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RESEARCH ARTICLE OPEN ACCESS

Design and Developement of Bench Lathe for Acetal Material

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ABSTRACT
This research shows how to design and build a low-cost bench lathe machine for acetal material based on the open-source hardware(ARDUINO) and software(Arduino IDE). The bench lathe machine has been dependent on the principle of stepper motor motion control using the Arduino Uno microcontroller and stepper motor driver. The objectives of this paper are to design and develop the bench lathe which can be easily controlled by using open source software(Arduino IDE).this bench lathe machine is having two-axis(X-axis and Y-axis) to control the motion of the cutting tool. this two-axis movement control two stepper motors which are controlled by the Arduino Uno controller board. This machine has another one stepper motor to control workpiece rotation.
Key Words: Bench lathe, , design of lathe, Arduino,Acetal material, Stepper Motor

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I. INTRODUCTION

In today's fast-growing world, there is a necessity of very fast & accurate devices. So, in modern manufacturing industries, there is a demand for very precise as well as economical production in less time.all this requirement can be achieved through machines that can be controlled by computer such as computer numerical control machine. To implement this technology in bench lathe we must have to understand several concepts such as Arduino board and software tools. In this machine Two axes can do movement starting with two primary axes which are X and Y-axis. The Z-axis is being paralleled with the X-axis. bench lathe Machine design by fusion 360 software. In this research paper we give detail about the implementation of Machine hardware and wiring connection.

1.1MATERIAL ANDMETHODOLOGY

In this section show how to do experimental of this paper, the method of this paper is generally a guiding principle to solve the problem. The implementation method is discussed briefly and specifically components. The flow framework must be clear to clarify to ensure that the paper runs smoothly, and the objectives are capable of success.

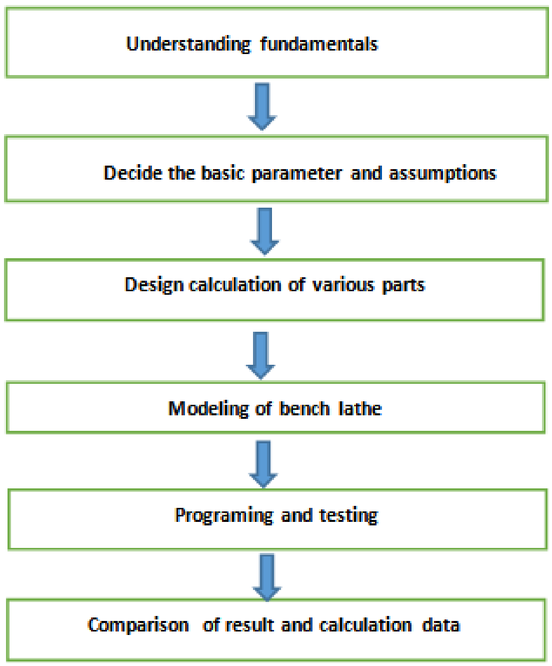


Fig. 1. flow chart for bench lathe machine

Fig.1 shows the flow chart of this bench lathe machine

1.2 MATERIAL PROPERTY

Acetal(polyoxymethylene)

- Tensile strength :- 65.5 MPa ,
- Modulus of elasticity :- 2757 MPa,
- Compressive strength :- 103 MPa,
- Shear strength :- 52.2 Mpa.

A.Mechanical SystemDesign

The structure of the bench lathe machine has been designed in fusion 360 software with dimensions and all parts of the machine will be achieved before the implementation of the hardware of the actual machine. The initial design will be drawn at the approval of the design. Before starting the design, many steps of criteria must be understanding. Length of movement means the linear movement of steppers motors that control X and Y from one point to another point. The left to right movement controlled by the X-axis stepper motor, front to back movement controlled by the Y-axis stepper motor, and the spindle rotation is controlled by the Z-axis stepper motor. Finally, the length travel of the lathe machine that decided as 600mm for the X-axis and 200mm for the Y-axis.

B. ElectronicsSystem

This section will be showing the electronics parts and wiring will be needed to design and manufacturing bench lathe machine. So, the main electronics component required are one Arduino UNO R3, three TB6600 Driver Module for Arduino, three stepper motor, D.C. power supply, some wires, and USB to serial adapter

- Arduino Uno R3: Arduino Uno board is a microcontroller based on ATmega328P Atmel AVR family microcontroller. It's open-source software(Arduino IDE) and hardware design and manufactures a single microcontroller. It has 14 digital input/output pins and 6 Analogue input can be sampled using on-chip ADC, using open-source software to programming Arduino Uno. It has 6 PWM outputs multiplexed on to the digital IO pins. The dimensions of Arduino Uno measured are (68.6 mm* 53.4 mm).

