 Proceedings of ICCES'08, pp.1269-1269

Measurement and Machining by using Polar Coordinate Desktop Machine Tool

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Summary

Along with miniaturization and diversification of products, development of machine tools suitable for measuring and machining small parts or complicated free-form surface are on demand. In this study, a polar coordinate desktop machine tool(P-DTMT) with 2 rotary motions and 1 linear motion that is a suitable formation for such measurement and machining in arbitrary moving in polar coordinate space is developed.

This P-DTMT has 1 linear motor for R-axis and 2 servo motors for θ and ϕ-axis and can arbitrary move in polar coordinate space. A touch trigger probe is mounted on the top of R-axis. Thus it register the position of their axes when contact occurs between the probe tip and the object. Resolution of encoders are 0.1 μm(linear axis) and $7.85 \times 10^{-}6$rad(rotary axis)

Various error factors have influence on this P-DTMT. Especially assembly errors in P-DTMT are identified and corrected by using form generation theory. 10 parameters related assembly errors are identified in turn by combining measurement of a master ball(roundness 0.55μm) and a block gauge (2^{nd}-class) and calculation.

Measurement accuracy of P-DTMT is investigated by measuring length of block gauges. Assembly errors subsisted in P-DTMT are correctly identified and moreover measurement accuracy is able to improved by applying form generation theory. In this polar the calibration process was proposed to companste the accuracy of movement. Polystyren foam which has complicated form was machined and measured by P-DTMT. It is found that this type of machine tool is available to machine and measure for free-form surface.

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