Design And Fabrication Of Three Axis Automatic Drilling Machine

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Abstract

The need for drilling and tapping operation plays vital role in manufacturing industries. Previous researches on tapping and drilling has mainly focused on cutting force variations, drill and tap wearing, and drill and tap design. A novel performance test system of tapping and drilling for a computer numerical control(CNC) machine tool is established in recent techniques. The target of the mass production is to increase the productivity and increase the accuracy. This is doneby reducing the set up cost and manual fatigue. Trial and error method is usually practiced until the axis of the hole is properly aligned with the axis of the drill. In such a situation a lot of time is being wasted to maintain the accuracy. Eventually it increases the operator's fatigue. The main aim of this project is to locate, hold and support the work securely so that the required drilling and tapping operation can be performed automatically which reduces the machining time and operators fatigue. The micro controller was used to control the tool path movement as well as clamping and declamping of workpiece. Embedded programming has been developed to perform these operations. The input operating conditions like feed rate, rotational rpm and cutting force has been calculated and fed into the memory unit of the micro controller through HMI. Based on the input communication provided through HMI the drilling and tapping operation will be performed automatically thereby it reduces the machining and operation time.

I. INTRODUCTION

This project Three Axis CNC drilling and Tapping is an automatic drilling and tapping machine that uses a microcontroller to drill and tap holes in a workpiece with precision with the help of a program. The microcontroller is used to control the movement of the tool in all 3 directions to performdrilling and tapping operations, accurately and efficiently.The drilling unit is used to create the holes in the workpiece, while the tapping unit is used to create the threads in the holes. Automatic drilling machines and tapping machines are used for drilling or threading holes in each surface. The models that combine the functions of drilling machines and tapping machines are referred to as the automatic drilling and tapping machines. Vertical drilling machine, also known as the drill press,

is the most commonly used drilling machine. When selecting a drilling machine and tapping machine, one must take the length of the thread to be formed, the material to be drilled or tapered, and the accuracy into consideration.

On the other hand, common types of tapping machine include pneumatic tapping machines and thread tapping machines. A pneumatic tapping machine is a tapping machine that incorporates air compressing mechanism. Specialized drilling machines and tapping machines are utilized for glass, plastics or woods that standard drilling and tapping machines could not use otherwise. All of these drilling and tapping machines are all commonly available.

2. METHODOLOGY

2.1 Cconceptual Design

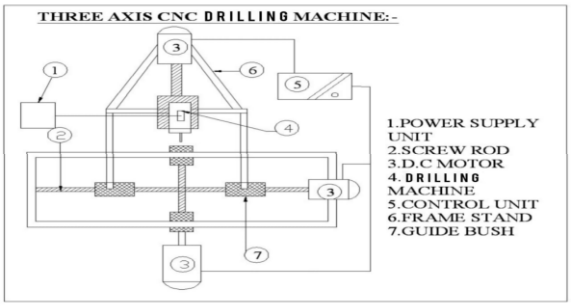

Figure.2.1

2.2 List of Components

S.No	Parts	Qty
1	DC Motor	3
2	Bearing	6
3	Lead screw	3
4	Frame	1
5	Drilling machine	1
6	Bolt & Nut	6
7	Bearing cap	6
8	Plate	3
9	Vice	1
10	Tool holder	1
11	Battery	1

2.2 Working Principle

The main objective of this project is to create a highly efficient and precise drilling system that can automatically drill holes of different materials. To perform the Operations with less effort by reducing the time taken for changing the tool. It is used with automation for automatic drilling and tapping.

The experimental setup consist of three motors, all are of Permanent magnet D.C motor type. Three motors, Drilling machine and microcontroller unit are used this projects.

Motor 1 – X direction

Motor 2 – Y direction

Motor 3 – Z direction

Keypad is used to set the three motor rotations and movement is controlled by the control box. We can change the movement distance by using switches. The drilling machine is fixed at the up/down movement (Z-Axis) with suitable arrangement.

3 Results and Discussion

This project was developed in view of reducing the machining and idling time during the drilling and tapping operation, and trails were conducted for three different materials with different thickness to calculate the machining time required by the existing machine and our model.

Based on the trials conducted the bar charts were plotted to show the machining time required to perform the drilling and tapping operation in which our proposed model produces more number of products when compared with the existing model therby it increases the productivity. Though there are various controllers are used to control the movement of the tool, microcontrollers are used because it is cost effective and suitable for small scale production.

