Visualisation Data Modelling Graphics (VDMG) at Bangor

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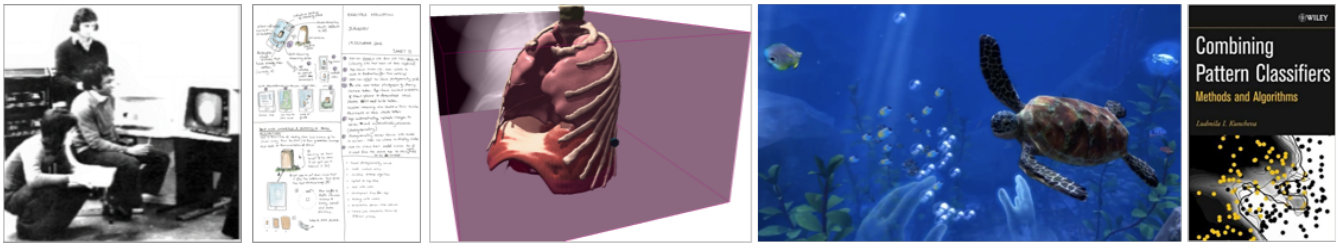

Jan Abbas with colleagues, c.1971 | The Five Design-Sheet (Roberts, Ritsos) | Real-time simulation of X-ray imaging with respiratory motion (Vidal) | Ocean Rift, underwater immersive VR experience. (ap Cenydd) | Pattern Recognition (Kuncheva)

Figure 1: *From early graphics researchers c.1971 to current research in design, medical, virtual reality and pattern analysis.*

Abstract

The Visualisation Data Modelling & Graphics (VDMG) research group at Bangor University brings together researchers in visualisation, modelling, data-mining and Artificial Intelligence. Our vision is to help people understand data, depict it visually and deliver enjoyable experiences. We design, develop and evaluate computing solutions that often incorporate AI, machine learning, interaction, underpinned with advanced computing, and are always user-focused. Located in Bangor University – a civic University on the North Wales shoreline that is close to the Snowdonia mountain range and National Park – much of our research is inspired by nature, motivated to be sustainable, and people focused.

1. Introduction and history

The year 2021 marks the 50th anniversary of computer graphics research at Bangor University, dating back to the 1970s, when Dr. Jan Abas started creating computers graphics images inspired by Islamic geometric art. Until the late 1990s, graphics research took place in the Mathematics group, focusing on algebraic topology, category theory, homotopy and pattern recognition. In the 1990s, as part of the School of Informatics, researchers focused on information processing, applied mathematics, pattern recognition and fluid modelling. 2003 saw the birth of the High Performance Visualisation & Medical Graphics (HPV-MG) group, and the installation of an SGI Altix 3000. In 2004, our School started an MSc in Advanced Visualisation, Virtual Environments and Computer Animation, and in 2010 the group changed its name to Visualisation Modelling and Graphics (VMG). **Today**, VDMG brings together researchers in pattern recognition, data mining, AI, scientific and information visualisation, virtual reality and extended reality. It was formed after the merger of the VMG group, Artificial and Intelligent Agents group, Pattern Recognition and Machine Learning research groups. **Our vision** has always been to to develop world-class research, and: (1) to build upon of the research activities of previous projects, such as the Research Institute of Visual Computing (RIVIC, £2m), (2) utilise and develop collaborative and interdisciplinary research teams, (3) utilise information Engineering, visualisation analytics, virtual and mixed reality, pattern recognition, artificial intelligence and learning analytics research, and (4) focus on engineering, environmental, sustainability and humanities.

2. Researchers and partners

Our group includes ten academics: Profs Roberts (lead) and Kuncheva, Drs Ritsos, Vidal, Lim, ap Cenydd, Teahan, Mansoor, Gray and Perkins, and hosts 12 PhD students and one postdoc. Interdisciplinary and collaboration is at the heart of our work. We participate in several large projects, such as Supercomputing Wales and the UKRI funded AI Machine Learning and Advanced Computing doctoral training centre (AIMLAC) funding at least two PhD students per year. We collaborate with other disciplines and centres across Bangor's research portfolio, including oceanographers and the Centre for Applied Marine Sciences (CAMS), and nuclear physicists in the Nuclear Futures Institute. The group collaborates closely with the Bangor University's Digital Signal Processing (DSP) Centre of Excellence, investigating applications of visual analytics, XR, AI and IoT in services that utilise future communication networks, such as 5G and beyond. Moreover, we work on medium scale projects on the domains of environmental sciences, health and medicine, law, archaeology, psychology and linguistics.

