International Journal of Advance Engineering and Research Development (IJAERD)
Volume 1,Issue 6,June 2014, e-ISSN: 2348 - 4470 , print-ISSN:2348-6406

# MODERN TECHNIQUES IN CNC MACHINES -A Review

Hinsu jindal[1], Rakesh kumar[2], Kartik D. Kothari

[1]*M. Tech. Scholar, Mechanical Engineering Department, RK University, Rajkot, Gujarat, India,*
*jindal.hinsu@gmail.com*
[2]*Assistant Professor, Mechanical Engineering Department, RK University, Rajkot, Gujarat, India*
*rakesh.kumar@rku.ac.in*
[3]*Associate Professor, Mechanical Engineering Department, RK University, Rajkot, Gujarat, India*
*kartik.kothari@rku.ac.in*

**Abstract:** In modern manufacturing schema, the complex nature of industrial processes, the requirement for quality products at ever reducing lead times and the strive for attaining higher profitability is enforcing researchers as well as practitioners to attain improved process control of the computer numerically controlled (CNC) manufacturing system. This paper describes modern techniques of Horizontal and vertical CNC machines, manufacturing problems for different processes, axis positioning problems, motion error inspection methods. Solution for above problem is also given to some extent.

## I. INTRODUCTION

In order to make various manufacturing operations automatic and to perform it simultaneously, presently there is a trend of numerically controlled and computerized numerically controlled machines. The traditional approach to construct CNC machine tools has been to use rotary drive motors and ball screws to achieve table motion. A linear motor provides several advantages over this proceed towards inclusive of low inertia, better performance, increased accuracy and reduced difficulties. So, they are preferred firstly. As we know there are various advantages of CNC machines over conventional machines like high accuracy, precision, time saving, increase in productivity etc.

The design of the machine consisted of the following tasks, which were carried out in the given order:
(a) Specifications of a high-speed electro spindle;
(b) Calculation of payload and specifications of the linear motor system and CNC control;
(c) Fabrication of machine chassis;
(d) Interfacing of the electro spindle with the CNC control
(e) Provision of a PC based user interface for the system.

**MAJOR PROBLEMS IN PRESENT CNC MACHINES:**

1) Most of the manufacturing industries face problems in position control of the vertical axis during machining on CNC machines, in the event of an exceptional power failure. The axis slips downwards due to inertia and gravitational force acting on vertical axis of CNC machines. In case of die and mould supplication, where the accuracy of jobs are perceptively very high, the damages caused due to this problem are very expensive when the material being machined is titanium or other costly materials. In order to avoid this problem it is obligatory to stop the axis run away immediately.

2) Decision-making process in manufacturing environment is increasingly difficult due to the rapid changes in design and demand of quality products. To make decision making process (selection of machining parameters) online, effective and efficient artificial intelligent tools like neural networks are being attempted.

 

3) A well known industry application that allows controllable processing times is the manufacturing operations on CNC machines. For apiece turning operation as an example, there is a nonlinear correlation between the manufacturing cost and its required processing time on a CNC turning machine.

4) Motion errors of the rotary axes of five-axis CNC machine tools are presented.

5) Nowadays, despite the needs of low price, capabilities withstand at higher cutting speeds and operate at high acceleration and deceleration with high quality machine, many customers request good-looking machine. Regarding this, our study aims to provide various form designs of machine tool structure with the help of structural modifications made in CNC machine tool bed.

6) Most of the manufacturing industries face problems in position control of the vertical axis during machining on CNC machines, in the event of an unprecedented power failure. The axis slips downwards due to inertia and gravitational force acting on vertical axis of CNC machines. In case of die and mould applications, where the accuracy of jobs are comparatively very high, the damages caused due to this problem are very expensive when the material being machined is titanium or other costly materials.

7) Five-axis CNC machine tools comprise three linear axes and two rotary axes, enabling the fabrication of complex work-pieces such as dies, turbo blades, and cams. Improved measurement methods are continually being researched to increase the accuracy of five-axis CNC machine tools. This paper presents a novel optical calibration system, called non-bar, with no linkage bars. The system comprises a master detector module, a balllens module and a signal module. The proposed measurement system was implemented according to ISO/CD10791-6 to measure A-type, B-type, and C-type five-axis CNC machine tools from three different manufacturers. The results demonstrate that the proposed non-bar measurement scheme provides high accuracy, high reproducibility, and simultaneous multi-axis measurement.

