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ABOUT ME

Bachelor in applied physics from the university of Tongji (China)

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Keywords

Physics-informed, self-learning, digital twin, meshless simulation food deconstruction, food mechanics

Physics-informed image analysis applied to food deconstruction

Graphical abstract

Context of the project

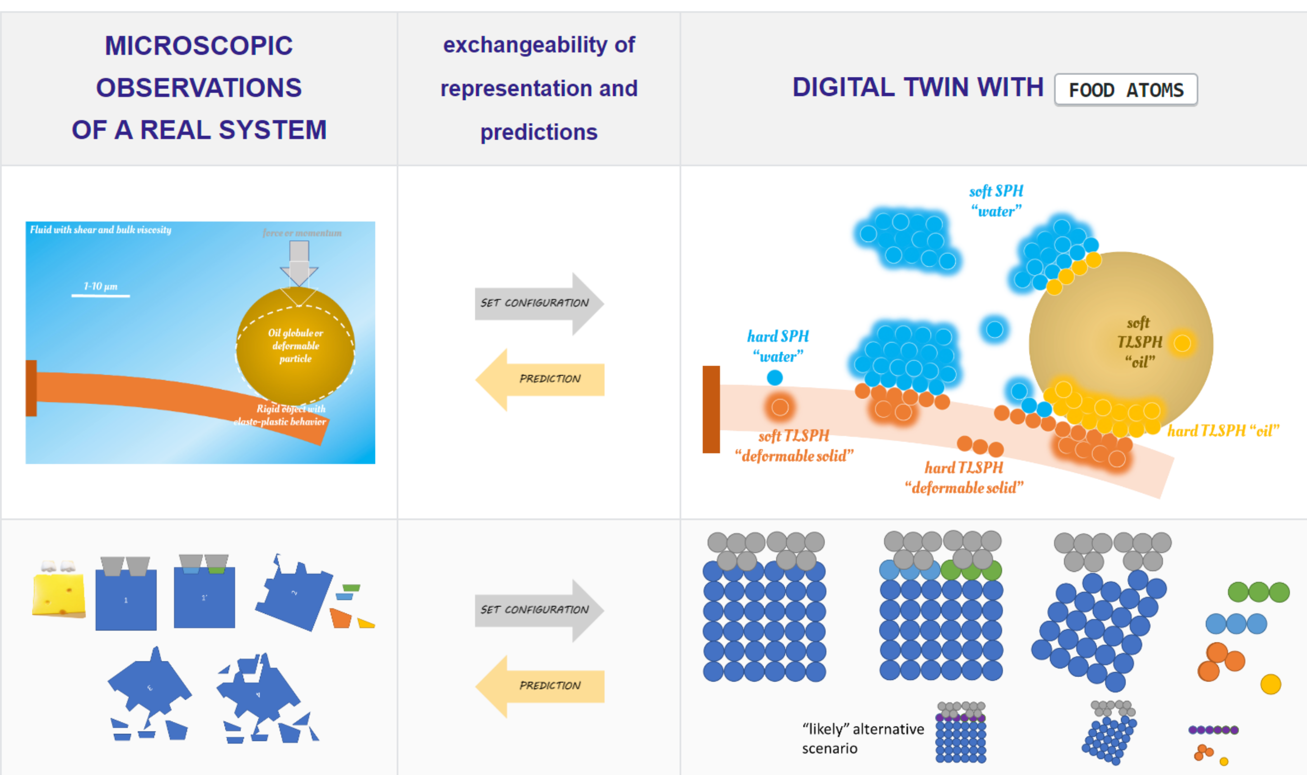
The MOUTHFEEL project seeks to establish a scientific correlation between the structural attributes of food and its sensory perception during oral processing. The ultimate ambition is to engineer food structures with tailored mechanical perceptions, facilitating a novel approach in food design and customization.

General Goal

The project aims to pioneer the development of a "Digital Twin" framework through advanced "Physics-Informed" image analysis techniques. These digital replicas are designed to be sufficiently accurate for applications beyond their original calibration scenarios, enabling a new dimension in food science and engineering.

Assumption and Tools

The concept of "food-atoms" is introduced to represent the smallest discernible particles generated during oral processing, with dimensions surpassing the colloidal scale. These food-atoms are modeled using SPH techniques, mimicking molecular dynamics simulations. They exhibit complex behaviors through pairwise interactions and forces, encapsulating the intricate physics of food materials.



Objectives

To leverage image analysis for deriving critical, yet traditionally unquantifiable, physical properties of food materials, including:

- Rheological attributes and fluid dynamics, such as viscosity, alongside solid material properties like elasticity, Lamé's constants, and Poisson's ratio.
- SPH-model-specific parameters that facilitate the transition from continuous to discrete representations of matter, including interactions modeled on Hertzian contact mechanics.
- Detailed mechanical stress profiles, encompassing pressure, viscous resistance, shear stress, and the forces involved in impact and fracture scenarios.

Techniques employed

- SPH-based simulation methodologies inspired by molecular dynamics for fluid and solid interactions.
- Peridynamics for a comprehensive, non-local description of the mechanical behavior of solids.
- Advanced image analysis paired with: particle Image Velocimetry (PIV) for fluid flow visualization, fluorescence microscopy and Laser Scanning Confocal Microscopy (LSCM) for high-resolution, three-dimensional imaging of food structures.

Financeurs

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