Matching and Registration Method for Remote Sensing Images

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Abstract

This paper describes a general purpose algorithm for registration and matching of remote sensing images using a least square fitting procedure based on a modified Besl algoritm [1]. An example from Ottawa [1] area will illustrate the procedure.

1 Introduction

This paper describes an algorithm for the registration of aerial images without human intervention based on a method developed by Besl in [1]. The approach proposed here is as follows; first, extract high curvature points in the two images and match them using correlation technique, then use the iterative closest point (ICP) algorithm [1] to compute registration function. To find the mapping function, the algorithm does not need to be given a fixed point but rather performs a best guess. At the same time, the oder of points matched in the two images is no more important; the algorithm finds the best candidate for each matched point..

2 Shape description

Edge pictures transformed from the geometrically corrected optical images are shown in Figure 1. In order to match two-edge images, near perfect edge registration is required. This is due to the fact that edges are usually thin and any uncorrected geometric distortion on the order of one or two picture elements will produce a considerably poorer match than those that are perfectly registered. To model the boundary curves, B-splines functions [3, 4] are used. A set of very stable control points and curve segmnents are obtained. They are invariant under affine transformations.

[1]The authors wish to acknowledge the Canadian Center for Remote Sensing for their help in providing these images.

3 Determination of initial points and matching

To reduce the computational time, a correlation technique was used to find an initial set of matched points. Then false matches in this set are discarded using a least squares error technique. A corner detector is first applied to each image in order to extract high curvature points; then the correlation is used to establish the matching candidates between the two images. Figure 5 shows the original image after corners are extracted and matched. An initial registration function having these two sets of matching points, is then calculated. This is used as an initial condition for the algorithm . Additional line segments from the model image are matched with the scene image. This new matched line are used to update the transformation function. A quality measure of the resulting match is calculated. This quality measure is given by:

$$\sum Q = Q(N) \tag{1}$$

where N is the number of segments. The process of matching ends when high quality is reached with certain transformation (i.e above a given

Rotatation(degree)	14	
Translation(pixle)	-10	16
Scaling	1	1

Table 1: Parameter Estimation

threshold). A modified Besl's algorithm is then applied to the sequence of points from the two images. The modifications introduced make the algorithm invariant to the choice of the initial point and to the order in which the points are taken .An optimal fit procedure inspired from HYPER [5] was used for the matching step.

4 Results

The images for part of the City of Kanata are shown in figures 1, 2; they are 512x512 SPOT PLA images taken on August 14, 1991 and 1978 respectively. The images were supplied by the Canadian Center for Remote Sensing. All images are normalized to a one byte value. The features present in both images were extracted using a Duda Rode Operator [2] and the resulting curves were modeled using B-splines as in figure 4. The line segments were labeled and the paired segments from both the image and the scene were matched.
Table 1 shows the translation, and rotation transformation for the image and its deformed version. It was noted that, for an image with low signal to noise ratio and not yet pre-processed, the error factor on matching is very high.

References

[1] P. J. Besl, and N.D.Mckey "A method for Registration of 3-D Shape" *IEEE Trans. Pattern anal. Machine Intel.*,Vol.PAMI-14, no2,pp 239-256, 1992.

[2] R. O. Duda and P. E. Hart, *Pattern Classification and Scene analysis,* New York: Wiley-Inter science, 1973.

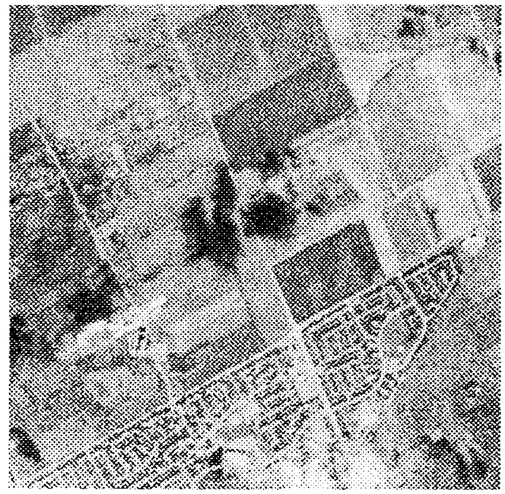

Figure 1: Reference SPOT PLA Image

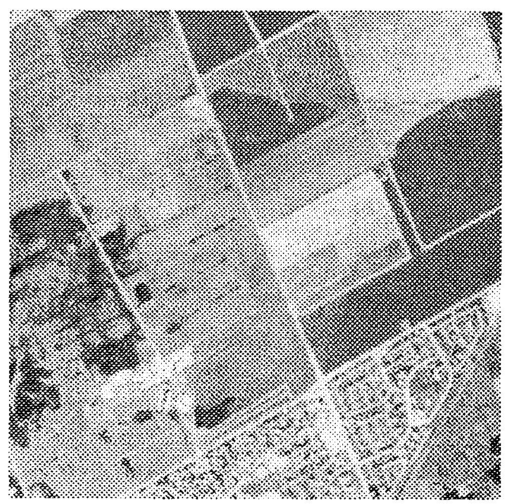

Figure 2: Model SPOT PLA Image

Figure 3: Feature map for the model image

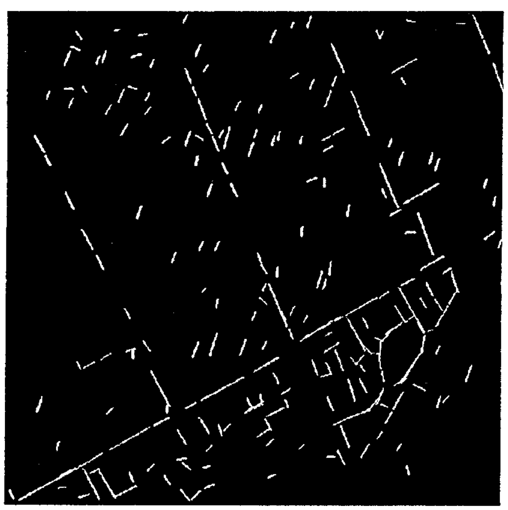

Figure 4: Shape Representation with B-spline

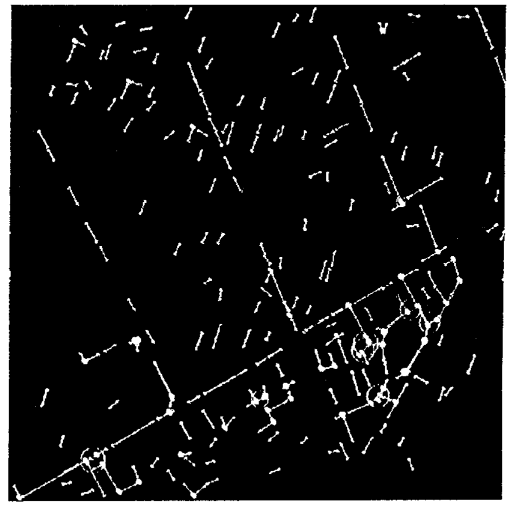

Figure 5: Corner extraction and matching

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[5] N. Ayache and O.D.Faugeras, " HYPER - A new approach for the recognition and positioning of two dimensional objects, *IEEE Trans. Pattern anal. Machine Intel.*,Vol.PAMI-8, No1,pp 44-54, 1986.