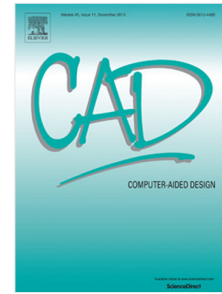


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# Automatic generation of efficient and interference-free five-axis scanning path for free-form surface inspection

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## Abstract

As a new contacting surface inspection technology, five-axis continuous sweep scanning enables a much higher inspection efficiency compared with the traditional three-axis point-by-point inspection. However, currently how to plan an interference-free scanning path for an arbitrary free-form surface still heavily depends on human intervention and the scanning path thus obtained lacks severely in inspection efficiency since the unique kinematic characteristics of the five-axis inspection are ignored. Motivated by these deficiencies, this paper proposes a practical algorithm for automatically generating an interference-free and efficient five-axis continuous scanning path for an arbitrary free-form surface. The algorithm adopts the guiding-path + trajectory-curve paradigm for the generation of scanning curves while the collision-free constraint on the stylus is taken care of by considering the aggregate accessibility of the reference curves. A digraph is then constructed on the aggregated accessibility domains of the sample points of the guiding path and the stylus orientation along the guiding path is determined by finding the shortest path in this graph. A simple surface partitioning scheme is also introduced in case a surface cannot be scanned in a single pass and needs to be divided into suitable smaller patches. Preliminary experiments in both computer simulation and physical inspection of the proposed algorithm validate that, when compared with the two leading commercial solutions, the proposed algorithm not only is fully automatic without relying on human intervention but also achieves a much higher inspection efficiency.

**Keywords:** continuous scanning path, interference-free, surface partitioning, graph-based optimization

## 1. Introduction

Five-axis sweep scanning is an emerging surface inspection technology that is becoming a popular and powerful means for accurate and efficient inspection of free-form surfaces. A typical five-axis inspection machine (as shown in Fig. 1(a)) is composed of a three-axis Coordinated Measuring Machine (CMM) (i.e.,

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