Since it uses a microcontroller it is a highly precise,efficient and capable of performing complex operations with ease. The machining time required to complete the operation for different materials having different thickness has been calculated by conducting the experiments and results are tabulated.

The following table 3.1 shows that three different material with same thickness (3 mm) was used and machining operations were carried out and time taken to complete the operation was tabulated below.

Table: 3.1

S.No	Material with 3 mm thickness	Manual operating Time (s)	Automatic operating Time (s)
1	Plastic	1.4	1.1
2	Wood	2.5	2.1
3	Mild Steel	3.6	3.3

The following table 3.2 shows that three different material with same thickness (6 mm) was used and machining operations were carried out and time taken to complete the operation was tabulated below.

Table: 3.2

S.No	Material with 6 mm thickness	Manual operating Time (s)	Automatic operating Time (s)
1	Plastic	2.4	2.2
2	Wood	3.4	2.8
3	Mild Steel	4.1	3.7

The following table 3.1 shows that three different material with same thickness (3 mm) was used and machining operations were carried out and time taken to complete the operation was tabulated below.

Table: 3.3

S.No	Material with 9 mm thickness	Manual operating Time (s)	Automatic operating Time (s)
1	Plastic	3.5	3
2	Wood	3.6	3.1
3	Mild Steel	4.6	4.2

3.1 Machining time comparison

Figure 3.1 shows that time comparison between manual operation and automatic operation taken for drilling a Plastic material of different thickness. (i.e 3mm,6mm & 9mm)

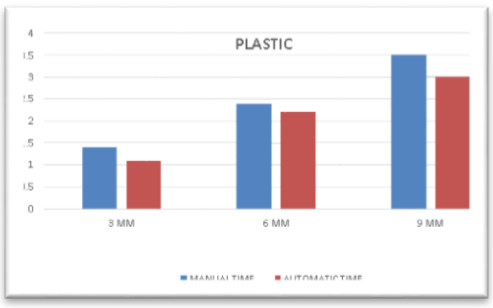

Figure.3.1

It is evident that the difference between 3mm and 9mm comparatively higher than 6mm the reason is due to impact load applied 3mm plastic material may lead to deform.

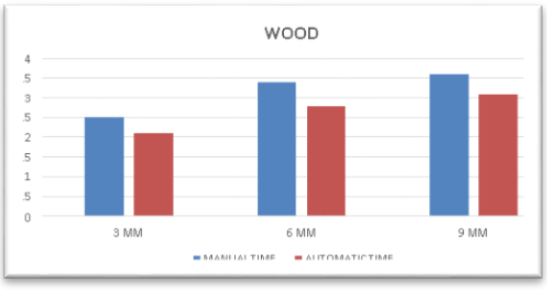

Figure.3.2

Figure 3.2 shows that time comparison between manual operation and automatic operation taken for drilling a wood material of different thickness. (i.e 3mm,6mm & 9mm)

From this figure difference of 6mm is comparatively higher than 3mm and 9mm reason is may be due to human error.

Figure 3.3 shows that time comparison between manual operation and automatic operation taken for drilling a Mild steel material of different thickness. (i.e 3mm,6mm & 9mm)

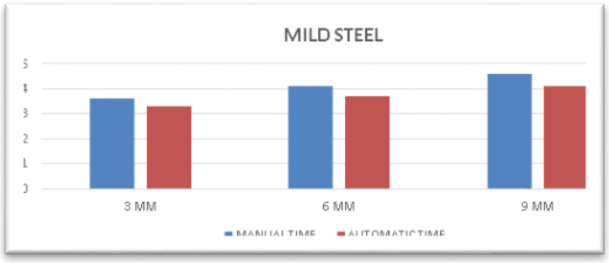

Figure.3.3

Figure shows that time difference between manual operation and automatic operation taken for drilling a Mild steel material for different thickness comparatively all the materials took optimum less time compared with manual operation.

3.2 Cost Estimation

Total cost = Material Cost + Labour cost + Overhead Charges

Total cost = 18330+1500+991 = Rs. 20821

3.2.1 Payback period

Let us consider a 9mm mildsteel material need to be drilled.

Manual operation cost & Production:

Time taken for manual drilling operation = 4.4 sec

So, for 1 work piece = machining time + loading / unloading time

= 4.4 sec + 10 sec = 14.4 sec

For 1 minute = 4 work pieces

Therefore for 1 hour = 240 work pieces

Automatic operation cost and Production:

Time taken when drilling operation our machine = 4.1 sec

So, for 1 work piece = machining time + loading / unloading time

= 4.1sec + 7sec = 11.1 sec

For 1 minute = 5 work pieces

Therefore for 1 hour = 300 workpieces

Let us assume a manufacturing unit performs drilling operation for a day.

