

Semi Automatic Lathe Machine Using ARM Processor

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Abstract: Nowadays, products are manufactured using modern technology which employs a communion of computer software, hardware and firmware and lathe machines play a vital role in the manufacturing sector. While the manual lathe machines are economical, they require to be operated by highly skilled workers otherwise their accuracy and efficiency is not up to the mark. On the other hand, CNC machine provide the desired accuracy and efficiency of output, but require a huge capital. As a remedy to this dilemma, switching to semi-automatic lathe machines can prove to be a boon for the developing countries as they cover the merits of both but demerits of none. This can be done using an ARM processor to control the functioning of the lathe machine. Additionally, a micro limit switcher is used for better cutting quality. On the mechanical front, the aforementioned solution provides accuracy in cutting size and depth. It also overcomes the issues of double lock, spacing and switching of cutter direction. Furthermore, it eliminates the need of manually applying the coolant. Thus upgrading the from manual to semi automatic lathe machines can significantly increase the accuracy and efficiency while, at the same time, keeping a check on investment cost and consequently provide a much needed escalation to the manufacturing industry.

Keywords: Lathe Machine, Milling, Retrofitting

1. Introduction

Retrofitting refers to the addition of new technology or features to older systems. This definition gives almost all information about the word. When use retrofitting in the context of some component, it means we try to upgrade that component and improve its efficacy through a present technology.

Here we are concerned with retrofitting in lathe machine. At times, Retrofitting is the process of replacing the CNC, servo and spindle systems on an otherwise mechanically sound machine tool to extend its useful life. Rebuilding and re-manufacturing typically include a CNC retrofit. The anticipated benefits include a lower cost investment than purchasing a new machine and an improvement in uptime and availability. But there are often other unanticipated benefits to retrofitting including lower energy costs, higher performance and a new level of manufacturing data accessibility.

As a remedy to this dilemma, switching to semi-automatic lathe machines can prove to be a boon for the developing countries as they cover the merits of both but demerits of none. This can be done using an ARM processor to control the functioning of the lathe machine. Additionally, a micro limit switcher is used for better cutting quality. On the mechanical front, the aforementioned solution provides accuracy in cutting size and depth. It also overcomes the issues of double lock, spacing and switching of cutter direction. Furthermore, it eliminates the need of manually applying the coolant.

Rebuilding typically includes the repair or replacement of some worn mechanical components such as ball screws, lubrication pumps, safety interlocks, guards, hoses, belts and electrical wiring. The rebuild is typically performed at the builder's facility, so there may be additional transportation and rigging cost [1].

Assuming the machine tool is generally in good shape mechanically, CNC retrofitting is typically the lowest cost solution to improve the overall performance of an older machine tool.

The main objective of the semi-automatic lathe machine is to improve the existing conventional lathe machine to provide it features of CNC machine with very low cost.

In addition to the above main objective there also several objectives of the retrofitting which is given below:

- To increased productivity and improved control of machine
- Constant production with high efficiency
- Far superior repeatability
- Fast machining cycle
- High accuracy and high feed-rate
- To increase accuracy and part finished due to controller
- To reduce machine downtime

2. Literature Review

In 1984, department of mechanical engineering IIT, New Delhi[1] has taken a research topic named as "machine tool failure data analysis for condition monitoring application " with the development of Modern manufacturing technology, flexible manufacturing system have become key equipment in factory automation machine tool is heart of flexible manufacturing systems. Ex example lathe machine is the general type of machine tool used by almost all the FESs. During the operation of this machine tool, different kinds of failures can are faced by the industry. A systematic study of such failures can help in identifying the condition monitoring needs the machine tools. This deals with the identification of critical sub-system based the failure data analysis for different type of machine tools.

Initially milling has been classified into various sub-systems as shown in figure. In the frequency of failures for each sub-system and failure modes have been considered for finding out the weakest sub-system. In analysis, failure frequency and downtime have been taken into consideration for deciding critical sub-system of machine tools. It can be observed that the maximum failures took into place in headstock and carriage sub-system. These sub-system face failures face failures in component like gear, gearbox, bearings, spindle bearing, clutch and cross-jib. Here it could be observed that the bearing failures cause longer downtime.

