



# Reliable Fusion of Knee Bone Laser Scans to Establish Ground Truth for Cartilage Thickness Measurement

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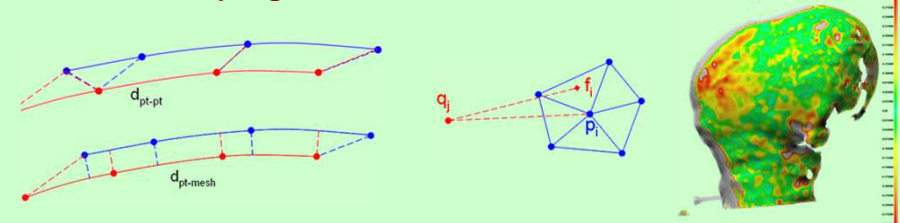


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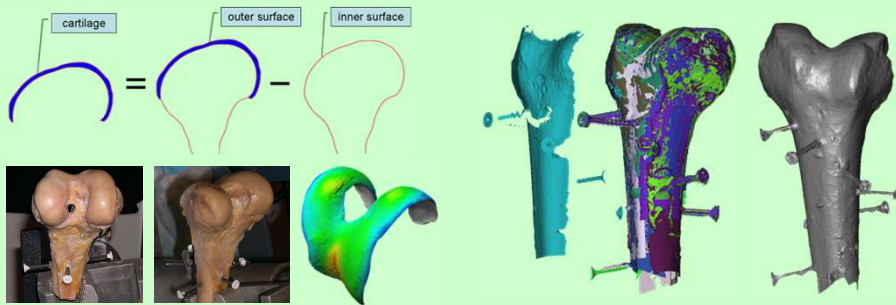
## Introduction

- Goal: construct reliable 3D model of knee cartilage from partial laser scans.
- Off-the-shelf ICP yield unreliable solutions because of sensing error and sampling error.
- Our contributions:
  - Reduce sensing error using bilateral Gaussian smoothing
  - Reduce sampling error using point-to-mesh correspondence
  - Fuse multiple scans following maximum spanning tree of overlaps

## Solution to Sampling Error: Use of Point-to-Mesh Correspondence



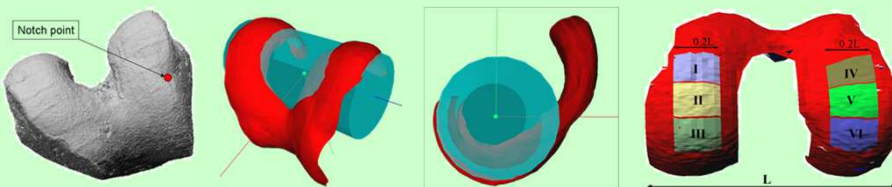
## Procedure to Construct 3D Model of Knee Cartilage



## Fusing Multiple Laser Scans

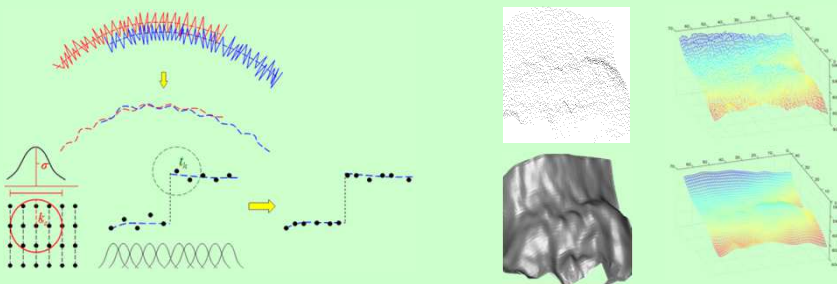


## Measuring Knee Cartilage Thickness Using Off-the-Shelf ICP



- Sensing error: error in depth estimation as the laser scanner scans the object surface
- Sampling error: error in distance measurement between two surfaces using point samples.

## Solution to Sensing Error: Bilateral Gaussian Smoothing



## Experiments

### Effect of smoothing

$$\begin{aligned} A &\xrightarrow{\text{smooth}} \tilde{A} \xrightarrow{\text{mesh}} \tilde{A}^* \\ B &\xrightarrow{\text{smooth}} \tilde{B} \xrightarrow{\text{mesh}} \tilde{B}^* \end{aligned}$$

	$d_{\text{pt-pt}}$	$d_{\text{pt-mesh}}$	diff %
Raw data	0.116	0.113	2.9%
Smoothed	0.091	0.079	32.0%

### Repeatability of thickness measurement

Region	I	II	III	IV	V	VI
Thickness(mm)	1.73	1.72	1.86	2.43	2.50	2.20
CV(%) – now	1.00	1.27	2.48	0.75	1.86	1.10
CV(%) – before	5.49	5.52	7.24	5.68	3.31	4.38

References: - N. Trinh *et al.*, CVAMIA 2006.  
- M-C. Chang *et al.*, CVIU 2009.

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