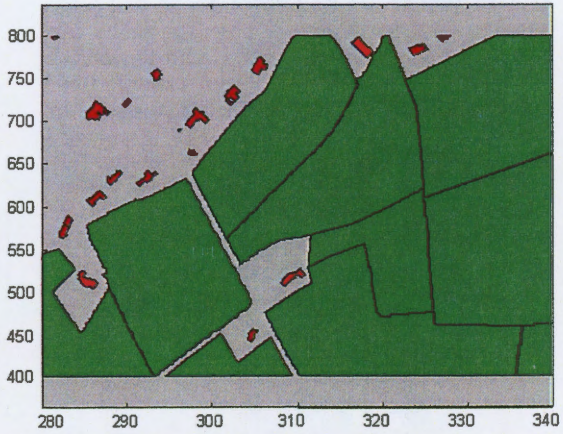
The shape on the map

Most people when they look at a map can easily recognise the objects being depicted. They do this through a combination of interpreting the form, size and shape of a feature plus the use of standard cartographic symbols and text annotation. To automatically process data for intelligent tasks such as in-car navigation, land-use planning and market analysis, a computer system must itself interpret the map. Part of the automatic structuring (feature coding and object recognition) of topographic data, such as that derived from air survey or raster scanning large-scale paper maps, requires the classification of objects such as buildings, roads, rivers, fields and railways, partially based on their shape.

Recognition is based on the matching of descriptions of shapes. Numerous shape description techniques have been developed. The application of one of these techniques, Fourier descriptors, to classify objects on large-scale maps is described here. Based on a Fourier analysis technique applied to the boundary co-ordinates of an object expressed as complex numbers, Fourier descriptors are widely used in computer vision to describe and classify shapes.

The Fourier transform is a way of separating out the different frequencies that make up a signal. For example, applied to a musical sound, it can separate the high from the low notes. It can be applied to two-dimensional objects by imagining a point tracing out the boundary. The east and north co-ordinates of equidistant points on the boundary can be expressed as complex numbers, $x + jy$, where j is the square root of -1. Travelling around the boundary yields a sequence of complex numbers. The Fourier transform of this gives the Fourier descriptor values of that shape. These Fourier descriptors can be normalised to make them independent of translation, scale and rotation of the original shape. The first few descriptors give general characteristics of the shape, the remainder representing the small detail. Classification is performed by comparing descriptors of the unknown object with those of a set of standard shapes, finding the closest match. Objects of similar shapes will produce similar descriptors and, in particular, man-made objects, such as buildings and roads, with sharp corners will be distinctive from the curved shapes of more natural objects.



A map automatically colour-coded using Fourier descriptors to distinguish buildings and fields.

Most applications using Fourier descriptors deal with the classification of definite shapes, for example identifying a particular type of aircraft. To identify topographic objects, the technique needs to be extended to deal with general classes of shapes (buildings, fields, roads etc.). It is envisaged that Fourier descriptors will be only one of several techniques of object recognition, which will be combined to produce the optimal result.

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