Release notes, AMMR v.1.6.1

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Minor updates

- Minor updates to template models: RunApplication operation is now defined locally in your template-based model and not using a shared file from the Toolbox section.
- Naming of default mannequin drivers updated slightly for the elbow joint.
- Application example:
  - THA-KneeBendDemo updated with improved FDK solver setting.
  - C3Dproject was discontinued, because it was not updated for the new body model scaling facilities. It is recommended to use the MoCap model instead, however notice that the MoCap model does not have the same AnyBody Project facilities as in C3DProject. Please contact us on the AnyScript forum or directly, if you are missing the project facilities.

AMMR, v.1.6.0

Introduction

The AnyBody Managed Model Repository (AMMR), version 1.6.0 is released with the AnyBody Modeling System, version 6.0. The following sections list modifications of the AMMR v1.6.0 regarding previous versions.

Body Models

This section contains the updates to the body models in Body section (Body folder) of the AMMR. Please notice that the generic ToolBox elements are considered separately below.

- **New body model interface** (BM interface):

- A body model interface using one include file (Body/AAUHuman/HumanModel.any) is introduced. Including this file brings a full body model with default settings into your model.
- Standard options (Referred to as BM options) can be set to change the models regarding features such as body parts, muscle types, scaling laws, strength parameters, draw settings, mannequin definition and default drivers. Basically all options previously available in the body models are still available just with this intuitive interface.
- Please refer to the new tutorial "Getting Started: The Model Repository (AMMR)" for more details. It also contains a full reference for all BM options.
- Special features:
    - **Default drivers** are (by default) present in the human model. They are by default so-called "weak" drivers so they only assist to prescribe posture unlike"hard" environment constraints. Weak drivers are intended to assist you while your environment model may be incomplete during development.
- **Implementation notes:** Currently, the HumanModel is implemented as a wrapper to the old concept (using BodyPartsSetup.any files). This implies that older application models should still run with this AMMR version (maybe with slight modifications). But please notice that the new BM-concept will be carried through the models in future AMMR version and at this time the old concept will cease to function. Therefore it is recommended to shift your important models to use the new BM-concept while working with this AMMR version.
- **Muscle strength: The s**pecific muscle strength in all body parts is now set to the default strength 90N/cm^2. Index parameters allow body parts strength to be changed individually, so previous strength settings can still be obtained, if needed. But now the values are consistent throughout the AMMR.
- The **Twente Lower Extremity Model (TLEM)** updated and prepare for future enhancement:
    - LegTD is renamed to LegTLEM.
    - The TLEM data has been moved to files in a sub-folder called TLEM1.1. This is in preparation for adding additional data sets for the LegTLEM.
    - Notes on TLEM versioning: Version 1.1 is considered to be the data set known from previous AMMR versions. This data set is basically the Klein Horsman original data, but with some modifications and corrections made. Version 1.0 is considered as the original data set unchanged. An updated data set, v.1.2 is under development and a completely new and improved data set has been prepared in the TLEMsafe project (www.tlemsafe.eu). The new data set will hopefully also lead to a new model morphology, which you can already find preparations for in AMMR.

TLEM1.0	Original Klein Horseman data set
TLEM1.1	Klein Horseman data set with some modifications and corrections (LegTD)
TLEM1.2	Klein Horseman data set with further modifications; under preparation
TLEM2.0	New cadaver set; under preparation

    - Muscle model implementations for simple and three-element muscles are merged into MusPar.any to avoid redundant code. MusParSimple.any is removed.

