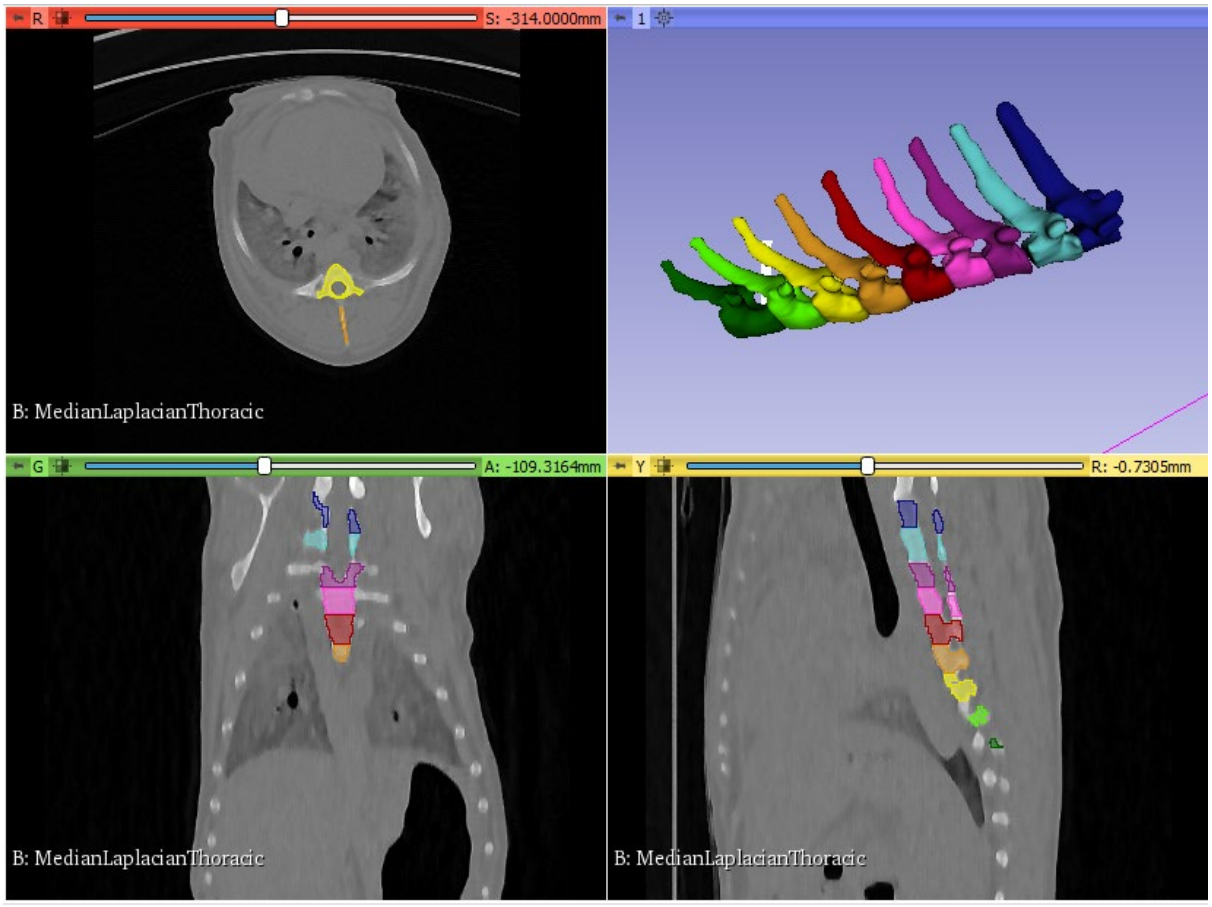
Glasgow School of Art Course Specification
Course Title: Medical Visualisation



Course Code	HECOS Code	Academic Session
PMVS105		2023-24

Course Title	Medical Visualisation
Course Contact	Dr Matthieu Poyade

Credits	40
SCQF Level	11
When Taught	Semester 1

Associated Programmes	MSc Medical Visualisation and Human Anatomy
Lead School	School of Innovation and Technology
Other Schools	N/A
Date of Approval	Programme Approval March 2023

