Feature Extraction From Line Drawing Images

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Abstract

This paper describes progress towards an automatic system for extracting line features from line drawing images. A semi-automatic system for tracking lines and for building features from the resulting line fragments has been developed. Operator intervention is required to guide the feature building when ambiguities arise. A knowledge based system, which works alongside the semi-automatic system, can execute some of the decision making tasks in place of the operator and as the knowledge base is increased the need for operator intervention will diminish.

1 Introduction

Line drawings can be found in many forms including maps, charts, cartoons, technical drawings, circuit diagrams and sketches. Although several approaches to automatic feature extraction have been described elsewhere, they have frequently been concerned with drawings where the feature geometry is well known; for example in character recognition [1], electrical schematics [2] and linear feature extraction [3,4].

Attempts to extract features of arbitrary geometry from complex drawings such as maps have mainly involved high cost facilities and often resulted in substantial operator intervention [5]. The aim here is to develop a general and relatively low cost system for extracting features from line drawing images with a diminishing need for user intervention. In the first instance the application area has been the extraction of contours and coastlines from images of hydrographic charts.

Three stages are involved in the approach. In the first, a line tracker is implemented to extract line fragments from the image. Although some line trackers perform well in specific circumstances, most have difficulty in handling lines of arbitrary geometry and produce a collection of line fragments rather than a complete and reliable continuous chain code. In the second stage a semi-automatic feature extraction system (SAFE) is developed to build features from the list of line fragments produced by the tracker. When ambiguities of interpretation

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arise or when feature codes have to be assigned, human intervention is solicited via a user friendly interface. The SAFE system can be used to extract features reliably but still involves substantial human assistance.

The third stage involves the development of an intelligent knowledge based system (IKBS) which works in collaboration with the SAFE system. When the SAFE system requires assistance the IKBS is consulted first. If it can resolve the problem then human interaction is not required. If the IKBS fails to satisfy a goal from SAFE then human intervention is again solicited. As the rule base is developed the need for human intervention should decrease.

2 Implementation of a Line Tracker

The possible non-automated routes for obtaining feature representations are to hand digitise the information using a digitising table or to use commercially available semi-automatic digitisation techniques; for example those based on Laser Scanning devices. However, these approaches are either heavily labour intensive or involve very expensive equipment. Amin and Kasturi [6] have recently described a system for map data processing which falls between these extremes but they use simple test maps and adopt a conventional approach to algorithm development. Our specific aim is to explore the use of image processing and knowledge based techniques for feature extraction at relatively low cost and with a minimum amount of user interaction.

Figure 1 shows a 256 x 256 image with 64 grey levels obtained using a monochrome video camera. The essential requirement is to devise an algorithm which will detect a line from the image and represent it by some explicit code with correct spatial positioning of the line as an important criterion. The tracker should ideally follow a continuous contour from its start to end point without fragmentation. Since no character recognition is used at present, the human operator should simply need to enter the depth reading for each contour feature to complete the procedure.

Several line extraction algorithms have been described in the literature in recent years. In general they make some constraining assumptions about the images considered or the features