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We collaborate with researchers across the world, including UK Universities of Aberystwyth, Bristol, Cardiff, Newcastle, Oxford, Surrey, Swansea, overseas Universities Maryland, the Institute of Applied Sciences of Lyon, INRA and Inria France, Eberhard Karls University of Tübingen, Tsinghua University, the University of Burgos, and the University of Thessaly. We have collaborated with, and received funding from, Samsung, Nvidia, JISC, and Oculus/Facebook. **We keenly engage with, and take lead in, research community activities**, particularly Eurographics, EuroVis, IEEE VIS, InfoVis and VAST. Roberts was Chair of the EG UK Chapter for 7 years (2002-09), Vidal is secretary of Eurographics UK Chapter, and other current and past members include John, Valsamidis, Ritsos, Lim have chaired conferences, sat on the EGUK committee, and so on. We hosted the SIGGRAPH 2005 Web3D Symposium and the Eurographics 2011 conference.

3. Activities

Our researchers are known internationally, with activities in the domains of: pattern recognition (Kuncheva) [Kun14], visualisation design methodologies (Roberts, Ritsos) [Rob*16], multiple-views (Roberts) [Rob07; Rob*19; Che*20], immersive analytics, with the VRIA visualisation toolkit (Ritsos) [But*20], and procedural animation in VR with the Ocean Rift immersive experience (ap Cenydd). The focus on modelling, visualisation and data analysis, with emphasis on interdisciplinary research has helped us develop a deep understanding of the natural environment and many domains including:

Environmental. The work of Mansoor and Ritsos, in the European H2020 MSCA-RISE funded project Water4Cities [Riz*18; Ken*18] and EU Interreg BODAH investigate the use of Information Visualisation in data-driven decision making, in Water Resource Management and Touristic Data Information Systems respectively. Roberts and Ritsos investigated visual analytics of hydrodynamic flux for coastal zones, developing the Vinca visualisation tool [Geo*14]. With colleagues from Electronic engineering, Gray and Teahan have pioneered a machine learning approach for extracting information from organic photovoltaic (OPV) solar cell data in published scientific literature [Dav*20] to facilitate the development of future OPV technologies.

Visualisation theory, design and visual literacy motivates much work in the group: helping others design visual explanations [Rob*18] and designing visualisation learning activities, visualising student data to help them learn better [Gra*20] , developing best practice in multiple views [Rob07], to analysing multiple-view layouts [Che*20] and words used in visualisation [Rob*19], to helping designers sketch interfaces [Rob*16; Rob*17].

Medical, health and human behaviour data. We have a long history in VR, MR, XR research, especially in medical imaging. From virtual reality 'beyond the desktop' [Rob*14], video image analysis photogrammatry [Mon*19], X-ray imaging [VV16], classification and comparison of on-line video summarisation methods [Mat*19], to biographic developing of Olympic Super-Elite and Elite Athletes using multidisciplinary pattern recognition analysis [Gül*19], natural language processing [Tea18], learning analytics and student behaviour [Gra*20]. While applying Machine Learning has allowed educators the ability to highlight and intervene with students at risk of academic failure from an early stage [GP19].

References

[But*20] BUTCHER, P W.S. et al. "VRIA: A Web-based Framework for Creating Immersive Analytics Experiences". *IEEE TVCG* (Jan. 2020). DOI: 10.1109/TVCG.2020.2965109.

[Che*20] CHEN, X. et al. "Composition and Configuration Patterns in Multiple-View Visualizations". *IEEE TVCG* (2020), 1–1. DOI: 10.1109/TVCG.2020.3030338.

