IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e- ISSN: 2278-1684, p-ISSN : 2320–334X
PP 06-12
www.iosrjournals.org

AUTOMATIC TOOL WEAR OFFSET CORRECTION BY ONLINE ADAPTIVE CONTROL

M. Ravikumar[1]
[1](PG Scholar, Dept of Mechanical Engineering, Karpaga Vinayaga college of engineering and Technology, Chennai, India)

ABSTRACT : *Tool wear is common problem in machining, where in tool wear is compensated by Wear offset in CNC machine. By measuring the dimension we give compensation in wear offset column. The CNC m/c operators enter the wear offset, mostly the error occurred during input the offset as direction is important, Due to this error we face more Rejection and assembly problem as dimension is important in fitment of assembly. And this error occurred due to the operator skill and fully depends upon the man. To eliminate the error we plan to give Automatic tool wear offset by simple automation.*

In this experimental work, simple online monitoring system adapted by studying various Adaptive control technology. The Air gauges are used for measuring Hard turned jobs with dim tolerance of 0.025mm and to know the ovality in the Hard turned jobs,, the operator adjust the tool wear by adjusting wear offset in CNC machine. He adjusts when the dimension reaches maximum which is indicated by RED light in Air gauge with alarm and also gives alarm when it reaches minimum. so we plan to trigger wear offset in CNC when it reaches maximum and minimum, so that dimension will be maintained middle in control chart.

Further, tool wears offset automats updated by eliminating manual offset error and following poko yoke method. The SPC study and MSA study done to know the process is stable or not the studies are done before and After the implementation of tool wear offset online adaptive control, and the result achieved is satisfactory.

Keywords: *CNC Machine, Tool Wear, Adaptive Control.*

I. INTRODUCTION

Online tool monitoring is studied by simple Adaptive control and by which tool life and cycle time improved by S.C.Lin [1]. The manual errors to be eliminated completely in which simple automation and simple online monitoring using Adaptive controls are used .MrC.Scheffer and H.Kratz [2]. developed the tool wear monitoring system for Hard turning.The Hard turning is the turning process which heat treated products with hardened above 55 HRC .Hard turning can dramatically reduce the production lead times. Dry cutting is a key benefit for environmental impact of cutting operations.A major drawback of hard turning is the tool wear,due to high hardness.The tool wear governs the dimension,surface finish.In this review optimization is done for cutting speed ,feed and depth of cut to achive better life.[3]Micheleti.W.koeng have carried out experiments for in process tool wear sensor for cutting operation, .in which he uses sensors for cutting operation and studied the tool wear. [4]Katsushi Furukani, Automatic tool compensation for Grinding.in which he uses Marposs gauge for automatic tool compensation for grinding operation, After grinding the gauge automatically checks the dimension and the offset is corrected automatically,same like that we planned for Turning operation. [5]M.Shiraishi Scope of inprocess measuring and monitoring and control technique in Machining process in which he studied the inprocess checking methods and monitoring techniques,we use Air electronic gauge for inprocess checking and monitoring dimension as the dimension is critical in assly.

[6]T.Kohino Inprocess measurement and work piece refered form accuracy control system,in which he studied measurement accuracy. [7]Y.Koren and Massery studied the adaptive control with process estimation with process estimation was studied,in which online adaptive control used for wear offset altering automatically. [8]J.Tlusy and G,c Andrews review the sensors for Unmanned machining,in which he reviewed sensors of various application and suitable for unmanned machining operation. [9]S,Jetly Measuring cutting tool wear online.he studied the tool wear online by acoustic sensors which the automatically cutting parameters changed according to the tool wear. [10]R.L.KEGG Online machine and process diagnostic ,in whch he studied the online dagnostic for tool wear .[11]S.M.WO Tool life testing by response surface technology in which the tool life testing done bt surface technology. .[12]Mr Ali Razak taken the case study for capabilitys machines in Tool capability and process capability,study some statistical calculations have been made to eliminate quality

