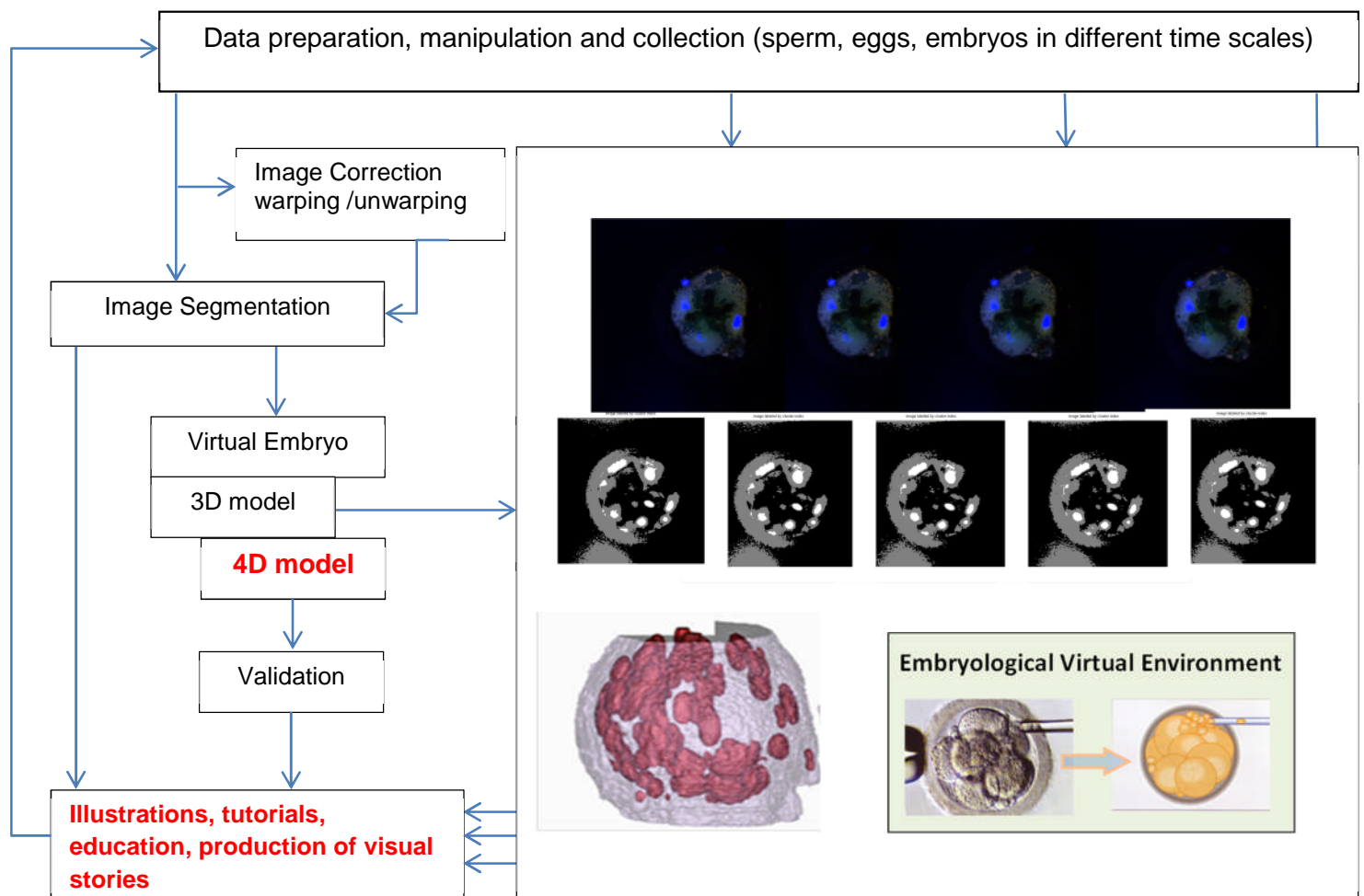


Modelling of behavioural changes of human embryos in very early stages of their development

