

Chapter 5

Reverse Engineering: A Review & Evaluation of Contact Based Systems

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Abstract

This chapter focuses on contact based reverse engineering systems. The major technique that we describe here is the utilization of co-ordinate measuring machines (CMMs). Different types of CMMs available are detailed. In addition the performance parameters of these systems are discussed. This chapter also explains the integration of data acquired from reverse engineering techniques with other design and manufacturing related software systems. This chapter concludes with a brief description of the state-of-the-art CMM technologies.

Key words

AFM; computer aided design; computerized numerical control; contact based systems; coordinate measuring machines; data collection; digitization; haptic volume sculpting; IGES; MEMS; Nano CMM; performance parameters; point cloud; point preprocessing; probe

accuracy; reverse engineering; rigid body errors; scanning speed; STM; structural deformations; surface fitting.

5.1 Introduction

Reverse Engineering (RE) is the process of generating a Computer Aided Design (CAD) model from an existing physical part¹. It enables the reconstruction of an object by capturing the component's physical dimensions and geometrical features. Essentially, it is a converse product design approach where the designer begins with the product and works through the design process in an opposite sequence to arrive at product specifications such as dimensions and form. This enables the designer to mentally simulate design ideas that occur during the design of the original product. Reverse engineering is accomplished in three steps²:

- Part digitizing,
- Feature extraction or data segmentation, and
- CAD or part modeling

As described in an earlier chapter, reverse engineering methodologies can be broadly classified as (a) non-contact based and (b) contact based systems. Non-contact based measurement systems include laser scanning through structured lighting³, the Moire method⁴, and phase shift interferometry⁵ techniques. In spite of achieving high measuring accuracy, they are generally limited to conditions such as sensitivity to vibration, improper scanning due to reflective surfaces and the inability to react to drastic change in surface curvature⁶ such as concavities and hidden surfaces. Contact based methods, the more traditional manner of collecting data that has been utilized for several years, requires contact between the surface and a measuring device, usually with a probe or stylus. Contact based measurements are usually more reliable, but more time consuming.

5.1.1 Need for Reverse Engineering

In today's competitive market lead time compression in a product development cycle with increased product variety is the essence of survival for an organization. Reverse engineering methodologies play a critical role in assisting designers and manufacturers in shortening time to market for new products. Some reasons for reverse engineering of component or product assemblies are as follows: