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Enhancing 3D Modelling Software for Inline Quality Control

Automated inspection of mechanical objects needs well-defined quality requirements in the form of tolerances. We want to move the process of specifying tolerances into the computer-aided design (CAD) systems. CAD software can also help studying the effects of different tolerance values. We take the most advanced open-source CAD system, BRL-CAD, and investigate how it can be modified to integrate tolerance specification.

Inline Quality Control

Mechanical Engineering

DSL

Automotive & Aerospace Industry

GD&T

Introduction

In the mechanical manufacturing industry there is an increasing demand for higher quality standards and decrease in the number of rejected parts. This trend is distinctively perceived in the automotive and aerospace industries. One of the measures taken to satisfy these increasing quality requirements is to apply automated quality inspection to all the instances of a manufactured component, as opposed to only testing samples.

Inspecting 3D Parts

Geometric and structural quality control requires the set-up of the following main processes: acquiring 3D data by techniques of non-destructive 3D scanning, reconstructing a digital model, matching the nominal CAD model with the reconstructed one, and performing the comparison between the models. The data about the allowed deviations must be provided in the form of tolerances, and we want to define all tolerances with the help of the software used for modelling.

Choosing Tolerances

The main focus of the study is the integration between CAD software and tolerance specification. The state of the art in tolerance specification using CAD software is presented, and the still standing major problems are identified: no tolerance analysis method has proved clearly superior, and mainstream CAD software was late to introduce tolerance analysis functionality, while none of the open-source suites provides this type of capability at all.

Having tolerancing functionality in the CAD software can help not only with inline checking, but also with sophisticated types of analysis: geometrical, for studying the effect on the fitting of components, and structural for the effects on the physical behaviour.

BRL-CAD - Case Study of a Powerful Suite

The main concepts in tolerancing are presented in a case study on BRL-CAD, the most advanced open-source CAD suite. The study goes then into the internals of BRL-CAD, presents the results of a week of efforts of integrating tolerancing functionality in BRL-CAD, and proves that many of the requirements for integrating tolerance analysis are already fulfilled by the suite.

While, with the current functionality, BRL-CAD cannot compete commercial suites in established production settings, it already contains many essential parts, and its open-source nature makes it an excellent platform for research and cooperation.

