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Ideal Selection of Circular Interpolation for CNC Turning Centers

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ABSTRACT

A circular interpolation algorithm used to determine the parameters of separate circular paths was used to generate round shapes on a computer-controlled numeric (CNC) turning machine. It is suggested that this calculation should be included in the CNC lathes ' resident software program. This would decrease the amount of blocks of data required for part of the program. In a single block, a complete circular interpolation cycle for the number of passes could be specified. The suggested algorithm is optimized for minimal machining time and enhanced surface roughness. The programming of the new interpolation scheme, using circular and linear segments, must be applied to the specific part.

Key words: Circular Interpolation, CNC, Turning Machine, Surface Roughness.

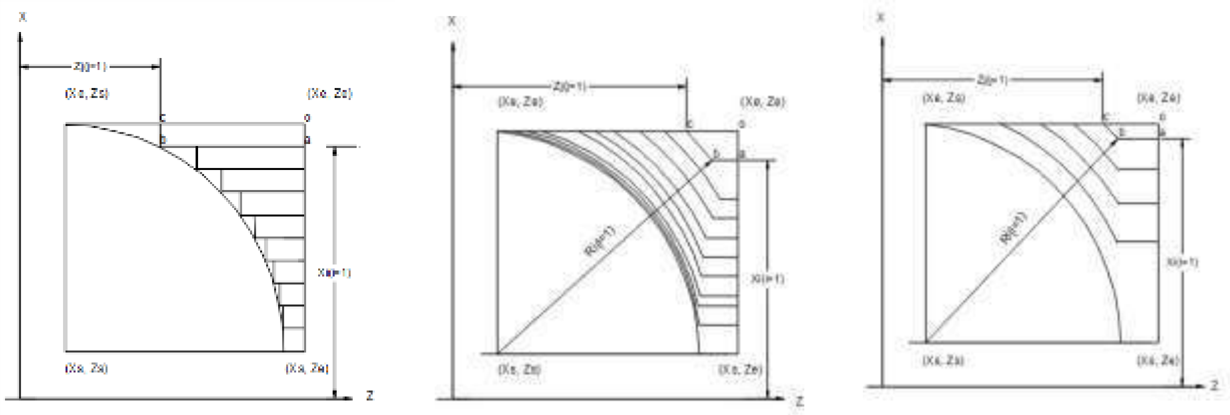
1. INTRODUCTION

PC has superseded machine tools that are once installed and powered by hand driven models. The product for programming these machines has enabled specialists to create high-quality components. [1] Reference has been made to the fact that contemporary machine tool ideas, sophisticated machining procedures and techniques are essential to achieving general quality and productivity objectives in order to satisfy future market demands. [2] It is referred to the reality that CNC tool path capabilities are prevalent in CAD/CAM systems, but STEP-CNC and Super Model Standards are the basis of technology for programming and monitoring CNC. This standard will permit software providers to revolutionize computer programming. The error compensation software system structure that can offset software errors by recreating CNC programs has been investigated [3]. Error compensation has proven to be a cost-effective method for improving machine tools precision.

The use of both spiral archimetrium segments and circulatory segments must be applied to accurate part programming on tri-axis lathes [4]. Where the polar coordinate system is more effective than the Cartesian coordination for rotating axes [5]. For the rotated component with steady forms, an optimization model has been formulated [6]. To study the work carried out on CNC machine devices to minimize surveillance and contour errors [7]. Experiments performed in the automatic five-axis CNC machine for contouring error detection [8]. The recommended vision and cross grid encoder are used to evaluate three kinds of paths contouring errors at distinct feed rates.[9] included an assessment of machined pockets surface roughness after machining and an enhanced pocket surface finish with real spiral tool path was achieved compared to the other tool paths under examination.

This suggests that CNC code-driven energy demand software which includes feed axis, vices and work pieces, the energy demand of the feeding unit for cutting is used to properly estimate the entire working time of the processing process by means of energy-efficient machining. [10] Reporting of the establishment, directly from its representation, of an efficient tool path schedule method, designed and used for 3axis CNC machining, for machining free-form surfaces without temporary surface fitting. The finished cylindrical bar sections are generated by CNC machines. The completed profiles consist of straight, facial and circular workmanship [11]. The programming of circular profiles requires a number of circular passes.

