along the end of the work piece, removing a thin layer of material to provide a smooth flat surface. The depth of the face, typically very small, may be machined in a single pass or may be reached by machining at a smaller axial depth of cut.
- Grooving - A single-point turning tool moves radial, into the side of the work piece, cutting a groove equal in width to the cutting tool.
- Thread cutting - The threads can be cut to a specified length and pitch and may require multiple passes to be formed.[14]

2.2.2 Internal operations

- Drilling - A drill enters the work piece axially through the end and cuts a hole with a diameter equal to that of the tool.
- Boring - The boring tool is a single-point cutting tool, which can be set to cut the desired diameter by using an adjustable boring head. Boring is commonly performed after drilling a hole in order to enlarge the diameter or obtain more precise dimensions.

- Reaming - Reaming removes a minimal amount of material and is often performed after drilling to obtain both a more accurate diameter and a smoother internal finish.
- Tapping - A tap enters the work piece axially through the end and cuts internal threads into an existing hole. [14]

2.3 POSSIBLE DEFECT WHEN SELECTING THE WRONG PARAMETER

Most defects in turning are inaccuracies in a feature's dimensions or surface roughness and also surface finish. There are several possible causes for these defects such as:

- Incorrect cutting parameters

If the cutting parameters such as the feed rate, spindle speed, or depth of cut are too high, the surface of the work piece will be rougher than desired and may contain scratch marks. A large depth of cut may result in vibration of the tool and cause inaccuracies in the cut. The cutting speed also will affect the surface finish of the work piece. [14]

- Dull cutting tool

As a tool is used, the sharp edge will wear down and become dull. A dull tool is less capable of making precision cuts.

- Unsecured work piece

If the work piece is not securely clamped in the fixture, the friction of turning may cause it to shift and alter the desired cuts. [14]

2.4 THE IMPORTANT OF TURNING OPTIMIZATION

There are many significant to be analyzed in order to optimize the turning parameter because it will affect the quality and the productivity of that material. Optimization of turning parameters is usually a difficult work, where the following aspects are required like knowledge of machining, empirical equations relating the tool life, specification of machine tool capabilities and knowledge of mathematical and numerical optimization techniques also is compulsory.

The purpose of these optimizations is to obtain the finished product with a minimum production cost, maximum the production rate and the finest possible surface finish and the surface roughness. It also to satisfy the objective criterion such as minimum time meanwhile produces a better productivity such as the quality of the product. [1]

There are many reasons why need to optimize the turning parameter, but the main point is to establish a machining process of high quality that means finding out the optimum parameters levels that are related to certain quality characteristics in order to achieve the objective function such as minimize the unit production cost. These parameters level generally are hard to find. [12]

2.5 THE PREVIOUS METHOD

1. **Taguchi method:**

M.Nalbant, H.Go'kkaya and G.Sur (2006) use the Taguchi method is used to find the optimal cutting parameters for surface roughness in turning. The orthogonal array, the signal-to-noise ratio, and analysis of variance are employed to study the performance characteristics in turning operations of AISI 1030 steel bars using TiN coated tools.

This research finding that Taguchi's robust orthogonal array design method is suitable to analyze the surface roughness (metal cutting) problem as described in this paper. It is found that the parameter design of the Taguchi method provides a simple, systematic, and efficient methodology for the optimization of the cutting parameters. The experimental results demonstrate that the insert radius and feed rate are the main parameters among the three controllable factors (insert radius, feed rate and depth of cut) that influence the surface roughness in turning AISI 1030 carbon steel.

2. **Ant Colony System method**:

K.Vijayakumar, G.Prabhaharan, P.Asokan and R.Saravanan (2002) use the ant colony algorithm for solving multi-pass turning optimization problems. The cutting process has roughing and finishing stages. The machining parameters are determined by minimizing the unit production cost, subject to various practical machining constraints.

This research finding that the ACO algorithm can obtain a near-optimal solution in an extremely large solution space within a reasonable computation time. The effectiveness of the ACO algorithm has been proved through an example. The ACO algorithm is completely generalized and problem independent so that it can be easily modified to optimize this turning operation under various economic

criteria, and numerous practical constraints; and the algorithm can also be extended to other machining problems, such as milling operations and threading operations.

3. **A Grey and Fuzzy Logic method**:

Y.S.Tarng, Z.M.Yeh, C.Y.Nian (1995) present an optimal fuzzy logic controller design using efficient robust optimization techniques called genetic algorithms. It is shown that the developed fuzzy logic controller can achieve an automatic adjustment of feed rate to optimize the production rate with a constant cutting force in turning operations.

This research finding that the design cycles time for the fuzzy control system in turning operations can be greatly reduced from hours to minutes. Computational simulations and experimental cutting tests are performed to confirm the proposed method.

4. **Deterministic Approach method**:

J.Wang, T.Kuriyagawa, X.P.Wei and D.M.Guo C (2001) shown that the deterministic optimization approach involving mathematical analyses of constrained economic trends and graphical representation on the feed-speed domain provides a clearly defined strategy that not only provides a unique global optimum solution, but also the software that is suitable for on line CAM applications. A numerical study has verified the developed optimization strategies and software and has shown the economic benefits of using optimization.

This research finding that the using a deterministic optimization approach, a realistic optimization strategy for single pass turning on CNC machine tools has been presented. This optimization study is based on the criteria typified by the minimum production time per component while allowing for the many practical constraints. It has also shown the substantial benefits in production time and cost per component that can be achieved when using the optimized cutting conditions rather than handbook recommendations.

5. **Multiple Performance Characteristic method**:

C.Y.Nian, W.H.Yang, Y.S.Tarng (1998) present the Taguchi method with multiple performance characteristics is proposed in this paper. The orthogonal array, multi-response signal-to-noise ratio, and analysis of variance are employed to study the performance characteristics in turning operations. Three cutting parameters namely, cutting speed, feed rate, and depth of cut, are optimized with considerations of multiple performance characteristics including tool life, cutting force, and surface finish.

This research finding that the parameter design of the Taguchi method provides a simple, systematic, and efficient methodology for the optimization of the cutting parameters. Therefore, a useful technical tool for the quality optimization of manufacturing systems with considerations of multiple performance characteristics has been proposed and verified in this study.

6. **Multiple Criteria Simulation method**:

Young Hae Lee, Hyun Moon Shin and Byung Hee Yang (1996) present the multiple criteria simulation optimization problem is developed and tested with a turning operation. The goal of the problem is to find the optimum cutting conditions for the turning process with minimum processing time and good surface texture

This research finding that the proposed method has produced better results in numerical experiments than other useful methods, except for the required number of interactions during the execution of the algorithm. The proposed method also shows good results with the turning process model on the lathe. The algorithm is capable of dealing with non-analytical representations of the feasible region.

7. **Machining Theory method**:

Q.Meng, P.Mathew, J.A.Arsecularatne (2000) justify a method is described for calculating the optimum cutting conditions in turning for objective criteria such as minimum cost or maximum production rate.

This research finding that the approach used should greatly reduce the experimental work needed in collecting tool life data as it allows variations in work material properties and tool geometry to be allowed for independently of experiments. It was also shown that, in determining the optimum cutting conditions for economic criteria such as minimum cost and maximum production rate.