

A Research on Construction and Design of Milling Attachment for Computer Numerical Control (CNC) Turing Center

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Abstract

Using conceptual design, a milling attachment was designed and placed in an existing Computer Numerical Control (CNC) turning centre. The CNC machine is controlled by mechatronics and has a computer interface. With the newly developed milling attachment, the CNC machine becomes multipurpose and can be used for both milling and drilling operations. It's a small, portable machine that can do a variety of milling operations that would ordinarily necessitate pricey single-purpose machines. This self-powered, vertical-feed, variable-speed precision tool can be mounted anywhere on other machine tools' carriages, tables, rams, turrets, or tool arms. The vibration analysis and surface roughness testing were completed, with satisfactory findings.

Keywords: CNC machine, milling attachment, microprocessor.

INTRODUCTION

CNC milling machines are milling machines that use numerical data rather than a physical template to control the cutter path. They're especially well-suited to operations like profile milling, pocket milling, surface contouring, and die sinking, which need simultaneous control of two or three axes of the worktable to

create the desired cutter path. In most cases, an operator is responsible for changing cutters as well as loading and unloading work pieces. When part tolerances are tight and floor space is limited, mill turn lathes are invaluable. Mill turn lathes maintain accuracy and surface finish since the technique allows for seamless integration of operations, so

there will be no loss of accuracy or time wasted with different setups. Product requirements, functionalities, probable behaviours, form/structure, and associated features are all part of a new product's concept.

Material, assembly level tolerance, critical surface roughness and hardness characteristics, and critical dimension are among the properties. The prototype design and development process is accelerated by using the conceptual design and development methodology.

It is aided by creativity, which results in the production of fresh, valuable, and innovative ideas. Multiaxis Machining with Additional-Axis NC System [1] has been the subject of some research. Four and five axis machining is a cutting-edge technique for dealing with complex curved items, but its use is limited because to the large initial investment.

The additional-axis approach, which involves connecting a rotary/tilt table to an existing three-axis machine, is a potent option for multiaxis machining.

Previous research has revealed that development of a CNC machine's lathe attachment. Using conceptual design, a

lathe attachment for an existing CNC machine (fitted with rapid prototyping attachment) was created. The five-axis NC machine's fundamental feature in Interference-Free Tool- Path Planning for Flank Milling of Twisted Ruled Surfaces is flank milling. When compared to bottom-edge based machining, flank milling, which primarily uses the side cutting edge, can considerably improve machinability. In terms of tool-path planning, the traditional method of aligning the cutter axis with the generator curves' ruling lines causes interference issues such as overcutting and undercutting.

Production of Form Surfaces by CNC Milling Machine Tool raises productivity and machining precision demands. As a result, CAM production systems must be implemented. A novel type of CNC machine tool interpolator is capable of creating the cutter path for freeform surface ball-end milling. On-line methods for cutter-contact (CC) path scheduling, CC path interpolation, and tool offsetting are included in the surface interpolator.

In virtual machining systems for dimensional and geometrical mistakes of three-axis CNC milling machines, virtual machining systems use computers and

various forms of software in manufacturing and production to replicate and recreate real-world defects in virtual reality systems.

METHODOLOGY

The milling attachment was designed and built for a CNC turning centre, and the processes necessary in completing the planned task are outlined below.

A. Problem Identification

Existing CNC turning centres can only do turning; if the component requires both turning and milling, it must be moved to another machine. Because this process is time demanding, the milling attachment must be integrated into the CNC lathe in order to do both turning and milling operations on the same machine.

B. Study of the Existing CNC Machine

Only turning operations were performed on the existing CNC machine (Figure 1).

FANUC Oi-Mate-TD is the control system. It has a 280mm capacity between centre lengths, a 140mm maximum machining diameter, a 200mm maximum turning length, and an 80mm maximum turning diameter. Full power spindle speeds are 1000-3000 rpm, whereas normal spindle speeds are 4000 rpm. The maximum capacity of the bar is 25 mm. The normal chuck size for holding work is 135 mm. The milling attachment was replaced instead of one of numerous turning tools at each of the eight stations. The bore diameter is 32mm at its widest point.

