"Developing a Cam Estimator for feature based machining time estimation in VB enviornment"

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ABSTRACT

Productivity improvement is the need of current market and manufacturing sector globally and machining time plays a very important role reducing cost and time. The NC machining time of any product depends on the machine characteristics, NC program, geometry process information and process planning. However consideration of all these factors in machining time estimation is quite difficult and hence the commercial software available today cannot efficiently estimate time. Hence in this research paper, a new prototype feature based model has been developed for NC machine time estimation. This model is then compared with the existing commercial software and experimental observations. The results indicate that the proposed feature based model is reliable, practical and feasible.

Keywords: *NC machining time estimation, productivity, feature based model, prototype model.*

1. Introduction:

The demand of the global market is high quality products with lower costs which can be achieved through appropriate planning and scheduling. Machining time has a vital impact on the production planning and scheduling. It is an important factor in deciding the cost estimation and hence has a direct impact on the productivity of any industry [1]. Much of the information needed in the life cycle of a product, particularly its design and manufacturing process, revolves around the geometric shape of the product. Historically this led to the interest on geometric and the current generation of CAD systems based on geometric modelling techniques that provide useful functionality for geometry drafting, detailing, visualisation and analysis [2]. According to J.J.Shah [3], a feature represents the engineering meaning or significance of the geometry of a part or assembly. Features can be thought of as building blocks for the product. Also Features are generic shapes useful in some computer aided application, such as geometry construction, process planning, and Design for X. It also includes manufacturing features containing information related to geometry and topology of the product.

NC machining time estimation is a basic element considered for manufacturing process planning and scheduling. In light of this time estimation process specialists can outline and create optimum design of products to decrease the manufacturing duration and consequently diminish producing costs.

2. Existing Work:

The authors YANG and LIN [2] described that the machining time can be completely estimated from the amount of material removed and can hence be roughly estimated. The authors SHEHAB and ABDALLA [3] proposed a similar approach to estimate time from material removal rate and roughness of each feature. JUNG et.al [4] also explained a model to estimate time based on material removal rates and manufacturing

features. HBAIEB et.al [5] also developed an algorithm to calculate machining time using material removal rates.

The authors BS.JUNG YH. PARK [6] described an algorithm to calculate 5 axis machining time based on manufacturing characteristics. HEO et.al [7] proposed a machining time estimation model based on the factors such as NC tool path blocks, feed rate, and acceleration and deceleration constants. SILLER et.al [8] presented a mechanistic approach in high speed milling of sculptured surfaces. COELHO et.al [9] proposed a practical approach for time estimation of milling free form geometries. JAHAN et al. [10] developed a multi valued fuzzy set to estimate time in a flat plate processing. ZHU et.al [11] proposed an ANN model for developing machining time through a hybrid method.

Subsequently, it can be expressed that the strategies proposed by different authors considers the accompanying three components for machining time estimation: Material removal rates, NC program, and Machine attributes. The current strategies proposed above can't accomplish the timeliness, precision and proficiency of time estimation.

3. Proposed Time Estimation method:

The proposed feature based time estimation method considers the following factors:

Fig-1 Factors affecting machining time

The most critical and introductory point for NC machine time estimation is the speed of the machine. This underlying component additionally relies on upon various elements. Among these variables control speed set in the NC program is the principal component.

Cutting conditions, procedures of interpolation, machine conditions influence the NC machine time estimation. Process planning of the tool path is subject to the machining highlights. Diverse machining highlights has distinctive tool path. The figure demonstrates the relation between features and machining time.