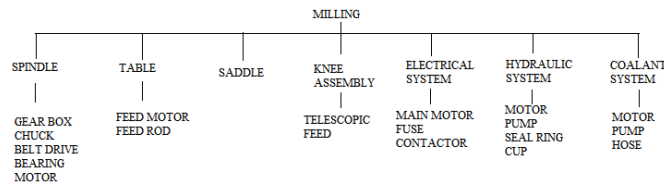


Figure1: Wearing parts of conventional milling ^[11]

On these different failure modes and their relative failure frequencies have been grouped into four modes, component damage, fuse burnt and looseness. It can be observed that dominant failure mode is because of component damage. the component are electrical, electronics and of mechanical categories.

In 2014, IJETAE published "Investigation on Automation of Lathe Machine"[1] with the new modern Technology and showing the specific parameters regarding synchronization between spindle speed and platform feed.

In 2012, Institute of Mechanical Technology, Poland[2] has taken a research in cone worm gear drive with conical worm on CNC milling machine . it gives the ides about cutting of a cone-gear with specified parameters.

In 2012, school of engineering, china [3] has taken research in "CNC Milling Machine Spindle Characteristics Analysis by FEM". As an important component of milling machine, the stiffness and vibratory model of spindle need to be analysed in the process of design.

In 2010, 8th IEEE International Conference on control and Automation [4] published "Mechatronic Modelling and Control of a Lathe Machine Equipped with a MR Damper for Chatter Suppression". The obtained results show that the proposed method has been successful in reducing the chatter conditions and improving the stability of turning operation with very low energy consumption.

In 2008, International Conference on Smart Application, Korea [6] has taken research in "Development of a Miniature Vertical Milling Machine for Automation Used in a Microfactory"

With the development of many benefits for saving resources, energy and coast. For the automated process, the VMC was selected and optimal configuration of the structure was examined to maximize loop stiffness between spindle and feed table.

In 2008, World Academy of Science, Engineering and Technology [7] has Taken Research in "Design of Hydraulic Circuit for CNC Lathe Machine Form Conventional Lathe Machine ", The design of hydraulic circuit is dramatically needed. These consist of changing the tool, working the machining processes and locating the tool in turret.

In 2006, School of Mechanical and Manufacturing Engineering, Australia [8], has Taken Research in "Very Low Compliance Force Control On a CNC Lathe Machine " with demonstrates how to carry out contact operation in a very stiff contact situation. The experimental set up used is a CNC machine that carries out metals spinning. The controlled forces are the metal forming process. The designed controller operates in a dynamic environment.

3. System Overview & Schematic Work

Retrofitting refers to the addition of new technology or features to older systems this definition gives an almost all information about the word retrofitting. When we say that retrofitting related to some component that mean we try to upgrade that component and improve their efficacy through a present technology. Here we are concerned with retrofitting in lathe machine. At times, Retrofitting is the process of replacing the CNC, servo and spindle systems on an otherwise mechanically sound machine tool to extend its useful life. Rebuilding and remanufacturing typically include a CNC retrofit. The anticipated benefits include a lower cost investment than purchasing a new machine and an improvement in uptime and availability. But there are often other unanticipated benefits to retrofitting including lower energy costs, higher performance and a new level of manufacturing data accessibility. Assuming the machine tool is generally in good shape mechanically, CNC retrofitting is typically the lowest cost solution to improve the overall performance of an older machine tool.

3.1. Problem Overview

- Cutting depth irregularities
- Wastage of time
- Low accuracy due to double loss
- Spacing issues
- Problem with coolant
- Motor position for cutter
- High production cost

4. System Block Diagram



Figure 2: Block Diagram

4.1. Implementation of Thesis

The main objective of the retrofitting in lathe machine is to improve the existing conventional lathe machine to provide it features of CNC machine with very lower cost than a new CNC machine. In addition to the above main objective there also several objectives of the retrofitting which is given below

- Increased productivity and improved control of machine
- Far superior repeatability
- Fast machining cycles
- High accuracy, high feed-rate
- To increased accuracy and part finished due to controller
- Eliminate additional tooling cost
- The Up-gradation Package is less expensive and more readily justifiable

