EXTRACTION OF AGRICULTURAL GREENHOUSE FROM HIGH-RESOLUTION REMOTE SENSING IMAGERY

Masayuki MATSUOKA
Associate professor, Research and Education Faculty, Kochi University,

200 Monobe-otsu, Nankoku, Kochi 783-8502, Japan;
Tel: +81(0)-88-864-5166; Fax. +81(0)-88-864-5200
E-mail: msykmtok@kochi-u.ac.jp

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Abstract: Automatic extraction of the ground objects from the remotely sensed imagery is one of the efficient but challenging topics of digital mapping and geographical science. This paper reported the schematic outlines of automatic extraction of the agricultural greenhouse by means of the combination of basic image processing methods. Current approach adopted the frequently used process such as edge detection, line fitting and pixel tracing. The paper describes the outline and current status of the extraction.

INTRODUCTION

Agricultural greenhouse has relatively rapid change compared to other architectural structure such as houses buildings and roads. The cultivation system of greenhouse, additionally, is totally different from open-field cultivation in terms of fertilizer application, irrigation, cropping period and so on. These characteristics affect the conditions of soil and groundwater of the region. Locations and areas of greenhouses, therefore, are desired to be extracted automatically from the remote sensing imagery. Agüera *et al.* (2006) detected the changes of the greenhouses on the Mediterranean coast by means of change detection and classification of QuickBird imagery, and concluded that about 91% of the detected greenhouses were true greenhouses on pixel basis. The objective of this study is to build up the methodological scheme of the automatic extraction of greenhouse using high-resolution remote sensing image.

Figure 1: Example of aerial photo of the study area and mask image for processing

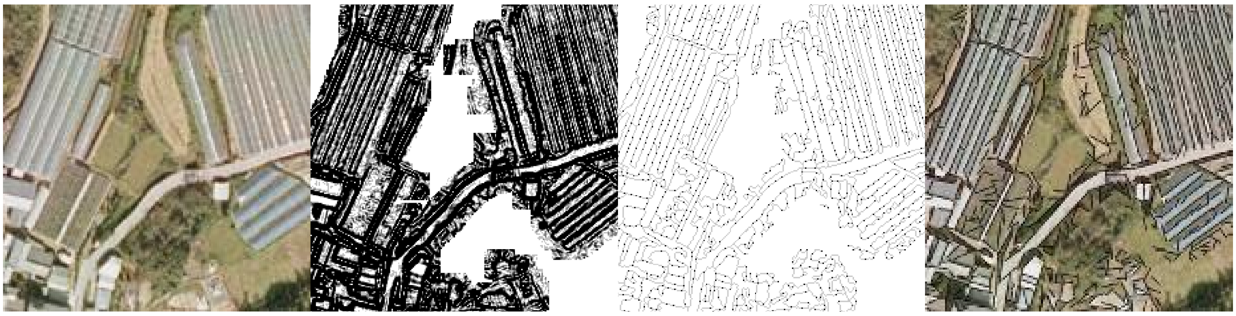
DATA AND METHOD

The color aerial photographs with the spatial resolution of 50 cm were used in study, and these were captured over the agricultural area on the plain along with the Pacific Ocean at Kochi Prefecture, Japan. A scene of the photos was shown in figure 1, with the mask image of processing area that is described below.

The extraction method is based on the line segment detection combined with the object identification by the spectral information. The scheme of the extraction process is outlined here. First step is the derivation of the edge intensity by image filtering in order to discriminate the components (objects) on the land surface such as roofs, agricultural fields, roads, and so on. The Sobel filter with the window size of 7×7 pixels was adopted here. The intensity, not the binary edges, was used this stage for discriminating the contrast in the original image. The filter was applied separately to each channel, i.e. RGB, of color photo, and then the minimum intensity among the channels was composed to single edge-intensity image. The binary mask image (shown in figure 1) was generated as second step and overlaid on unnecessary areas for the purpose of reducing the false extractions and of saving the processing time. The saturation component that was derived by the HSV transformation of RGB channels (OpenCV, 2012) were applied in this study, because the greenhouses and other architectural structures like houses and roads have lower saturation component due to the grayish or whitish colors. NDVI and near infrared band images are another possibilities for cutting out the vegetated and water surface, if these are available. In the next step, strong edges were traced for making the outlines of the objects, starting from the seed pixels. Seed pixels were picked up by local maximum filtering, that is, the center pixel of sliding block window with 5 × 5 pixels was selected as seed pixel, if it has the highest intensity among the pixels within the window. Pixels, subsequently, were selected sequentially in order to follow the higher ridge of the edge intensity image, and not to hang about, until it contact to another line segment. The straight-line segments were, then, detected by the line fitting using the pixels of edge segments, and the lines were extended by connecting the adjacent straight-line segments. The distances of the pixel and straight line were utilized as the criterion of linearity.

RESULTS AND DISCUSSIONS

Figure 2 showed the example of images at each processing steps of greenhouse extraction. Edge intensity (b) successfully emphasized (i.e. darkened) the edges of greenhouses, houses and roads, additionally; the agricultural fields and trees were masked out. A large number of seed pixels (black dots) were selected along the edges of the objects (c), and line segments were drawn from seeds out along the outer frame of the objects (d). The straight-line segments were generated along the line of structures. Relatively larger number of false extractions, however, was identified on the roofs and agricultural open-fields. This is because of the small changes of contrast on the image, which were misidentified during the process of edge tracing and linear fitting. These short segments separated the correct segments or single land surface elements, and it resulted in the fragmentation of the objects. The screening of erroneous segments and the connection of correct segments are the challenges at this moment.



(a) Original image (b) Edge intensity (c) Edges and seeds (d) Extracted line segments

Figure 2: Images at the processing steps of greenhouse extraction

CONCLUSIONS

This paper reported the outline and the current situation of the extraction scheme of the greenhouse using high spatial resolution remote sensing imagery. The method is based on the image processing techniques as screening, edge detection by filtering, tracing and fitting using the pixel location. The effort is devoted to connecting linear segments by recovering the fragmentations caused by the misdetections of short and low-intensity edges.

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