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An Advanced Chamfering System

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ABSTRACT

This paper describes a system for automated surface finishing operation. A complete model is developed for chamfering on edge of the square type geometry. An experimental platform is developed for automated chamfering. The advanced chamfering system consists of assembly which have x y table, frame and chamfer tool. The advanced chamfering system approach to finish parts can reduce the manufacturing cost of a part by scrap and rework, and improving the quality.

Introduction

To be competitive in today's marketplace manufacturer must be able to change quickly in response to demands. This flexibility must be attained without sacrificing quality or productivity.

Conventional machine tool operated by CNC, are used to remove material in large amount to shape a part to its desired geometry. This machined parts requires finishing operation in which small amount of material is removed to bring the part to required tolerance. Example of this surface finishing operation is chamfering, grinding and deburring. These surface finishing operation constitute a significant amount money and effort in industry. Automation of these operations is very important and crucial in industry.

Automation is a step beyond mechanisation. Automation plays an increasingly important role in the world economy and in daily experience. Presently, manual finishing accounts for 12% of the total labor cost and 10%–30% of the manufactured parts need rework after the manual finishing process. By automating chamfering process, tolerances could be held to less than 0.07 mm (0.003 in), the finishing costs could be reduced as much as 50%, and the rework rates could be nearly eliminated. Chamfering is required for the variety of the reasons: to guarantee component fit, prevent injury to worker, enhance part appearance.

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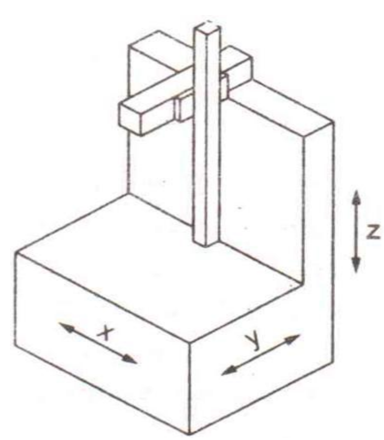
Conceptual models

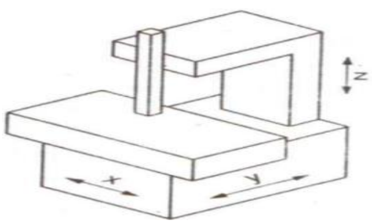
The machine incorporates the basic concept of three coordinate axes, so that precise movement in x, y, and z directions is possible. Accordingly, there may be five types of arrangement:

Cantilever type arrangement-



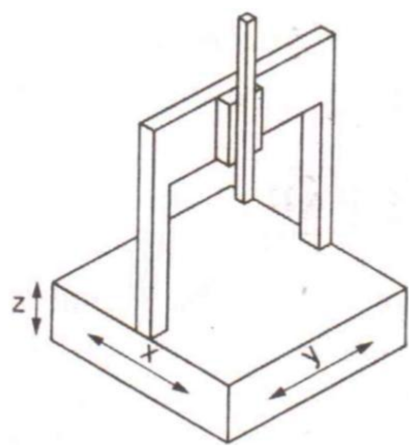
For a cantilever type, a vertical tool moves in the Z-axis, which is attached to a cantilevered arm that moves in the Y-axis. This arm also moves along the X-axis, or the table can have X-axis independent travel. The cantilever construction combines easy access and relatively small floor space requirements. It is typically limited to small and medium sized machines part. Parts larger than the machine table can be inserted into the open side without inhibiting full machine travel.

Column Type arrangement-



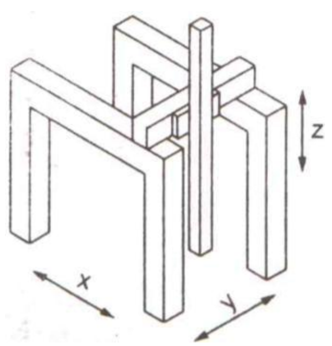
Column type structure is very rigid and accurate. The Z-axis is connected to the arm and the table moves independently in the X and Y-axis. The constructional difference in column type with the cantilever type is with x and y-axes movements.

Bridge Type arrangement-



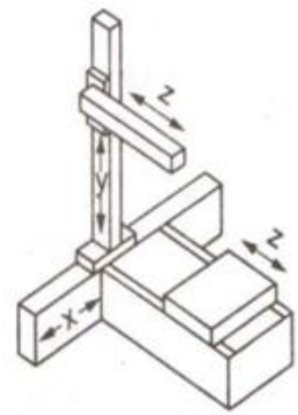
The bridge type structure is similar to the cantilever type because of the Y-axis support. The bridge construction adds rigidity to the machine, but both ends of the Y-axis must track at the same rate. Loading the machine part can be difficult at times because there are two legs that touch the base.

Gantry type arrangement-



For the gantry type structure, support of the workpiece is independent of the X and Y axes, which are overhead and supported by four vertical columns rising from the floor. One can walk along a workpiece with the tool, which is helpful for very large workpieces.

Horizontal type arrangement-



In the horizontal type arrangement, the tool is carried along the Y-axis moving arm. The Y-axis arm moves up and down on a column for Z-axis travel, and the column can move along the edge of the work table in the X direction. It has a very large, unobstructed work area, which makes it ideal for very large parts.

