Statistical Shape Model of the Knee

The **statistical shape model** was developed using 50 natural healthy knees (25 males, 25 females) consisting of the distal femur, proximal tibia, and patella bone as well as associated articular surface cartilages. Attachment sites and line-of-actions for select soft tissue structures were also included. Local coordinate systems for each bone are represented as triads using 1D beam elements. Alignment of the joint is in the MRI as-scanned position. Bones are modeled as 2D surface meshes using R3D3 tri elements. Cartilages are modeled as C3D8R hexahedral elements and soft tissue attachment sites as nodes (no elements).

All models created in Matlab

Open Source Option:
DU_SSM.m   Source code provided for statistical shape model of the knee.
                Option to generate training set, PC modes and user-defined new instances
                Note: Includes bones and ligament attachments, but does not include cartilage as it
                requires mesh morphing with Hypermesh

Executable Option:
This executable code has been pre-programmed with the cartilage and is able to generate models of bone, cartilage and ligaments for pre-specified instances.
DU_SSM_MODES/distrib/DU_SSM_MODES.exe Generates mean and instances at +/-1.5 std deviation
                                        for Modes 1 to 5

Directions for executable option:
- The **R2013a MATLAB Compiler Runtime** (MCR) must be downloaded. It is available at http://www.mathworks.com/products/compiler/mcr/.
- Option 1: Double-click on the executable listed above to generate the files.
- Option 2: Run the application in DOS command window to see application information and real-time status.
- Model files created are in .inp format for use with Abaqus and other FE software.
- MODEL.inp is the main file in each folder below and calls on all other files.

DU_SSM_MODES Folders:
- Mean
- Mode 1 +1.5 standard deviations
- Mode 1 -1.5 standard deviations
- Mode 2 +1.5 standard deviations
- Mode 2 -1.5 standard deviations
- Mode 3 +1.5 standard deviations
- Mode 3 -1.5 standard deviations
- Mode 4 +1.5 standard deviations
- Mode 4 -1.5 standard deviations
- Mode 5 +1.5 standard deviations
- Mode 5 -1.5 standard deviations

File Names for a representative input file deck. All files created in Abaqus input format (.inp).

Model.inp	High level input file
BONE_FEM.inp	Contains nodes for femur
BONE_TIB.inp	Contains nodes for tibia
BONE_PAT.inp	Contains nodes for patellar bone
ELEM_FEM.inp	Contains elements for femur
ELEM_TIB.inp	Contains elements for tibia
ELEM_PAT.inp	Contains elements for patellar bone
CART_FEM.inp	Contains nodes for femoral cartilage
CART_TIB_LAT.inp	Contains nodes for lateral tibial cartilage
CART_TIB_MED.inp	Contains nodes for medial tibial cartilage
CART_PAT.inp	Contains nodes for patellar cartilage
ELEM_FEMCART.inp	Contains elements for femur cartilage
ELEM_TIBLATCART.inp	Contains elements for lateral tibial cartilage
ELEM_TIBMEDCART.inp	Contains elements for medial tibial cartilage
ELEM_PATCART.inp	Contains elements for patella cartilage
CS_FEM.inp	Contains nodes defining ML, AP and SI axes of the femur
CS_TIB.inp	Contains nodes defining ML, AP and SI axes of the tibia
CS_PAT.inp	Contains nodes defining ML, AP and SI axes of the patella
LIGAMENTS.inp	Contains ligament input filenames for reference to Model.inp

Note: Locations are provided for the following soft tissue structures in respective input files (.inp):
- ACL: Anterior Cruciate Ligament
- LCL: Lateral Collateral Ligament
- LPFL: Lateral Patellofemoral Ligament
- MCL: Medial Collateral Ligament
- MPFL: Medial Patellofemoral Ligament
- PAT-LIG: Patellar Ligament
- PCAPL: Lateral Posterior Capsule
- PCAPM: Medial Posterior Capsule
- PCL: Posterior Cruciate Ligament

- RECT_FEM: Rectus-Femoris
- SMCL: Superior Medial Collateral Ligament
- VASTI: Medialis Obliquus, Medialis Longus, Intermedius, Lateralis Obliquus, Lateralis Longus

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