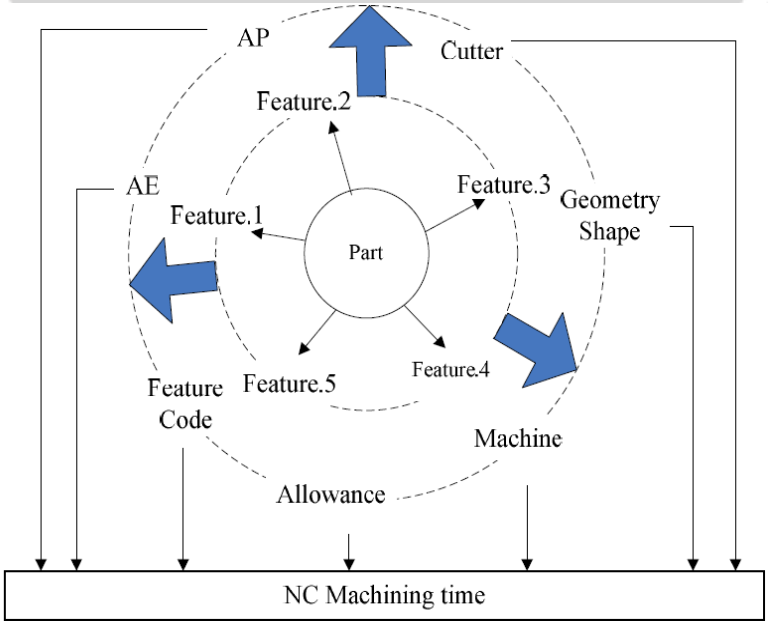

Fig- 2 Relationship between machining time and features

Coordinating all the above components for machining time estimation is an extremely dreary and intense errand. Be that as it may, a late research on STEP based NC program has been done which incorporates machine attributes and geometry data.

The path movement of the tool for the entire machining feature includes rapid locating, approaching and retreating, and cutting. Hence the machining time can be expressed as:

$T_{mf} = t_r + t_{ar} + t_m$

Where t_r shows rapid locating time, t_{ar} shows approach and retreating time and t_m shows the machining time for the feature.

a) **Geometry process information**

A knowledge based library contains the geometry process information which comprises of machine characteristics, machining steps and manufacturing features as shown in the figure.

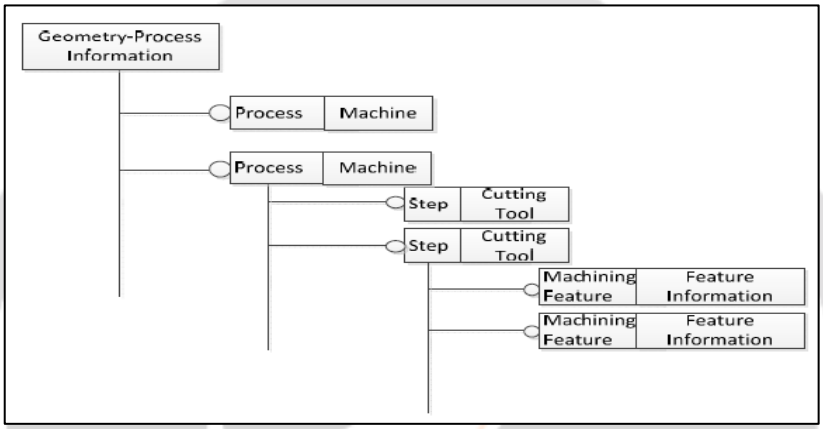

Fig- 4 Geometry Process Information

b) **NC Program**

The proposed technique recommends another method for setting up the information identified with NC programs as features. In this technique the features are utilized as a unit. Relating to every feature and feature code there is NC code.

c) Machine characteristics

In the proposed strategy the machine attributes are additionally put away in the learning based library including three constituents: machine library, CNC framework library and rate control mode library.

The relationship among these data base library (knowledge based library) is as shown in the figure:

Fig- 5 Knowledge Based Library

d) **Machining time calculation**

The roughing and drilling operations being low speed operations their evaluated machining time is very near the genuine time. The finishing operations are fast operations and consequently the impact of machine qualities is entirely high for time estimation and along these lines it ought to be considered.

As discussed about over the machining time of a specific feature is made out of fast locating, approaching and withdrawing time and cutting. Fast locating is anything but difficult to compute. Approaching and withdrawing time is entirely mind boggling. Subsequently the machining time can be figured utilizing the proposed technique.

3. Results and Discussion:

The proposed system has been developed on the visual basic environment. Some of feature affecting the machining time has been included on the front end of the VB environment as the structure shown in the figure shown below. The proposed CAM-ESTIMATOR has a data library consisting of standard speed and feed ranges for the materials, diameter of the cutter and type of cut, which acts as the back end of the system. As the system is feature based, two features have been included in the proposed system.