- o A switch allows entering a pennation angle compensation of the muscle strength for the simple muscle models. This reduces the strength of pennated muscles. It is currently entered for testing purposes and is not adopted as default setting in AMMR 1.6.
- o Scaling of the patella and patella ligament was improved. This leads to small changes in patella position.
- o Muscle wrapping definition Vasti and Rectus Femoris has been updated for better initial positions.
- o Fixed small issue in hip joint net moment measure. Psoas was by mistake not included here for the special case where the trunk is equipped with muscles while the leg is not. This is very rare scenario, so it is unlikely to affect many models.
- **Simple Leg model:**
  - o AnkleEversion was renamed to SubTalarEversion to be consistent with LegTLEM.
  - o Anatomical frames for scaling are added, though not well-defined based on bony landmarks because this information currently does not exist in this data set.
- **Arm model:**
  - o The arm model has been improved by enhanced elbow muscle wrapping:
    - New wrapping surface for elbow flexor muscles added
    - Enhanced initial positioning for wrapping for elbow, forearm and wrist muscles.
    - #define statement ARM_MUSCLE_UPDATE_V16 encapsulates these changes and can be undefined to revert changes for comparison. This is aimed at backward compatibility checking and conversion and the statement will be removed in future versions.
  - o Anatomical frames for scaling are added, though not well-defined based on bony landmarks because this information currently does not exist in this data set.
- **New foot model Glasgow Maastricht Foot (GMFoot):**
  - o The new foot model is located in the GMFoot folder. It is currently connected to the previous version of the TLEM model (LegTD) located in the AAUHuman/LegTD-FootGM folder.
  - o Future work will fusion GMFoot and the LegTLEM.
- **Interface morphing** between leg and trunk model allows leg models with a different pelvis to be fitted to the pelvic bone of the trunk model or vice versa.
- **Scaling Laws** are updated:
  - o All Scaling Laws in AMMR have been updated and significantly cleaned for redundant code. A new concept, which allows the same geometrical scaling in all body parts, has been entered. The Scaling Laws are now referring to Anatomical Frames for the segments, which must be the same for similar segments in all model parts, for instance thigh, shank and foot of the leg models.
  - o New definitions of the Anatomical frames (previously also referred to as the ScalingNode) have been employed, in particular in the LegTLEM model. This has slightly altered the scaling of the model for the same input parameters for the same Scaling Law, but the scaling is now more well-defined and reproducible for future versions and model data sets.
    - The LegTLEM foot segments are the most affected part. In particular, the foot's anatomical frame has been moved from the heel point to the tibial malleolar

midpoint and shank's has been moved from the ankle to the knee (tibial epicondyles' midpoint).

- o Implementation comments:
    - In all segments GeomScale scaling function objects are found. These are references to the Scaling Law. They are inserted in the Scale functions members that also handle a pre- and post-transformation from the segmental frame to the anatomical frame (when needed).
    - Anatomical frames (basis of scaling) are defined using the fundamental concept that they must be defined by bony landmarks. This ensures that they can be reproduced in different data sets despite differences in the segmental frames. For extremities, the anatomical frame is located close to the proximal joint.
    - The ScalingNode members still exist in segments where they existed before, but the name is deprecated and will be removed. They are identical to the AnatomicalFrame. In some places, where changes where significant, a ScalingNodeOld is kept (but deprecated) to assist with backwards compatibility checking and conversion.
- o Scaling family members AnyAnne and AnyArne are discontinued.
- Non-human models:
    - o A rat lower extremity model developed by University of Ulm, Germany has been added. It is called UlmRatHindlimbModel.
    - o AAUCow model is updated adopt new folder structure.

Applications

This section considers the updates to the Applications section (Applications folder) of the AMMR.

- **A new and recommended folder structure** is introduced in most models.
    - o Only Main files are found at root level
    - o Other model script files are found in dedicated folder (typically called Model)
    - o Input and Output folders contain input and output data, respectively. This makes it easier to distinguish between the various data, but also easier to point to new input data and direct output to a location of your choice. All models use a standard path definition for output location. This is strongly recommended for all modeling.
    - o An AutoSave option allows for saving the model output as part of RunApplication operation. This enables for instance easy replay. By default AutoSave is off in examples and demos.
- **The new body model interface** is introduced into many Example models, but not all.
- **New example models:** Notice that several of the new examples are simply merged by previous version in order to share code, and to provide a better overview for the users.
    - o StandingModel is a merged version of the previous models with the StandingModel prefix. Model options allow to switching between features previously in the different examples.
    - o FreePosture is a merged version of the previous models with the FreePosture prefix. They all shared the same capability of setting the posture freely using joint angles.

