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Knowledge base model for automatic probe orientation and configuration planning with CMMs

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ABSTRACT

Different support applications are available for generating programs to run inspection with Coordinate Measuring Machines (CMM). However, the operator must decide the criteria and strategies to apply, so that quality of inspection depends on his knowledge and skills. Nevertheless, many of the activities involved in inspection planning are repetitive, therefore an adequate formalization of the involved knowledge makes it possible to develop applications to automate inspection and, thereby, to avoid operator errors during the decision making in planning. To this end, a knowledge base model for inspecting prismatic parts with complex surfaces has been developed. First, the required knowledge is represented in an informal model using an ontology called ONTO-Process. Later on, a formal model is generated that constitutes the basis for developing a computer application to support the automatic inspection planning. This article provides the definition and modeling of the necessary rules for one of the most complex activities to automate: determination of probe orientations in the inspection by contact of mechanical parts.

1. Introduction

To increase the level of automation of the different tasks involved in the planning of activities of the production cycle is a concern required every day more and more. Although some of the activities in the operation planning have already specific applications to generate the plans, other activities such as inspection are featured for the poor planning applications or the existent ones are very simple. In particular, in inspection planning with CMM there are several applications for supporting the planning work, but basically they are focused on machine program generation. The inspection operator is the responsible of making decisions to establish the criteria, strategies, resource selection, probe orientations and sensor paths for conducting the inspection. However, many of the activities involved in the planning are repetitive. Consequently, the extraction and structuring of knowledge involved in inspection planning would allow more efficient applications. Our research models the knowledge behind the best practices in the field. This knowledge has been collected from several sources (experts, research reports, guides, handbooks, etc.). In the cases where knowledge is not directly available, we describe and propose specific rules to represent it. The result constitutes a first step for developing computer inspection planning applications to help the operator to make decisions.

In this paper the scope is the inspection of mechanical type parts inspected by contact using a CMM equipped with an indexed head. It is worth mentioning that the focus is in inspection by contact with an indexed head and a straight tip, assuming it represents the most common case in real practice with touching probes. Therefore, star tips or scanning heads have been not considered in this research. This work is focused mainly in the planning related to probe assembly orientation in order to achieve the maximum precision whereas keeping the accessibility to inspection geometry, a critical aspect in CMM metrology. In a previous work [1] we settled down a conceptual basis which is now developed, extended and justified completely to consider different casuistry.

All research works found in this context are based on simplifications and assumptions which, in almost all the cases, make the problem of accessibility to be far away from industrial practice. The work of Spyridi and Requicha [2] has been considered during years the reference for subsequent works in the scope of accessibility. These authors defined the concept of cones of accessibility to determine both the probe orientation and the part orientation. They considered that a feature is accessible by a probe with a particular orientation in case that all points over it can be inspected without causing collision with the part or any other element of the environment. Spitz et al. [3] continued this work doing

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