Creation of the Panoramic View of Surroundings from Succession of Photos

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Abstract - *The method of "gluing" images is examined in the scope of this article. It is shown that when it is necessary to photograph an object which does not fully fit in the angle of the view lens, the images are taken by parts and then glued together. It is necessary to preprocess images before gluing because there may be a difference in size, angle, and light exposure. Two approaches for light exposure and size corrections are presented. You can also find solutions for angle correction. The results of suggested methods are illustrated. For algorithm representation the program is developed.*

Keywords: Panoramic images, rotation of images, color processing, change angle, "gluing".

1. Introduction

For control of researched terrain, often there is a necessity to photograph the big object which isn't located in the vision field of photo cameras. In this case, it is necessary to photograph the object in parts then "glue" the individual pictures to resemble a panoramic image. It is also possible to receive a panorama with a 360 degree view point irrespective of whether it is an open territory such as an airport or parking lot, or indoor setting such as a hotel lobby or a bank. Parts of the panoramic image can be taken with a variety of luminance, from different distances, or a corner relative to a photo camera's axis. In the given article methods of obtaining of the panoramic image of researched terrain are considered.

2. The general methods of obtaining of the panoramic images

The main requirement which the images should have is that each individual image should include a part from the subsequent image in order to maintain consistency when "gluing" and avoid losing parts of the object.

2.1 Technique of gluing

For image gluing it is necessary to find areas of the coincidence of images. For this purpose, one image moves in relation to another from left to right and top to bottom. Each position calculated for the characterizing coefficient is equal to the total of squares of different RGB components on a vertical left line of coincidence area divided by the total number of points of coincidence. The position which has the minimum value, i.e. its points have a minimum quadratic deviation, are coincidence areas. After choosing the vertical line of "gluing" in the field of the coincidence area, images can be "glued". [1] The line in the picture represents the gluing vertical line. The "gluing" patching is carried out by the formation of the general array in which the points are from both images.

Fig. 1. Glued images

Let's examine the process of obtaining the panoramic image while considering various environmental factors and photographic conditions.

2.2. Obtaining of the panoramic image relative to different color saturations

Different parts of the panoramic image can be received with a variety of luminance. For example, during one photographing session cloud darkening of the sun was not present while during the other presence of a cloud caused the picture to be darker. In this case, before gluing it is necessary to perform color corrections.

Fig.2. Images taken from different light exposure

Color correction is done in two steps. First, it is necessary to define the value of color difference, and then produce multiplicative operations to every RGB component.
Determination of a color difference is carried out by two methods known as automated or with user intervention. With the user intervention method, a specific area on each of the two pictures is selected with the area on the primary picture having a larger selection than the area on the picture selected to perform the color correction on. Then search of a small area in the big picture is carried out by moving it in the big area from left to right and top to bottom.
For each position, the total number of squares of differences of each RGB components for all points is counted. The position in which that value has the minimum value is considered the coincidence area for which the mean value of square deviations of every RGB a component is counted and on a basis that mean value is carried out with multiplicative action in relation to the stereotyped image [2].

Fig.3. Color corrected and glued images

The automated approach method insists that both images are corrected. In this case the middle of the left part selected in the second image in the area for which the coincidence area is in the first picture is defined. Both images are exposed to color adjustment one half coefficient mean value of shift

2.2. Obtaining of the panoramic image at various distances and angles of photographing

It is possible to "glue" individual photographs even if they have been taken from varying distances. In this case, the objects represented in a picture will have various sizes. It is necessary to lead them at first to one size, producing reduction of large images.

Fig. 4. Part of images taken from different distance

For reduction of image sizes two approaches are suggested. According to first approach for realization of reduction of the object it is initially necessary to define a difference of sizes of both represented objects, then to produce conversion. For determination of a difference of the images' sizes, the user selects on two points of images which belong to both images. Then the sizes of objects, which include the selected point, are defined. The ratio of the sizes of those objects defines a difference of the sizes of the images.

