הטכניון מכון טכנולוגי לישראל TECHNION Israel Institute of Technology

הפקולטה להנדסת מכונות Faculty of Mechanical Engineering

SEMINAR - סמינר

הנך מוזמן/ת להרצאה סמינריונית של הפקולטה להנדסת מכונות, שתתקיים ביום ב' 30.11.2020
(י"ד בכסלו תשפ"א), בשעה 14:30 באמצעות הזום :
https://technion.zoom.us/j/95912657715

מרצה:

Professor Angelo Alessandri
Department of Mechanical, Energetics, Management, and Transportation Engineering
University of Genoa, Italy

על הנושא:

Control of Level Sets from Hamilton-Jacobi PDEs: Experience Versus Theory

The seminar will be given in English

להלן תקציר ההרצאה :

In many applications it is necessary to model separation interfaces between different physical processes. These moving interfaces can be described by a level set arising from the solution of Hamilton-Jacobi PDEs, such as the normal flow and mean curvature flow equations. Motion of two- and three-D dynamic surfaces is fundamental in a number of research fields, including fluid mechanics, image processing, and material science. Theory and practice of this modeling paradigm is part of the wide research area of the so-called level set methods. Such methods handle moving interfaces by the Eulerian approach, which turns out to be more easily tractable from a computational viewpoint as compared with particle-tracking or Lagrangian approach and more general with respect to those developed in the research framework of shape optimization, which are purely static and do not allow to account for temporal evolutions.

Two biggest challenges in control of dynamically evolving interfaces concern their uncertainty and computational tractability. Uncertainty that affects the processes generating moving fronts is critical since small disturbances can cause instability even if they are transient and vanishing. In more technical detail, the nonlinear PDEs governing the front dynamics as the level set of their solution are not input-to-state stable. Input-to-state stability is pretty well-established for finite-dimensional systems but is much less understood in the infinite-dimensional case, especially when the PDEs are nonlinear. This poses the challenge of robust design for closed-loop control of level sets, namely, guaranteeing the input-to-state stability. The second challenge consists in coping with numerical difficulties occurring in real applications, where the PDE used to model the front may be coupled with other PDEs governing the physical processes underlying the front dynamics.

Despite the vast literature on the control of systems described by PDEs, very little has been proposed on the control of level sets generated by them. The lecture will present first several attempts to attack such problems from the perspective of the control theory by focusing on the difficulties arising in devising a control scheme with guaranteed stability, as well as on potential applications. The main steps of the presentation will concern

- normal flow and mean curvature flow PDEs
- optimal control of level sets vs shape optimization
- approximate solution of optimal control problems of level sets
- optimal control of level sets with an experimental setup
- control of level sets based on stability criteria
- input-to-state stability in the control of level sets.

Finally, a prospect of future work with applications to the control of bioreactors, wildfire containment, and nuclear fusion will be presented.

מארח : פרופ' מיכאל שפירא

בברכה,

פרופ'/ח מתי סאס
מרכז הסמינרים