



University of HUDDERSFIELD

University of Huddersfield Repository

Li, Duo

The Challenges in Dimensional Metrology and Machine Tool Metrology

Original Citation

Li, Duo (2017) The Challenges in Dimensional Metrology and Machine Tool Metrology. In: The 3rd International Society for NanoManufacturing (ISNM) Summer School, 10-15 July 2017, Tianjin. (Unpublished)

This version is available at <https://eprints.hud.ac.uk/id/eprint/33264/>

The University Repository is a digital collection of the research output of the University, available on Open Access. Copyright and Moral Rights for the items on this site are retained by the individual author and/or other copyright owners. Users may access full items free of charge; copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational or not-for-profit purposes without prior permission or charge, provided:

- The authors, title and full bibliographic details is credited in any copy;
- A hyperlink and/or URL is included for the original metadata page; and
- The content is not changed in any way.

For more information, including our policy and submission procedure, please contact the Repository Team at: E.mailbox@hud.ac.uk.

<http://eprints.hud.ac.uk/>



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

挑战8： 高曲率的自由曲面

挑战9： 内孔，内孔微结构

挑战10： AM 内部

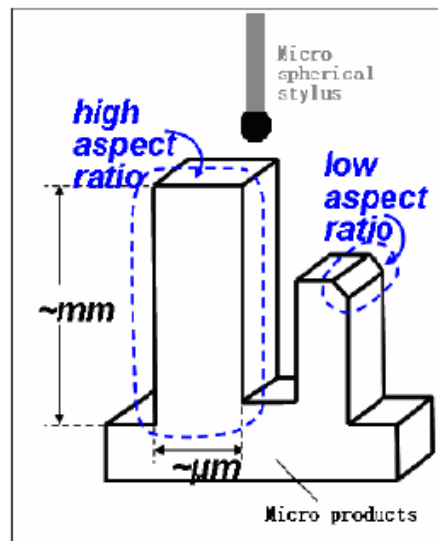
挑战11： Sensor net & Cloud

**挑战12： Real-time compensation
control**

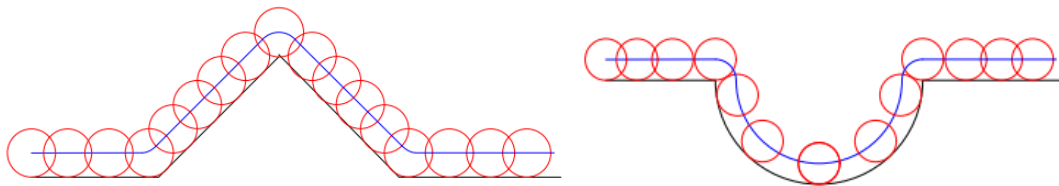
1、 Micro scale measurement

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



探针测量示意图

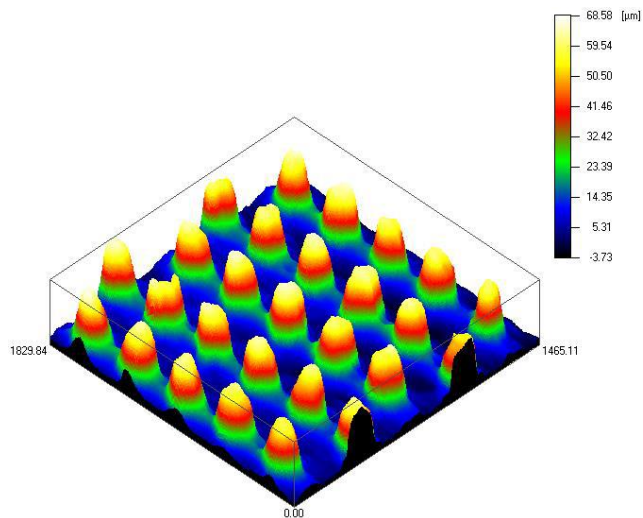


探针测量误差示意图

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



高反射曲面零件的超精密加工技术已成为国防和现代高科技领域的**前沿研究方向**,准确测量和评价超精密加工高反射曲面零件的三维形貌,研究表面几何特性与使用性能的关系,对提高加工表面的质量和产品性能具有重要的意义。