**ADVANCE TECHNIQUES FOR SOLUTION OF SOME GENERALIZED PROBLEMS**

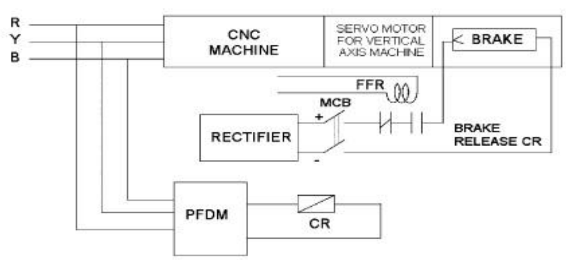


Fig. 2. CNC machine control with PFDM.

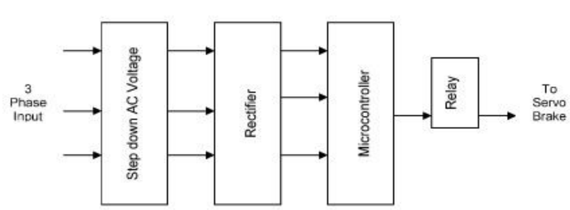


Fig. 3. Block diagram of microcontroller module.

a) A low cost and reliable system was implemented on a CNC machine and the performance analysis was carried out on it. It can also be used in machines and in applications where power failure plays a major role such as computer applications, etc. Microcontroller technique can be used to detect power failure in this case. As the clock frequency at which the microcontroller operates is on the order of MHz, it is possible to monitor the input voltage on the order of µs. Whenever there is power failure the microcontroller output port becomes high thus driving the relay of the brake circuit. The time taken to detect the power failure with the PFDM is nearly 50 µs. The module can be interfaced with the CNC machine and tested with three conditions like idle, feed traverse and rapid traverse conditions as shown in figure 3. In all the three cases the drop in the vertical axis is within the limits as per the industrial requirements. Also, when machine was operating for feed traverse, observed reading was 3-7 µm and for rapid traverse it was 10-15 µm.

b) Turning is one of the important and widely used machining processes in engineering industries. In turning, the cutting conditions such as cutting speed, feed rate, depth of cut, features of tools and work piece materials affects the process efficiency and performance characteristics Performance evaluation of CNC turning is based on the performance characteristics like surface roughness, material removal rate, tool wear, tool life, cutting force and power consumption. Very few research attempts have been done to estimate the significance of energy required for the machining process. Previously some Experiments were based on Taguchi's Design of Experiments (DoE) and conducted with cutting speed, feed rate, depth of cut and nose radius as the process parameters and surface roughness and power consumption as expected objectives.

c) As we know, processing time decisions affect the manufacturing cost as well as the scheduling performance. Decision variables in this case will be $Pi, Xij, Vi, Fi, Ui$.

Where,

*Pi* is processing time of job i

*Xij* is binary variable to state if job i precedes job j.

*Vi* is cutting speed for operation i

*Fi* is feed rate for operation

*Ui* is usage rate of required cutting tool to process operation *i*

d) The main aim of this method is to find a suitable test path for the DBB test of the two rotary axes. The ideal test path should result from simultaneous motions of the two tested rotary axes alone, and the other three linear axes should remain stationary. In this way, only the motion or dynamic errors of the rotary axes appear in the measured results. More importantly, the tested rotary axes should undergo velocity reversal one after another, so that frictional force-induced motion errors at quadrant changes can be stimulated and measured by the ballbar.

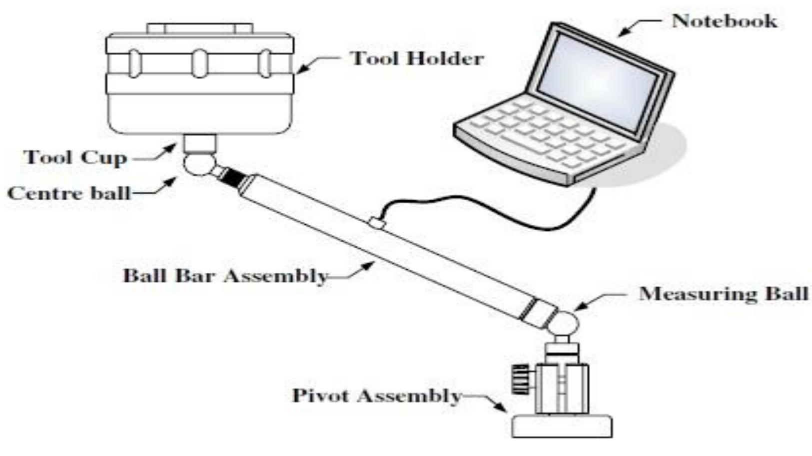


Fig. 2. Structure of Renishaw DBB instrument.