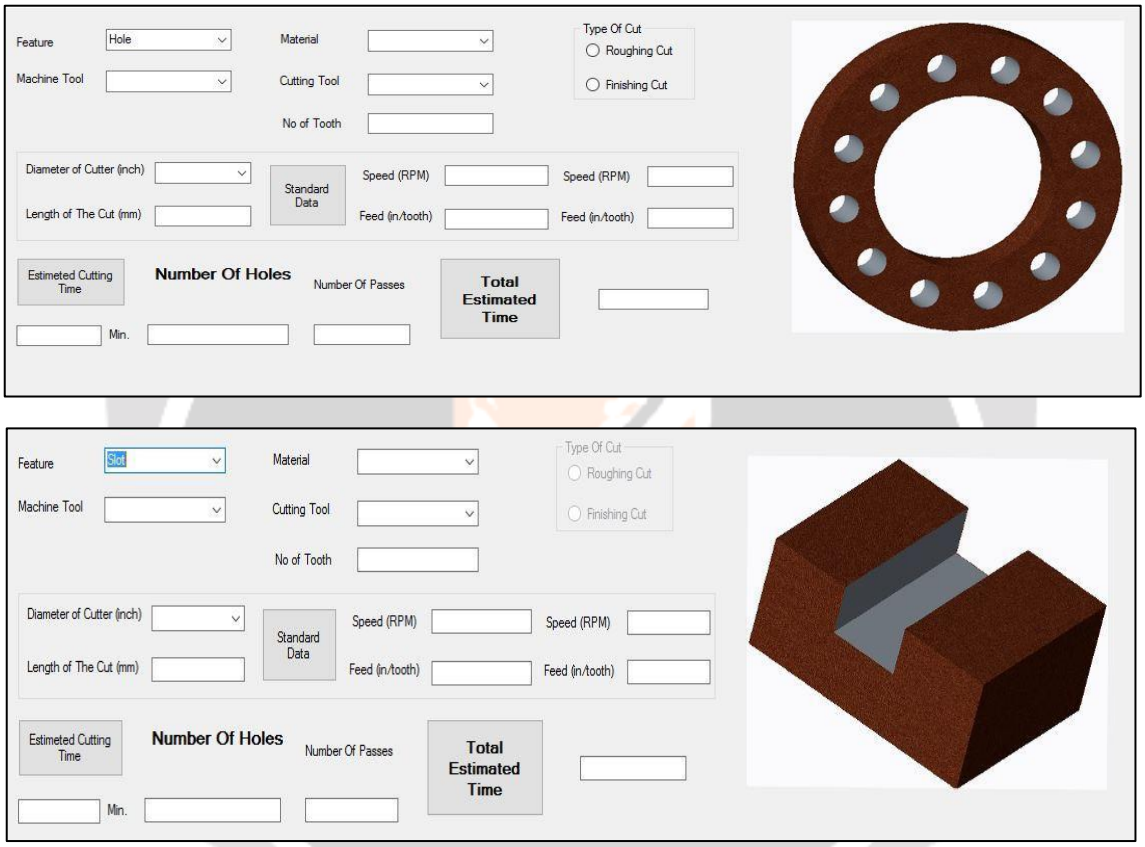

Fig- 6 Structure of the Proposed System in VB

The proposed Prototype system has been developed only considering two features: Hole and Slot. The Cam Estimator developed calculates only the time estimates for the above stated two features.

a) Case Study:

For developing a tailor-made software we required a programming language such as C, C++, Java, Visual Basis etc. Problem regarding the interfacing with other database with the use of above said language so, we will be switch over to another Programming Language Visual Basic (VB) [17]. The testing of the developed Cam Estimator implementing the proposed technique is done by selecting a product: holes machined on the inside periphery of the impeller blades. The adjacent figure shows the image of the product selected for testing.

Fig- 7 Test Product

The actual machining of the holes on three raw materials was performed using different sets of cutting speed and feed and different diameter of cutter and the cycle time of the machining process is recorded from the controller of the machine VMC 1050 (JYOTI made).

The specifications of the impeller is as follows:

- **Material**: Aluminium
- **Diameter of hole**: 17 mm
- **Depth of hole**: 20 mm
- **No. of holes**: 8

The adjacent figure shows the CNC machine setup for the experimental work.

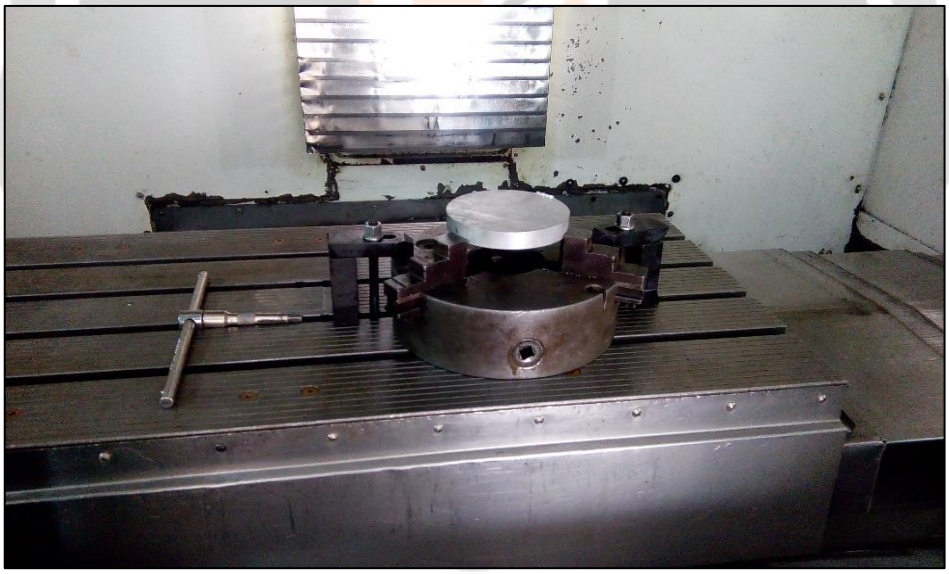

Fig- 8 Setup for machining holes on VMC

The following assumptions have been made before the experimental work:

