# Models for Three-dimensional Objects

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**Abstract**

Stereophotogrammetry uses pairs of cameras and sophisticated computing algorithms to collect information defining the surface shapes of objects in three dimensions. Surface representation can be in the form of dense point clouds or triangular meshes. Collaborative work among dentists, computer scientists and statisticians at the University of Glasgow is using a system of this type to study the growth of the faces of young children. A quantitative understanding of normal shape and growth is particularly helpful in assessing the effectiveness of surgical repair of cases of cleft lip and palate.

Statistical models for data of this type most naturally begin with landmark data for which a well developed set of tools is available in statistical shape analysis, as described by Dryden and Mardia (1998; Wiley). A much richer representation is expressed in three-dimensional curves, selected to correspond to meaningful anatomical features. Here, functional data analysis, as described by Ramsay and Silverman (1997; Springer-Verlag) provides suitable techniques which can be adapted to the surface anatomy setting. Other aspects of analysis include a local version of the standard technique of Procrustes analysis to assess smooth changes in shape with relevant covariates, including object size. Assessment of symmetry also needs to be considered. All of these aspects will be illustrated on the baby faces study.