C. Computer and SoftwareTools

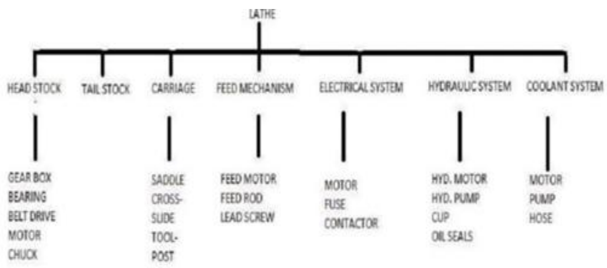
Arduino IDE: The Arduino IDE (Integrated Development Environment) is used to write the computer code and upload this code to the physical board. It is simplified C/C++ functions language-based programming can be download functionality with a rich set of library functions. After download and install on pc can write the program by C language and from tools and port must choose the port connection between computer and Arduino through USB. After this step can verify the program by error checking and the message is done compiling when it finished and no error. After this step can be upload to the program on the Arduino. Fig. 9 shows the Arduino software IDE program for a stepper motor.

D. Stepper Motor:

The digital pulse stepper can be converted into the movement of the cutting tool with respect to the X and Y axes directions.The stepper motor is distributes full rotation in various number of equal steps.The stepper motor is defined by the property of converting several drives to a specific increase in theposition of the column. Each step moves the column through a fixed angle. This machine has used two stepper motors with a lead screw.The motor output willbe in the form of the rotation of the leadscrew with respect to the X and Y axis

II. LITERATURE REVIEW

1) In 1984, **Department of Mechanical Engineering, IIT, New Delhi**, 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 Systems have become key equipment in factory automation. Machine tool is heart of the Flexible Manufacturing Systems. Ex example Lathe machine is the general type of machine tool used by almost all the FMSs. During the operation of this machine tool, different kinds of failures are faced by the industry. A systematic study of such failures can



LATHE SUB SYSTEM CLASSIFICATION

help in identifying the critical sub-system of these machine tools. This will be useful for identifying the condition monitoring needs of the machine tools. This deals with the identification of critical sub-system based on the failure data analysis for different type of machine tools.Initially lathe has been classified into various sub-systems as shown in Figure. In the frequency of failures for each subsystem 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-systems of machine tools. It can be observed that the maximum failures took place in headstock and carriage sub-systems. These sub-systems face failures in components like gear, gearbox bearing, spindle bearing, clutch and cross slide jib. Here it could be observed that the bearing failures cause longer downtime.On histogram different failure modes and their relative failure frequencies have been grouped into four-failure modes, component damage, fuse burnt, circuit fault and looseness. It can be observed that the dominantfailure mode is because of component damage. Thecomponents are electrical, electronics and of mechanical categories

2)In 2013, **V. Roy & S. Kumar**from J institute Engineering, India published development of Lathe machine attachment for CNC machine.He has developed attachment for an existing CNC machine. The CNC machine operates on mechatronic controls and a computer interface called CAMSOFT, and is used as a CNC Lathe after installing the respective attachment to it. He has design the attachment using CAD software & fabricated different model. He has successfully design & fabricated the model. The working of the CNC Lathe attachment is tested & checked by making proper machining operation like turning and thread cutting. The machining operations are successfully done. The CNC machine becomes multifunctional with the presently developed lathe attachment and can be used accordingly by installing the respective attachment to it. The CNC machine isuseful for research work in both the fields, wheninstalled with the proper attachment.

Developed design is successfully implemented in the proposed work for the development of the lathe attachmentincluding headstock, tailstock and tool post. The work shows the process of the conceptual design and use of proper process planning for the development of the different components of the lathe attachment. The previously attachment and developed lathe attachment make the CNC machine multifunctional. Thus further research can be carried out in both the fields respectively. The CNC machine is based on the mechatronic controls and the computer interface CAMSOFT. Various lathe operations like plain turning, step turning, taper turning, arc turning, threading operations and manufacturing of a bolt are successfully performed on the CNC machine, when installed with lathe attachment. The successful development of the lathe attachment for the CNC machine is done.