现有的接触式测量方法具有测量速度慢、易划伤测量表面的缺点,而单一的光学非接触测量方法**难以**完成对大面形或曲率较大的高反射曲面零件三维形貌的高精度测量。

展望: 可综合运用空间曲面共轭啮合原理、牛顿迭代法、矢量分析法、基于误差建模仿真法等理论和方法,利用 **UG**建模、**ADMAS**仿真、**Matlab**编程等工具,开发设计一套可行的测量方案。

4 Online Inspection Technology Integrated With NC Machine Tools

研究背景



挑战

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

机床在线测量过程

Ref.: Li Jianguang, Aero. Manu. Tech. (2014)

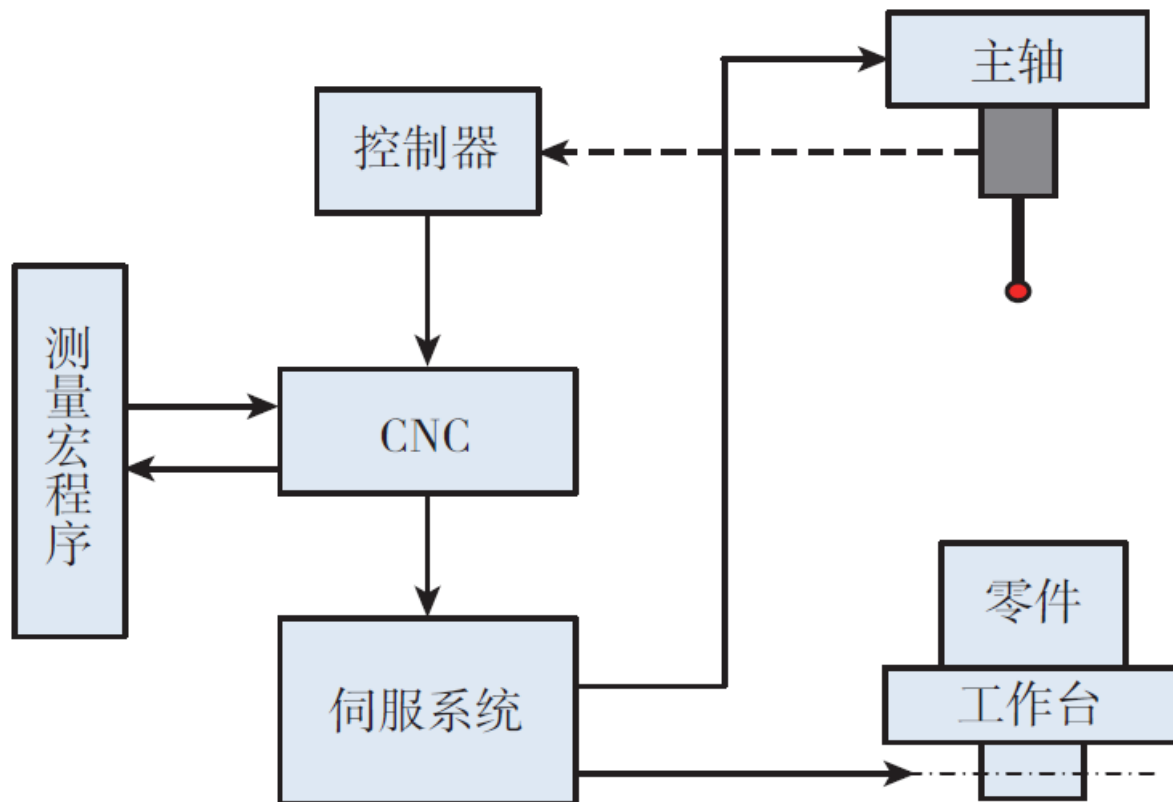
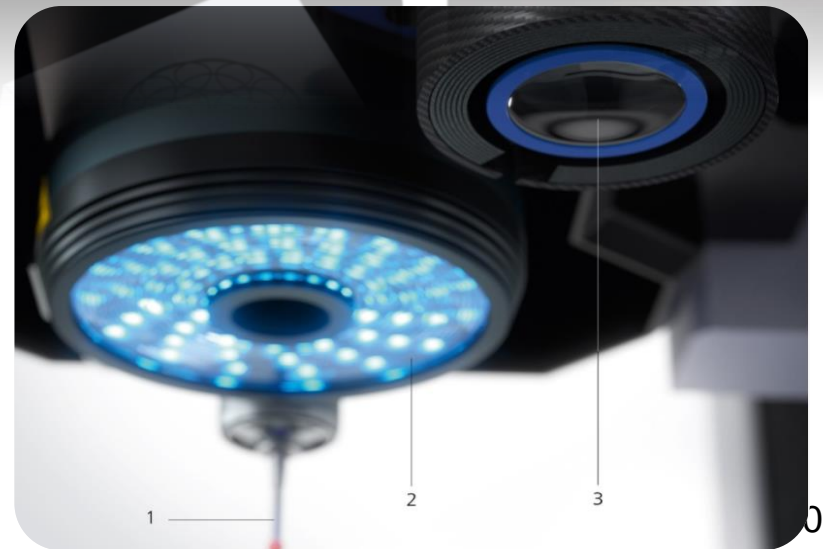
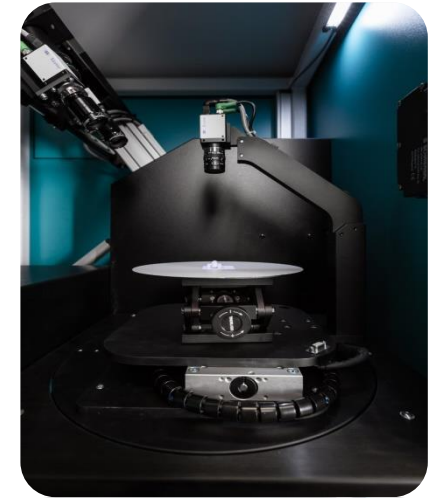
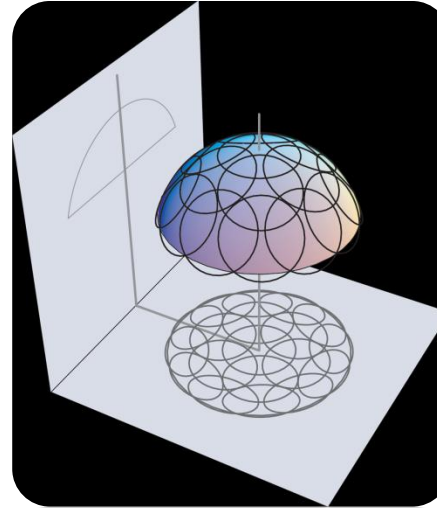
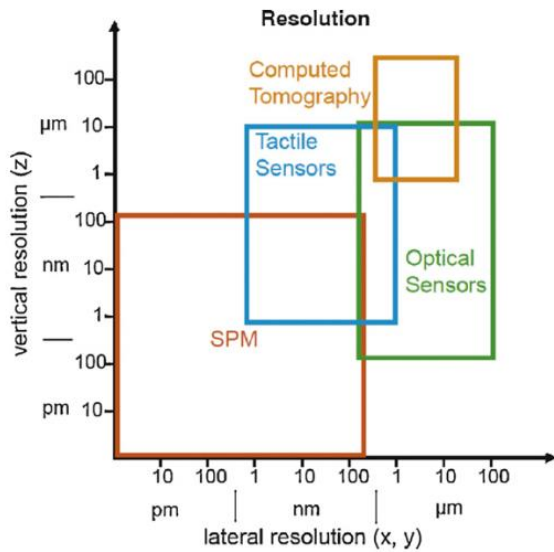
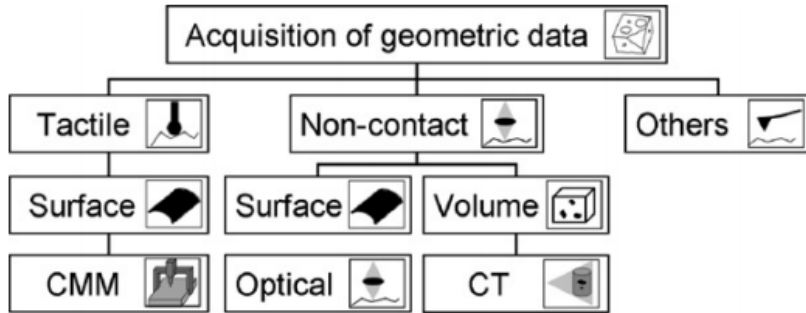


