Automatic generation of partially homogenized FEM human body models based on 3D body scan data

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Introduction

The design of any functional clothing requires elastic human body models. The detailed FEM models as for instance THUMS (Total Human Model for Safety) (Toyota THUMS Webpage) for car crash simulations are unnecessary accurate, computational intensive and not practicable for clothing and other product development processes. For correct simulation of the mechanical interaction a full-scale FEM Models of the humans with enough suitable accuracy and complexity, but at efficient computation and often in specific poses are required. This works presents the development steps and current state of an algorithm for automatic solid FEM mesh generator for human bodies, based on high speed 3D (4D) scan data.

Methods

The data from the 3D scanner is used for two purposes: a) for detection of the main sizes of the bones of the human body and b) the surface mesh is used as a basis for the building of the inner solid layers of the skin, inner soft structures and the bones.

The high speed 3D scanning (4D scanning) hardware obtains all data points within milliseconds. This allows accurate reconstruction of the body geometry at different poses, and does not contain the errors from the human body during its motion and breath as the classical and slower 3D scanning process. The multiple frames allow reconstruction of the deformations of the body during the motion (Figure 1). After the triangulation of the raw data points and closing the geometry to watertight mesh (Figure 1b), one closed mesh for the body at each pose is available. The workflow, described in Figure 2 is applied for the construction of the FEM mesh from the scan data. After filling the closed boundary of the body surface with solid elements, different level of accuracy can be applied. The bone geometry has to be scaled to the size of the human and after that based on their position, the suitable material properties are applied on the solid elements in this region. The procedure is implemented currently in its initial simplified form within

gmsh Software and python script, where the bones are considered only in some parts of the body (legs) and are approximated as cylinders.

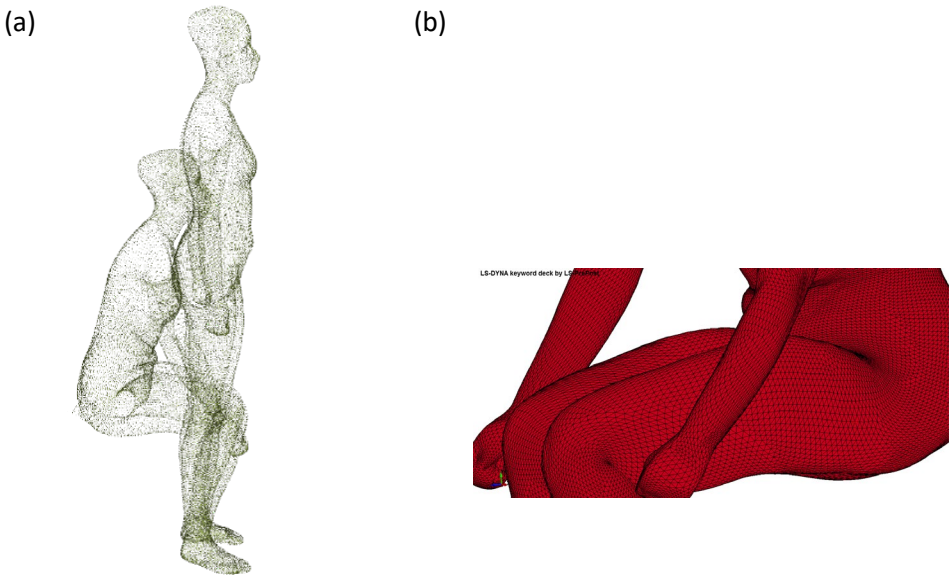

Figure 1. Scanned human geometries a) raw points of a human at two different positions after high speed 3D body scanning with MOVE4D b) triangulated mesh of the body at one position

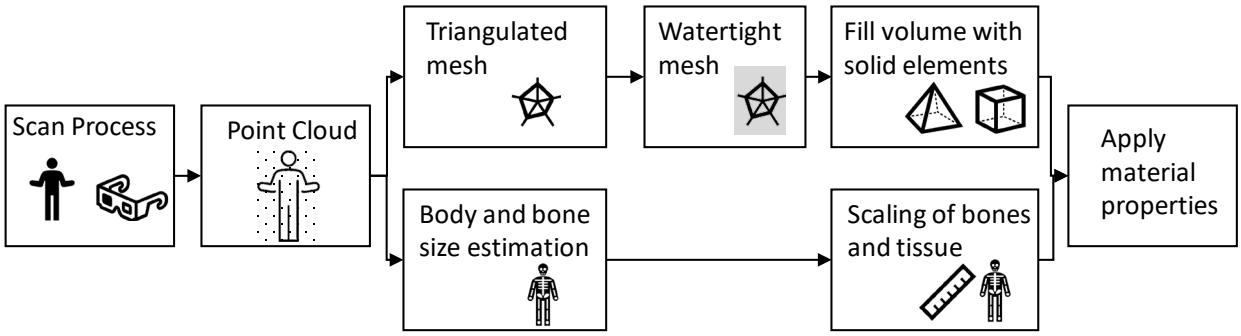

Figure 2. Workflow for the homogenized FEM mesh generation

References

https://www.toyota.co.jp/thums/

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