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基于二维轮廓点云的螺纹中径计算

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Calculation of thread pitch diameters based on two dimensional profile point clouds

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摘要 基于轮廓点的螺纹多参数综合测量方法由于螺纹工件的定位误差、非均匀磨损等情况会导致中径计算偏差,因此,提出了一套基于二维轮廓点云的螺纹中径计算方法.该方法利用三次样条插值均匀密化采样数据,再用稳健高斯回归滤波处理得到轮廓滤波中线;然后通过定义相邻两段牙侧线之间距离均方差最小的目标函数,利用复合形-模拟退火(CMSA)算法求解出实际螺纹轮廓的中径线;最后根据所求中径线计算出螺纹中径参数.实验结果表明:当X、Y、Z轴的轴向定位偏差为1 mm,旋转偏差为2°时,所得到的中径测量误差比范一保和TONG Q等人的方法平均减小17.23%和96.93%,说明所提出的计算方法可以有效减少定位偏差对中径参数计算的影响.提出的计算方法具有通用性,可应用于接触式和非接触式采样得到的二维螺纹轮廓点云数据.

关键词 : 螺纹工件, 二维螺纹轮廓, 中径计算, 定位误差, 三次样条插值, 稳健高斯回归滤波, 模拟退火算法

Abstract : The multi-parameter measurement of a thread based on profile points may show calculation errors for thread pitch diameters owing to the alignment deviations and inhomogeneous abrasion of thread work-pieces. Therefore, a new method for calculating the thread pitch diameters based on the 2-dimensional profile point clouds was proposed. The cubic spline interpolation was used to increase the data point densification uniformly, and the robust Gauss regression filter was adopted to get the midline of contour. Then, an objective function was put forward to minimize the mean square error of the distance between two adjacent flank segments, and the complex simulated annealing algorithm was adopted to solve the function to get the pitch line. Finally, the pitch diameter parameters were calculated with the obtained pitch line. The experimental results show that the measurement error of pitch diameter obtained by the proposed method is reduced by 17.23% and 96.93% respectively compared with the methods from FAN Y B and TONG Q *et al*, when the alignment deviation along axes directions of *X, Y, Z* is 1 mm and the rotation deviation of each axis is 2°. The proposed method effectively reduces the influence of alignment deviations on the thread pitch diameters, and can be used for two dimensional point cloud data by both contact and non-contact 2-dimensional scannings.

Key words : thread workepiece   2-dimensional thread profile   pitch diameter calculation   alignment deviation   cubic spline interpolation   robust Gauss regression filter   simulated annealing algorithm

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