- o MoCapModel is a merged model comprising previous models using C3D data as input. It comprises GaitLowerExtremity and GaitFullBody. It now has a new option to use the detailed neck model.
  - Notice also that all marker locations have been updated according to the new scaling/anthropometric coordinate systems. The update is an attempt to achieve approximately the same location of the marker on the segments as in previous version.
  - o MoCapModel-UniMiami is replacing GaitUniMiami it now use the C3D file instead of text files.
  - o MoCapModel-Runner replaces the previous Runner example.
  - o BikeModel is a merged version of several previous bike models, which now run as different configurations in this new and combined BikeModel.
- **Removed example model:**
  - o FullBodyBikeModel is now part of the new BikeModel.
  - o Bikemodel3d is now part of the new BikeModel.
  - o BikeModelTD is now part of the new BikeModel.
  - o BikeSpring is removed from AMMR.
  - o GaitUniMiami is changed to MoCapModel-UniMiami.
  - o GaitLowerExtremity and GaitFullBody are merged into one, MoCapModel.
  - o Runner is renamed to MoCapModel-Runner.
  - o FreePostureMove is now part of FreePosture.
  - o FreepostureHandSR is now part of FreePosture.
  - o Lunge is removed; please consider MoCap model instead.
  - o GaitVaughan is removed from the Examples section but still exists in the Validation section.
  - o HandPump is removed
  - o StandingModelCircumduction is removed; please look at StandingModel instead.
  - o StandingModelVisualization is now part of StandingModel.
  - o WheelChair is removed. The WheelChairRancho is in all aspects a better wheel chair example.
- Model updates
  - o **AnyGait** has been significantly updated in order to employ for instance the new Scaling Law implementation.
  - o CrossTrainer model is updated with improved definition of the foot machine contact and new initial positions due to the updated human scaling.
  - o The Egress model has been updated so it uses a special muscle wrapping setting: For subscapularis1 and 2, it now sets the option for using initial position for each time step. This is a remedy muscles wrapping on the wrong side occasionally for models doing large time steps.
  - o ArmCurl: Improved solver tolerance settings for wrapping wire.
  - o TKA-KneeBendDemo (beta): More appropriate description has been entered. We apologize for the previous poor references to the source of the model.

- **Templates models:** A new folder in Applications holds template models aimed at providing good starting points for new models. Notice that AMS 6.0 has new functionality to apply these and your own developed templates.
  - A standard Library Definition (libdef.any) is supplied, which by default points to the body models of the AMMR installed together with AMS.
  - Current templates in AMMR's Applications are
    - **Basic Main:** A more or less empty main file convenient for starting small models from scratch.
    - **Human:** A human model with default settings without any interface to an environment. It is supported at pelvis (all translations and rotations) and the default mannequin drivers are active as weak drivers.
    - **Human Standing:** A human model standing on plane ground. The human model employs default settings including the default mannequin drivers as weak drivers. Additionally, the JointAndDrivers.any file contains drivers for connecting the feet to the ground and for positioning the center of mass. Feet reactions are bilateral (for unilateral foot-ground contact, please refer to the StandingLift model in the Example section).
    - **Sub Library:** A template for making a sub library, i.e., a sub folder in an existing library. It basically creates a new folder and a libdef.any file, which points to the library definition above.

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Toolbox

The ToolBox contains elements that are not really part of the body models but which are generic elements needed when using the body models. These are typically tools for connecting the body model to the environment (e.g. MoCap tools) or visualization.

- **MoCap marker definitions:**
  - A new class, CreateMarkerDriver, for creating markers has been added and is available in CreateMarkerDriverClass.any. It provides universal functionality for replacing the previous two versions (CreateMarker and CreateMarkerTD, which were specific of LegTD).
    - Notice that during kinematic optimization this new class optimizes a relative displacement of the marker instead of the absolute location itself.
    - This new class is used in all MoCap models in the Examples section.
  - Previous versions (CreateMarker and CreateMarkerTD) classes still exist and have been update according to the new Scaling Law implementation. It is, however, strongly recommended to shift to the new CreateMarkerDriver in all places of usage.
- **Force plates:**
  - Force plate definitions have been equipped with detection and correction of wrong signs of the ORIGIN value in the C3D files according the specification at www.c3d.org.
  - Center of pressure (CoP) is now referring to the center of the plate's top surface for all force plate types. Previously, it referred to the force plate transducer location, which is not unique for all plate types.

- Cylinder fitting to 5 points (in \ToolBox\WrappingSurfaces\WrappingCylinder5PointFit.any) was updated with better positioning of elongated cylinders. Previously, elongation only extended to one side.

General comments

- Specific setting of the member OutDim is done for all linear-combination measures (AnyKinLinComb) in the AMMR. This is required by AMS v.6.0 and should not affect using the repository on older AMS versions. (Please notice that AMS v.6.0 will warn about this new requirement so the same modifications can easily be done in older AMMR)
- Comments on significance of the changes
    - Kinematics changed slightly due to scaling, in particular in closed loop models. Possible need for updating initial positions