Required parameters for the selection of model-

Following are the required parameter for the selection of best suitable model structure -

1] Simplicity in the structure.
2] Rigidity of the structure.
3] cost.
4] Easy loading of the workpiece.
5] Floor space.

Proposed model -

According to above parameters column type structure model is best suitable. Because column type structure is simple in construction. The column type structure is also rigid as compared to other. Overall cost associated with this model is less as compared to other model. Loading of the work piece on the table is easy due to openness of all positions. Structure is build according to work piece area, so the floor space required is less as compared to other model.

Features of Advanced chamfering system include-

operator– controlled.

A graphical user interface to exploit the CAD part models to generate offline part program.

Feature based chamfering process.

To maintain the constant cutting force on the edge an active tooling is used.

A typical advanced chamfering system consists of metal frame, XY table, chamafer tool, lead screw, and square type workpiece. Wooden XY table is used, movement of this table is done through channels engaged in table. The cost associated with the metal made XY table is too high to make prototype, so the good replacement to it is wooden XY table which is situated on the base frame. In this system the chamfering is done through movement in X,Y direction and in the Z direction the tool is stable, only the tool rotate in Z direction. Depth of cut is kept constant

Throughout the chamfering process and it is adjustable in the frame structure. Controller is designed to operate the motors, which enables the movement in X,Y direction and tool rotation.

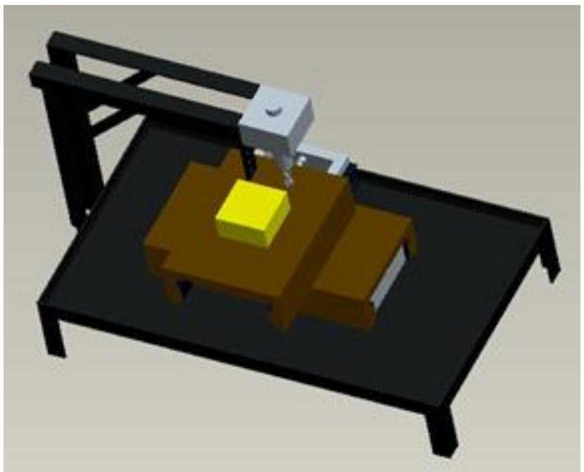


Fig- solid model of the advanced chamfering system

A typical automated surface finishing process i.e, chamfering involves the following sequence: the tool starts from the home position and moves freely for some time, and makes contact with the workpiece, follows the workpiece contour while removing material, and leaves the surface returning to home position.

In case of complex contours with disconnected segments on the same workpiece to be machined, the tool has to leave and makes contact with the workpiece several times. In chamfering operation it is typical that the part to be machined has very high stiffness. On the workpiece if the tool impacts with non zero velocity, than there is a possibility of bouncing behaviour. It is very important to minimize these bounces during transition and to maintain stability of the tool for the entire operation.

The material removal rate (MRR) of a chamfering pass is a function of the velocity of the tool bit along the edge and the cross sectional areas of chamfer. This relationship can be expressed as:

MRR= Area of chamfer × velocity of tool

Parameters in the above equation is function of the other parameter such contact forces and stiffness of material. The cutting force in a chamfering operation is a nonlinear function of the feedrate and the depth of cut. The cutting force can be resolved in to planer normal and tangential components.

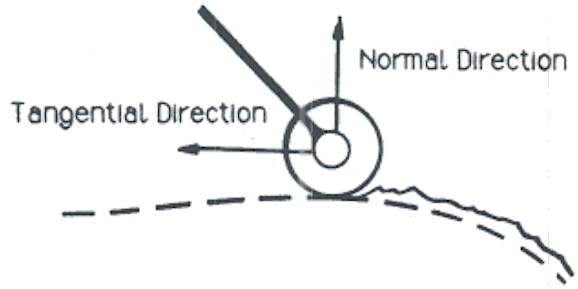


Fig- Chamfering pass.

The chamfer depth must often within specific tolerance. Part fixturing error and burrs are other potential disturbances. To obtain more accurate control it is necessary to obtain sensory feedback related to chamfer depth. For a given material, if burrs are present and small relative to depth, and feed rate is constant, the depth will be proportional to the forces. When there is material hardness or feed rate variation, or burrs relatively large to depth the force is no longer an accurate measure of the depth. Force control is also prone to overshoot or even instability at the time of initial tool/part contact.

` Given an accurate sensor measurement, the depth can be controlled by performing corrections to tool path. These corrections are typically performed in the direction normal to the chamfer surface. The correction may be performed by either passive or active control.

Conclusion

For the advanced chamfering system the model is chooses according to parameters such as simplicity in the structure, rigidity of the structure, associated cost, easy loading of the workpiece, floor space. Selected model is simple in construction and also rigid as compared to the other model. Overall cost associated with the structure is also less .Loading of the workpiece is also easy and floor space required for setup is also less.

Key features of Advanced chamfering system are-

1. operator– controlled.
2. A graphical user interface to exploit the CAD part models to generate offline part program.
3. Feature based chamfering process.
4. To maintain the constant cutting force on the edge an active tooling is used.

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