An algorithm was introduced to improve the precision of interpolation in turning activities [12]. The parts considered shall be formed by the rotation of the free-form profile, which shall be carried out in terms of the formulation around the center linear axis. Each pass is linked to a fast cross, an approach, an indirect presentation, and lastly a fast exploration. Each of these is shown by a unique piece of data in the program portion. The program is given these features by free selection. Planning for such an amount of data squares is particularly annoying. These progressions can be submitted through the software as a process. The software includes post-processors with altered CNC lathe. The most important prerequisites for effective concurrent engineering are integrated design and production procedures [13]. This means that complex goods such as formed rolls, rotating blades, prostheses, etc. are much better quality.



Model I Model II Model III

Figure 1. Different models of machining methods used for circular interpolation

2. EXPERIMENTAL WORK

In order to make any statistical inference concerning the distinct patterns, a sample size of "n" is required from each technique. To study the qualitative reaction resulting from the three patterns of circular machining, an assessment of variance can be of excellent assistance. Testing the surface roughness factor resulting from three distinct round machining patterns is a single three-level variance analysis. Five runs per machining model were used as a sample size. Aluminum compound material was used for the samples where Table 1 used two groups with three sets for each. Machining assignments have been finished with the Emco Concept Turn 155, PC-controlled CNC-Lath. A 35 mm round, powerful bar was used to machine round radius R= 17 mm, as shown in Figure 2. A program [14] was drawn up for each suggested machining sample using the Xi and Zi characteristics to meet this need.

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Figure 2. A round sample performed on the CNC machine

The technique and the suggested cutting conditions for each proposed machining sample are shown in Table 1 for the two groups.

Table 1. Machining conditions for various machining patterns

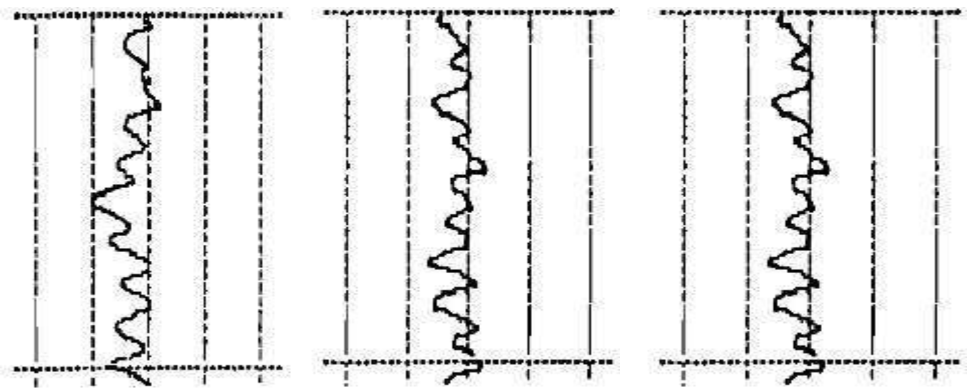
	Group I			Group II		
Machining Method	A	B	C	D	E	F
Machining Model	I	II	III	I	II	III
Feed (mm/min)	100	100	100	100	200	100
Cutting Speed (rpm)	900	900	900	1800	900	900
Max. Depth of Cut (mm)	1.35	1.35	1.35	1.35	1.35	2.8
Machining Time (sec.)	82	148	102	82	82	82

The machining time determined and shown in Table 1. Each of the samples was machined under the predefined machining and machining circumstances. The surface roughness was taken using the square root of the arithmetic mean of the squares of the set of values (RMS). The RMS of the machined surface was estimated using the Mitutoyo Surftest 301[15]. Four measurements were done in regions halfway along the circular surface and 90 degrees were divided. Test printouts for the three specific group-1 methodologies are shown in Figure 3. The least significant difference (LSD) technique [16] was used to compare these measurements for important contrasts in their impacts. LSD is determined using the mean square error (0.0052) in Table 3. Such test for the LSD was determined to have a value of 0.1.