[Dav*20] DAVID, TW et al. "Enhancing the stability of organic photovoltaics through machine learning". *Nano Energy* 78 (2020), 105342. DOI: 10.1016/j.nanoen.2020.105342.

[Geo*14] GEORGE, R L.S.F. et al. "Interactive visual analytics of hydrodynamic flux for the coastal zone". *Env. Earth Sci.* 72.10 (Nov. 2014), 3753–3766. DOI: 10.1007/s12665-014-3283-9.

[GP19] GRAY, C C. et al. "Utilizing Early Engagement and Machine Learning to Predict Student Outcomes". *Computers & Education* 131 (2019), 22–32. DOI: 10.1016/j.compedu.2018.12.006.

[Gra*20] GRAY, C C. et al. "Degree Pictures: Visualizing the university student journey". *Assessment & Evaluation in Higher Education* 20.4 (Aug. 2020), 568–578. DOI: 10.1080/02602938.2019.1676397.

[Gül*19] GÜLLICH et al. "Developmental Biographies of Olympic Super-Elite and Elite Athletes: A Multidisciplinary Pattern Recognition Analysis". *Expertise* 2.1 (2019).

[Ken*18] KENDA, K et al. "Smart Water Management for Cities". *KDD2018*. Ed. by ABE, N. et al. Aug. 2018.

[Kun14] KUNCHEVA, LUDMILA I. *Combining pattern classifiers: methods and algorithms*. John Wiley & Sons, 2014.

[Mat*19] MATTHEWS, CLARE E et al. "Classification and comparison of on-line video summarisation methods". *Machine Vision & Applications* 30.3 (2019), 507–518. DOI: 10.1007/s00138-019-01007-x.

[Mon*19] MONKMAN, G. G. et al. "Accurate estimation of fish length in single camera photogrammetry with a fiducial marker". *ICES Marine Sci.* (2019). DOI: 10.1093/icesjms/fsz030.

[Riz*18] RIZOU, S et al. "Water4Cities: An ICT platform enabling Holistic Surface Water and Groundwater Management for Sustainable Cities". *Proc. EWaS, Lefkada, Greece*. 2018. DOI: 10.3390/proceedings2110695.

[Rob*14] ROBERTS, J C. et al. "Visualization Beyond the Desktop - the next big thing". *IEEE CG&A* 34.6 (Nov. 2014), 26–34. DOI: 10.1109/MCG.2014.82.

[Rob*16] ROBERTS, J. C. et al. "Sketching Designs Using the Five Design-Sheet Methodology". *IEEE TVCG* 22.1 (Jan. 2016), 419–428. ISSN: 1077-2626. DOI: 10.1109/TVCG.2015.2467271.

[Rob*17] ROBERTS, J C. et al. *Five Design-Sheets: Creative Design and Sketching for Computing and Visualisation*. Springer, June 2017. ISBN: 978-3319556260. DOI: 10.1007/978-3-319-55627-7.

[Rob*18] ROBERTS, J. C. et al. "The Explanatory Visualization Framework: An Active Learning Framework for Teaching Creative Computing Using Explanatory Visualizations". *IEEE TVCG* 24.1 (2018), 791–801. DOI: 10.1109/TVCG.2017.2745878.

[Rob*19] ROBERTS, J. C. et al. "Multiple Views: different meanings and collocated words". *CGF* 38.3 (2019), 79–93. DOI: 10.1111/cgf.13673.

[Rob07] ROBERTS, J. C. "State of the Art: Coordinated Multiple Views in Exploratory Visualization". *Proc. CMV 2007*. 2007, 61–71. DOI: 10.1109/CMV.2007.20.

[Tea18] TEAHAN, W. J. "A compression-based toolkit for modelling and processing natural language text". *Information* 9.12 (2018), 294. DOI: 10.3390/info9120294.

[VV16] VIDAL, F P. et al. "Development and validation of real-time simulation of X-ray imaging with respiratory motion". *Computerized Medical Imaging and Graphics* 49 (Apr. 2016), 1–15. ISSN: 0895-6111. DOI: 10.1016/j.compmedimag.2015.12.002.

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