Master Thesis

Non-Rigid Registration for C-arm CT datasets of knees acquired at multiple flexion angles

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November 04 2013
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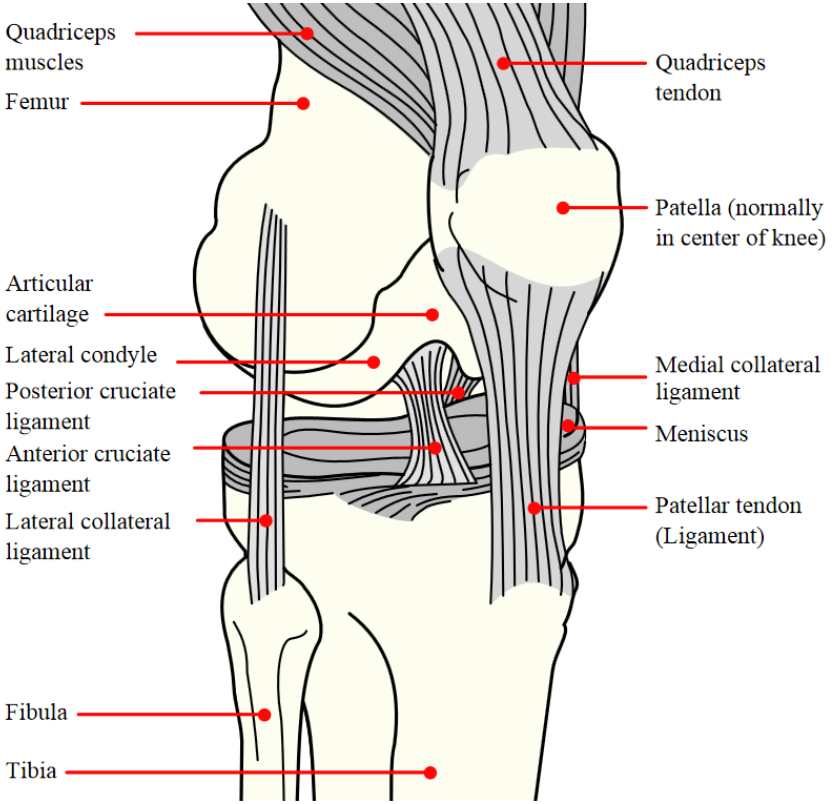
Agenda

- Introduction
- Goal
- Method
- Current Work and Outlook

Introduction



Source : Wikipedia - Knee diagram

Introduction

This work is part of a project that further investigates:

- Knee cartilage deformation between multiple flexion angles and different weight bearing conditions.
- Multiple acquisitions acquired using a C-arm CT scanner for upright positions and supine positions.
- Extracting cartilage deformation between these scans requires the application of non-rigid registration.

Introduction

Data Description:

Synthetic data

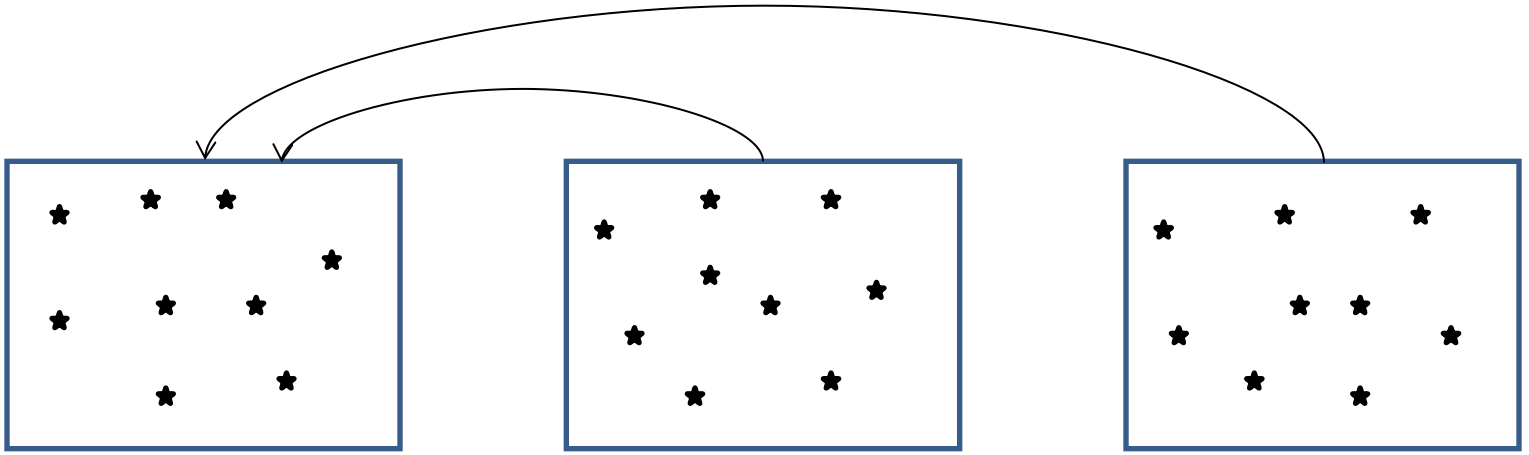
- XCAT phantom in CONRAD.
- Realistic.
- Flexion is simulated for different angles (0, 20, 40 degrees).
- Ground truth is known.