C. Milling Attachment

The attachment consists of the following component

Bracket

The bracket for holding the motor to the tool station was developed with the axis in mind.



Fig 1 CNC machine

Micro Controlled Motor Assembly

The selected motor is a single phase induction motor with a maximum output of 40W and has specifications of 1440 rpm. The motor consumes 0.5A of current and operates at a voltage of 200V. The motor's frequency ranged between 50 and 60 Hz. The attachment's functions are controlled by an AT mega 328 microcontroller, as indicated in Figure 2. The microcontroller is used to switch the motor on and off as well as change the direction.

Adapter

Arbors and milling cutters are adapted to the conventional tapers used for milling machine spindles using spindle adapters. If the diameters and tapers are standard, any tapered or straight shank cutter or arbour can be mounted to any milling machine with the correct spindle adapters.

Collar / Reduction Bush

A collar/reduction bush is a cylindrical structure on a shaft-mounted part that prevents axial (sliding) movement.

Drill Chuck

Drill chucks are found on a wide range of tools, from professional equipment to low-cost hand and power drills for home usage. The milling attachment's above-mentioned components were prepared, and the assembling of these components yielded a proposed milling attachment.

D. Milling Operation using Milling Attachment

The milling procedure was carried out on a variety of samples made of mild steel, aluminium, copper, and brass. Different operations such as horizontal keyways, tapered slots, and splined profile were done in the milling attachment.

Surface roughness testing was performed on the machined samples for further validation, and vibration analysis was performed during the milling operation on the CNC turning centre.



Fig 2 Electronic circuit board

A. Machine Performance Test

The machine's performance is usually determined by the machine's vibration levels at various areas. The vibration levels were measured using a device called a Shock Pulse Meter (SPM). The vibration levels at various sites were recorded and analysed further. If the results were disappointing, more research with a more advanced equipment is required. The method of checking vibration levels is depicted in Figure 3.

FABRICATION OF MILLING ATTACHMENT

The following are the fabrication stages that were used in the project; the present CNC machine could only execute turning operations. The attachment of a milling apparatus, on the other hand, will lead to milling operations being performed as well.

RESULTS AND DISCUSSIONS

A. Vibration Analysis

The vibration analysis carried out during milling operations utilising the designed attachment on a CNC turning centre is shown in the sections below.

Vibration Level at No Load Condition

The readings are taken in all three directions, horizontal, axial, and vertical, with no load, and the findings are summarised in table 1.

The machine centre axis from the existing CNC machine was used to create the bracket. Bracket was originally conceived as a rectangular flat plate. The flat plate was eventually machined to the desired dimensions by removing the uneven shape.



Figure 3. Vibration level recording using SPM

Table 3.1 Vibration level at no load condition

Vibration level (mm/sec)		
Horizontal	Vertical	Axial
0.2	0.3	0.3
0.2	0.3	0.3
0.2	0.3	0.3
0.2	0.3	0.3
0.2	0.3	0.3
0.2	0.3	0.3

