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Development of an Efficient Image Segmentation Algorithm via Splitting and Merging Techniques

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Abstract— Segmentation is a vital step in image processing, especially when image has to be transferred over a network. This paper presents an image segmentation algorithm via four different splitting and merging techniques, namely, Rectangle Technique, Matrix Technique, Line Technique and Free Hand Technique.

Keywords-Image Segmentation; Image Merge; Image Splitting; Image Processing.

I. Introduction

Due to the high standers of nowadays computers, along with the high speed of internet, the use of images become more and more popular every day. In fact, most computer software's deal with images.

Image splitting is very important process in image processing, because it aids to transfer the image over networks such as internet. One of the most important problems is canonical jigsaw puzzles that use image splitting and merges it again [1].

There are many algorithms for solving the jigsaw puzzles problem, i.e. splitting then merge images. This paper well proposes a way to split and merge the image among with four old technique then study and compare them together. The algorithm proposed will be very easy as described below. But first let us present some terms like Image Segmentation, Jigsaw Puzzles Problem and some related works.

II. Image Segmentation

Image segmentation is a necessary step in any image processing task involving a variety of image operations that is the labeling and identification of constituent parts of an image or scene. For example, it may be of interest to identify the number of items of a given color, size, or shape of image. The simplest form of image segmentation is to split the image into two parts, the object and background, based on the amplitude value of a pixel

III. Jigsaw Puzzles Problem

In 1982, Radack and Badler propose a solution for Jigsaw as "Given a set of simply connected planar regions (silhouetted puzzle pieces), rotate and translate each piece so that the pieces fit together into one region, with no significant area gaps or overlapping pieces" [2].

H. Freeman and L. Gardner first tackled the problem in 1964, and their work remains fundamental in the field. Because of limitation in computer language, digitizer resolution and device imaging, they only managed to solve this problem by using the piece boundary shape information [7].

There are two strategies when solving this problem by a computer: top-down or bottom-up. The top-down methodology is very similar to the way a jigsaw puzzle is fabricated. Usually, to generate a jigsaw puzzle, a large piece of picture is cut into numerous small irregular pieces by using cutting-rules.

Glassner (2002) took a photograph of the entire picture of the jigsaw puzzle, and then drew jigsaw-shaped pieces in Adobe Photoshop. Then, the pieces were separated and scattered by a program with the orientation of each piece being fixed [2][8]. E. D. Demaine and M. L. Demaine. 2007 shows that the jigsaw puzzle can be reduced to the Set Partition Problem which means that jigsaw has a computational complexity of NP-complete (Non-deterministic Polynomial) [9].

IV. Related Works

Brun and Domenger Jean (1996) presented a new split and merge algorithm combining alternatively split and merge

operation at each recursive step. The algorithm based on a data structure encoding topological maps in a discrete plane, this allows to design efficient segmentation algorithm which are almost impossible to implement with usual data structure, the new ability allow users to guide the segmentation process and thus to obtain the desired partition, data structure allows searchers to implement quickly new segmentation algorithm based [6].

In 2009, Lin and Chiang proposed a complete procedure based technique which is capable of reconstruction a full page of shredded document [4].

FH Yao and GF Shao (2003) solved subsets of typical jigsaw puzzles by proposing an algorithm combines shape and image matching with a cyclic growth process that tries to place pieces in their correct positions [9].

V. The Proposed Split and Merging Algorithm

The proposed algorithm consist of working in two parts (Image Splitting and Image Merging) in this section we will discuss both in details.

A. First: Splitting the image

To split the image the user have to select a portion of the image that he want to cut it, then start in this part as following:

1. Read the original image and view it to the user.
2. Save the properties of image (size, width, height) in text file.
3. Save the start and end point coordinates of the split image in text file.
4. Construct a new empty image in the same size of the original one.
5. Draw a copy of the split image in the new constructed image at the same place of the original.
6. Save the new image to the disk.

As seen in the previous steps, original image information along with information about the selected part has been saved to text file. Later on, a data structure will be generated from the text file to facilitate the merging process and reconstruct the original image.

B. In this part, the original image will rebuild and saved by reconnecting the split image as following:

1. Read the text file that has the image properties.
2. Build an empty image in the same properties of the original one.
3. Start reading the split portion images and read the text file of each corresponding portion.
4. Redraw the portion in the same place it was split from.
5. Save the new image

The efficiency of the proposed algorithm is highly depending on the accuracy of reading the start and the end points of the split images. Therefore, four techniques have been tested to accomplish this task.