2) In 2013, **Karl-Heinz Schumacher** is invented about Multi Spindle Lathe.Multi spindle lathe comprising a machine frame as spindledrum which is arranged in the machine frame is rotatable about a spindle drum axis and is made up at least partially of segments which are cut out from flat material in a stacking direction parallel to the spindle drum axis and extend in stacking planes transverse to the stacking direction these segments having receiving cutouts and cooling channel cutouts which overlap with one another such that the spindle drum has spindle motor receptacles for spindle motors and a cooling channel system separated there from by wall webs characterized in that the cooling channel system has several channel subsystems for a liquid cooling medium Which are fed in parallel.

3) In 2013, **M. Moses & Dr. Denis Ashok** [4] M. Tech, Mechatronic from School of Mechanical and BuildingScience, VIT University, Vellore, India published titled as Development of a new machining setup for energy efficient turning process. In the production unit, lathe is one of the important protection machines. This paper focuses on producing a quality product in lathe machine with less power consumption. In order to achieve that, a special setup is developed in the lathe machine for turning and finishing of the components, to achieve quality product and also to improve the productivity. As a result of this new approach, profuse amount of energy can be saved, quality product can be obtained and tool life can be increased. The study aimed at evaluating the best process environment which could simultaneously satisfy requirements of both quality and as well as productivity. By conducting many experiments it was found that this special setup process improves the quality and also reduces the power consumption as compared with the existing process

He has concluded that the addition of surface finish tool in turning process helps to improve the surface finish and this setup increases the tool life of the turning tool. From the experimental results, it is confirmed that there is no change of power consumption even after the additional usage of surface finish tool. Hence, the set up will be helpful in improving the quality product, with lesser load and power consumption.

F. .FORMULA& DESING CALCULATION:-

4. The horsepower, needed for turning (P) $P = (F_t \times V_{max})/4500\ hp$

5 . The power rating, of the cutting drive (P_{RC}) $P_{RC} = P / \eta_C hp$

5. The power rating, of the feed drive (P_{RF}) $P_{RF} = (Q \times F) / \eta_f$

7. The feed force, for lathe operations(Q) $Q = k.F_a + \beta(F_c + F_r + W_d)$

DESIGN OF SHAFT:
Diameter of Workpiece- 60mm
Spiral Speed – 100
Cutting Speed - 25 mm/min
Feed Rate - 2mm/rev.
Motor specification:-
Max. Radial Force - 75 N
Max. Axial Force 15N
Holding Torque - 10-1 kg.cm
Detent Torque - 0.36 kg cm
Rotor Inertia- 275 g.cm
Torsional Moment (Mt) :-
Mt = (60×10^6 kW / 2πN)
Ʈmax = Sys / F(s)
= 0.5 Syt / F(s)
FOR N = 400 ;
Mt = 3821.65 N/mm
Weight of Motor = 1kg = 9.8N
Weight of chuck = 4 kg = 39.22 N
Total Force = 9.81 + 39.22
= 49.02 N
Bending Moment(Mb) :-
Mb = 3696.5 Nm
Mt = 3821.65 N/mm
$Ʈmax. = [16/ \pi d^3] [(Mb^2) + (Mt^2)]^{1/2}$
Design of ball screw:-
Screw (d) = 10 mm
Nut (D) = 10.5 mm
Minor die (d1) = 8 mm
Area of core = 50.3 mm
$50.3 = \pi/4(dc)^2$
dc= 8 mm
Pitch (P) = 2
Axial load (W) :
Surface resistance (F) = 5N
Table mass (m1)=15kg
Work mass (m2) =5kg
Frictional coefficient = 0.003

Maximum speed (Vmax) = 1 m/s
Gravitational acceleration (g) = 9.80 m/s^2
Acceleration time (tz) = 0.15 sec
Acceleration (α) :-
α = Vmax./t1
=6.67m/s
Force acting on ball screw while in motion:-
During forward acceleration :
Fa1= μ(m1+m2)g + F + (m1+m2) × α
= 138.98 N.
During forward uniform motion :
Fa2= μ(m1+m2)g + F
= 5.5886N
During forward declaration :
Fa3= μ(m1+m2)g + F - (m1+m2) × α
= 127.81 N
During backward acceleration :
Fa4 = - μ(m1+m2)g - F - (m1+m2) × α
= - 138.810 N
During uniform backward motion :
Fa5 = - μ(m1+m2)g - F
= -5.58 N
During backward deceleration:
Fa6 = - μ(m1+m2)g - F+(m1+m2) × α
= 127.81 N
Maximum Force acting while in motion:-
W = 138.98N