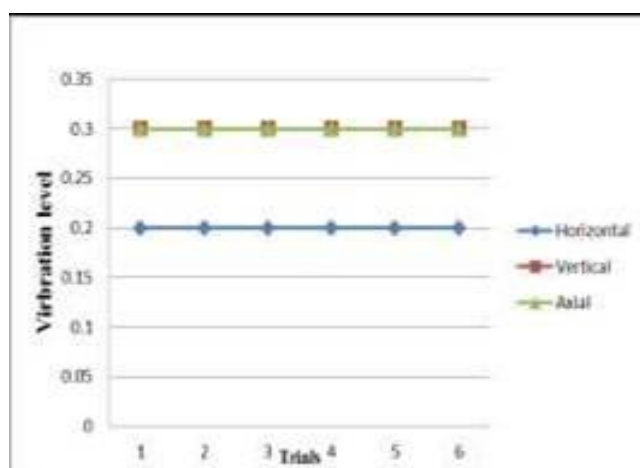


Fig.4: Vibration level at no load condition

Vibration Level in Horizontal Direction

Table 2 Vibration level in horizontal direction for different materials

Vibration level (mm/sec)			
Aluminium	Mild Steel	Brass	Copper
0.8	0.5	0.4	1.5
1	1.1	0.3	1.1
0.4	1	0.3	1
0.4	0.9	0.4	0.9
0.4	0.7	0.6	1
0.4	0.3	0.3	0.9

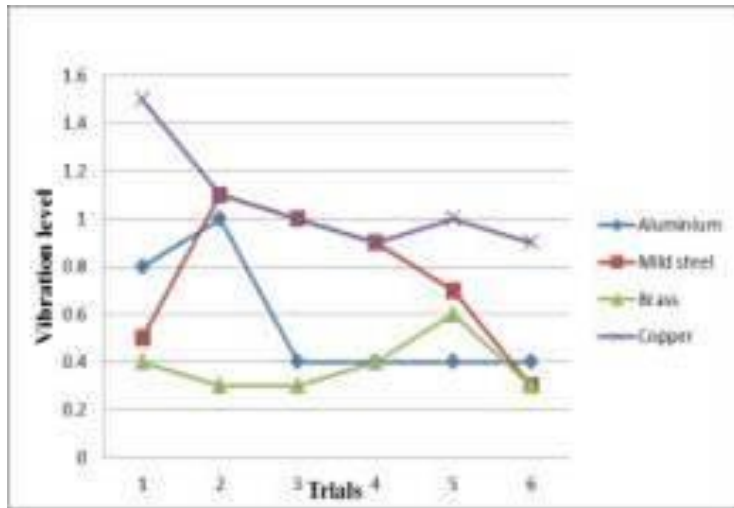


Fig.5: Vibration level in horizontal direction

Vibration Level in Vertical Direction

Table3 shows the vibration level recorded in vertical direction for different material.

Sl.no	Vibration level (mm/sec)			
	Aluminium	Mild Steel	Brass	Copper
1	0.5	0.9	0.7	1.5
2	0.5	3.3	1.6	2.2
3	1.3	2.8	1.2	1.9
4	1.2	2.7	1.3	2
5	1.3	2.9	1.3	2.1
6	1.2	2.9	1.2	1.8

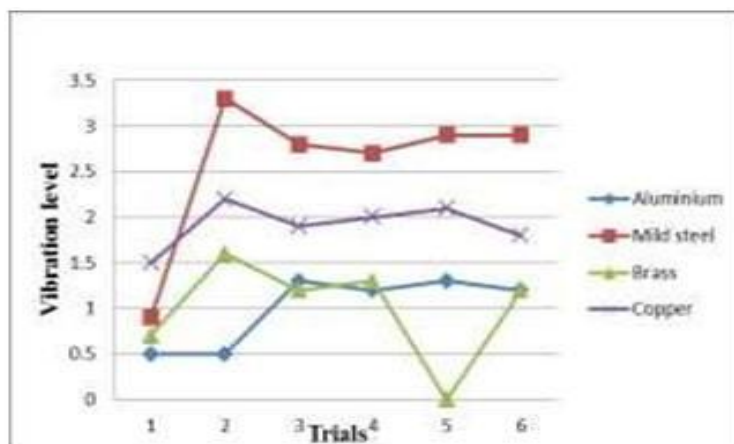


Fig.5: Vibration level in vertical direction

Vibration Level in Axial Direction

Table 4 shows the vibration level recorded in axial direction for different material.