problems.X-R control charts have been constructed on the data obtained from manufacturing to discover and correct assignable causes..[13]Mohammad abdolshah et al.measured process capability with Fuzzy data and he compared with other Fuzzy logic indices and with the result the capability improved. .[14] H.A. Kishawy et al.made attempt to evaluate the self-propelled rotary carbide tool performance during machining hardened steel. Although several models were developed and used to evaluate the tool wear in conventional tools, there were no attempts in open literature for modeling the progress of tool wear when using the self-propelled rotary tools. .[15]Chien wei wu et al. developed Process capability indices (PCIs), C_p, C_a, C_{pk}, C_{pm}, and C_{pmk} in certain manufacturing industry as capability measures based on various criteria, including process consistency, process departure from a target, process yield, and process loss. It is noted in certain recent quality assurance and capability analysis works that the three indices, C_{pk}, C_{pm}, and C_{pmk} provide the same lower bounds on the process yield. In this paper, we investigate the behavior of the actual process yield, in terms of the number of non-conformities (in ppm), for processes with fixed index values of C_{pk}=C_{pm}=C_{pmk}, possessing different degrees of proces.[16]G.King alan studied the ceramic cutting tools which can be used for Hard turning..[17]Richard case studied where tolerance analysis techniques were used to analyze the cause of poor product performance and determine new specifications and process settings. Both 1D and 3D Monte-Carlo simulation analyses are described. A procedure for compensatory tolerancing is presented and demonstrated as a method of determining the appropriate tolerances once the product is in full-scale production.[18]Peter scalan studied about the quqlity assurance methods. [19]J,Richard et al.studied about the integrated manufacturing system[20]Peter Beelay explained about the quality improvement methods,

II. EXPERIMENTAL DETAILS

In this study, the gear for differential assembly is taken for study.The gear has Hard turn operation in Hub dia which the tolerance is 0.025 mm and it is critical in assembly.The hard turning is done CNC lathe,The cutting parameters are optimized for tool life.We planned to use Air gauge for measuring dimension,In this Air gauge digial output is converted in to binary which CNC can accept for online altering, The Fig**. 1** shows the job in Air gauge in which it is attached to the CNC for easy checking, In Fig**. 2** the block diagram which explains the online gauge alteration how it is done(Input and output),In Fig**. 3** the block diagram for Air gauge circuit is drawn in which two relays are used for triggering.

Figure. 1, Air Gauge

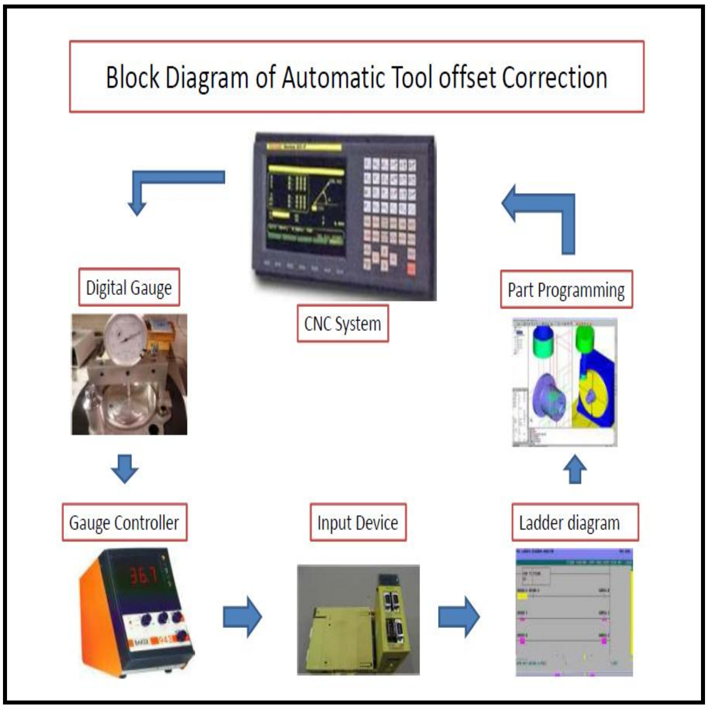

Figure 2. .Block Diagram.

III. WORKING PRINCIPLE

- The machined component from CNC is subjected for measurement.
- The digital gauge is used to measure the value and it is connected to the Gauge controller.
- The gauge controller is used to convert /amplify the value.(Digital to binary form with voltage level of 24v).
- Binary signals from the gauge controller is connected to the CNC through Fanuc I/O device.
- Binary signals are converted into digital value in ladder logic and that value is assigned to custom macros. With customized macro programming in CNC, tool wear offset will be corrected automatically.

