Domain Decomposition for Micromagnetism: How to Manage Non-local Contribution?

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Abstract: In this presentation, we will give a strategy in order to parallelize simulations for a non-local and no -linear problem: the computation of magnetization in ferromagnetic material. The problem we are interested in is written as follows: given Ω an open bounded set of $\mathbb{R}^3$, find m in $H^1([0,T]\times\Omega)$ such that

$$\begin{aligned}&\tfrac{\partial m}{\partial t} = -m\wedge h(m) - \alpha m\wedge(m\wedge h(m)), \text{ in } L^2([0,T]\times\Omega),\\ &m(0,.) = m_0 \in H^1(\Omega),\end{aligned}$$

where h is a linear operator, sum of two linear operators: $h(m) = A\triangle m + \triangle^{-1}\nabla \text{div}(\tilde{m})$ for $\tilde{m}$ the function defined on $\mathbb{R}^3$, prolongation of m outside of Ω. The second part of the so-called magnetic contribution, named demagnetization field, is a non-local operator. In order to compute the dynamic of m, a computation code has been developed based upon a finite volumes approach on a regular grid (see [2] and also [3]).

A first successful study has been performed in order to parallelize the algorithm when the magnetic contribution is restricted to the first term [1] using a Robin algorithm. In the present work, we develop a paralyzation strategy for the non local contribution based upon the Robin algorithm developed in the previous work and a multi-level approximation of the demagnetization field. The goal of this multi-level decomposition is to minimize the data exchanges between domains in order to allow an iterative algorithm.

Bibliography

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