A Web-Service Based Computational Environment for Biomedical Computing*

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Problem

The Defense Advanced Research Projects Agency Virtual Soldier Project (VSP) will investigate methods that will revolutionize medical care for the soldier. The project will produce complex mathematical models to create physiological representations of individual soldiers. These holographic medical representations (known as Holomers) can be used to improve medical diagnosis on and off the battlefield. The Holomers coupled with predictive modeling software, will facilitate a new level of integration in medical procedures.

A complex project such as this requires a flexible computational environment that, on the on hand, can support "real-time" prediction of outcomes of wounds and, on the other hand, support a large collaboratory of researchers in developing this capability. We are designing just such a flexible problem-solving environment, based at least partly on Web services, specifically to support the Virtual Soldier biomedical modeling, simulation, and prediction of outcomes to injuries.

Method

The focus of the project is on biomedical modeling of the heart. X-ray CT images of the heart will be segmented, and surface and volume models created. Individual-specific finite element (FE) mesh models of the heart will be created and computations performed using the Continuity program [1]. In addition, high-level integrative physiological models [2,3] will be constructed and validated against both experimental data and the higher resolution FE models for use in a "real-time" predictive capability.

The problem-solving environment we are developing consists of the following elements:

- Data storage for model and experimental results
- Web services to provide access to the high-level integrative models and their results
- Web services for access to anatomical and physiological ontologies
- Other services for file location, transfer, and conversion
- Support for visualization of the predictive results as well as their supporting model calculations.

Associated with this project is the development of a sophisticated predictive engine based on Kalman Filter processing. The various parts of the problem-solving environment must work smoothly with the prediction engine and associated control software (referred to as the Integrator) in "real time" response mode, where the prediction of the consequences of a wound will be nearly in step with the actual consequences, so that medic and medical professionals can make quick and decisive corrections. But it must also support the broad general needs for connectivity for the entire project. The Web service approach is flexible in that it can be scoped down to a single location if need be, yet can be distributed over a wide Internet. if so desired. We will demonstrate this capability at the meeting.

Conclusion

This talk focuses on the development of a problem-solving environment for biomedical modeling using Web services. The application of this approach to the Virtual Soldier Project is described. The services provide access to biomodeling simulations (using the JSim modeling environment [2,3]. This type of problem-solving environment plays an increasingly important role in biomedical computing, by providing large collaborations, such as the Virtual Soldier Project, with a single distributed computational environment.

Discussion

As the VSP problem-solving environment is developed in the future, additional areas of the body will be included. This will require the incorporation of additional computational and visualization capabilities into the problem-solving environment.

References

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