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Electrical capacitance tomography and imaging industrial processes

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Biography

Professor Wuqiang Yang received BEng (with Distinction), MSc and PhD (with Distinction) degrees from Tsinghua University in Beijing. After 3 years Lecturer at Tsinghua University, he joined UMIST in 1991 and currently he is a Professor at The University of Manchester. His main research interests include industrial process tomography, especially ECT, image reconstruction, sensing and data acquisition systems, electronic circuit design, instrumentation and multiphase flow measurement. Professor Yang is a Chartered Engineer, Fellow of IET and Senior Member of IEEE. He has published 250 papers, including review articles and he reviews papers for 30 journals. He is a Visiting Professor/Science Advisor in 5 universities/organisations and an editorial board member of 4 journals. He received 1997 IEE Measurement Prize, 1997 Honeywell Prize from the Institute of Measurement and Control, 2000 IEE Ayrton Premium and 2009 IET Innovation Award Finalist. His biography has been included in Who's Who in the World, Who's Who in Science and Engineering and Who's Who in America since 2002. He is recognised by International Center for Scientific Research (France) as one of top 30 technology researchers in the world. Since 2010, he has been an IEEE Instrumentation and Measurement Society Distinguished Lecturer.

Abstract

Electrical capacitance tomography (ECT) is an imaging technique for industrial applications. ECT is based on measuring capacitance from a multi-electrode capacitance sensor and reconstructing cross-sectional images, aiming to visualise the distribution of dielectric materials, such as gas/oil flows in an oil pipeline and gas/solids distribution in a fluidised bed. The internal information is valuable for understanding complicated phenomena, verifying computational fluid dynamic (CFD) models, measurement and control of industrial processes, which are difficult with conventional process instruments. Compared with other tomography modalities, ECT is the most mature and offers advantages of no radiation, rapid response, non-intrusive and non-invasive, withstanding high temperature and high pressure and low-cost.

Research into ECT involves sensor and electronic circuit design, data acquisition, computer interface, mathematics, finite element analysis, software programming, and general knowledge in chemical engineering. Because of extremely small capacitance to be measured (down to 1×10^{-4} pF) and the nature of soft-field, ECT presents challenges in engineering and mathematics. The University of Manchester (formerly UMIST) pioneered research into ECT. The latest ACECT system presents the state-of-the-art technology, which can generate on-line images at 100 frames per second with 73 dB signal-to-noise ratio (SNR) and has been used for many challenging industrial applications, such as gas-oil-water flows in oil pipelines, wet gas separators, pneumatic conveyors, cyclone separators and fluidised bed dryers. It is foreseen that ECT will make major contributions to the gas/oil, pharmaceutical and power industries. In this tutorial, the principle of ECT, capacitance measuring circuits, image reconstruction algorithms and some applications will be discussed, together with a demonstration of an ACECT system.

Target audience: postgraduate students, researchers from universities and research organizations, industrialists