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Compensation of Thread Profile Distortion in Image Measuring screw thread

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Abstract The thread measuring method possesses an efficient and easy to install with image measurement of axial section but results in thread profile distortion. Through the geometric analysis of the axial section projection image of the screw thread, it is confirmed that phenomenon of thread profile distortion always exist in measuring screw thread by projection image, meanwhile, the requirements of depth of focus is put forward with the method, calculation formula of thread profile distortion is deduced, and the corresponding compensation algorithm is given; through the simulation, analysis of coarse thread, it found the distortion has influence in thread angle and pitch diameter significantly, reaching 2.3% and 3.36% respectively, the unilateral shaded proportion of the thread profile in the root region is up to 7.12%, but the root diameter itself remains unaffected mostly. Take metric coarse thread gauge as measurement object, and compared the results with tool microscope, experiments show that the compensation effect is more than 85% in pitch diameter, more than 70% in thread angle.

Keywords Image detection systems; Machine vision algorithms; Image analysis; Thread profile distortion

1. Introduction

Image measurement (e.g. machine vision) is widely applied and studied in measuring screw thread, as for it has characteristic of high efficiency and function of online measurement [1] [2].

There have many researches on image measurement of thread be reported recently [3] [4]. Joshua MUTAMBI et al. proposed the image processing method of profile extraction from thread digital images and analyzed effects of source errors in measurement procedures like illumination and calibration on measurement accuracy[5]. Zhimin RAO et al. reported an algorithm of major diameter, thread pitch, pitch diameter and thread height based on its axial section images[6]. ES Gadelmawla designed the thread measurement and calibration software of machine vision[7][8]. Sheng CHEN et al. proposed a measurement approach of thread part installation error based on machine vision when extracting thread parameters by using scanning probe[9]. Hu-Tian Feng et al. acquired thread section of large lead screw with picking sensor and extracted thread parameters of rollaway nest according to scanned normal section[10].

According to thread section, image measurement can be divided into normal section method and axial section method in measuring screw thread. Since thread with different diameters or leads have different helix angles, the normal section method has to adjust the installation position frequently and the acquired normal section thread parameters have to be converted into axial section ones. It has complicated computations and measurement. On the contrary, the axial section method that using the central hole at both ends of the work piece or cylindrical surfaces of ends to be clamped directly, and no further adjustment of the projection direction be adopted. The can realize overlapping of measuring basis and manufacturing basis and is convenient for online measurement.

Comparing installation requirements between axial section method and normal section method, the axial section method will be widely used to extract thread parameters in order to realize high-efficiency thread detection despite of large-lead thread parts like dynamic screw. However, image measurement of axial section thread will cause thread profile distortion due to the extended helical surface, thus resulting in ambiguous boundaries of the thread profile. These will influence the