Research project offer

Location : ISAE SUPAERO, Toulouse, France

Department : DISC

Research group : MA

Supervisor : Denis MATIGNON and Ghislain HAINE

Email : denis.matignon@isae.fr ghislain.haine@isae.fr

OFFER DESCRIPTION

Title : Structure-preserving reduction for port-Hamiltonian Differential Equations

Proposed duration and period : 6 months, september 2021 – february 2022 (3 days per week)

Context (max 10 lines)	The modeling of complex physical systems based on the exchange of energy between connected domain allows a modular description of complex dynamical systems. To this aim, the port-Hamiltonian (pHs) formalism proves to be a powerful tool for the modeling and the control of physical systems, both in finite or infinite dimension. A recent difficulty arising in structure-preserving discretisation of physical systems is the big size of the resulting system. The classical example concerns Maxwell's equations where two 3D-vector fields have to be approximated. An approach to tackle this issue is to make use of model reduction methods, but again ensuring the preservation of the power balance. This internship will be the first one of the starting school project FAMAS funded by the AID, and will be followed by two other internships (which will be granted by the FAMAS project).
Objectives and work (max 20 lines)	During the internship, the student will start by studying our recent results on the structure-preserving discretisation of Maxwell's equations [1] by the Partitioned Finite Element Method (PFEM). The algebraic constraint inherent to the divergence of the inductions constitute the major difficulty of this part. The model reduction will be studied with the help of our colleagues Charles Poussot-Vassal and Pierre Vuillemin from ONERA Toulouse, experts in this domain, The structure-preserving property of the model reduction will be mandatory during this step. After these two studies of known results, the student will have to apply the structure-preserving reduction to the discretized Maxwell's equations and compare his results with those obtained on the full size system in [1]. Another important part of the internship will concern the redaction of a precise manuscript for the following internships of the FAMAS project. Furthermore, it is intended that the student will present his results in the GdT pHs of the institute, gathering members of DISC, DMSM, DAEP and DCAS. If time allows it, control on the magnetic induction divergence, as the first step for coupling with charged particles, could be investigated. [1] G. Payen, D. Matignon, and G. Haine. Modelling and structure-preserving discretization of Maxwell's equations as port-Hamiltonian system. In Proceedings of the 21st IFAC WC, volume 53, pages 7671–7676, 2020. Invited session.

Illustration(s) / picture(s)

Possibility to continue with a PhD (Yes/No) : XXX

REQUIRED APPLICANT PROFILE AND SKILLS

Study level (tick possible choices)	☐ Undergraduate students (3rd or 4th year) ☐ Master students (1st or 2nd year) ☐ PhD students
Required profile and skills	XXX

Other useful information	XXX