

Satellite Image Mosaics by Using Radon Projections

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فسيفساء الصور الفضائية بوساطة مساقط رادون

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المستخلص

في هذا البحث تم تقديم طريقة فسيفساء جديدة تعتمد على تقنية النافذة المنزلقة لبناء صورة كبيرة من مشاهد فضائية مختلفة، والتي تعتمد على استخدام مساقط رادون (التكاملات الخطية) كخصائص للمقارنة بدل مقارنة عناصر النافذة المنزلقة. هذه الطريقة الجديدة ونسختها المسرعة أثبتت إنها أسرع من طريقة RMS المعتادة، لذلك يمكن تبني هذه الطريقة في إجراء عملية الفسيفساء للصور الفضائية لبناء مشهد كامل من مشاهد منفصلة لنفس الموقع.

Abstract

In this research a new mosaics method to build large image from different satellite senses by using slide window technique is presented. That depend on using radon projections (line integrals) as features to compare instead of comparing each element in the slide windows. This new method and its faster version proved to be a fast matching method than the regular RMS method; therefore, it can be adopted in the satellite images mosaics to build a complete view from separated views for the same location.

Introduction

The automatic construction of large, high-resolution image mosaics is an active area of research in the fields of photogrammetry [1], computer vision [2], image processing [3], and computer graphics, video [4]. Image mosaics can be used for many different applications. The most traditional application is the construction of large aerial and satellite photographs from collections of images. Satellite image merging is essential preprocessing step to obtain a large view of the interest location from a number of scenes taken from one or different satellites, where each scene cover fragment of the complete view. The main obstacle in such task is to find criterion that can find the match locations in the different scenes in

order to merge them. Using a regular distance metric like RMS will not detect the similar location if any change happened in either locations since the regular distance metric is variant for scaling, transition, flipping and rotation operations or if some kind of noise is present in the seines, and it utilizes huge computation to find the matched location between two seines.

Radon Projections

Tomography refers to the synthesis of sectional images or slices from external measurements of a spatially varying function. Line integrals are the most common external measures, also known as projections. Availability of multiple projections at different orientations allows accurate recovery of the originating function. Because practical implementation of tomography typically requires large amounts of data and calculations, modern computing technologies are important. [5]

The line integrals for a certain angle represent a signature for that angle when its calculated for an object; figure (1), the line integral calculated by using Radon transform formula, which is:[6]

$$g(\phi, s) = \int_l f(x, y) dl$$

$g(\Phi, s)$ as a 1-D projection at an angle Φ . $g(\Phi, s)$ is the line integral of the image intensity $f(x, y)$, along a line l that is distance s from the origin and at angle Φ off the x-axis. [5]

The projection for two distinguished angles can be used as features to calculate the similarity between two objects (images).

Research Procedures

The images that view the International Airport, Baghdad, Iraq were used to merge and form the fall view; the images were collected multispectral image using IKONOS figurer (2). Slide window technique was used to find the close match between the two image parts, where two criteria are used, the first by calculating the direct root-mean-square RMS between the two sliding windows and this be will called the RMS method while the second method can be summarized by calculating two projections for the two slide windows and then calculate the accumulated absolute error between the two projections which will be referred to as projections method PM.

Two accelerate projections matching technique the projections for two angles (0° and 90°) are calculated for all slide windows for the two images so that the projections don't recalculated during the matching process, this procedure will be referred to as the fast projections methods FPM.

Results and Discussion

All methods succeeded to merge the two images to form the full view, but when we compare the overall computational time needed to find the matched location between the two images in figure 3, it will be obvious that the PM is faster than the RMS method and the accelerating step preformed by calculating the projection in advance to prevent recalculating the projections for all windows will fast the PM (i.e. FPM) by recording the lowest overall computational time for different window size. In figure 3 one can notice that the computation time decreases with window size for all methods, since selecting bigger window size mean less number of windows to process, but it the same time selecting bigger window size mean more element (pixels) to compare between the two windows; therefore, it will increase the computational time to decide if the two windows are match.

To solve the paradox of increasing the window size mean less number of windows to process and more elements to be compared between the sliding windows. Figure 4 shows the computation time per window, by dividing the overall computation time needs to find the match locations by the total number of sliding window that needed to be examined, and indeed the computation time that recorded to compare two sliding window increase with increasing window size.

In figure 3 and 4, it is clearly that the FPM is faster than the MP and the regular RMS matching method since in this method there is no need to compare each element in the sliding window with the other sliding window. In fact we need to compare the pattern of the accumulated columns (columns projection) and accumulated rows (rows projection) of each sliding windows, therefore it record less computational time than the regular RMS method.