Sl.no	Vibration level (mm/sec)			
	Aluminium	Mild Steel	Brass	Copper
1	0.4	1.1	0.4	1
2	0.4	1	0.5	1.6
3	0.5	0.8	0.5	0.8
4	0.5	0.9	0.5	0.7
5	0.5	0.8	0.5	0.7
6	0.5	0.9	0.6	0.7

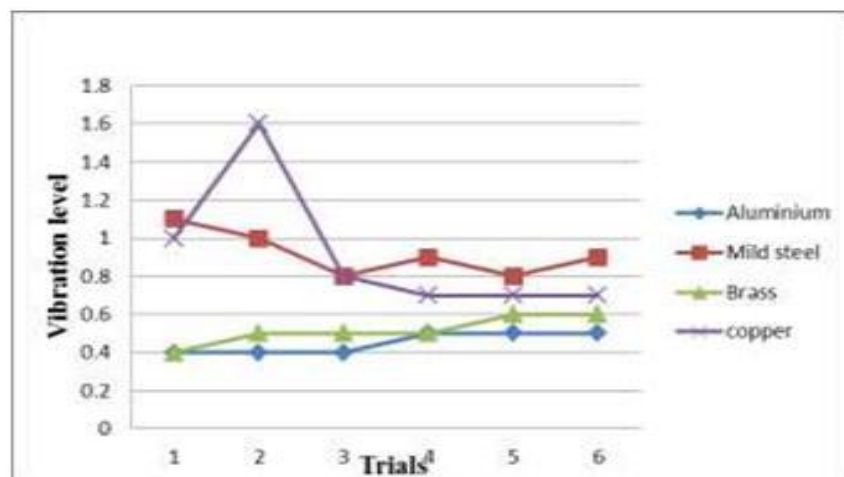


Fig.6: Vibration level in Axial direction

Tables 1–4 show that, as compared to mild steel and copper, aluminium and brass have lower vibration levels in the horizontal, vertical, and axial directions. Copper and mild steel, on the other hand, have vibrations that are well inside the limit. As a result, aluminium and brass are the best materials for this configuration.

A. Surface Roughness

The surface roughness of aluminium, mild steel, brass, and copper was compared using a conventional milling machine and a milling attachment. Perfect Alloy Components in Shivamogga conducted the surface roughness test. Table 5 lists the conditions under which surface roughness measurements were taken.

Table 5: Measuring conditions carried out for surface roughness

Standard	ISO 97
Measuring length	6.000
Unit	Mm
Cut-off	Gaussian
Cut-off wavelength	0.8
Measuring range	80µm

Roughness Measurement of the Slot

Average Roughness (Ra) Arithmetic Average (AA), Center Line Average (CLA), and Arithmetical Mean Deviation of the profile are other terms for the same thing. The integral of the absolute value of the roughness profile height over the evaluation length, or the area between the roughness profile and its mean line, is the average roughness.

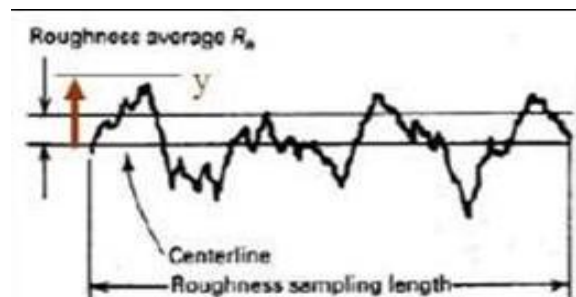


Figure 7. Roughness profile along the length of the tool

Table 5 shows the roughness of the slot generated by a typical milling machine on various materials.

Table 5 Roughness values of the slot by conventional milling machine

Material	Ra (in µm)
Mild Steel	3.687
Aluminium	0.418
Brass	0.184
Copper	0.466



Fig 8 Graph shows slot roughness for conventional milling machine

Roughness of the Slot Produced By CNC with Milling Attachment

Table 6 shows the slot roughness of the materials conducted on CNC with milling attachment.

