Int. J. Metrol. Qual. Eng. **3**, 47–54 (2012)

DOI: 10.1051/ijmqe/2012003

Control of involute curve of gear tooth using the fuzzy logic

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Received: 12 February 2012 / Accepted: 24 March 2012

Abstract. Three dimensional coordinate metrology is a firmly established technique in industry. Scanning technology is now widely used in coordinate metrology and is increasingly used for the measurement of small features. This paper presents a new real shape approach to closest point inspection involutes curve of gear tooth by coordinate measuring machinery (CMM). This method aims to select the most likely contact point for each successive arc by applying geometrical criteria and a fuzzy logic estimator. This method is particularly, but not exclusively, suitable for the metrology of features with small radii as well as metrological discontinuities. It does not require obtaining the normal vector traditionally used for probe tip correction. Elapsed time is 144.09 s. Tests have been done on limps of machine tool speed (pinion type cutter), which is highly applied in our country.

Keywords: CMM; gear; scan probe; fuzzy logic

Nomenclature

Notation	Nomenclature
P_i:	center ball style
X_{si}:	point determine of vector normal (mm)
Δz_i:	distance between line $(P_{i+1}P_{i-1})$ and point P_i (mm)
Δk_i:	distance between line $(P_{i-2}P_{i-1})$ and point P_i (mm)
$\Delta\alpha_i$:	angle between normal vector (P_iX_{si}) and fuzzy logic vector (P_iX_{pi}) (radian)
ε_i:	error acceptance (mm)
r:	ball radius (mm)
X_{pi}:	Point determined by the logic fuzzy
X_{ci}:	Point of contact between sphere of probe and tooth surface in reality

1 Introduction

Coordinate measuring machines (CMMs) are becoming increasingly important in measurements and verification of dimensional quality of manufactured parts and products. On the other hand, the now a days gear measurement inspection of today refers to a description of the nominal gear geometry, which is limited to only a few prescribed tracks across the flank (profile, lead) or singular points (pitch). Principle of the new method of corrected measured point determination in coordinate metrology. It means, in order to accurately measure, amongst other things, small features, we propose a new algorithm for the compensation of the stylus tip radius in a CMM scanning process (as shown in Fig. 1). The proposed algorithm is dedicated to high definition measurement. Advantages of the algorithm are that we do not calculate the normal vector and we do not use a NURBS for smoothing (filtrating) of the measured shape [1]. The method is based on the fuzzy logic algorithm, which is a well known method to approximate the ideal position that minimizes the sum of squared residual errors between the clearance and the model. This choice is motivated by the robustness of this method and it is important to underline here that, no attempt to implement it within Coordinate Measuring Machines (CMMs) software has been reported in the three-dimensional metrology literature. A numerical application treating the case of a tooth of the toothed wheel which equips the gear box on limps of machine tool speed (gears of turn) in our country is presented. The comparison between the real surface obtained by acquisition and the ideal model led to the calculation of the form defects of the tooth gear. But this accuracy is generally achieved only for the measurement of well-known shapes as well as when feature size largely exceeds probe tip radius because of the algorithms used for stylus tip radius correction. For instance, free surfaces form profiles, which are not sections of a known geometric primitive such as a plane, (circle, sphere, cone, gear, etc.) [2]. Present particular difficulties in establishing the normal correction vector.

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