Real Data:

- Three supine scans for different flexion angles (0, 20, 40 degrees).
- There might be a problem with the contrast agent.
- Beads placed around the knee.

Goal

- Evaluate joint rigid and non-rigid registration using motion free supine scans acquired under different flexion angles.



Method

- Obtain the scans from CT in three different angles.
- Afterwards apply the following steps:

Step1:

Segment the bones out of CT images.

Step2:

Compute the point correspondences by using the ICP algorithm for registering rigid bones.

Step3:

Compute an initial transformation from point correspondences.

Method

Step4:

Use known point correspondences as a constraint to the non-rigid registration.

Step5:

Evaluation of the method by:

1. Synthetic Data.
2. Real Data

Note: Step1, Step2 are in Matlab and Step3, Step4 are in ITKX.

Method

Synthetic Data:

In synthetic data the ground truth deformation is known.

In order to evaluate the method we compute the SSD between the synthetic and the estimated deformation fields.

$$SSD(\mathbf{D}_{gt}, \mathbf{D}_{est}) = \|\mathbf{D}_{gt} - \mathbf{D}_{est}\|_{\mathrm{F}}$$

$\mathbf{D}_{gt}$ = Ground Truth Deformation.

$\mathbf{D}_{est}$ = Estimated Deformation.

Method

Real Data

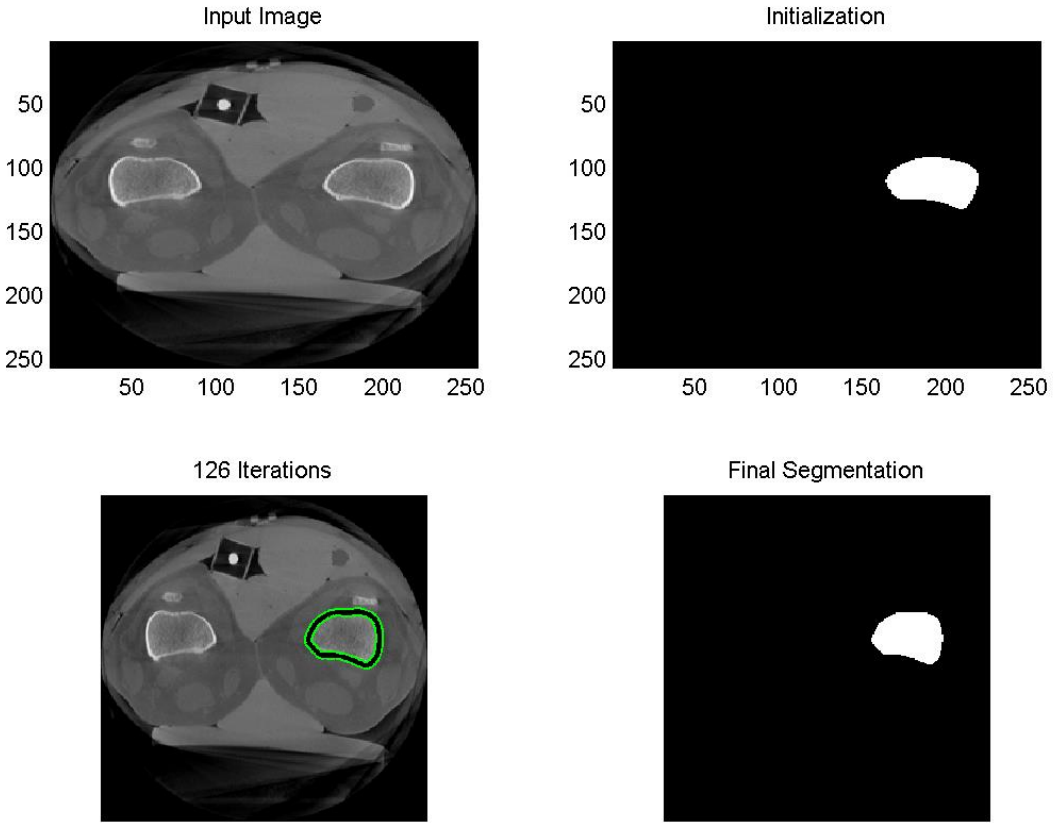
- In real data the deformation of the beads is known by manual annotations.
  1) Beads are at distinct positions around the knee.
  2) Beads are placed on the skin.
  3) Beads are removed before we apply our method.
- Quantitative evaluation by computing the SSD between the bead deformations and the corresponding estimated deformations.

Problem in real data:

Ground truth deformations are only known at the bead positions.

Current Work and Outlook

Current work is on segmentation of knee bones.



Segmentation result

Thanks for your attention!

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