In embryology, light microscopy is used routinely to assess embryonic appearance. It is well known that visible cues provide information about embryonic developmental potential. These characteristics are used clinically to select embryos for transfer to the patient. Traditional indicators, such as cell number and fragmentation, are readily assessed non-invasively but have limited diagnostic potential. A more detailed understanding of the molecular basis of the 3-D organization of the developing embryo, and the developmental changes that take place over time, may provide improved predictive value, but such indicators are more challenging to assess without detriment to the embryo. Many researchers, including ourselves, are seeking markers that would indicate developmental potential, or lack of it, to improve embryo selection. Towards this aim, we are acquiring images of human embryos both live and fixed. We already have the necessary ethical approval and Human Fertilisation and Embryology Research Licence required (Hartshorne, 04/Q2802/26, R0155). Fixed embryos are highlighted using molecular probes for key structural elements (eg actin) or spatially oriented molecules or features (eg polarized markers, chromatin) and imaged using confocal microscopy. Live embryos are subjected to photography or time lapse microscopy.

For this project, we propose to extend and apply our accumulating bank of images to **model the behavioural changes of human embryos in very early stages of their development.**



Requirements

Good knowledge of Matlab and/or programming in C/C++ would be an advantage

Prospective deliverables

Segmented embryological datasets with several ROIs

3D models of human embryos in very early stage of their development (1-3 days)

Visualisation of behavioural changes of human embryos development in time (4D models)

PhD follow-up project

Develop an **underlying implicit modelling environment** (IME), which will provide us with capability to define and store arbitrary implicit models, and also dedicated tools for processing of these models (visualization, polygonization, voxelization, computation of quantitative attributes).

The further required properties of IME correspond to addition of a physical layer to all models in order to use them in training environment. There are two important issues in building virtual environments for training purposes: collision response solving (deformations) and growth of objects. The realistic collision solving procedure is today still a challenging task. When a collision between two objects is detected, it is necessary to specify the hardness of both colliding objects and, subsequently, to modify their implicit functions in order not to collide. Our algorithm could be based on [TBG95], where authors introduced three areas formed around the intersection zone: an inter-penetration area, a propagation area and an area outside the propagation. In each area a special deformation term is defined and added to both implicit functions of colliding objects. Implicit surfaces generated by skeletons are especially well suited to this kind of approach. Moreover, it is required to specify the properties of deformable objects. The alternative method could be based on deformable surfaces designed for animation called active implicit surfaces [DC98]. This approach allows any topological changes, and similarly to snakes in computer vision, the surface can track a target and exhibit surface tension under its own criteria.

An import property of the desired IME will be to load the segmented data into the environment and automatically construct the required implicit models. One class of reconstruction methodologies uses implicit functions. They allow extracting an iso-surface either by a procedural method, or skeletal implicit surfaces (surfaces generated by a field function and a skeleton). To represent and process volumetric data, we will exploit the f3d library [SD02], which is an open source development library for storage and manipulation with volumetric data written in C++. Another relevant modelling technique often used in real world modelling is based on metamorphosis of 2D and 3D objects. The application of metamorphosis could be seen as an alternative way of model reconstruction directly from volumetric data. Moreover, their utilization in creating animations is promising as well.

[TBG95] N Tsingos and E Bittar and M Gascuel, Implicit Surfaces for Semi-Automatic Medical Organ Reconstruction, Computer Graphics, development in virtual environments, proceedings of Computer Graphics International '95, Leeds, UK, May 1995

[DC98] M. Desbrun and M. P. Cani. Active Implicit Surface for Animation. Graphics Interface'98, 143-150, June 1998

[SD02] M. Sramek and L. I. Dimitrov. f3d — a file format and tools for storage and manipulation of volumetric data sets. In 1st International Symposium on 3D DataProcessing, Visualization and Transmission, Padova, Italy, 2002.