

Sensitivity analysis 2: Rotate the knee joint to the flexion angle in which the robot data is obtained

Methods

- To find out if we can rotate the knee joint into the flexion angle in which the robot data was obtained and then apply the prestretch and axial load.
- Sensitivity analysis performed for six models (oks001, oks002, oks004, oks006, oks007, oks008)
- Timesteps:
 1. 0 - 0.1 Apply prestretch
 2. 0.1-0.6 Rotate to flexion angle in which the robot data was obtained (~0deg)
 3. 0.6 - 1.0 Apply -20N axial load
- Prestretch values:
 - 1 ligament prestretch changed at a time while the others are kept at 1.
 - ACL: 0.9 – 1.05 in steps of 0.01
 - PCL: 0.9 – 1.10 in steps of 0.01
 - MCL: 0.9 – 1.10 in steps of 0.01
 - LCL: 0.9 – 1.10 in steps of 0.01
- Looking at convergence

Results

Full results can be found in: *Sensitivity analysis 2 results.pptx*

oks001 Flexion angle robot = 0.0859 Fixed flexion angle model = 0.0862
ACL: All simulations fully converged except for 2
LCL: 7 simulations fully converged (prestretch > 0.92)
MCL: 8 simulations fully converged mainly prestretch > 1.0
PCL: 8 simulations fully converged mainly prestretch < 1.0

oks002 Flexion angle robot = 0.0802 Fixed flexion angle model = 0.0800
ACL: 6 simulations fully converged mainly prestretch < 1.0
LCL: 7 simulations fully converged mainly prestretch > 1.0
MCL: 6 simulations fully converged mainly prestretch < 1.0
PCL: 10 simulations fully converged scattered over prestretch values

oks004 Flexion angle robot = 0.1320 Fixed flexion angle model = N.A.
ACL: No simulations fully converged, crashed before reaching the flexion angle.
LCL: No simulations fully converged, crashed before reaching the flexion angle.
MCL: No simulations fully converged, crashed before reaching the flexion angle.
PCL: No simulations fully converged, crashed before reaching the flexion angle.

oks006 Flexion angle robot = 0.0523 Fixed flexion angle model = 0.0524
ACL: 8 simulations fully converged mainly prestretch < 1.0
LCL: 5 simulations fully converged prestretch > 1.0
MCL: 9 simulations fully converged scattered over prestretch values
PCL: 6 simulations fully converged scattered over prestretch values

oks007 Flexion angle robot = 0.1017 Fixed flexion angle model = N.A.
ACL: No simulations fully converged, only 2 applied prestretch, flexion angle not reached
LCL: No simulations fully converged, only 3 applied prestretch, flexion angle not reached
MCL: No simulations fully converged, only 4 applied prestretch, flexion angle not reached
PCL: No simulations fully converged, only 6 applied prestretch, flexion angle not reached

oks008 Flexion angle robot = 0.3278 Fixed flexion angle model = 0.3277
ACL: All simulations fully converged
LCL: All simulations fully converged
MCL: All simulations fully converged except for 4
PCL: All simulations fully converged except for 2

Conclusion

- Most models showed some difficulty converging, especially at the edges of the ranges of the prestretch values tried.
- Especially *oks004* and *oks007* show convergence difficulties
- We decided to look into why these models showed a lot of issues and we found that there might be problems with the meshes and the contacts.
- Since changing the contacts in the models did not solve the issues entirely, there was decided to make new models for *oks004* and *oks007*, going through all the steps of the model development workflow again. This resulted in models that converge similarly to the other models.