4.2. System Flowchart

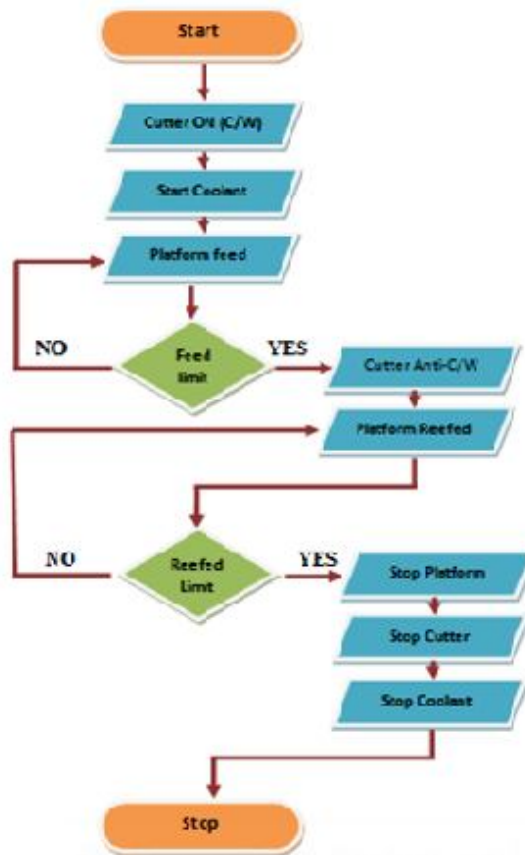


Figure 3: Flow Chart

Human machine interface is used to control the machine through a control panel. When a start pulse is given to the panel, system will first start to rotate the cutter in clockwise direction. It also activates the coolant system. The platform starts moving in the feed direction till maximum limit is reached upon which, it starts moving in re-feed direction. The platform is stopped when it reaches the minimum limit and thus, one cycle is completed.

5. Schematic Design & Modelling

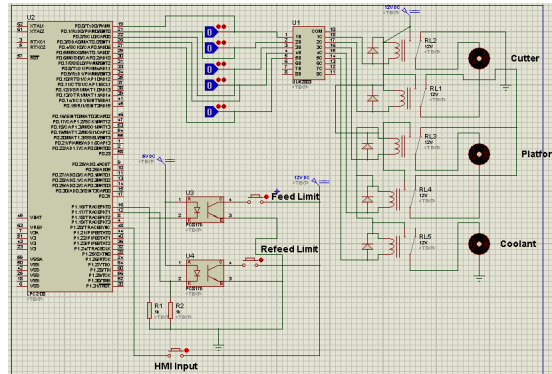


Figure 4: Schematic Diagram

This is whole circuit schematic design. In this circuit, the ARM 7 Processor is used for control the whole System, ULN2803 Driver IC is used for drive the motor through Relay. Proximity Sensor is used for detect the platform position and it control through the stepper motor. The Opto-coupler is used for regulate the supply from Sensor.

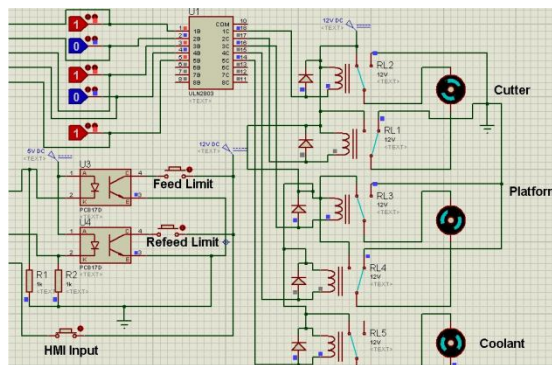


Figure 5: Motor in Forward Direction

This circuit shows the forward direction of Motor, When HMI give the output first, the cutter and coolant rotate in clockwise direction.

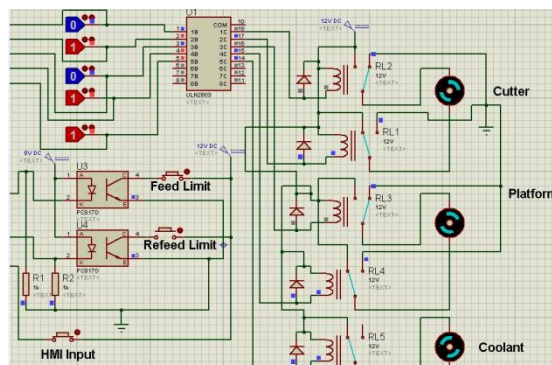


Figure 6: Feed Limit Reached

In this circuit we can show that , Proximity Sensor sense the Maximum Limit of Platform , So the feed limit is reached.

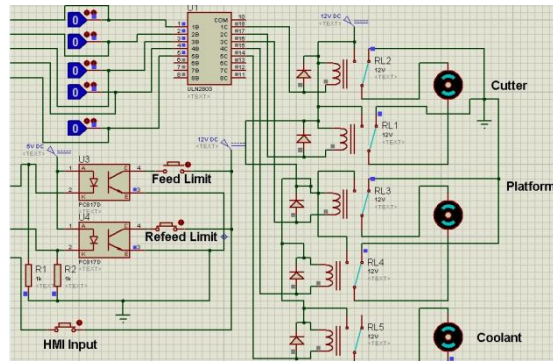


Figure 7: Motor in Reverse Direction

In this circuit we can see that the minimum limit is reached so that, the system is stop, one cycle is completed.