e) In order to avoid this problem it is necessary to stop the axis run away immediately, by applying the electromechanical brake connected to the axis servo motor or ball screw rod in advance.

f) The concept based on genetic algorithms assures evolutionary generation and optimization of NC programs on the basis of CAD models of manufacturing environment. The structure, undergoing simulated evolution, is the population of NC programs. The NC programs control the machine which performs simple elementary motions. During the evolution the machine movement becomes more and more complex and intelligent solutions emerge gradually as a result of the interaction between machine movements and manufacturing environment. The examples of evolutionary programming of CNC lathe and CNC milling machine tool for different complexities of the blanks and products are presented. The proposed concept showed a high degree of universality, efficiency, and reliability and it can be also simply adopted to other CNC machines.

g) A well known industry application that allows controllable processing times is the manufacturing operations on CNC machines. For each turning operation as an example, there is a nonlinear relationship between the manufacturing cost and its required processing time on a CNC turning machine. If we consider total manufacturing cost (F1) and total weighted completion time (F2) objectives simultaneously on a single CNC machine, making appropriate processing time decisions is as critical as making job sequencing decisions. We first give an effective model for the problem of minimizing F1 subject to a given F2 level. We deduce some optimality properties for this problem. Based on these properties, we propose a heuristic algorithm to generate an approximate set of efficient solutions. Our computational results indicate that the proposed algorithm performs better than the GAMS/MINOS commercial solver both in terms of solution quality and computational requirements such that the average CPU time is only 8% of the time required by the GAMS/MINOS.

## ACKNOWLEDGEMENT

I thank my my project guide Rakesh kumar and head of department Kartik D. Kothari of R.K. University and all faculty members who helped me.

## REFRENCES

1] B. Vinod, G. Gurusamy, C. Sasikumar, “Design and analysis of power failure detector module for control of axis runaway in CNC machines during unprecedented power failures”,Department of EEE, PSG College of Technology, Coimbatore, Tamil Nadu, India, International Journal of Machine Tools & Manufacture 46 (2006) 1610–1616.

2] C. Ahilan, Somasundaram Kumanan, N. Sivakumaran, J. Edwin Raja Dhas, “Modeling and prediction of machining quality in CNC turning process using intelligent hybrid decision making tools” ,Department of Mechanical Engineering, Oxford Engineering College, Tiruchirappalli, 620009 Tamil Nadu, India”,”Department of Production Engineering, National Institute of Technology Tiruchirappalli, 620015 Tamil Nadu, India”, “ Department of Instrumentation and Control Engineering, National Institute of Technology Tiruchirappalli, 620015 Tamil Nadu, India”,”Department of Automobile Engineering, Noorul Islam Centre for Higher Education, Nagercoil 629180, Tamil Nadu, India”, Applied Soft Computing 13 (2013) 1543–1551.

3] Sinan Gurel, M. Selim Akturk , “Considering manufacturing cost and scheduling performance on a CNC turning machine” ,Department of Industrial Engineering, Bilkent University, 06800 Bilkent, Ankara, Turkey”, European Journal of Operational Research 177 (2007) 325–343.

4] Wenyuh Jywe a,n, Tung-HuiHsu a, C.-H.Liu b, “Non-bar, an optical calibration system for five-axis CNC machine tools” Department of Automation Engineering, National Formosa University, No. 64, Wunhua Road, Huwei Township, Yunlin County 632, Taiwan, ROC, Department of Mechanical Engineering, National Chung Hsing University, Taichung, Taiwan, ROC, International Journal of Machine Tools & Manufacture 59 (2012) 16–23

5]S.T. Newman*, A. Nassehi, R. Imani-Asrai, V. Dhokia, “Energy efficient process planning for CNC machining” Department of Mechanical Engineering, University of Bath, BA2 7AY, UK, CIRP Journal of Manufacturing Science and Technology 5 (2012) 127–136

6]W.T. Lei, M.P. Sung, W.L. Liu, Y.C. Chuang, “Double ballbar test for the rotary axes of five-axis CNC machine tools”, International Journal of Machine Tools and Manufacture 47 (2) (2007), 273–285.