

# Automatic Road Network Recognition and Extraction for Urban Planning

D. B. L. Bong, K.C. Lai, and A. Joseph

**Abstract**—The uses of road map in daily activities are numerous but it is a hassle to construct and update a road map whenever there are changes. In Universiti Malaysia Sarawak, research on Automatic Road Extraction (ARE) was explored to solve the difficulties in updating road map. The research started with using Satellite Image (SI), or in short, the ARE-SI project. A Hybrid Simple Colour Space Segmentation & Edge Detection (Hybrid SCSS-EDGE) algorithm was developed to extract roads automatically from satellite-taken images. In order to extract the road network accurately, the satellite image must be analyzed prior to the extraction process. The characteristics of these elements are analyzed and consequently the relationships among them are determined. In this study, the road regions are extracted based on colour space elements and edge details of roads. Besides, edge detection method is applied to further filter out the non-road regions. The extracted road regions are validated by using a segmentation method. These results are valuable for building road map and detecting the changes of the existing road database. The proposed Hybrid Simple Colour Space Segmentation and Edge Detection (Hybrid SCSS-EDGE) algorithm can perform the tasks fully automatic, where the user only needs to input a high-resolution satellite image and wait for the result. Moreover, this system can work on complex road network and generate the extraction result in seconds.

**Keywords**—Road Network Recognition, Colour Space, Edge Detection, Urban Planning.

## I. INTRODUCTION

IN recent years, the road network changes at a rapid rate because of urban development. Thus, it is hard to maintain the accuracy and precision of the road network. In order to execute massive applications such as city planning and management system, automatic extraction of roads for updating city map has recently come to a popular research topic [1]. Research in Automatic Road Extraction using Satellite Images (ARE-SI) has been carried out in Universiti Malaysia Sarawak. Road extraction strategies can be divided into two categories namely semi-automatic extraction and automatic extraction. In semi-automatic road extraction, all the initial points or road seeds need to be provided. However,

in fully automatic extraction, the road seeds can be detected automatically and linked to complete the road network [2]. In generally, automatic way is more preferable than the manual operations that acquire lots of manpower and time in mapping the road network [3].

There are many researchers interested in this topic. Some of them propose the use of Hough Transform to detect road lines and implementing “snake” method to reconnect the broken road lines [4]. However, Hough Transform has low efficiency in detecting curve road, and “snake” requires user to select initial seed points to start, turning its system into semi-automatic which is more time-consuming. Furthermore, these two methods are not applicable for complex road network involving complicated curve lines.

There are alternative ways suggested by researchers. However, they only manage to extract simple road networks [5]. On the other hand, there exists some methods that can work for complex road network, but unfortunately, they always utilize long and complicated procedures before the result is gained [6].

In this project, a new algorithm based on hybrid simple colour space segmentation and edge detection (Hybrid SCSS-EDGE) is proposed for the road extraction system to solve the stated problems. It performs the extractions fully automatic and properly works on complex road networks with satisfactory results generated within seconds. The key techniques used for the algorithm are segmentation using edge detection together with colour space components (i.e. luminance, saturation and hue values) of the satellite imagery. Satellite images from Google Earth are considered because of its wide availability and less deployment cost for this project.

## II. HYPOTHESES OF ROAD FEATURES

Several important hypotheses have been made for the road extraction process, as mentioned in [7], [8], [9] and [10].

- a) Road width variance is small and road width change is likely to be slow.
- b) Road direction changes are likely to be slow.
- c) Road local average grey level is likely to vary only slowly.
- d) Grey level variation between road and background is likely to be large.
- e) Roads are unlikely to be short and the curvature of roads varies slowly.
- f) Texture enclosed by the road edge is homogenous despite of shadows.

D.B.L. Bong is with the Universiti Malaysia Sarawak, Faculty of Engineering, 94300 Kota Samarahan, Sarawak, Malaysia (phone: +60-82-583313; fax: +60-82-583410; e-mail: bbldavid@feng.unimas.my).

K.C. Lai is with the Universiti Tunku Abdul Rahman, Malaysia.

A. Joseph is with the Universiti Malaysia Sarawak, Faculty of Engineering, 94300 Kota Samarahan, Sarawak, Malaysia.