图2 数控机床在线测量系统^[8]

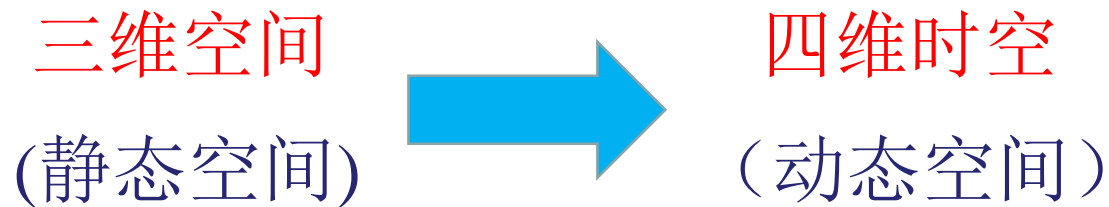
5、 Multi-sensor fusion

For dimension metrology



6、 One dimensional to Multidimensional

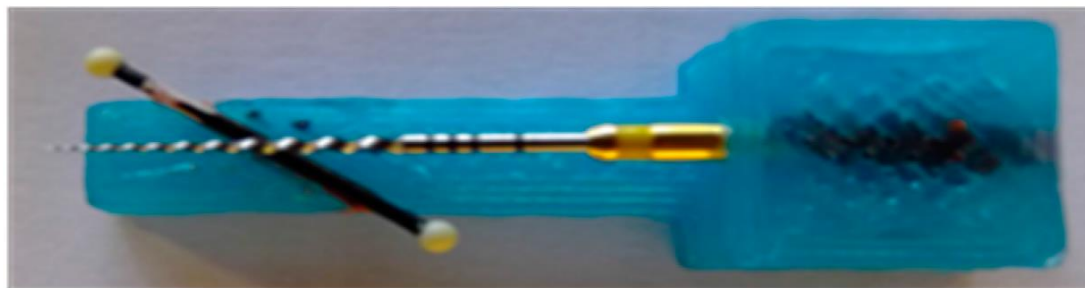
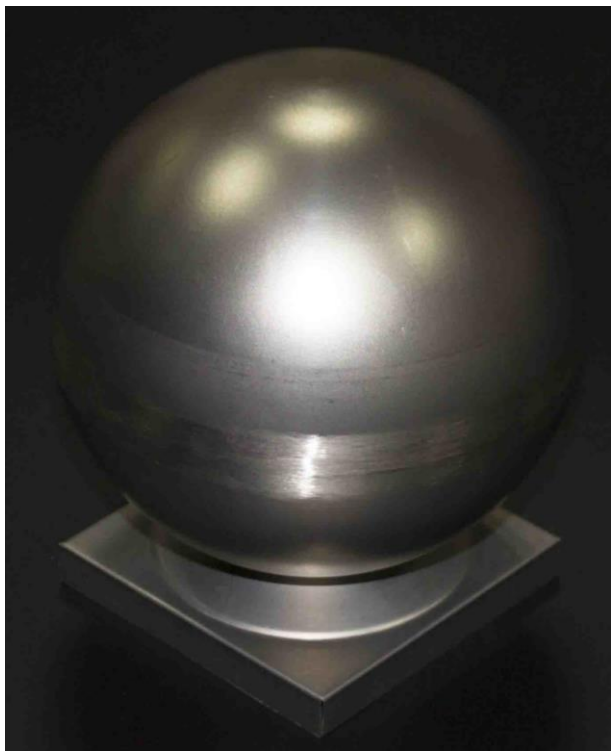
任何一个物体在空间都有6各自由度，即x,y,z方向的平动和绕3各方向的转动。（若考虑时间维度的话，有多了一个时间维度的演变，又增加一个自由度），随着复杂零件、工具的产生及其应用，传统一维的检测受到一定的限制。