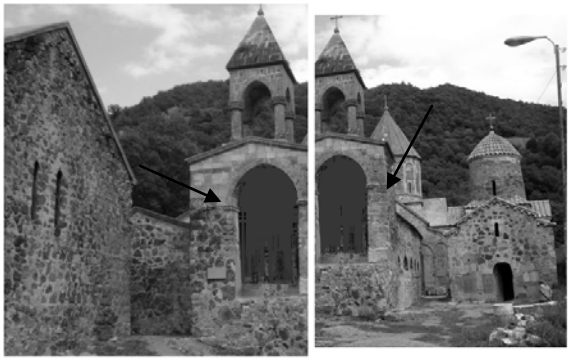

Fig 5. The objects defined in the images.

Hence, having found on one image length and object height included in the selected point and comparing these values to similar parameters of the second image, we will receive a difference of the sizes of the images. Proceeding from this information, the large image decreases. The magnification

isn't considered because it can lead to loss of quality of images.
According to second approach there is no need of user interaction.

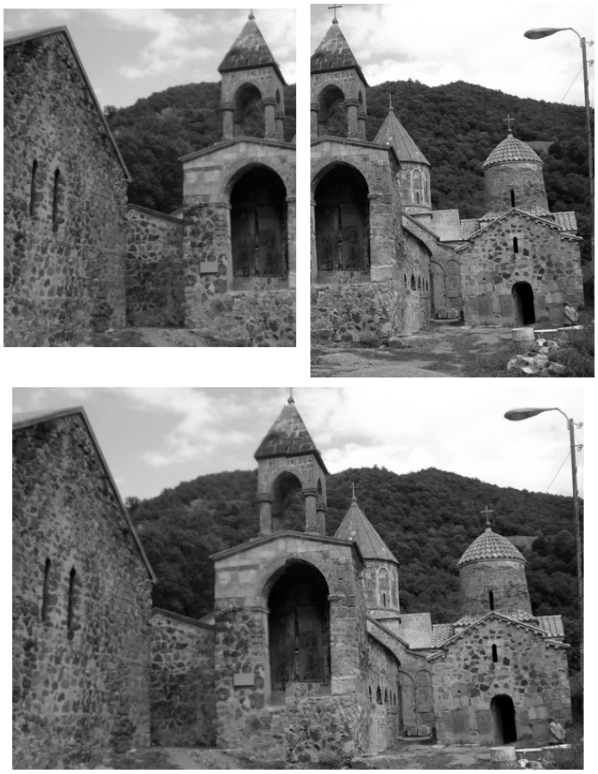

Fig. 6. Size corrected and glued images

For examining the second approach let's consider that the first image is taken from further distance, so the object in it smaller. Algorithm tries to find the mean coefficient of differences between image height and width. Let's discuss the algorithm for finding coefficient for image height.
According to this method algorithm tried to find the line corresponding to the right line in the first picture in the second line. It is supposed that the second image is larger than first image by 1.5 times. If the imaged differs more than 1.5 the part of second image will be lost. The searching algorithm is done as for image gluing, e.g. tries to find the line which will have minimal color deviation, then the second image is decreased with 1.05 coefficients to 1.5 with 0.05 deltas. The second image will be greater from first image by the coefficient for which the color deviation is minimal. To find the exact coefficient after finding the minimal coefficient this value is approximated e.g. selected the coefficient are around the minimal value, and the algorithm repeats above mentioned steps, but in this time with smaller delta.
The image is decreased with the mean coefficient value for height and width [4].
Pictures can also be taken under a different corner of an axis of a photo camera. If the object is photographed at an angle, the part of the object nearest to the camera will turn out larger than that which is further (fig. 2.).

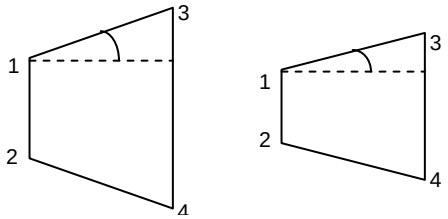

Fig.7. Schematic view of objects taken under different angles

In this case it is necessary to correct the image as if they have been taken perpendicularly. As the color image represents a two-dimensional array, the decision of this task is reduced to reduction with the appropriate coefficient of each column of images. That coefficient will most likely be identical for several columns.

