

Einladung des Instituts für Elektrische Messtechnik und Sensorik:
Gastvortrag des Herrn Professor Marko VAUHKONEN, PhD,
University of Eastern Finland

Titel: State Estimation and Neural Network Approaches for Two-Phase Flow Imaging using Dual-Modal Electrical Tomography

Wann: Dienstag, 30.04.2024 um 10:00 Uhr

Wo: Seminarraum EMS, PZ402104, 4530 IEMS, Inffeldgasse 23/2. OG, 8010 Graz

Abstract:

This talk shows results of a study, in which we explore the potential of state estimation and neural networks for image reconstruction in dual-modal tomography of two-phase oil-water flow. The accurate measurement of two-phase flow quantities is crucial for effective production management across various industries. However, the complexity inherent in two-phase flow poses challenges in accurately estimating the quantities, necessitating the development of reliable reconstruction techniques. Our approach involves utilizing electromagnetic flow tomography (EMFT) for velocity field estimation and electrical tomography (ET) for determining phase fraction distributions. To account for the contribution of the velocity field to the temporal evolution of the phase fraction distribution, we employ a convection-diffusion model in the state estimation process. Furthermore, the extended Kalman filter (EKF) and fixed-interval Kalman smoother (FIKS) are used for reconstructing the spatio-temporal velocity and phase fraction distributions. In addition, we study the possibility of utilizing deep neural networks (DNNs) for directly estimating the oil flow rate in two-phase oil-water flows. The effectiveness of our approaches is demonstrated through simulations and experimental investigations on a laboratory setup, considering different cases with stationary and non-stationary average flow speeds. The simulations and experimental results reveal that the proposed time-varying approach outperforms conventional stationary reconstructions, highlighting the potential of state estimation for achieving more accurate dynamic image reconstruction in dual-modal tomography of two-phase flow. Furthermore, the simulation results demonstrate promising potential of the proposed DNN approach in accurately estimating the oil flow rate in complex two-phase flow systems.

Biography:



Marko Vauhkonen completed his PhD in physics in 1997 at the University of Kuopio, Finland. Following his graduation, he served as a researcher and research director at the same university until relocating to Germany in 2006. During this time, he held the position of Marie-Curie Research Fellow at Philips Research GmbH, Aachen, for two years. From 2008 to 2009, Vauhkonen assumed the role of Chief Technology Officer at Numcore Ltd., a spin-off company. In 2009, he joined the University of Kuopio (now University of Eastern Finland) as a professor in the Department of Applied Physics (currently the Department of Technical Physics). His research interests encompass inverse problems, time-varying reconstruction, process tomography, geophysical inversion, and image reconstruction in medical imaging modalities such as PET, SPECT, and MRI. He has authored over 120 scientific journal articles.