5.1. Retrofitting Procedure

Here the complete construction procedure is divided into five steps in which the complete Retrofitted Milling machine has been developed from conventional Milling machine.

These steps are listed below:

Step-1: Purchasing all electrical parts

Electronic parts like stepper motor, stepper drive, proximity switch and control panel have been purchased

Step-2: Disassemble some parts from conventional milling machine

As per definition of retrofitting process, the non-used parts from conventional milling machine have been removed. As a result, Head stock gearing mechanism, Lead screw, lead screw mounting bracket, Hand wheel etc. have been removed.

Step-3: Dimensional Design and Fabricated of required mechanical parts

Some parts which are required for retrofitting & fabricated and/ or manufactured have been designed.

To obtain accurate results, gear and motor for drive lead screw or ball screw has been used.

Step-4: Assemble all manufactured parts & electronics parts at desired place

After manufacturing or fabricating all required parts, assembly procedure is carried out. All the mechanical & electronic parts are attached to their desired place.

Step-5: Inspection & testing of new developed retrofitted Milling machine.

In this step all components are properly fitted with machine body and alignment of lead or ball screws have been checked.

Then the job is manufactured on developed retrofitted milling machine operation program which is from manual part program method and surface finishing of the job has also been checked.

6. Conclusion

By developing automation in conventional milling by retrofitting stepper based method, the machine works as CNC trainer for teaching, learning of the student subject. Also cost of machine minimizes approximate 4 times below the original CNC trainer.

As automation of new developed retrofitted milling is done by replacing or removing the components from conventional milling machine, therefore setup costs high as compared to standard milling machine but production rate is too much high. So it is very useful for mass production.

The accuracy of the job manufactured in retrofitted milling machine is also high so repeatability and dimensional stability of manufactured part is achieved. At last some complex job which is not manufactured in conventional milling machine can be manufactured in new developed retrofitted milling machine.

7. References

- [1] Prakash N. Parmar¹, Prof. N. C. Mehta², Prof. Manish V. Trivedi³, "Investigation on Automation of Lathe Machine", International Journal of Emerging Technology and Advanced Engineering (IJETA), Volume 4, Issue 5, May 2014
- [2] Frackowiak P, "Forming a modification involute line of teeth of a cone worm gear drive with conical worm on CNC milling machine" Carpathian Control Conference (ICCC), 28-31 May 2012
- [3] Wu Fuzhong, "CNC Milling Machine Spindle Characteristics Analysis by FEM", Intelligent Computation Technology and Automation (ICICTA) Volume 1, 11-12 May 2010
- [4] Behbahani, S. ; Tabatabaei, S.M.K. "Mechatronic modeling and control of a lathe machine equipped with a MR damper for chatter suppression", Control And Automation (ICCA), 2010.
- [5] Fitzner, Arthur O., "An Automatically Controlled Vertical Turret Lathe" Industrial Electronics, IRE Transactions on (Volume: PGIE-9), 2 June 2009.
- [6] Seung-Kook Ro, Sung-Kweon Jang , Byung-Sub Kim , Jong-Kweon Park , "Development of a Miniature Vertical Milling Machine for Automation Used in a Microfactory", 9-11 April 2008
- [7] Zin Ei Ei Win, Than Naing Win, Jr., and Seine Lei Winn , "Design of Hydraulic Circuit for CNC Lathe Machine Converted from Conventional Lathe Machine", World Academy of Science, Engineering and Technology Vol:2 2008-06-24
- [8] Hanafi, D , Katupitiya, J, "Very low compliance force control on a CNC lathe machine" Robotics and Automation, 2006. ICRA 2006. Proceedings 2006 IEEE International Conference, 15-19 May 2006
- [9] Xianzhong Yi Shengli Fu ; Yang Lin ; Jingkun Zhao "5-axis CNC Whirlwind Milling Model for Complex Freeform Surfaces" Mechatronics and Automation, Proceedings of the IEEE International Conference, 25-28 June 2006
- [10] Zhan, Yiqing Zuo, Zhiyong ; Xie, Yun ; Wei, Wen, "Research and application of automation technology in renovation for old import machine tool", Technology and Innovation Conference, 2006. ITIC 2006. International, 6-7 Nov. 2006
- [11] www.wikipedia.org/wiki/Milling_machine