ArtiSynth: A 3D Biomechanical Simulation Toolkit For Modeling Anatomical Structures

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We describe ArtiSynth, an open-source system for creating dynamical models of complex anatomical structures. Implemented in Java, the system provides an extensible biomechanical modeling API that supports integration of diverse components such as rigid and deform-able bodies, particles, springs, and muscle actuators, together with contact handling, rigid body constraints, and the ability to add customized components. A primary focus of ArtiSynth is interactive simulation, with an emphasis on fast solution techniques and the ability to switch between high and low fidelity models as required.

Interactive simulation is also supported by various graphical interface mechanisms, such as control panels, and a Timeline for temporally arranging input and output data. Such interactivity allows easy exploration of a model's dynamic properties, and is useful for training, education and research.

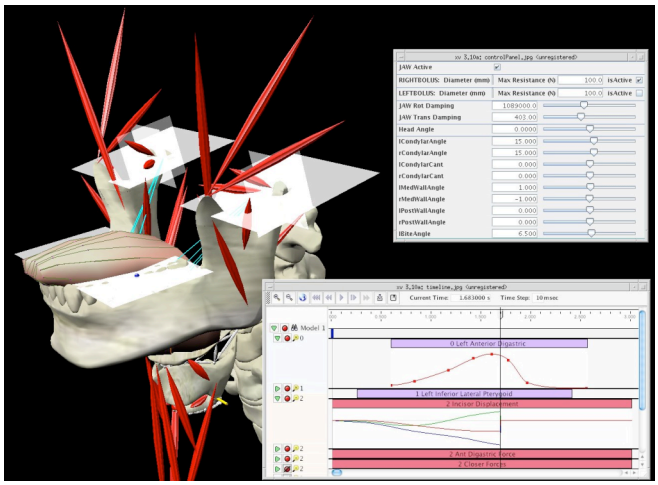

Figure 0: An integrated model of the jaw, larynx, hyoid, and tongue, together with a control panel for interactively controlling muscle activations, and a Timeline for specifying muscle activation trajectories and logging the motion of reference points.

Originally designed for speech research[1], ArtiSynth has been used to create muscle-activated models of both the jaw-laryngeal system[2] and of the tongue[3], and these have been combined into a single integrated model as shown in Figure 1. Currently, we are extending this to form a complete model of the upper airway (including lips, face, soft palate, and pharyngeal structures) for use in studying disorders such as dysphagia, obstructed sleep apnea, and speech pathologies. More generally, ArtiSynth should be broadly applicable in medicine, dentistry, and physiology. Medical applications include pre-operative planning and the design of interventional devices, while an important application in physiological research is inverse modeling (e.g., determining the neural control inputs associated with actions such as chewing or swallowing).

Our vision is for ArtiSynth to serve as a platform for collaborative research and development, hence feedback and contributions from the community are encouraged. It is freely available for non-commercial use at www.artisynth.org.

REFERENCES:

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[3] Vogt, F., Lloyd, J., Buchaillard, S., Perrier, P., Chabanas, M., Payan, Y., and Fels, S., ***Investigation of Efficient 3D Finite Element Modeling of a Muscle-Activated Tongue***, Proceedings of ISBMS 06 in Springer LNCS 4072. Pages 19-28. 2006.