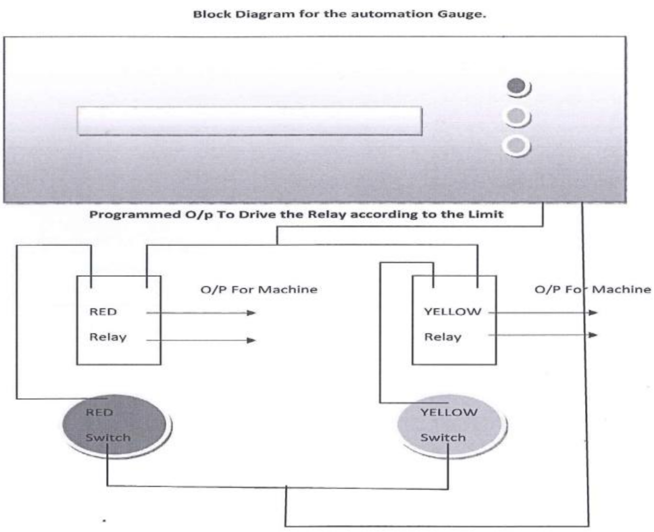

Figure 3. Connection Diagram

3.1 PROCESS PARAMETERS

Machining study is carried out to observe the dependant process variables based on the intentionally varied independent process parameters and that leads to generate models and optimization process. The independent process parameters considered in this work are as follows:

1. Spindle Speed (Rpm)
2. Feed rate (mm/Rev)
3. Depth of cut (mm)

Subsequently the various analysis done before and after implementing online altering tool wear offset are done:

1. Rejection data analysing
2. SPC data analysing
3, MSA study for Air gauge

3.2 REJECTION DATA ANALYSING

The rejection due to offset altering error is analysed before and after implementing online offset altering in which rejection reduced from 3% to 1%.Till the data analysing is continuing after the Online offset is implemented from April 1st.In **figure 4** the rejection due to hub dia under size is studied for six months and plotted in graph.

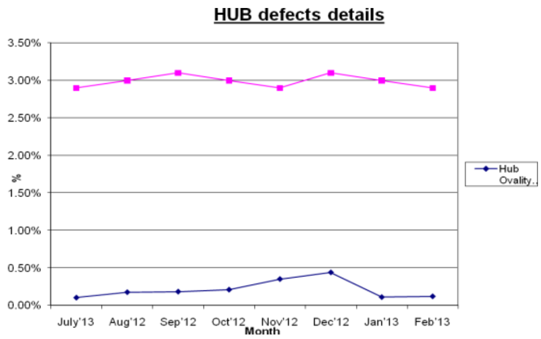

Figure 4

3.3 SPC DATA ANALYSING

The Cp and Cpk values are analysed before and after implementing online offset correction and result found satisfactory.The analyses results before **Figure 5** and After **Figure 6** are tabulated

INTERVAL		**FREQ.**	**CU. FREQ.**
34.9361	34.9403	0	0
34.9403	34.9445	0	0
34.9445	34.9487	0	0
34.9487	34.9529	0	0
34.9529	34.9571	5	5
34.9571	34.9613	25	30
34.9613	34.9655	15	45
34.9655	34.9697	3	48
34.9697	34.9739	1	49
34.9739	34.9781	1	50
34.9781	34.9823	0	50

34.9823	34.9865	0	50
U.C.L.8 ={8+A2x2}		34.966605	
L.C.L.8 ={8-A2x2}		34.95540	
U.C.L.2 ={2 x D4}		0.020045	
L.C.L.2 ={2 x D3}		0	
Std.Dev." □ "=		**0.00409**	
Cp=(S/6 □)=		**1.01810**	
Cpk={1-K}xCp)=		**0.89600**	
AUD. BY	Ravikumar.M		10-02-2014
ROCESS NEEDS CORRECTION ,Cp & Cpk SHOULD BE >=1.33			

Figure 5(Before)

INTERVAL		**FREQ.**	**CU. FREQ.**
34.9405	34.9436	0	0
34.9436	34.9467	0	0
34.9467	34.9498	0	0
34.9498	34.9529	0	0
34.9529	34.9560	1	1
34.9560	34.9591	8	9
34.9591	34.9622	24	33
34.9622	34.9653	15	48
34.9653	34.9684	2	50
34.9684	34.9715	0	50
34.9715	34.9746	0	50
34.9746	34.9777	0	50
U.C.L.8 ={8+A2x2}		34.964604	
L.C.L.8 ={8-A2x2}		34.95800	
U.C.L.2 ={2 x D4}		0.011816	
L.C.L.2 ={2 x D3}		0	
Std.Dev." □ "=		**0.00279**	
Cp=(S/6 □)=		**1.49610**	
Cpk={1-K}xCp)=		**1.35250**	
AUD. BY	Ravikumar.M		12-02-2014