Conclusions

In this research, the following conclusions can be derived:

- The projection method (and the fast version of it) is recommended to find the match location between two images in order to mosaic them because it need less computational time than the regular RMS method to find the match location on the images.
- In the projection method, two projections is fair to be used as features to find the matched location between two images by using the sliding window technique, taking the two projections orthogonal is recommended.
- In the fast projection method, calculating the projection in advance and using them in the comparsion to prevent recalculating them will reduce the computation time and accelerate the algorithm to find the match location faster.
- Using the computational time per window to match two sliding windows is more accurate than using the total computation time to find the match locations because it is independent on the two images size and the number of slide windows that needed to be examined.

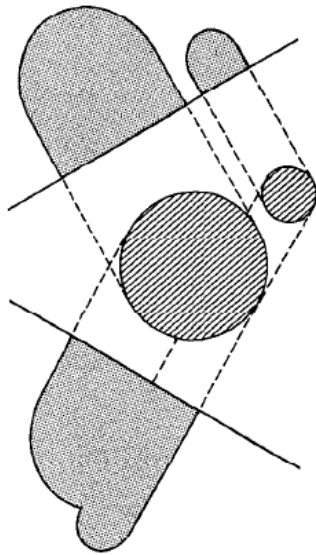


Figure (1) the line integral for two different ingles (two radon projections)



a



b



c

Figure (2) the scene of Baghdad Internationals airport a) first view b) second view c) the merged complete view

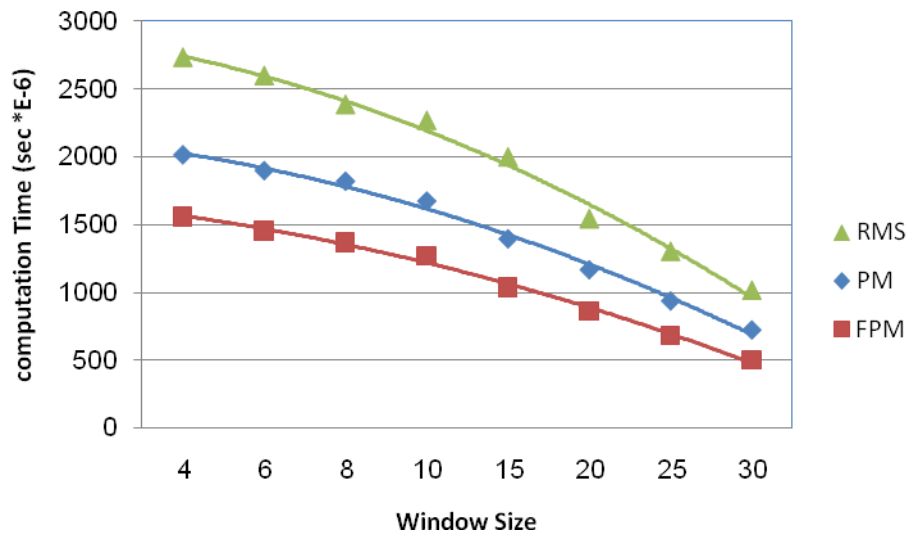


Figure (3) the total computation time to find the match locations

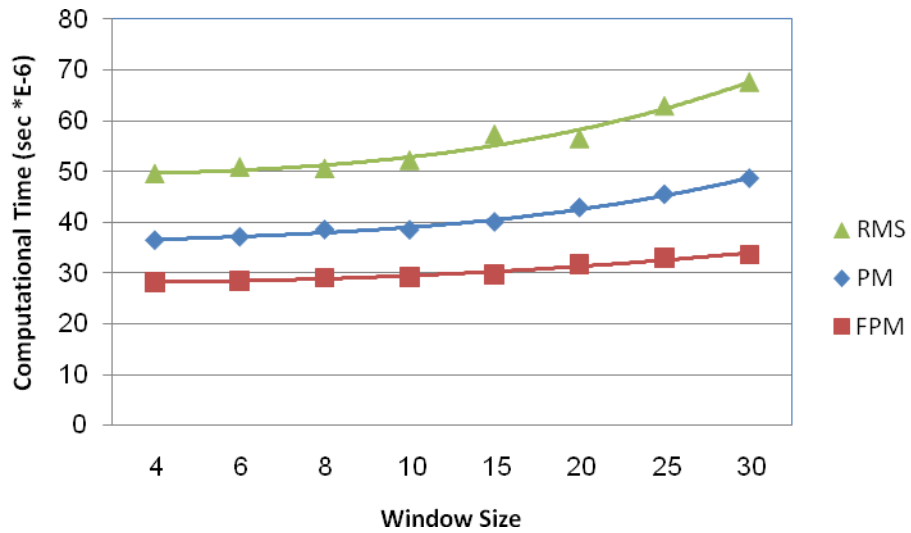


Figure (4) the computational time per window to find the match locations

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