1. The machine and work piece setup time is not considered in the machining cycle time.
2. During machining the value of depth of cut is taken constant as 0.3 mm
3. The coolant used for the machining process is Synthetic oil.
4. For comparison of results of NX CAM and the proposed CAM ESTIMATOR, same factors are considered in both the systems.
5. The material used for the cutting tool is High Speed Steel.

The table showing the results of actual, NX CAM and proposed CAM Estimator for all three
Work piece employing different cutting parameters for roughing and finishing cut have been shown as follows:

A. Work piece – 1:

Type of cut	Diameter of cutter	Speed (RPM)	Feed (mm/min)	Actual Time (min)	NX CAM Time (min)	CAM Estimator Time (min)	Error between Actual and NX time (%)	Error between Actual and CAM Estimator time (%)	Error between NX and CAM Estimator time (%)
Rough	9/16″	750	60	3.55	3.45	3.38	4.25	7.23	3.11
Finish	1/2″	3000	100	2.17	2.10	2.05	5.11	8.76	3.85

B. Work piece – 2:

Type of cut	Diameter of cutter	Speed (RPM)	Feed (mm/min)	Actual Time (min)	NX CAM Time (min)	CAM Estimator Time (min)	Error between Actual and NX time (%)	Error between Actual and CAM Estimator time (%)	Error between NX and CAM Estimator time (%)
Rough	5/8″	700	65	3.42	3.30	3.22	5.4	9.00	3.81
Finish	1/2″	3000	100	2.17	2.10	2.05	5.11	8.76	3.85

C. Work piece – 3:

Type of cut	Diameter of cutter	Speed (RPM)	Feed (mm/min)	Actual Time (min)	NX CAM Time (min)	CAM Estimator Time (min)	Error between Actual and NX time (%)	Error between Actual and CAM Estimator time (%)	Error between NX and CAM Estimator time (%)
Rough	1/2″	850	75	3.07	2.59	2.50	4.27	9.09	4.02
Finish	1/2″	3000	100	2.17	2.10	2.05	5.11	8.76	3.85

The following graphs can be generated from the above stated result table:

