HumMod Explorer: A Multi-Scale Time-Varying Human Modeling Navigator

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1 Introduction

HumMod [Hester et al. 2011] models interactions between the cardiovascular, respiratory, renal, neural, endocrine, skeletal muscle, and metabolic physiologies. One of the difficulties which must be overcome with HumMod is the fact that the number of parameters is prohibitive in developing a clear and comprehensive view of the interactions between parameters. Currently the HumMod model contains more than 5000 variables. Therefore, good visualization techniques are needed to discern non-obvious relationships between variables. We present HumMod Navigator, a multiple-scale physiology data browser for exploring casual relationships of time-varying human modeling data. The visualization makes use of a circular layout and hierarchical relations to effectively visualize interactions between model parameters in an attempt to obtain both a local and comprehensive view of the physiological modeling environment.

2 Parameter Interactions and Our Methods

In HumMod Navigator (Fig. 1, the first type of interaction represented is the hierachical relationship. Every parameter used in HumMod has an assigned "global" name. For example, Co2Total includes the parameters or global names of `CO2.CO2Total.Inflow` and `CO2.CO2Total.Outflow`. Each global name is made up of three distinct components, namely `CO2`, `CO2Total`, and `Inflow`, and `CO2`, `CO2Total`, and `Outflow`. This represents the fact that within the folder describing `CO2`, and the specific file describing `CO2Total`, there are local elements corresponding to both `Inflow` and `Outflow`.

A second type of relationship is the functional relationships. Each XML file for a parameter details the dependence of its value on the value of other parameters. For example, the XML file details the dependence of the value of `CO2.CO2Total.Inflow` on the value of parameters corresponding to the outflow of CO2 from other body organs, as well as the dependence of the value of `CO2.CO2Total.Outflow` on the values of `Lung.LungCO2.Expired` and `CO2.CO2Tools.LitersToMols`. These relationships constitute the functional relationships between different global parameters.

To combine both the hierarchical and functional interactions, we designed HumMod Navigator by employing the technique of Holten [Holten 2006] which uses hierarchical information to induce edge bundling. Cubic splines are used for the edges, and the possible control points are determined by drawing the hierarchical trees along circular rings moving inward. Possible control points along the innermost ring (those points corresponding to level 0 names) may be thought of as being connected by an inner cycle. The control points for an edge between nodes i and j are chosen to be the points corresponding to a shortest path between i and j along the interior nodes of the circle.

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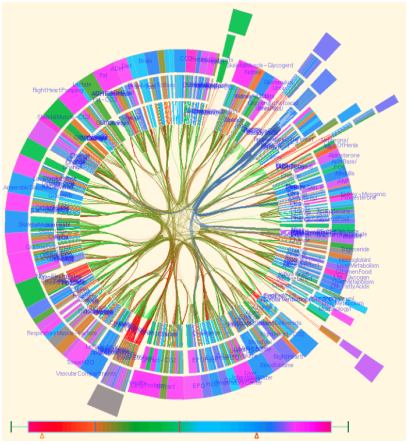

Figure 1: *View of Hierarchical Tree around inner ring. The node at the center of the figure corresponds to the level 0 name. From the adjacent node on the left, the nodes clockwise around the cycle correspond to the level 2 names given on the right. Edges from these nodes to the root have been suppressed, except for the rightmost and leftmost neighbor. The level 2 names can be projected downward onto the inner circle to determine their associated global name parameters.*

Each parameter is time varying and interpreting such data imposes cognitive and perceptual load to physiologists. To address this issue, we further show variations through a perceptually unformed coloring space. A color space is said to be perceptually uniform if the perceptual difference between any two colors in just noticeable difference units is equal to the Euclidean distance between the two colors in that color space. Figure 1 shows the result of the parameter variances coloring mapped to the L*a*b color space at L=60 for a half-an-hour simulation of a normal person.

Each node in the surrounding forest of hierarchical trees can be selected. Upon selection, this highlights the adjacent nodes (and corresponding edges) for all descendants of the selected node. At the lowest level, this gives a local view of parameter interaction. Selecting a node at a higher level in the hierarchical tree gives a semi-local, semi-global view of parameter interaction. The second important aspect of the diagrammatic view of the model was that the overall structure of the model could be viewed at a glance.

References

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