# Morphology and Optics of Human Embryos from Light Microscopy

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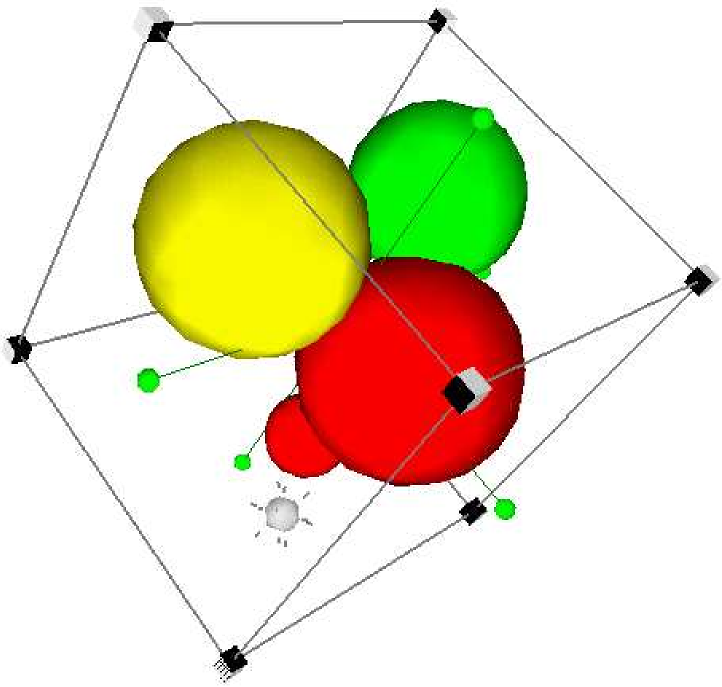

**Abstract**

Evaluation of fertility of living embryos is of practical importance in the daily routines at fertility clinics and an ongoing biological research topic. Living embryos may be studied through a light microscope. By focusing the microscope at different optical sections, the three-dimensional structure of the embryo may be studied. The purpose of the Fertimorph project is to develop methods for fertility evaluation via measurements of the three-dimensional embryo morphology.

Reconstruction of the 3D structure of living embryos from optical sectional images, must be based on a model of the image formation. The image formation is a result of the optical characteristics of the embryo and the microscope optics used. Human embryos are "large" refractive objects, so the usual model of rectilinear light propagation in a 3D Euclidean geometry does not hold. Since this model of light propagation is central in the linear translational invariant models of light microscopy, these traditional models of image formation and corresponding techniques for 3D reconstruction cannot be used. Instead the morphology has to be inferred directly from the images.

A major challenge in such inferences, in addition to modelling the image formation, is modelling of the morphology and shape variability. Models of shape variability are needed as model structures for analyzing object shape and as tools for inferring and describing the task specific prior knowledge of the imaged objects, often essential for successful inference.

I present investigations of embryo optics, Hoffman Modulation Contrast image formation, and 3D reconstruction of human embryo morphology from HMC images - all in the context of the Fertimorph project. In addition to this, general Lie group models of point set variability inducing well-defined shape variability are discussed, as basic tools in models of shape; and the descriptive power of linear transformation groups for modelling shape variability is analyzed.