SIFEM: Using semantic technologies to support Finite Element biosimulations

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1 Introduction

Scientific investigation practice is evolving in the direction of the creation of large-scale, highly complex, multi-domain and multi-scale scientific models and theories [1]. The recent advancement of technologies has given increasing computational power to biomedical researchers for building complex biosimulation systems. However, as models and simulations grow in complexity, researchers find it more difficult to communicate, reuse, reproduce and interpret existing models. This situation is more severe in the biosimulation domain where the data cannot be easily shaped into a first-order symbolic model. Biosimulation models are dependent on multiple and complex representation dimensions including topology, geometry, physics, mathematics, algorithmic models and physiology.

Semantic Web standards and technologies have a key role in providing the infrastructure for the evolution towards a more reproducible, automated and efficient scientific praxis. The SIFEM project aims at creating a *semantic infrastructure* to support finite element (FE) biosimulations. *Finite Element* (FE) methods are numerical techniques for finding approximate solutions for differential equations, and are examples of computational models which are present in different branches of science, including Biology, Physics and Engineering.

The target domain model for the SIFEM project is the creation of a *multi-scale finite element model of the inner ear*. The creation of a realistic model of the inner ear function and behavior is a complex scientific task which depends on the understanding of different structures which crosses the boundaries of different domains of expertise. The hearing process involves the orchestration between anatomical structures which have different scales (from centimeters to the protein level) and are governed by different physical and chemical principles. Therefore, modelling the mechanics of hearing is an exemplar case of a complex, multidisciplinary, large scale scientific endeavour.

2 Areas of Interest & Collaborations

The following list describes the primary areas which are investigated under the scope of the project:

- *Representation of biosimulation experiments:* With a particular emphasis on Finite Element models, qualitative Physics, representation of analytical, numerical and physiological models.
- *Evolution of scholarly communication:* Methods for improving reproducibility in eScience environments, such as executable papers, nanopublications.
- *Scientific analysis automation:* Using semantic technologies and standards to reduce the effort in setting up and interpreting biosimulations.
- *Personalised medicine:* Using biosimulations to support personalised medicine.
- *Clinical validation of biosimulation models:* Facilitating the experimental validation of biosimulation models.
- *Multi-scale finite element models:* Integration of multi-scale finite element models.

The project is looking for collaborations with a particular focus in (but not restricted to) the above areas. The SIFEM platform will be made available as an open source tool at the end of the project. We are aiming to push forward data standards in the finite element modelling area and to improve the integration with the Virtual Physiological Human (VPH).

The project offers:

- Its expertise and momentum in the areas outlined above.
- Real eScience uses cases with leading researchers in Finite Element and cochlear mechanics research.
- Real simulation and clinical validation data.

3 SIFEM Project Fact Sheet

About: The SIFEM project is a 3 years project with total cost of € 3,908,831. It is coordinated by INSIGHT @ NUIG which is one of Europe's leading data analytics and semantic technologies centre. Project partners are highly specialized in a wide range of domains including bioengineering, mathematical models, biomedical, clinical and computer science. **website:** http://sifem-project.eu

Partners: National University of Ireland, Galway, Ireland; ICCS, National Technical University of Athens, Greece; ISVR, University of Southampton, UK; Linkpings University, Sweden; BioIRC d.o.o. Kragujevac, Serbia; INTRASOFT International SA; Ear Institute, University College London, UK; Department of Otolaryngology, National & Kapodistran University of Athens, Greece; The Research Trust of Victoria University of Wellington, New Zealand; Technical University of Munich, Germany.

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References

1. Freitas et al., Towards a Semantic Representation for Multi-Scale Finite Element Biosimulation Experiments, 13th IEEE Intl. Conf. on BioInf. and BioEng., 2013.