VI. Experiments

In this part, a set of experimental tests will be conducted over the four techniques of split/merge

A. Split image techniques:

1. Rectangle Split Technique:

In this technique user will use the mouse to draw rectangle over the original image as shown in Figure 1, the software will capture the start point as (X1,Y1) and end point as (X2,Y2)

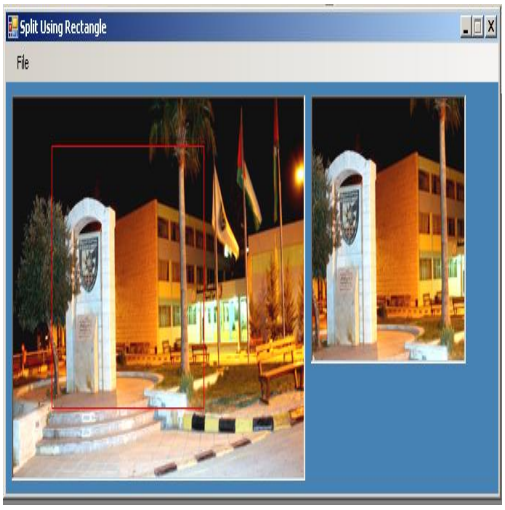

Figure 1: Rectangle Split screen.

2. Matrix Split Technique:

In this technique the algorithm will use matrix to split the image. The user has to select number of portions to split the image (number of columns and rows) as shown in Figure (2).

Figure 2: Matrix Split screen.

The following formulas were used to find the new point to the split images

$W = OI.Width / MC$

$H = OI.Height / MR$

Where OI is the Original Image; MC is number of matrix column; MR is number of matrix rows, then algorithm will start from point (0, 0) to draw rectangle to split the image.

3. Line Split Technique:

In this technique user will use the mouse to draw lines over the image. Then the algorithm will use this line as a diameter (or inverse diameter) to draw a rectangle as shown in Figure 3.

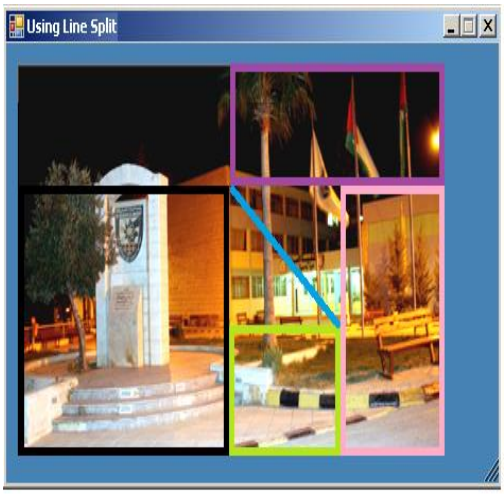

Figure 3: Line Split screen.

4. Free Hand Split Technique:

In this technique user has a free choice to select any part of image by drawing the shape he likes over the image as shown in Figure 4. Then the algorithm saves that sector of image along with its coordinates in text file.

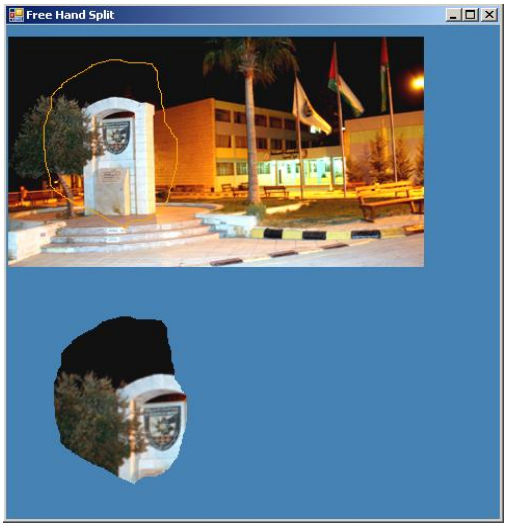

Figure 4: Free Hand Split screen.

A. Merge image techniques

Since every technique has its data stored in specific way, then we have to know the technique that has been used in splitting in order to rebuild the image.

All the four techniques work in the same way to rebuild a copy of the original image; firstly the system will select all image portion along with their configuration text file, secondly the system will read the original image data file then build new image with the same size, thirdly the system reads an image portion along with the files that contain the information about it, fourthly the system will redraw that portion in its place in the new image, lastly the system will repeat step tree and four until it process all portion, after that the user will save the new image.

VII. Comparative test Result

In order to determine which technique will perform better a comparative test conducted where time was the main factor. Figure 6 shows detailed results.

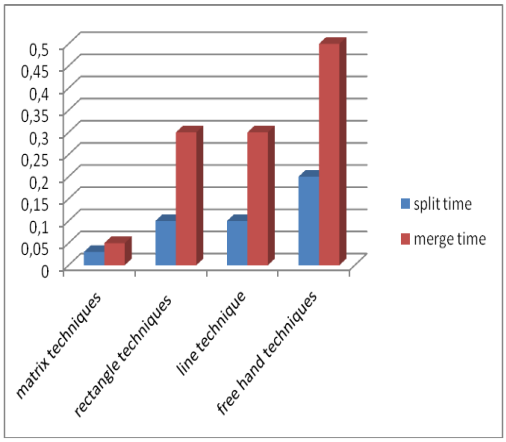

Figure 5: Run time comparison.

VIII. Conclusions

This paper proposed an algorithm for splitting/merging image depending on a points provided by user in four different technique. The comparative test reveled that matrix technique scored the highest performance among the four technique, while the rectangle and line technique scored the second place, finally the free hand technique was the slowest among them all when it scored around ten times as much as matrix.

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