Therefore, any set of techniques for any machining instance has a flat comparison in techniques of more than 0.1 value, which would suggest that the comparison of pairs of mean populations is fundamentally unique. The difference in techniques for different sets is as follows:

$X_A - X_B = 0.206$; $X_A - X_C = 0.004$; $X_B - X_C = 0.204$

FILTER		**2CR**	**FILTER**		**2CR**	**FILTER**		**2CR**
CUTOFF	0.8 µm	x3	CUTOFF	0.8 µm	x3	CUTOFF	0.8 µm	x3
Ra	1.51	µm	Ra	1.27	µm	Ra	1.31	µm
Rq	1.83	µm	Rq	1.53	µm	Rq	1.56	µm
Ry	7.5	µm	Ry	6.8	µm	Ry	6.8	µm
VER	5	µm	VER	5	µm	VER	5	µm
HOR	0.8	µm	HOR	0.8	µm	HOR	0.8	µm



Method A Method B Method C

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Figure 3. Samples printouts of the surface roughness for the three methods 'A', 'B', and 'C'

Unmistakably, the main pair of implies that does not vary essentially is for machining design "A", and "C". At the interim, machining with example "B" demonstrates bigger critical contrasts with either design “A” or "C". These demonstrates that both of machining design "A", and "C" are factually proportional, and these watched varieties in the nature of the machined surfaces by these patterns are because of ordinary test errors as opposed with the impact of the utilized machining strategy itself. In addition, it is inferred that technique "B" gives a superior surface roughness contrasted with the other two machining technique "A", and "C".

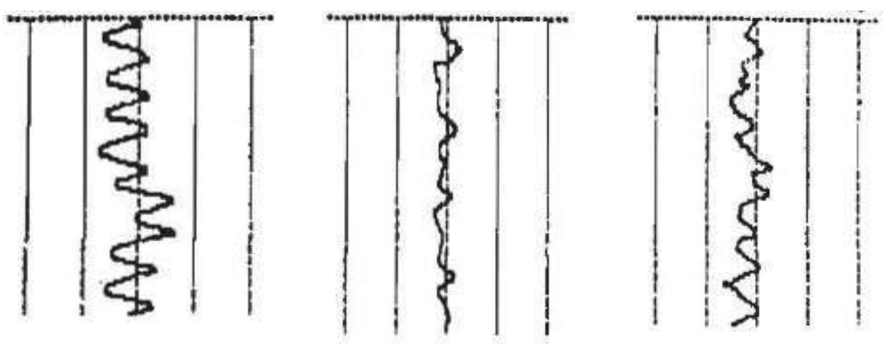
Unmistakably, the primary pair of means that does not differ is mainly "A" and "C" for machining. In the interim, "B" machining shows greater critical contrasts with either "A" or "C" design. These show that both the machining design "A" and "C" are factually proportional, and these observed varieties, in the nature of the machined surfaces, are due to ordinary test errors, as opposed to the impact of the machining strategy itself. In fact, it is inferred that the "B" method provides a superior surface roughness compared to the other two "A" and "C" machining techniques.

In order to increase the additional requirements for the upgrade of these three suggested machining models, machining time may be used. Examination of the machining time determined by the machining time circumstances for each machining model. It is very clear from Table 1 that the machining cycle using the "B" method is very much greater by almost 76% and 45 percent over the "A" and "C" patterns, respectively.

The above findings indicate that the predominant quality for surface roughness is achieved by the round machining of technique "B" which has a progressively drawn machining time. The author has tried to cope with this problem of either how to use "B" design with a shorter machining time that is ideal with the machining time of "A" or "C." Dealing with this problem can give rise to the common quality of the machined surface in a shorter moment, which is the ideal reaction for any technique of machining when using CNC machines.

