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*Statistical Shape Analysis and Applications*

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In applications, objects rarely have exactly the same shape within measurement error; hence the randomness of shapes need to be taken into account. Thanks to the development of information technologies, the last decade has seen a considerable growth of interest in the statistical theory of shape and its application to various scientific areas.

The solution to the problem of describing a shape via functions taking values in a finite dimensional space, without loosing relevant information, is needed for the mathematical and statistical analysis of the objects.

Recently new geometrical descriptors of shapes, the size functions, have been proposed. These functions are able to capture globally the geometric characteristics of an object, differently from landmarks (which usually are specific points, angles, distances, on the objects, chosen by an expert), which are widely used in literature, but whose results in the statistical analysis are strongly dependent on their choice, leading to a sort of subjective quantitative analysis.

Size functions depend on the choice of a measuring function, and usually only a small number of choices lead to different statistical results; the measuring functions are chosen on the basis of the invariance properties that the geometrical descriptors must satisfy (e.g. invariance with respect to rotations, translations, scaling, etc.). The theory of size functions has been developed mainly in a deterministic framework. A first attempt of joining this theory with randomness and to develop the related statistical analysis is here presented.

The approximation of size functions with their discrete counterpart leads to the formulation of suitable algorithms which may compute a graphical representation of the size function associated with a shape. The main features of the shape are thus described by a finite number of points and lines on a plane. The descriptor is robust, since small variations in the shape produce small variations in the location of such points and lines. Thus, by applying some cluster analysis techniques, it is possible to find 2D confidence regions for a family of shapes, and to detect the presence of outliers, i.e. of shapes not belonging to the family under study.

Applications to problems arising in microlithograpy and biomedicine will be presented.