EVALUATION OF POSITIONING ACCURACY OF DESKTOP MACHINE TOOL

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ABSTRACT

In recent years, the further miniaturization of products and machine parts is progressing. On the other hand, the size of the machine tool has still remained from the conventional size. Since the rigidity is regarded as the most important in the design of machine tools, therefore downsizing of machine tools has not considered much [1].

Therefore, we propose a unique machine tool which consists of hollow CFRP pipes, and it has driven by the original NC controller. It has truss structure, thus we can save the space for setting machine tools. In addition, it has also the enough high rigidity [2].

In this paper, it will reported the measurement results of positioning accuracy. Thus, we solved the torque deficiency to drive with harmonic drive reducer unit. In addition, we also estimate its control performance when simple machining test is carried out with this machine tool.

DESKTOP MACHINE TOOL

The schematic diagram of the desktop machine tool is shown in Fig. 1, and the specification table is shown in Table 1. Since commercially available compact machine tools generally have a side of 1000 mm and a mass exceeding 200 kg, it is considered that sufficient miniaturization has been achieved.

This machine tool consists of a pipe frame structure for the bed in order to reduce its weight. In addition, the table is tilted 20 degrees to increase the eject ability of the chips. This machine adopts a helical rack and a worm gear for feed drive. A configuration diagram of the device is shown in FIG. 3. The rotational power output by the servomotor is amplified by way of the speed reducer, and its output is transmitted to the worm gear by the timing belt, so that the worm gear rotates, which
causes the helical rack to make rectilinear motion. Similarly, the table and the main spindle slide have a structure that makes rectilinear motion. By adopting this mechanism, it is possible to reduce the influence of chips by allowing the feed drive to fit under the table.

CONTROL SYSTEM

All the control systems of this machine are using our own control system. Fig. 2 is a diagram showing the control model. Controllers and software adopt National Instruments’ FPGA module and LabVIEW respectively. In addition, there are features such that two control methods can be arbitrarily switched. Semi-closed control using feedback from the rotary encoder attached to the servomotor used for feed drive and full closed control using feedback from the linear sensor attached to the linear guide. The block diagram of the feed drive system for the desktop machine tool is shown in Fig. 3.

MEASUREMENT TESTS OF POSITIONING ACCURACY

The measurement tests of the positioning accuracy were carried out (based on JIS B6190-2) by using a laser measurement system (XL-80 RENISHAW). The target positions were set to be 9 points at 15 mm interval. Measurements are made five times in the + and - directions, respectively, and the positioning accuracy and backlash are evaluated. Figure 4 and 5 shows the schematic diagram of measurement tests and measurement results of positioning accuracy of X-axis with semi-closed control. It can be seen from the results that the positioning error increases as it approaches the target position. In addition, it has the backlash at 40 μm.

Then, the measurement tests carried out with full closed control system also. As the results, the positioning accuracy was 19 μm, which was improved by 94% compared to the case of semi-closed control system. Backlash was also reduced to 3.1 μm. In desktop machine tools as well as general machine tools, it was shown that full closed control is effective for precise positioning.

CONCLUSIONS

The measurement tests for positioning accuracy were carried out. Then, its positioning accuracy and backlash with semi-closed control and full-closed control respectively.

As the results, with semi-closed control, the positioning accuracy deteriorates due to the pitch error of worm gear and helical rack. On the other hand, the positioning accuracy is improved by 94% and backlash is reduced to 3.1 μm by full-closed control.

REFERENCES