Fig. 8. Objects taken from different angle

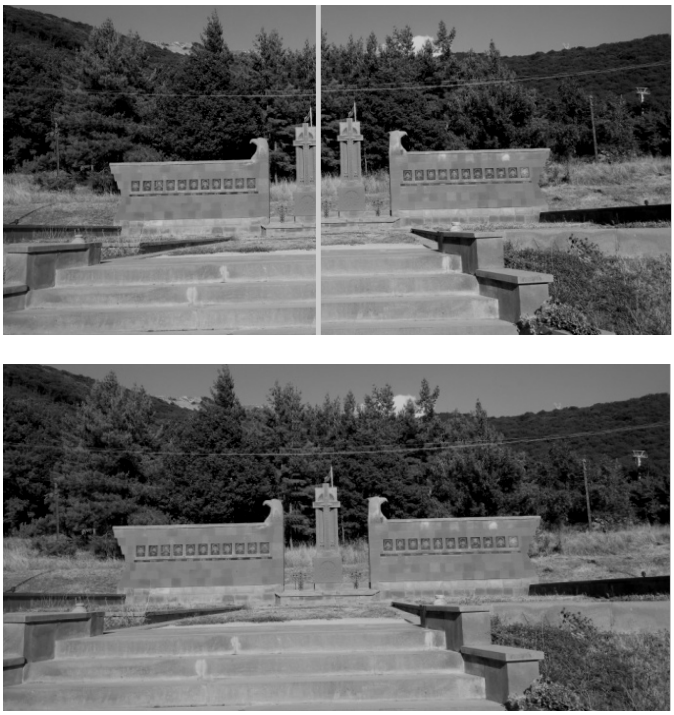

Fig.9 Angle corrected and glued images

After "gluing", because of the various qualities of images on a connection section, there may be a line. This passage can be made smoother by applying an interpolation method. It is offered by three methods: linear, parabolic, and Lagrange [5]. The area round "gluing" line is selected arbitrary width for application of an interpolation method from scope of the user. Linear interpolation is defined under the following formula:

$$y_i = y_1 + \sum_{j=0}^{i-1} (j * \frac{y_{2n+1} - y_1}{2n+1}), \qquad (1)$$

Where y_1, y_2, y_i a color component of points in interpolation area according to right, left and the intermediate values, 2n width of interpolation area.

If the results of the liner interpolation do not satisfy the user, it is possible to apply parabolic interpolation at which the curve transits through three points.

$$\begin{cases} a_0 + a_1 x_1 + a_2 x_1^2 = y_1 \ , \\ a_0 + a_1 x_2 + a_2 x_2^2 = y_2 \ , \\ a_0 + a_1 x_3 + a_2 x_3^2 = y_3 : \end{cases} \qquad (2)$$

There the formula colors n points to the right, to the left and points of connection from a line of "gluing" and accordingly coordinate y1, y2, y3 ¨ x1, x2, x3 interpolation area are resulted. Coefficients are defined with which help count colors of intermediate points.

If results of parabolic and linear interpolation don't satisfy the user, it is possible to use a method of Lagrange under the following formula:

$$y = \sum_{i=1}^{n} y_i \prod_{j=1, i \neq j}^{n} \frac{x - x_j}{x_i - x_j} \ , \qquad (3)$$

Where y_i colors n points to the left, to the right and points of connection from a patching line, and y - colors of intermediate points for which calculation is produced. These formulas are applied separately to all three components.

If needed, deriving of a vertical panorama turn on 90 degrees to the left or to the right is produced, thus resulting in the task decision in a case of a horizontal direction. After "gluing," turn in the opposite direction is produced.

3. Conclusion

The article provides the solutions of obtaining panoramic images. For the decision of the specified tasks and "gluing" realization, the program is developed. The program is easy to use and provides simple user interface. The program gives the chance to load and display the image of any format on the screen. The images can be translated from a disk of the arbitrary size from any point. The results of program are presented above. The given technique of obtaining of the panoramic image can be used in systems of protection of various objects, and also persons engaged in photographing.

References

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