IMAGING & 3D VISUALISATION, ANATOMY, & MEDICAL EDUCATION

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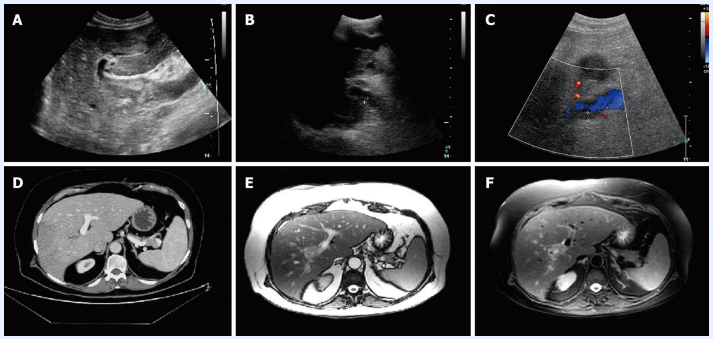
1 Imaging: radiomics, an AI diagnostic system

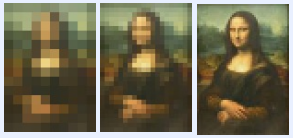
Radiomics is a novel field and refers to the extraction of mineable data from medical imaging. It has been applied within clinical disciplines such as oncology to improve early diagnosis, prognostication, and clinical decision making, with the goal of delivering precision medicine.



Medical imaging datasets convey meaningful information about disease (such as tumour) biology, behaviour, and pathophysiology and may reveal important information with regions of interest that is not otherwise apparent to current radiologic and clinical interpretation.

The Principle: Each region of interest (ROI) is made up of pixels. An analysis of the pixels and their relations can provide critical information on anatomical features and textures that predict disease.

The goal: is to analyse the pixel characteristics, compute this to mathematical algorithms to which machine learning can be applied to create an artificial intelligence model.



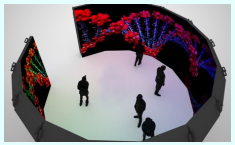
This model can be used to automate analysis of medical images to detect the smallest changes indicative of disease.

Our focus is on improving early diagnosis using clinical imaging data through an evidence-based correlation of anatomical features and textures to inform the development of robust radiomics and AI models. Our research group is part of a multidisciplinary team that focusses on the radiomics pipeline.

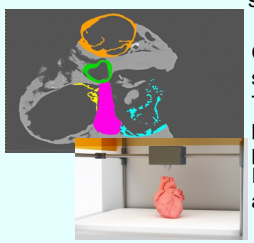
Projects available in this area aim to develop:

- Developing a radiomics pipeline for early detection of cardiac, liver, renal, prostate and vascular disease, including tumour staging
- Evaluating the applicability of published radiomic pipelines
- normal anatomical relations for surgical procedures
- paediatric growth algorithms to assess normal development for endocrinology and forensic cases

2 3D Visualisation: VR and AR; 3D Printing



VR and AR has gained popularity for medical management of a range of clinical disorders (e.g. dementia, PTSD), surgical planning, and educational experiences. VR/AR can actively embody immersive experiences offering a mode of learning experiences and understanding that cannot be easily replicated. Immersive Virtual Environments (IVEs) can significantly contribute to immersive learning and pedagogy in disciplines that involving the simulation of real world scenarios such as anatomy, clinical skills and surgery.



Our group develops real-world VR/AR models by segmentation of patient clinical imaging datasets. These models are then embedded into game platforms such as Unity and used in surgical planning and/or anatomy and medical education. In addition, we 3D print patient specific models to assist in surgical planning of complex case

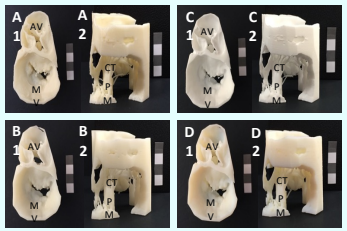


Fig. Superior and anterior views of 3D printed MV models. A virtual model was produced using Mimics® Research 18.0 and 3D printed using fused deposition modelling (FDM), stereolithography (SLA), selective laser sintering (SLS) and polyjet methods. (A) FDM model. (B) SLA model. (C) SLS model. (D) Polyjet model. AV, aortic valve; CT, chordae tendineae; MV, mitral valve; PM, papillary muscle. [Note: calibration inset, 10mm x 10mm squares]

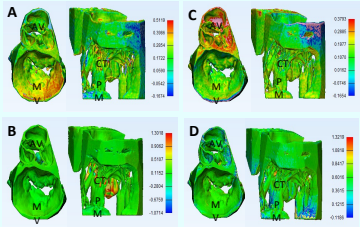


Fig. Superior and anterior views of part comparison analysis of FDM, SLA, SLS and polyjet MV models, performed using 3-matic® Research 10.0 . The scale indicates the distance in millimetres between digital reconstructions of the 3D printed models and the original virtual MV model. (A) FDM model. (B) SLA model. (C) SLS model. (D) Polyjet model. AV, aortic valve; CT, chordae tendineae; MV, mitral valve; PM, papillary muscle.

Our focus is on improving the development of interactive VR models and 3D printing, and related pedagogy. We work with computer and biomedical engineers as well as art and design specialists.

Projects available in this area aim to:

- evaluate the usefulness of VR and 3D print for surgical planning and patient education
- develop pedagogy & learning using Immersive Reality
- analyse student engagement, and impact on assessment and related clinical competencies, and
- evaluating the impact of VR on brain activity and development
- Develop improved VR models for anatomy & medical education

3 Anatomy, Medical Education & Ethics

We have a significant interest in designing learning that is student centred through evidence-based pedagogies, tools and strategies. In this domain we have published extensively and are well-recognised.

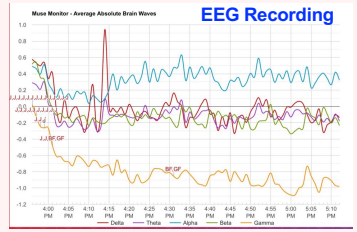
Our focus is on:

- **Technology and simulation in medical education**
- **Course and assessment design**
  - Inclusive education and educational design
  - Wellbeing and student success
  - Cognitive load effects
  - Impact of COVID on future education design and practice
- **Humanities in medical education**
  - Human enhancement, beginning and end of life ethics
  - Body and organ donation
  - Perceptions of, and education on, female anatomy
- **Development of essential skills and attributes**
- **Professional development**

We use a range of methodology including systematic reviews, randomized control studies, pre- and post-assessment, and surveys and focus group studies. Of note, our group was one of the first to develop a methodology for objective assessment of cognitive load using recordings of brain activity. Prior to this, cognitive load was assessed through perception surveys such as NASA task-load survey.

Quantifying Cognitive Load

Intrinsic load decreases when content is introduced in face-to-face interaction
Extraneous load decreases when design is simplistic (both use, & assessment activity)
Germane load correlated with reconsolidation, revision and review



Our focus is on improving education design and learning and work with a range of experts and students from across the world.

Projects available in this area aim to:

- evaluate whether we can design courses and assessment that support student wellbeing, sense of belonging and success
- analyse the COVID impact on student groups (e.g. international and regional, HDR students), medical education & future practice
- evaluate the impact of VR/AR, ultrasound and simulation on collaborative learning, brain activity and cognitive load
- assess the role of cultural factors on willingness to donate organs or body, and perceptions of care at the beginning and end of life
- evaluate the influence of gender in learning communities and academic roles