Journal of Manufacturing Systems 37 (2015) 149–163

Contents lists available at ScienceDirect

Journal of Manufacturing Systems

journal homepage: www.elsevier.com/locate/jmansys

Technical Paper

KBE rules oriented to resources management in coordinates inspection by contact

S. Martínez-Pellitero [a,*], J. Barreiro [a], E. Cuesta [b], A.I. Fernández-Abia [a]

[a] University of León, Department of Mechanical, Informatics and Aerospace Engineering, Campus de Vegazana, 24071 León, Spain
[b] University of Oviedo, Department of Manufacturing Engineering, Campus de Gijón, 33204 Gijón, Asturias, Spain

ARTICLE INFO

Article history:
Received 16 December 2014
Received in revised form 24 April 2015
Accepted 28 July 2015
Available online 17 August 2015

Keywords:
Knowledge
KBE
Inspection planning
Coordinates measuring
Contact inspection

ABSTRACT

Different proposals have been presented along last years with the purpose of automating the process of dimensional inspection planning with coordinate measuring machines (CMM) and touch probe technology. These proposals have focused mainly on particular items such as analysis of accessibility, orientation of the part or trajectory paths among surfaces or inspection points. The main limitation of these proposals is in the use of a predefined probe configuration, although current technology allows automatic probe change for improving the inspection process. In this paper, detailed rules are explained for developing a knowledge based engineering (KBE) application. These rules make it possible to incorporate the selection of the most appropriate configuration of sensor group with the basis of precision.

1. Introduction

One of the most important activities when carrying out inspection process planning is the selection of necessary resources to achieve results with the best possible precision. Once the capacity of a coordinated measuring machine (CMM) has been proved for inspecting tolerances associated to a particular part (uncertainty/tolerance correlation), the first task is to select the sensor configuration to be used. Then, the most appropriate probe orientations are determined for this configuration. However, sensor selection should be linked to linked to orientation of sensor group, since there is a direct connection among precision achieved in measurement, probe orientation and type of probe. In most cases, these relationships are not always well-known for CMMs operators and it is common to prioritize operation speed and easiness when selecting CMM sensors. In other cases, tacit knowledge of skillful operators is difficult to formalize and represent; in this circumstance it is a decision of CMM operator without aid of expert systems, routing sheets or orders derived from planning.

In this paper CMM operator knowledge is identified for storing it in the form of knowledge rules. An ontology called Onto-Process is used, specifically defined for process planning and, in particular, for inspection process planning [1]. The Onto-Process ontology is necessary for implementing a KBE system so that the process of inspection planning can be automated as much as possible, both for simple or complex parts.

Inspection activities are classified into two levels in the proposed model of knowledge:

- **Inspection macro-plan**. This plan includes high-level activities in the planning, such as the definition of the scope of inspection (for example, contact or no contact inspection, hybrid inspection with different inspection technologies, etc.), selection of CMM and the right head and probe body, identification of part position-orientation-fitting on the machine, classification of inspection elements and high level sequence of operations.
- **Inspection micro-plan**. Micro-plan includes low-level activities to specify with more details of the inspection operations to be carried out for each inspection element (sampling strategies, probes and probe modules selection, orientations, trajectories, number of points, etc.).

The work in this paper is focused on one of the planning activities, the planning of resources necessary for inspecting mechanical parts. In this paper developments belong to the micro-plan level. Many CMM operators use always a common and practical sensor configuration, without making a standalone approach to the matter. This is due to lack of time, resources and even the dispersion and absence of knowledge. So, although very much knowledge exists in

* Corresponding author. Tel.: +34 987 291000x5358.
E-mail addresses: smarp@unileon.es (S. Martínez-Pellitero), jbarg@unileon.es (J. Barreiro), ecuesta@uniovi.es (E. Cuesta), aifera@unileon.es (A.I. Fernández-Abia).

http://dx.doi.org/10.1016/j.jmsy.2015.07.005
0278-6125/