Another set of studies was suggested to enhance the machining method by using the round interpolation calculation of pattern "B" and the fresh features for cutting circumstances as shown in Group 2 of Table 1. These fresh features for cutting speeds, feeds and cutting depth guarantee a basic machining time of 82 seconds. A summary of the verifiable outcomes for the preliminary information obtained to consider the impact of the modified cutting circumstances is shown in Table 2. Test printouts for the fresh balanced group 2 method are shown in Figure 4.

FILTER		2CR	FILTER		2CR	FILTER		2CR
CUTOFF	0.8 µm	x3	CUTOFF	0.8 µm	x3	CUTOFF	0.8 µm	x3
Ra	1.39	µm	Ra	3.44	µm	Ra	1.35	µm
Rq	1.67	µm	Rq	4.25	µm	Rq	1.66	µm
Ry	6.9	µm	Ry	20.0	µm	Ry	8.8	µm
VER	5	µm	VER	20	µm	VER	5	µm
HOR	0.8	µm	HOR	0.8	µm	HOR	0.8	µm



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Method D Method E Method F

Figure 4. Sample printouts of the surface roughness for the three methods "D", "E", and "F"

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3. RESULTS AND DISCUSSION

The following Table 2 shows measurable test outcomes A, B, and C of group I of table 1 for surface roughness, showing that the circular interpolation algorithm can obviously improve the movement accuracy of a heavy-duty CNC floor-type instrument by reconstructing CNC programs. In this system, the circular algorithm for interpolation, reconstruction of the CNC program, simulation of the tool path, etc. can be carried out.

Table 2. Statistical results of surface roughness (RMS) for Group I

Method	A	B	C
Average (microns)	1.81	1.61	1.81
Variance (microns)2	0.00088	0.007	0.008

Comparing the average for each method, the "B" technique obviously provides the surface roughness of the machine a superior value than the other two techniques. Meanwhile, it appears that the "A" technique causes fewer disparities in output compared to the "B" and "C" methods. Before a powerful choice for machining design can be made by "B"" method over "A" and "C"' techniques, the assessment is advised. Table 3 shows the delayed implications of the assessment applied to the information collected from each machining technique. The findings of this inquiry show that the mean square between the techniques is numerous times greater than the mean square within the policy. This almost definitely shows that the means of the multiple methods have not been raised.

Table 3. Investigation of the surface roughness from three machining techniques

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square
Between Method	0.141	2	0.0705
Within Method	0.063	12	0.0052

From the view of Table 4, the mean of the three methods is unique and has a critical impact in the delivery of different surface roughness features due to the use of distinctive circular insertion machining models for the CNC-machine. This is a factual assumption regarding the mean and difference of "A," "B" and "C" machining patterns. In comparison to each other, sets of machining models such as "A-B," "A-C" and "B-C" are used. Return to Table 2, Measurements for the comparison of mean and variance for Group II methods "D," "E" and "F" and Group 1 methods "B" may suppose that sample "B" forces the largest value for machined surface roughness with the shortest machining time compared to separate samples from separate techniques.

Table 4. Group II results for surface roughness

Method	D	E	F
Average (microns)	1.83	3.7	1.67
Variance (microns)2	0.03	0.158	0.0005

4. CONCLUSIONS

The technology is used by a CNC turner and is based on various models of circular passes. The algorithm described uses a CNC interpolator in real time, in order to provide the highest precision possible for the rotating machine. The entire working process can be programmed as a sidelong cycle cutting depth that increases the generation capacity of the current fixed cycles G02/G03 CNC rotation. Three lineal algorithms of interpolation, liner passes, direct and circular passes and lingering of different cutting depths were proposed and applied in the machination of hemispheric geometry by CNC machines.

Pattern "II" was discovered to give a superior surface roughness to the machined surface. This conclusion relied on the measurable derivation of the analysis examination and the right selection of the LSD method was made. In addition, upgrade the machining operation as stated by the moment of machining. Pattern II was redesigned with the aim of streamlining its machining time, yielding cutting speed, feed rate and cutting depth. It was inferred that pattern-II with increased depth of cutting forces was of the highest quality for machined surface roughness with base machining time. The calculation of this model is specified as necessary as an optimal round addition calculation that is appropriate for CNC turning points.

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