ABSTRACT

A 2½ dimensional measurement and inspection system realized on the machine tool using a touch trigger probe and measuring G codes is synthesized in this paper. Measuring G codes have been constructed according to geometric forms, precision attributes, relationships between two parts, datum hierarchies, and relevant technological data by using measuring arguments. Algorithms for calibration and compensation of measuring errors are proposed to ensure the measuring accuracy by using a laser interferometer and ring gauges. Classification of feedrates according to the objectives of movement makes it possible to reduce measuring time and also implement collision-free measurement. Experiments are conducted to verify the validity and effectiveness of proposed methods.

1. INTRODUCTION

On-machine inspection systems can be used to inspect dimensional errors of workpieces with respect to design requirements on the machine tools. Efforts have been devoted to develop accurate and rapid measurement systems on the machine tools[1~4]. Many kinematic reference standards and artefacts such as magnetic ball bars, master disks and ball plates have been used to calibrate the accuracy of machine tools[2~6]. In order to reduce measuring time of inspection processes, some of research works have been studied on coordinate measuring machines [7~8].

In this paper, we propose a design methodology of the 2½ dimensional measurement and inspection system realized on the machine tool using a touch trigger probe and measuring G codes. Items considered in the system design are 1) accuracy insurance of measuring results, 2) reduction of measuring time and countermeasure for probe protection, and 3) improvement of measuring and inspection processes.

Algorithms for calibration and compensation of measuring errors are proposed to enhance measuring accuracy by using a laser interferometer and ring gauges. Classification of feedrates according to the objectives of movement can reduce measuring time and implement collision-free measurements. All functions needed for measurement and inspection processes have been constructed as measuring G codes, which have similar forms with machining G codes. Arguments of measuring G codes are as follows: geometric forms, precision attributes, relationships between two parts, datum hierarchies, and relevant technological data. Comparing the developed system with the previous on-machine measurement and inspection system[9], problems such as difficulties in management of measuring part programs, needs of experts and the frequent walk between a CNC and a PC can be minimized through the measuring G codes. The validity and effectiveness of the developed system has been confirmed on a vertical machining center.

2. MEASURING ERRORS

Fig. 1 shows measuring errors generated due to discrepancy between the ideal contact point and the position recognized by a CNC on the machine tool. These measuring errors are caused by geometric errors of the machine tool, probing errors, and fixing errors of a probe assembly. The probing errors mean probe lobing errors and axis reversal errors[3].

Fig. 2 shows a typical error pattern due to measuring errors when a ring gage is probed with a