stress in Screw body :
$\sigma c = W/ (\pi/4)\times (dc)^2$
$Ʈ = 16 (Mt)/ (\pi\times dc^3)$
$Ʈ = 19.01\ N/mm^2$
$Ʈmax. = [(\sigma c/2)^{1/2} + (Ʈ)^2]$
$Ʈmax. = 19.10\ N/mm^2$
stress in threaded of screw ;
t = 0.5× P
Ʈs = W/ π× dc × t × z
=0.5x2

COMPNENT NAME	SIZE	STRESS	MATERIAL
SHAFT	*Dia. = 5mm*	*Tmax.=237.5Mpa*	*Mild steel*
LEAD SCREW	*d=10 (screw)* *D=10.5 (nut)*	*Stress=2.74M/mm* *Tmax.=19.01M/mm*	*Mlid steel(screw)* *Copper(nut)*
GUIDEWAYS	*L=500mm* *Distance bet. Two guideways =85 mm*	*Calculate for life(L):-* *695.32KN*	*Mild steel*
BED	*L=600mm* *B=200mm* *H=150mm*	*Stress=19.62KN.M*	*Mild steel*

TABLE 1.RESULT DATA

Ʈs= 1.844 N/mm2
t=1mm
Stress in threaded of Nut :
Ʈ = W / π d t z
Ʈ= 1.47 N/mm^2
Bearing Pressure :-
Sb = 4W / [π z (d^{2}dc^2)]
Sb= 1.639 N/mm^2
= 22.66KN
Calculation of life of guideways:-
L = (Fn × Ft × c / Fw × Pc)
=645.32hr

III. CONCLUSION

Therefor design of bench lathe for acetal material is successfully developed by modeling software.which has the communion for both hardware(Arduini UNO) and software(Arduino IDE).resulting to the developed of bench lathe for acetal material As automation newly developed Arduino bench lathe is done by implementing some new features to the standard lathe. this set up cost much lower compared to the fully automated CNC machine. the accuracy of acetal job manufacturing is high in this machine compare to conventional lathe machine relatively, so dimension stability and dependability are high since the production rate is high, therefor this bench lathe is very useful in mass production.

REFERENCES

[1]. Pabitra Kumar Nandi, "Design and Development Stepper Motor Position Control System Using Atmel 85c51 Microcontroller" International Journal of Emerging Research in Management &Technology Vol. 2, Issue 12, December 2013
[2]. 2020 the Arduino website . available.arduino.cc
[3]. Machine Tool Failure Data Analysis for Condition Monitoring Application, Department of Mechanical Engineering, Indian Institute of Technology, New Delhi. Kegs. R. L., On-line Machine and Process Diagnostics, Annals of the CIRP. , 32(2), 469-473, 1984.
[4]. V. Roy • S. Kumar from Inst. Eng. India Ser. C(April–June 2013) 94(2):187–195 DOI: 10.1007/s40032-013-0064-2
[5]. Karl-Heinz Schumacher (2013), Multispindle Lathe. US patent # 2013008702/2013
[6]. In 2013, M. Moses & Dr. Denis Ashok M. Tech, Mechatronic from School of Mechanical and Building Science, VIT University, Vellore, India 978-1-4673-6150-7/13/$31.00 ©2013 IEEE
[7]. We have also used following links,
http://en.wikipedia.org/wiki/Numerical_control
http://en.wikipedia.org/wiki/Lathe
http://www.epa.gov/ozone/title6/609/technicians/retrguid.html
[8]. ZinEiEi Win, Than Naing Win, Jr., and Seine Lei Winn (2008), Design of Hydraulic Circuit for CNC Lathe Machine Converted from Conventional Lathe Machine; World Academy of Science, Engineering and Technology,2,380-384

[9]. Implementation and Manufacturing of a 3-Axes Plotter Machine by Arduino and CNC Shield, Yousif Mohsin Hasan, Layth Fadhil Shakir, Hassan Hamed Naji College of Engineering, University of Al-Qadisiyah Diwaniyah

Kaushar chavada, et. al. “Design and Developement of Bench Lathe for Acetal Material. *International Journal of Engineering Research and Applications (IJERA)*, vol.10 (07), 2020, pp 53-58.