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Design and Optimisation of 3 Axis CNC Wood Carving Machine

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Abstract:-As a result of rapid growth in technology and industrialization, the utilization of CNC machines in industries has increased. The fabrication of low-cost CNC machines is used to reduce the cost and complexity of machining. This paper deals with the design of a three-axis CNC operated wood carving machine. The idea behind this project is to carve complex profiles on wood in low cost by using micro-controller. The microcontroller converts the profile into G codes which instruct the stepper motors to rotate. Due to its low cost and ease of use, no technical knowledge is required to operate the wood carving machine.

I. INTRODUCTION

Wood carving involves various techniques of removing wood from a raw material and finishing it into a carved object. This involves various traditional carving tools such as achisel, gouge, knife, and hammers.

Wood carving system is used to engrave the wooden particles. It is difficult to carve complex profile manually, so woodcarving system is introduced. Wood carving system is designed at low cost so that all the carpenters can afford it.

Wood carving tool (router) is guided with a jig. It uses two-axis to create geometry. The supporting column guides the tool in alinear direction. The system is operated by using stepper motors integrated with amicrocontroller. It differs from the traditional wood carving system as it uses a string to drive the tool. The required drawing or pattern is drawn with CAD software. G codes are generated according to the pattern by using CAM software.

II. LITERATURE SURVEY

A. According to the x-Y Plotter System.

By moving the first belt, the arm is moved along the length of the first belt or in the X-direction. By moving the second belt the firstbelt is keptstationary and the carriage is moved along the length of the arm in the Y-direction [1].

When the XY table is moved in X direction, Y direction isnormal to the X direction. [2].

The mechanism helps in converting the rotary motion into linear motion. [3].

Flat-bed plotters of this type are used for drawing, cutting, milling or similar operations, with the appropriate tools being set in the tool holder. In flatbed, a beam-shaped tool carriage having opposite ends and movable in a first coordinate direction; a tool holder slides disposed on said tool carriage and movable in a second coordinate direction orthogonal to said first direction [4],[5].

The basic mechanism of operating a 2-dimensional plotter, the device has ten pulleys, six cables, two rails, and a stylus. Pulley 1 connects to pulley 2 via a short infinite reciprocating cable. Pulley 2 connects to 3 via a longer reciprocating cable attached along its upper course to one end of the vertical rail (6), and then a third cable runs from 2 to 3, 4, and 5 via another much longer loop of cable between 4 and 5 to the other end of the vertical rail. Likewise, A connects to B, B connects to C and attaches to the horizontal rail (F), and finally B connects to C, D, and E, attaching to F at its other end between D and E. Turning pulley 1 counterclockwise makes 2 rotate the same way, and this makes all pulleys connected to 2 (3, 4, and 5) do the same. The rail these cables connect to (6, connection points marked in red) move to the left, both at ends, making the stylus move in the same direction along the other rail (F). Clockwise movement of the first pulley has the opposite effect. Pulleys A-E operate the same as 1-5 and act on the horizontal rail (F) to slide the stylus up and down along the vertical one (6) [6].

B. According to Woodcarver And Engraver Comprising

The cutting or carving tool utilized is a conventional hand-held power router, which is mounted to the unit [7], [8], [9].

The object of this paper is to provide a simple fixture for positioning and guiding a hand-held router around a stationary wooden workpiece in order to create anengraving of variable depths and widths which may be consistently repeated within a particular workpiece or between various workpieces [10], [11].

This paper deals with aworker who will allow a relatively unskilled operator to efficiently, effectively and rapidly

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produce a great number of engravings of consistent quality and with a minimum of error [12].

The developed mathematical model and computational procedure allow for significant reduction of theprocessing time of CNC routing operation of solid wood. In turn, when milling, the only active constraint is surface finish. Generally, application of variable feed rate for wood routing is essential to gain high productivity and to take full advantage of machine capabilities [13].

By using Linear Motion Guideway, a high accuracy & precision motion can be obtained. It has various advantages like easy installation, operation, installation, long life with high accuracy and high positional accuracy [14].

The Linear Motion Guide ways provide a smooth and linear motion in machine tools, due to which higher accuracy and precision can be obtained [15].

Small-scale parts are fabricated using small machine toolswhich provide both flexibility and efficiency in manufacturing approaches and reducesthe capital cost, which is beneficial for small business owners [16].

G codes insist the stepper motor rotate or stop the process whenever needed. Making a small machine brings a flexibility to do the work [17].

This is a low-cost project as compared to other CNC product. The machine is designed with a very simple construction scheme and can be carried anywhere without much effort. The algorithm used is simple. The pen can be replaced with a pinhead or laser head or any other tool for thedifferent purpose of use [18].

In this paper, a low-cost, desktop prototype 3-axis vertical CNC mill is developed. Open source microcontroller platform Arduino is used for control of the motors, and open source software is used for executing the G code and M code for machining applications [19].

In this paper, the three-axis motion is controlled by Arduino Uno board with Atmega [9] 328p microcontroller. The Arduino works here as an open source burner which burns the microcontroller with given hex codes [20].

