SEMINAR - סמינר

הנך מוזמן/ת להרצאה סמינריונית של הפקולטה להנדסת מכונות, שתתקיים ביום ב' 8.11.21
(ד' בכסלו תשפ"ב), בשעה 14:30 סמינר יתקיים באמצעות הזום:
https://technion.zoom.us/j/93688068626

מרצה:

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על הנושא:

Fusion of CFD and Sensor Observations for Physical Fields Calibration and Reconstruction

The seminar will be delivered in English

להלן תקציר ההרצאה:

In this seminar, we explore the issue of dense and sparse information fusion with indoor physical fields (e.g. temperature, humidity, air velocity, etc.) as the information of interest. Physical fields are very useful information in many energy-efficient system design problems. Computational fluid dynamics (CFD) simulation is essentially the de facto tool to estimate the dense indoor physical fields. But the simulations are based on ideal boundary condition assumptions and the results are inaccurate as compared with actual sensor observations. Extensive CFD simulation is also computationally expensive and time consuming. Therefore, a new method to rapidly obtain accurate calibration/reconstruction of indoor physical fields is of practical interest. In this talk, we shall discuss how sparse sensor observations can be effectively used for indoor physical fields estimation by solving the three problems: 1. Calibration of simulated physical fields using sparse sensor observations; 2. Reconstruction of physical fields from sparse sensor observations; 3. Sensor placement for the optimal physical field reconstruction.

Current CFD calibration work has mainly focused on the calibration of input parameters of CFD simulation, and there is no reported work on calibrating the simulated results. To calibrate the physical fields, we took inspiration from the image editing problem to develop a methodology to fuse the CFD with sparse sensor observations. We formulated the calibration work as an optimization problem where the cost function has two terms. One term guarantees a good local adjustment of the simulated physical fields while the second term transmits the adjustment from regions around sensing locations to the global domain. Thus, the simulated physical fields are calibrated at sensor locations while the overall original profile is preserved. For physical field reconstruction, we provide a two-stage approach to rapidly reconstruct a physical field by fusing observed input parameters of the CFD simulations with sparse observations of the physical field. With a physical field database obtained from CFD

simulations, we determine the principal component analysis (PCA) modes of the physical fields. In the first stage, we built a regression model between the input parameters and the PCA coefficients. With the regression model, which is obtained by using a quick AI algorithm, we can obtain the PCA

coefficients to reconstruct an approximated physical field. In the second stage, we estimate the error of the approximated physical field from sparse sensor observations, with which we can correct the physical field estimated in the first stage.

With the above results, we noted that sensor placement is a critical problem for accurate calibration/reconstruction. To address the problem, we develop a new greedy algorithm, named maximal projection on minimum eigenspace (MPME). In this algorithm, the sensing locations is determined one-by-one until the required estimation accuracy is satisfied. The minimum eigenspace is defined as the eigenspace associated with the minimum eigenvalue of the dual observation matrix. For each sensing location, the projection of its observation vector onto the minimum eigenspace is shown to be monotonically decreasing w.r.t. the worst case error variance (WCEV) of the estimated parameters. Hence, we select the subsequent sensing location whose observation vector has the maximum projection onto the minimum eigenspace of the current dual observation matrix. The proposed MPME is shown to be one of the most efficient algorithms. Our Monte-Carlo simulations show that it outperforms the state of art sensor placement algorithms, especially when the number of available sensors is very limited. The MPME algorithm can be easily used for the indoor physical field reconstruction, while the current methods cannot because of their high storage requirement and high computation cost.

About the Speaker: Yeng Chai SOH received the B.Eng. (Hons. I) degree in electrical and electronic engineering from the University of Canterbury, New Zealand, and the Ph.D. degree in electrical engineering from the University of Newcastle, Australia. He joined the Nanyang Technological University, Singapore, after his PhD study and is currently a professor in the School of Electrical and Electronic Engineering. Dr Soh has served as the Head of the Control and Instrumentation Division, the Associate Dean (Research and Graduate Studies) and the Associate Dean (Research) at the College of Engineering. He was also the founding director of NTU’s High Performance Computing Centre. Dr Soh has served as panel members of several national grants and scholarships evaluation and awards committees.

Dr Soh’s research interests are primarily in robust control and applications, robust estimation and filtering, and energy efficient systems. He has published more than 300 refereed journal papers in these areas. His most recent research activities are in the areas of sensor networks, sensor fusion, distributed control and optimization, and multi-agent systems. He is currently an Editorial Board member of Sensors.

<u>מארח</u> : פרופ' מיכאל שפירא

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