PROCESS IS GOOD BUT STILL IMPROVEMENT IS REQIURED

Figure 6(After)

3.4 MSA ANALYSIS OF AIR GAUGE

The MSA analysis is done for the gauge using and recorded and found the result is satisfactory.The analyses results are tabulated.,in **Figure 7**

Total Variation(TV)		
TV = SQRT(GRR^2+PV^2)		
	TV	**0.00157646**
% EV = 100(EV/TV)		
	% EV	**5.552056383**
% AV = 100(AV/ TV)		
	% AV	**3.607946787**
% GRR = 100(GRR/TV)		
	% GRR	**6.621375243**
% PV = 100(PV/TV)		
	%PV	**99.78054615**
Number of distinct Categories(ndc)		
ndc = 1.41(PV/GRR)		
	Ndc	**21.24793792**

Figure 7

IV. CONCLUSION

In this experimental study, with different cutting speed and feed the tool life is optimized,by making one constant and another variable.By online monitoring of dimension in Air gauge in which tool wear offset is automatically altered and maintained with in control spec.The operator manual input error of offset is completely eliminated.The rejection percentage is reduced from 2% to 1%.The fitment problem in Assembly is eliminated.

REFERENCES

[1] S.C.Lin Online tool life monitoring, RWTH Aachen 1996.
[2] MrC.Scheffer and H.Kratz Tool wear offset for Hard turning,volume43,issue 10Augest 2003,pages 973-985.
[3] G.F Micheleti.W.koeng,In process tool wear sensor for cutting operation,CIRP,vol-25/02/1976.

[4] Katsushi Furukani,Nguyen Trm Hieu Automatic tool compensation for Grinding.
[5] M.Shiraishi Scope of inprocess measuring and monitoring and control technique in Machining process-1989
[6] T.Kohino Inprocess measure ment and work piece refered form accuracy control system precision engg 1989
[7] Y.Koren and Massery adaptive control with process estimation Ann CIRP 1981
[8] J.Tlusy and G,c Andrews 1983 Annals of CIRP A review of sensors for Unmanned machining
[9] S,Jetly 1984 Measuring cutting tool wear online.
[10] R.L.KEGG Online machine and process diag nostic ,Ann CIRP 1984.
[11] S.M.WO Tool life testing by response surface technology, May(1964)
[12] Ali Riza motoecu,Abdulkadir gullu ,Statistical process control in machining,a case study for machine tool capability and process capability, Original Reasearch Article,Materials&Design volume,Issue5.2006.
[13] Mohammad Abdolshah, Rosnah Mohd. Yusuff, Tang Sai Hong, Md. Yusof B. Ismail, Aghdas Naimi Sadigh-Measuring process capability index Cpmk with fuzzy data and compare it with other fuzzy process capability indices,Expert Systems with Applications, Volume 38, Issue 6, June 2011, Pages 6452-6457
[14] H.A. Kishawy, Lei Pang, M. Balazinski ,Modelling of tool wear during Hard turning,with self probelled rotary tools,International Journal of Mechanical Sciences, Volume 53, Issue 11, November 2011, Pages 1015
[15] Chien-Wei Wu, W.L. Pearn, Samuel An overview of theory and practice on process capability indices for quality KotzInternational Journal of Production Economics, Volume 117, Issue 2, February 2009, Pages 338-359
[16] Alan G. KingAlan,Introduction of ceramic cutting tools in1994 page(1-12)
[17] Richard J. Gerth, Walton M. HancockRichard ,computer aided tolerance analysis for improved process controlComputers & Industrial Engineering, Volume 38 Issue 1, 1 January 2000, Pages 1-19
[18] Peter scallan,process planning 2003(324-380),selection of quality assurance methods.
[19] J. Richard, E. Rondeau, E. BajicComputer Integrated Manufacturing Systems, Volume 7, Issue 3, August 1994, Pages 179-190
[20] Peter Beelay,Quality assessment and control,Foundary technology second edition2001pages(319-361).