For 1 hour, we can produce 240 drilled work pieces by manually.

Total work piece = 1920 in a day for 8 hours.

For 1 hour, we can produce 300 drilled work pieces using Automatic machine

Total work piece = 2400 in a day for 8 hours.

Difference b/w Automatic & Manual operation is = 2400 – 1920 = 480 Work pieces / day

If we assume Cost per drill = 1 Rs / WP (vary for different type of WP)

Therefore, using our automatic machine, we can show a profit level of Rs. 480 per day for 8 hours.

Therefore, the payback period is 44 days.

4. Conclusion

This project Three axis CNC drilling machine was fabricated successfully using microcontroller. Later real time test were conducted on different materials and satisfactory results were obtained. This project can be improvised by changing the controlling method i.e in place of microcontrollers PLC's can be adopted so that it can be suitable for Industrial requirements. The force required to produce the hole cannot be varied without changing the program is a drawback in this model so the implementation of proper force measurement device the force required to pierce the hole can be identified and used for effective utilization of this model.

REFERENCES

[1] De-Yuan Zhang and Ding Chang Chen, Relief face friction in vibration tapping, International Journal of Mechanical sciences, 40, (12), 1998, 1209-1222.

[2] E. D. Doyle and S. K. Dean, Effect of axial forces on dimensional accuracy during tapping, International Journal of Machine Tool Design and Research, Pergamon press, Vol. 14, 1974, 325-333.

[3] E. D. Doyle and S. K. Dean "On tapping torque and tap geometry". Division of Manufacturing Technology Annals of the CIRP, CSIRO, Melbourne, Australia, 1980, pp. 1-4.

[4] E. J. A Armarego and Marilyn N. P. Chen, Predictive cutting models for the forces and torque in machine tapping with straight flute taps, Department of mechanical engineering, The university of Melbourne, Australia, 2001

[5] E. M. K. Lai and K. S. Chan: "Design and development of an automatic drilling and tapping machine with PLC control." Journal of Manufacturing Technology Management, vol. 14, no. 1, 2003, pp. 51- 60

[6] G. Lorenz, "on tapping technology, Annals of the Melbourne, Australia, 1980, pp. 1-11

[7] Manish kale, "Design, fabrication, and analysis of special purpose machine for drilling and riveting operations", V-5 No.1, IJRSE, ISSN: 2319-3182, February 2016, Pune University.

[8] Jahanzaib M. Khattak, Usman Tariq, and Asif Ali: "Design and fabrication of an automatic drilling and tapping machine using programmable logic controller (PLC) and human-machine interface(HMI)." Journal of Mechanical Science and Technology, vol. 35, no. 2, 2021, pp. 513-521.

[9] M. A. Razzaque, M. A. Hannan, and A. Z. A. Saifullah: "Design and development of an automatic drilling and tapping machine for mass production." Journal of Mechanical Engineering, vol. ME 41, no. 2, 2010, pp. 45-53.

[10] Prof. P.R. Sawant, Mr. R. A.Barawade, "Design and development of SPM-a case study in multi drilling and tapping machine", IJAERSE- ISSN2249–8974 Vol. I Issue II January-March, 2012.

[11] S. S. Patil, S. S. Pande and S. Somasundaram, Some investigations on vibratory tapping process, International Journal of Machine Tools Manufacture, 27(.3), 1987, 343-350.

[12] Shaik Subhani, Md. Azaruddin, and Mohammed Arif: "Design and fabrication of automatic drilling and tapping machine using Arduino controller." International Journal of Innovative Technology and Exploring Engineering, vol. 8, no. 7, 2019, pp. 1177-1180.

[13] S. S. Kumaravel, A. Rameshkumar, and R. Thirumalai: "Design and development of a low-cost automatic drilling and tapping machine." International Journal of Advanced Manufacturing Technology, vol. 96, no. 1-4, 2018, pp. 285-292

[14] Werner Babel, Pfronten, Fed. Rep. of Germany."Milling Head," United States Patent. Sep. 1994

[15] Yousef M. Abujela, A. Albagul, Ibrahim Masur, and Obida M. Abdallah, "Automated drilling machine based on PLC", IJISET, Vol. 2 Issue 3, ISSN: 2348-7899, March 2015, University of Lybia