Course Introduction

This course provides an overview of a range of topics relating to medical visualisation and the required workflows for producing interactive digital reconstructions of anatomical structures, and has emerged as a result of the long-standing research collaboration between the School of Innovation and Technology (SIT) and the University of Glasgow (UoG). Over this course, studies are split into three key topics:

- Volumetric visualisation – This project is intended to provide students with critical knowledge about volumetric data (e.g. MRI, CT, PET), techniques for volume visualisation and anatomically accurate 3D digital reconstruction of anatomical structures presented in volume dataset. This project will also provide students with the necessary skills to use medical visualisation software and tools to demonstrate a critical understanding of the theories and concepts.
- 3D Modelling – This project provides an introduction to a range of digital creative practices and is intended to provide students with critical knowledge and understanding of 3D production techniques, and the necessary skills to successfully create and animate 3D models in the context of medical visualisation. This project will look at various modelling, texturing, animation and rendering workflows.
- Interactive Application Development - This project is intended to provide students with the programming/scripting skills, knowledge and understanding that are necessary to develop interactive applications for medical visualisation. This project will look at cutting edge commercial software to implement interactive 3D visualisation of specific anatomy, diagnosis and communication of complex pathologies, pre-operative planning of surgical interventions, custom-made implant design, production of customised medical devices, surgical templates, teaching aids, etc.

Course Aims

This course aims are to:

- Provide an evolving up-to-date snapshot of leading-edge visualisation methodologies and techniques, e.g. digital reconstruction techniques, volume and surface rendering, medical data acquisition in and visualisation;
- Provide an introduction to, and exploration of, the relevant theoretical and practical issues involved in three-dimensional modelling and animation;

- Introduce and consolidate knowledge and understanding of the fundamental principles of design and development of interactive 3D visualisation/simulation systems in medical visualisation.
- Develop communication, documentation and interpersonal skills for communicating design goals and research outputs in medical visualisation, and support collaborative working to complete work according to a shared vision

Course Intended Learning Outcomes

By the end of this course students will be able to:

1. Demonstrate a critical understanding and knowledge of, and effective practice in, 3D modelling and in the development of interactive 3D visualisations
2. Demonstrate a critical understanding of the history of contemporary issues in the application of visualisation methods in biomedical sciences
3. Demonstrate practical understanding and knowledge of the principal techniques for volumetric and 3D surface data rendering, and their application in interactive medical visualisation;
4. Demonstrate understanding of, and apply, workflows, communication and interpersonal practices relevant to Medical Visualisation

Indicative Content

This course will cover issues including:

Volumetric Visualisation:

- The concepts behind the collection of medical volumetric data, e.g. MRI, CT, PET scans.
- The principles, methods and techniques for visualizing volumetric dataset (e.g data processing, direct volume rendering, transfer functions and colour maps) and extract topology looking at the digital reconstruction of anatomical structures (e.g. registration techniques and dataset transformation principles, segmentation methods and tools, mesh refinements techniques, and iso-surface rendering methods).
- Using professional volume visualisation software, e.g. 3D Slicer, MITK

3D Modelling:

- 3D Coordinate systems (units & scale, 2D, 3D)
- Scene organisation and file/data handling
- 3D Modelling & Digital Sculpting methodologies for anatomical reconstruction
- Texturing, materials and shading for anatomical reconstruction
- Reference gathering for production methods
- Lighting, Cameras & Rendering for pre-rendered visualisation
- Composition & Graphic Design principles for medical visualisation
- Introduction to Animation principles in 3D Software

Interactive Visualisation:

- Interactive simulation and visualisation platforms and technologies
- Interactive computer graphics fundamentals for 2D and 3D representations for medical visualisation

- Techniques for input, animation, collision detection, and similar interactive systems and tools used in application development.
- Fundamental programming concepts
- Implementing states and object-oriented scripting techniques in interactive medical visualisation development

Description of Learning and Teaching Methods

This course is taught across three distinct projects (Volumetric Visualisation, 3D Modelling, Interactive Application Development).

