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Li, Duo

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The Challenges in Dimensional Metrology and Machine Tool Metrology

Reporter: Duo Li

2017.07.15
挑战1：微小尺寸测量
挑战2：大尺寸测量
挑战3：复杂曲面的测量
挑战4：在线检测
挑战5：多传感器融合
挑战6：一维到多维
挑战7: 高深比的微结构
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挑战9: 内孔，内孔微结构
挑战10: AM 内部
挑战11: Sensor net & Cloud
挑战12: Real-time compensation control
1. Micro scale measurement

接触探针测量

- 探针挠曲变形、制作误差
- 微结构补偿难以实现
- 测量速度慢
- 可能会造成表面损伤
- 无法测量复杂结构
1. Micro scale measurement

非接触测量

- 结构复杂
- 环境因素（温度、湿度）
- 蜂窝结构、内壁、盲孔测量
- 全反射

非接触测量示意图
2、Large scale measurement

Metre-scale telescope and X-ray optics
3 Complex freeform measurement technology

High reflection curvilinear parts have become a front-line research direction in the defense and modern high-tech fields. Accurate measurement and evaluation of the three-dimensional shape of high-reflection curvilinear parts are crucial to studying the geometric characteristics and usage performance relationships, which significantly improve the processing surface quality and product performance.

Existing contact measurement methods have drawbacks of slow measurement speed and easy scratching of the measured surface. Meanwhile, single optical non-contact measurement methods cannot accurately measure the three-dimensional shape of large surfaces or high reflection curvilinear parts with large curvature.

Prospect: Integrating space surface conjugate meshing principles, Newton iteration method, vector analysis method, error simulation method, utilizing UG modeling, ADAMS simulation, Matlab programming tools, develop and design a feasible measurement scheme.
研究背景

高精度
复杂大型零件
精度评价

加工—测量—修整
数控机床
4 Online Inspection Technology Integrated With NC Machine Tools

图2 数控机床在线测量系统[8]

5. Multi-sensor fusion

For dimension metrology
任何一个物体在空间都有6各自由度，即x, y, z方向的平动和绕3各方向的转动。（若考虑时间维度的话，多了一个时间维度的演变，又增加一个自由度），随着复杂零件、工具的产生及其应用，传统一维的检测受到一定的限制。

三维空间（静态空间）

四维时空（动态空间）
1. 叶片形貌、结构尺寸、孔、型腔的角度及自由曲面的矢量等等共同影响着叶轮的加工质量。

2. 残余应力、结构强度、材料特性等随加工过程变化也在发生演变。