I. Cutter diameter v/s Total time

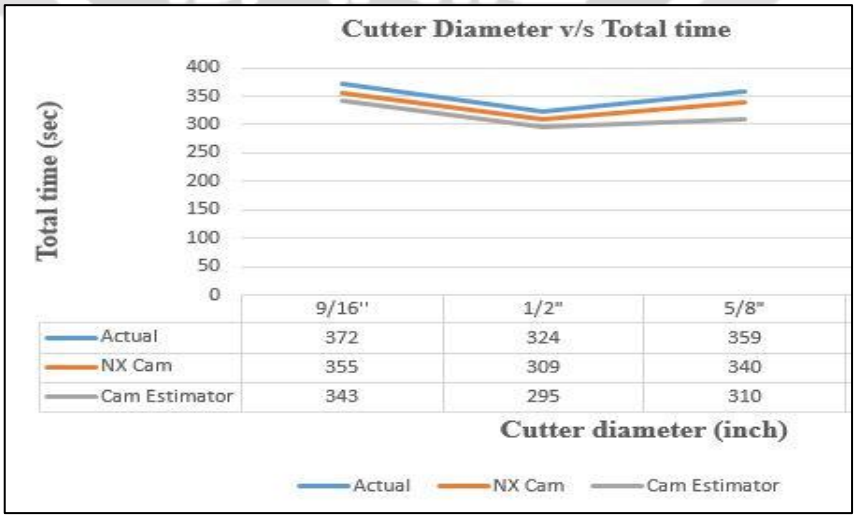

Fig- 9 Cutter Diameter V/S Total Time

II. Speed v/s Total time

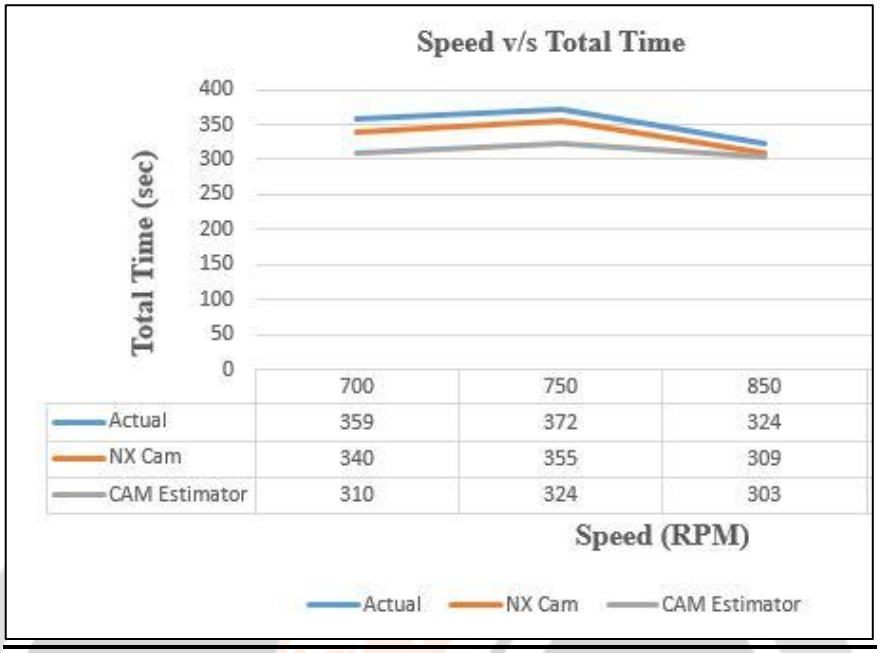

Fig- 10 Speed V/S Total Time

III. Feed v/s Total Time

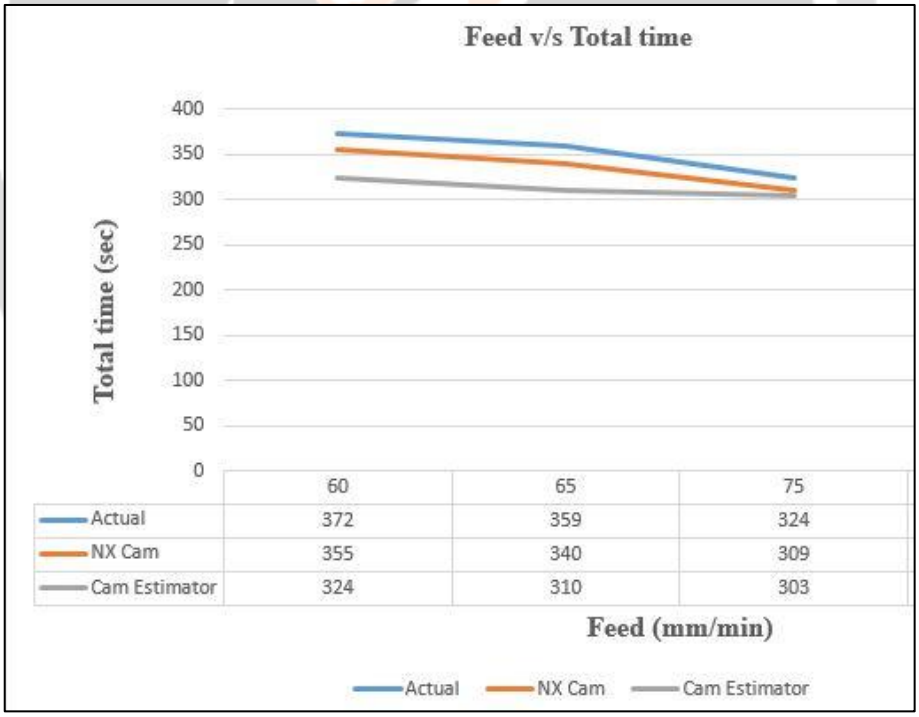

Fig- 11 Feed V/S Total Time

It is evident from the graph that the time estimate results of NX CAM and CAM Estimator are very much nearer to the actual experimental results.

4. Conclusion:

A prototype system for calculating machining time has been developed based on feature based techniques. The proposed system is very much helpful to the Job Work Industry which has been in the developing stages lately. The workers in such industries quote the prices to the customers based on the time required to machine particular feature. Hence such industries can use such Cam Estimator to estimate time and hence quote prices for the work to the customers. This will also ensure customer satisfaction. The results indicate that the proposed method is also feasible and applicable in industry. Many new features can be included in the developed prototype system and other factors affecting time estimation such as tool path influence can also be included in the software.

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