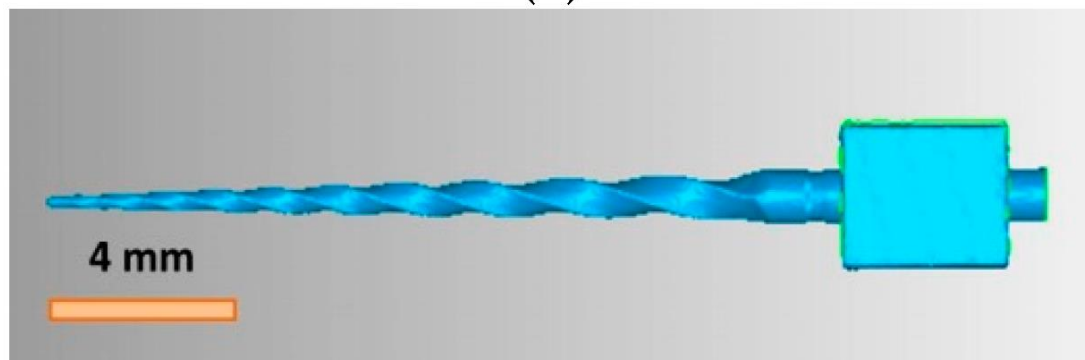


1、叶片形貌、结构尺寸、孔、型腔的角度及自由曲面的矢量等等共同影响着叶轮的加工质量。

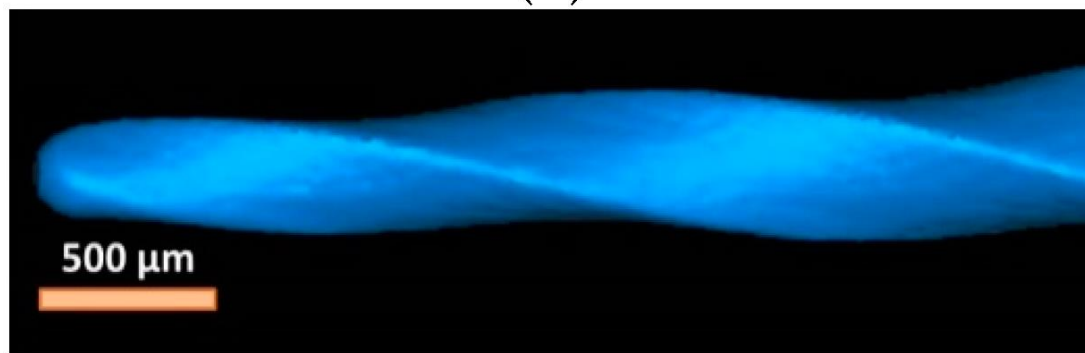
2、残余应力、结构强度、材料特性等随加工过程变化也在发生演变。



(a)



(b)



(c)