SCIENCES & BIOENGINEERING SCIENCES

The Department of
Mathematics and Data Science

has the honor to invite you to the public defense of the PhD thesis of

Tan Lu

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Homogeneity models for image processing in the cultural heritage sector

Promotor:
Prof. Dr. Ann Dooms

The defense will take place on

Friday, October 23rd 2020 at 10h00

at the Campus Etterbeek of the Vrije Universiteit Brussel, Pleinlaan 2 - 1050 Elsene, room D2.01. The defense can be followed through a live stream. Contact Prof. Jan.De.Beule@vub.ac.be for more information.

Members of the jury

Prof. Dr. Ann Nowé (VUB, chair)
Prof. Dr. Jan De Beule (VUB, secretary)
Prof. Dr. Kenny De Commer (VUB)
Prof. Dr. Kurt Barbé (VUB)
Prof. Dr. Apostolos Antonacopoulos (University of Salford, UK)
Prof. Dr. Frederic Dufaux (Université Paris-Saclay, France)

Curriculum vitae

Tan Lu obtained his Bachelor and Master Degrees in Engineering at University of Electronic Science and Technology of China (Chengdu, China). He worked later as a visiting Lecturer in Ngee Ann Polytechnic and Singapore University of Technology and Design, and briefly as a research associate in the Nanyang Technological University before starting his PhD in the Department of Mathematics and Data Science at the VUB. His work mainly concentrates on image processing in the cultural heritage sector, where he obtained 5 publications and a patent application.

Abstract of the PhD research

Large-scale digitization projects are conducted in the cultural heritage sector, where a sheer volume of images is being produced. This PhD work focuses on the formulation of mathematical frameworks for image processing pertaining to applications in the cultural heritage sector.

To this end, homogeneity models were developed and exploited in different scenarios. First of all, a probabilistic homogeneity model was proposed, where human perceptual recognition of text regions from complicated layouts was exploited. Through encoding several Gestalt principles which reveal the whole-parts reciprocal relations, a probabilistic local text homogeneity (PLTH) model was formulated and applied to document image segmentation, resulting in an award-wining segmentation framework.

This PLTH model was further exploited for distortion recognition, where a joint local and global homogeneity model was formulated for the recognition of arbitrarily shaped distortions in document images, an open problem in document processing despite being a hurdle especially for text recognition on scans of old manuscripts. In this part, local homogeneity was exploited using Markov random field based inference as well as wavelet approximation propagation, and the local and global homogeneities were integrated in a Bayesian framework, resulting in a generic method for distortion recognition, which was absent in document image processing.

Lastly, the cross domain homogeneity between document and natural scene images was exploited in a non-parametric manner using deep convolution neural networks, where a unified blind image quality assessment (UIQA) model was explored using transfer learning as well as a contractive generative adversarial network (C-GAN). The C-GAN was formulated to model cross-domain homogeneity by generalizing across different sources with heterogeneous distributions. This has led to the development of a content aware UIQA model which can be applied to process natural and document images simultaneously.

To sum up, homogeneity models were formulated in different scenarios and applied to address several problems, including document image segmentation, distortion recognition and quality assessment. This work demonstrates the capacity of a mathematical approach in tackling image processing problems in the cultural heritage sector, where the development of novel mathematical models can unleash the true potential hiding behind the digitization of documents.