Table 6 Slot roughness for CNC with milling attachment

Material	Ra (in μm)
Mild Steel	1.641
Aluminium	0.764
Brass	0.859
Copper	0.869

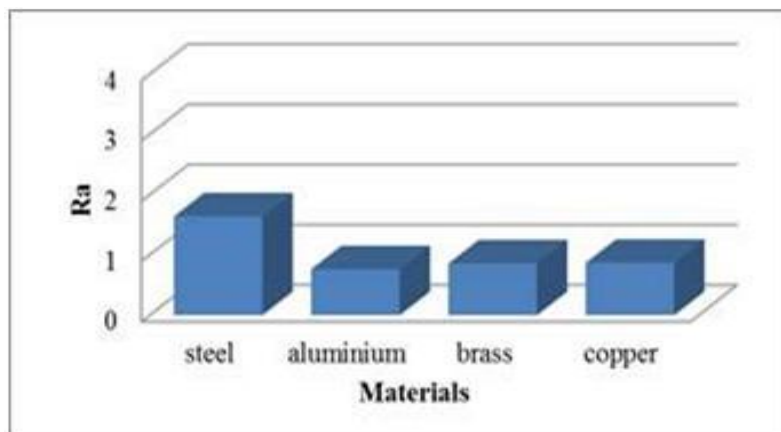


Fig 9 Graph shows slot roughness for CNC with milling attachment

As shown in Figure 6, the slot roughness of the specimen machined using CNC with milling attachment was less than that of the conventional machining method. The specimens composed of aluminium, brass, and copper, on the other hand, have reduced surface roughness. Surface roughness of steel specimens was higher than that of aluminium, brass, and copper specimens, as shown using a conventional milling machine. The specimens composed of aluminium and brass, on the other hand, have a smoother surface.

CONCLUSIONS

The following conclusions are drawn from the present work which involves the design and development of milling attachment for a CNC turning centre:

- Milling operations can now be carried out in the existing CNC turning centre, which previously could only carry out turning operations.
- The performance of the proposed work was validated by vibration analysis using comparative analysis where in the results yields the vibration levels within the acceptable limit.
- As a result of the findings, the current work is better suited to milling aluminium and brass materials.
- The milling on mild steel and copper materials shows slightly more

vibration levels in the attachment compared to aluminium and brass materials.

- Comparing the surface roughness of specimen machined by the milling attachment on turning centre and that of conventional milling machine, the slot roughness of the materials are in between average achievable roughness and finer

REFERENCES

1. S.-H. Suh, J.-J. Lee and S.-K. Kim —Multiaxis machining with additional-axis NC system: Theory and development || , The International Journal of Advanced Manufacturing Technology 1998, Volume 14, Issue 12, pp 865-875.
2. V. Roy, S. Kumar — Development of Lathe Attachment for a CNC Machine || , Journal of The Institution of Engineers (India): Series C April 2013, Volume 94, Issue 2, pp 187-195.
3. Jae-Kwan Kang and Suk-Hwan Suh —Interference-free tool- path planning for flank milling of twisted ruled surfaces || , The International Journal of Advanced

- Manufacturing Technology 1998,
Volume 14, Issue 11, pp 795-805.
4. Jozef Stahovec, Jan Varga —
Production of Form Surfaces by
CNC Milling Machine
Tool || ,Manuf. and Ind. Eng.,
11(1), 2012, ISSN 1338-6549 ©
Faculty of Manuf. Tech. TUKE
 5. Chih-Ching Lo —CNC machine
tool surface interpolator for ball-
end milling of free-form surfaces || ,
International Journal of Machine
Tools and Manufacture Volume 40,
Issue 3, February 2000, Pages 307
– 326. Mohsen Soori, Behrooz
Arezo, Mohsen Habibi
 6. Dimensional and geometrical
errors of three-axis CNC milling
machines in a virtual machining
system || , Computer-Aided Design
Volume 45, Issue 11, November
2013, Pages 1306 – 1313.