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Editorial: Moving boundary problems in multi-physics coupling processes

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Editorial on the Research Topic
Moving boundary problems in multi-physics coupling processes

In many problems such as propagation of crack, fluid-structure interaction, flow in deformable porous materials, material forming process and so on, the boundary of material/structure or the interface between different materials/structures varies depending on the *in-situ* responses of associating components and environmental factors. Such problems are also named as moving boundary problems, and the time-dependent boundary poses significant challenges to the numerical modelling of such problems as well as the study of inherent mechanisms dominating the evolution of moving boundaries. Severe nonlinearity caused by the moving boundary requires development of advanced numerical algorithms, while interaction of multi-physics behaviors in moving boundary problems such as mechanical, thermal, electrical and even chemical response, necessitates research of multi-physical modelling methodologies.

This Research Topic "*Moving Boundary Problems in Multi-physics Coupling Processes*" collects 16 papers contributing to the experimental, numerical and theoretical research on moving boundary problems of multi-physics processes. While focusing on "*Moving Boundary Problems in Multi-physics Coupling Processes*," the selected papers show a good diversity in terms of their research objects, methods and findings. Some contributors have obtained valuable achievements on modelling of cracks. For instance, Ma et al. used discrete element method to establish a numerical model of porous concrete with random circular defects inside, to study the influence of the porosity or size homogeneity of the defects on the mechanical behavior, crack evolution, and acoustic emission (AE) responses. Their findings can aim the understanding of micro-scale mechanism of crack propagation in porous concrete. To accelerate the numerical simulations of fracture, Liu et al. employed degradation function that decouples the phase-field and physical length scales, to reduce the mesh density in large structures. By incorporating the Drucker-Prager failure surface into the phase field model to characterize the tension-compression asymmetry of fractures in rocks, they can capture the crack propagation path in rock materials with a good accuracy and efficiency. Instead of using conventional numerical methods, Lian et al. proposed a novel framework for efficient simulation of crack propagation in brittle materials, whereby the partial differential equations of the phase field models are solved with physics informed neural networks (PINN) by minimizing the variational energy, enabling accurate and efficient modelling of fracture behavior of brittle materials.

Another important aspect of this Research Topic is directed to the multi-physics problems. Xiao et al. conducted experimental tests and fluid-structure coupling simulations of pavement-clogging of pervious concretes, and found that the pervious pavement with smaller coarse aggregate is easier to be clogged, and the discontinuous graded coarse aggregate has a good shielding effect on the clogging material. Yuan et al. focused on electromagnetic problems, and proposed an efficient method of moments (MoM) based on polynomial chaos expansion (PCE) to efficiently calculate the electromagnetic scattering problems. Li et al. established a Polynomial Chaos Expansion (PCE) surrogate model for flexoelectric materials, and developed a sensitivity analysis method for the surrogate model. Apart from these contributions, some other authors paid efforts on the acoustic-structural coupling problems. For instance, Jiang et al. studied the interaction between the wake of rods and airfoils by solving the Reynolds average N-S equation and non-linear acoustic equations. Zhao et al. experimentally investigated the influences of the fan parameters including axial distance, blade number, blade pattern and blade thickness on the performance and noise characteristics under variable rotational speed regulation. Chen et al. conducted numerical simulation and sensitivity analysis of structural-acoustic fully-coupled systems via combination of FEM and BEM. Xu et al. employed various surface integral methods to numerically calculate the sound generated from a flow passing through a circular cylinder, and analyzed the pros and cons of each aeroacoustic prediction method.

Optimization and design of moving boundary problems also attracted much attention of researchers. Zhang et al. introduced an approach to optimizing the patterns of vibrating structures contributing to radiated sound power, and found that the corner radiation properties of the plate can be suppressed by the optimization, minimizing the integration of non-negative intensity. Peng et al. studied the effect of the geometrical parameters of periodically opening and closing drying cabinets on their drying efficiency, and obtained an optimized configuration. Hu et al. proposed a new approach for topology optimization of complex structures by combing the pix2pix, an image-to-image translation framework, and the isogeometric multi-patch analysis. By using a simple centroid design method, Xiao et al. developed an optimization procedure that can design the mixture of pervious concrete, and obtained some specimens exhibiting obvious improvement of strength. The research work of Du et al. and Wu et al.further broaden the scope of this Research Topic, in terms of studying the Rayleigh wave extraction method based on microtremors signal analysis, and refining large knowledge bases using co-occurring information in associated KBs.

The success of this Research Topic owes to all the contributors including the reviewers, authors, editorial office and many colleagues. Reviewers are sincerely acknowledged for their careful and rigorous reviews on the submitted manuscripts, which are the most important step in selecting appropriate work for publication. Many thanks are also given to the authors of submitted manuscripts, which are the key component of this Research Topic. The editors handling this Research Topic also significantly appreciate the help from the editorial office of Frontiers in Physics, and are grateful to friends and others who have offered their help in dissemination of this Research Topic.

Author contributions

PL: Drafting and Revision LC: Revision EA: Revision. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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