Learning and teaching is through a combination of lectures, in-class discussions and studio-based supported practical 'lab' sessions, along with student self-directed study and practice.
Teaching is primarily based in the studios, supported by asynchronous/online learning. All elements make extensive use of the GSA's web-based virtual learning environment and video lecture delivery platform, supporting student engagement with independent learning and practice.

Indicative Contact Hours	Notional Learning Hours
80	400

Description of Formative Assessment and Feedback Methods

For all projects, Individual feedback will available during tutorials/labs to provide verbal formative assessment on a regular basis.

For the 3D Modelling project, written formative feedback will be provided on 3D production methods in week 6 based on a snapshot of skills learned at that point in progression.

For Interactive Application Development, a small individual interactive diorama project is submitted for written formative feedback, mid-semester.

Description of Summative Assessment arrangements

Students on this course will be assessed on their ability to demonstrate an understanding of the detailed processes involved in visualising medical data; Modelling workflow, and design and implementation of medical visualisation systems;

Coursework 1: Volumetric Visualisation (35%)
Students work individually to produce 3D medical visualisations from medical dataset using dedicated visualisation platform(s) and compile the outcomes into a finished report with appropriate reflective content. This project should:

- demonstrate a detailed and informed grasp of the different types and format of volumetric data, along with the principal techniques for visualising volumetric dataset, and their use in developing sophisticated medical visualisation systems;

- show an understanding of the practice and theory contexts in relation to which their project is positioned;

Coursework 2: 3D Modelling (30%)
Students will create 3D models with renders and animations and submit with report. This is assessed on how students:

- exhibit appropriate level of skill demonstrated in the production of 3D models and animations.
- show critical understanding of the techniques and methods employed in the production of rendered imagery and movies in line with graphic design and composition principles.
- demonstrate ability to deliver structured projects that are using consistently designed digital assets and coherent file formats.

- Coursework 3: Interactive Application Development (35%) - A group project to develop a simple interactive medical visualisation application. Of this, 20% will be based on a short individual report (500-1000 words). Taking individual contributions to the group project into account, the remaining 80% is based on the practical project submission. Students will be assessed on their ability to:
  - design and develop a prototype of 3D serious game, visualisation or simulation system using appropriate professional tools;
  - demonstrate ability to work in a team and collaboratively manage a small project

Submissions will be assessed and moderated in line with the Code of Assessment. Written feedback will be given.
Reassessment opportunities where a student has not passed the course are outlined in the Code of Assessment.

Description of Summative Assessment Method	Weight %	Submission week
Series of 3D Visualisations of medical scan data produced using professional medical visualisation software (50%) with reflective report (50%)	35%	Week 13
Production of a 3D modelling portfolio	30%	Week 13
3D interactive medical simulation/visualisation and individual reflective report	35%	Week 12

Exchange/Study Abroad	
Can this course be taken by Exchange/Study Abroad students?	No
Are all the students on the course taught wholly by distance learning?	No
Does this course represent a work placement or a year of study abroad?	No
Is this course collaborative with any other institutions?	No
If yes, then please provide the names of the other teaching institutions	n/a

Reading and On-line Resources
Current MedVis general reading list: https://gsa.keylinks.org/#/list/593

MSc Visualisation Core reading list: https://gsa.keylinks.org/#/list/595

Key resources for this course include:

- Berhard Preim, Dirk Bartz (2007) Visualisation in medicine: theory, algorithms, and applications, Morgan Kaufmann Publishers Inc. ISBN 9780080549057
- Hocking, J., (2022) *Unity in Action, 3rd Edition,* Multiplatform game development in C#
- Autodesk, 3DS Max Tutorials , http://docs.autodesk.com/3DSMAX/16/ENU/3ds-Max-Tutorials/