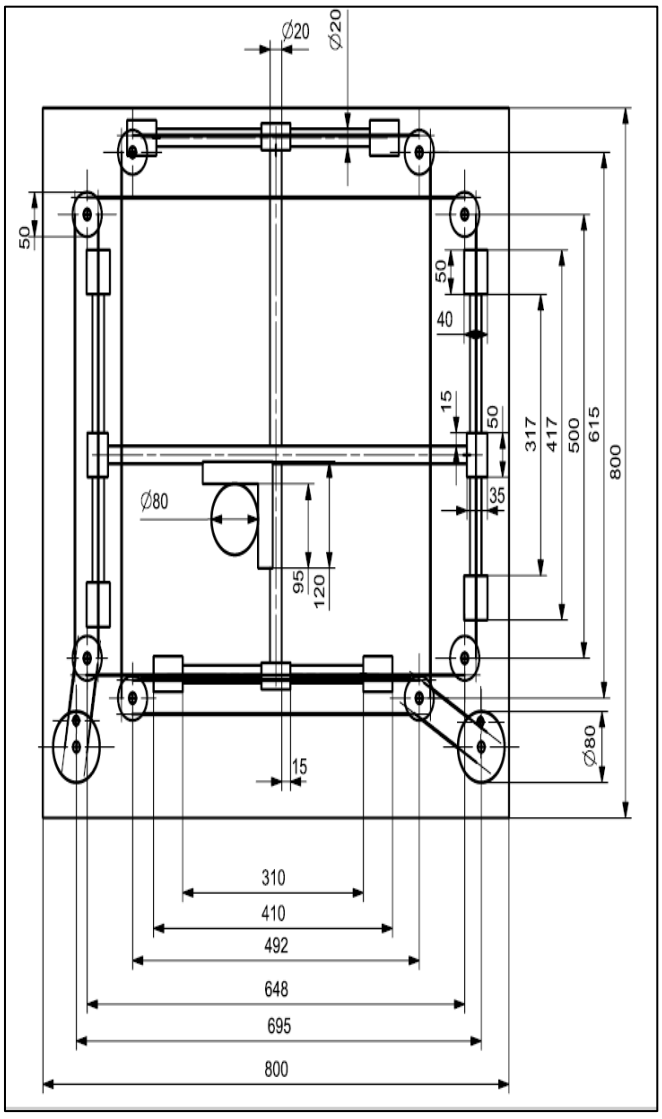
III. PROBLEM IDENTIFICATION

From the above literature survey we found that:

- According to the journal, sliding motion achieved by using thelead screw is costlier [2].
- Under the basic two-dimensional plotting mechanisms, belts are not friendly to use [3].
- Using linear motion guide ways increase the manufacturing cost [14].
- Instead of using guide ways,a shaft with sliding mechanism is more convenient to provide the linear motion [15].
- Economically, a simple clamping is enough for the workpiece while machining the wood [10], [11].

IV. CONSTRUCTION

It consists of shaft, pulleys, cutting tool, rope, stepper motors and microcontroller. The cutting tool is attachedto a linear arm. This attachment is mounted on a bracket to move in the linear direction. The sliding mechanism is used to achieve the linear motion. The vertical motion and horizontal motion is achieved by mounting the pulleys in a loop system. The motor bracket is attached to thestepper motor in order to provide continuous rotation. The carving tool utilized is a conventional hand-held power router, which is mounted to the unit.The sliding bars are used to guide the axis movement. The string attached to the sliding bars helps in moving the setup. The axis movement is achieved according to the number of rotations of driver pulley. Two sliding bars are used to achieve x and y-axis movements. The cutting tool is fixed in the center to machine the wood according to the required profile.



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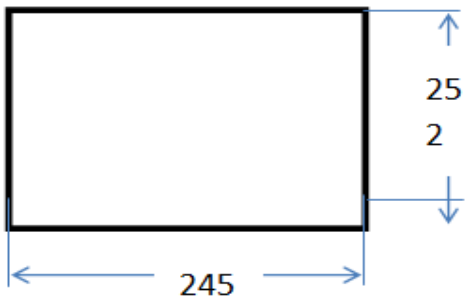
V. WORK AREA



Area of work = 245 × 252

= 61740 mm²

A. Distance Traveled By the Wire Rope

Circumference of the pulley = 2πr

= 2 × π × 27

= 169.56 mm

Distance travel by the wire rope = 16.95 cm

VI. WORKING

When the driver pulley is rotated, the driven pulleys are rotated by using wire rope. The driven pulley helps in attaining the axis movement. The sliding bars are used to guide the axis movement. The string attached to the sliding bars helps in moving the setup. The axis movement is achieved according to the number of rotations of driver pulley. Two sliding bars are used to achieve x and y-axis movements. The cutting tool is fixed in the center to machine the wood according to the required profile. The depth of cut is provided by using rack and pinion mechanism provided by the jig. The feed is provided by using micro-controller. The micro-controller insists the stepper motors to rotate in a specific rpm to obtain arequired profile. The cutting tool is then guided by stepper motors to attain complex profile.

VII. ADVANTAGES

- Low cost
- Easy operation
- Can be used for multi purposes
- No complex mechanism is involved

VIII. CONCLUSION

The developed prototype exhibits the expected results. Further modifications and working limitations will put this work in the main league of use. The operating procedure of the system is very simple. So any person can operate. By using more techniques, this can be modified and developed according to the applications. This concept saves time and money. The machine will help carpenters by reducing their expenses. The carving of names can be done only by a CNC. By using manual wood carving machine the carpenter need not go for Computer Numeric Control.

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