Moving Path Tracing of Image Central Position with Autocorrelation Function

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ABSTRACT

For an complete image composition to be stitched on several mosaic images, tracing displacement of direction and distance between successive images are important parameters. The input image is modeled by using a general second order two-dimensional Taylor-series and then converting it to a 3x3 correlation block and storing the data. A moving factor and coordinate is calculated by comparing the continuos correlation blocks. The experimentation result has a success rate of 85% for moving path tracing as continuous images are moved to 10% of image central position.

KEYWORD

Autocorrelation, moving path tracing, stitched image, image central position, affine transformation

I. INTRODUCTION

Image stitching or image mosaics which make one panorama image by synthesizing a several continued cuts are useful for the variety of tasks in video and image processing. A particularly convenient way to generate mosaics is by 'stitching' together many ordinary photographs.[1,5] The aim of a stitching algorithm is to produce a visually plausible mosaic with two desirable properties. First, the mosaic should be as similar as possible to the input images, both geometrically and photometrically. Second, the seam between the stitched images should be invisible. While these requirements are widely acceptable for visual examination of a stitching result, their definition as quality criteria was either limited or implicit in previous approaches.[3] There are two main approaches to image stitching in the literature, assuming that the images have already been aligned. The other approach minimizes seam artifacts by smoothing the transition between the images. But, actually a user takes a hand-held consumer camcoder, pans around a scene capturing the region of interest, and obtains a complete description of the surrounding environments. The existing algorithms are focused on capturing static scenes mostly. However the input images of object are moved, and according to the visual angle they have an error between images. This error enables to appear in case of camera angle for capturing image or rotation of a background scene.[2,4]

Thus, this paper is proposed the stitching a several continued image cuts for a panorama image. The stitching method results from searching for image boundaries. The error of image variations are acquired by moving and rotating of captured image from camcorder. The stitching positions for image composition are detected and corrected by those error data. The distance of moving image is calculate using autocorrelation function.

II. AUTOCORRELATION FUNCTION

The center position of the captured image from CCD sensor is changed as shown in Fig. 1. in multiple scanning. The combined image is made by overlap same region after moving to displacement. So, Find a displacement is necessary in stitching image.

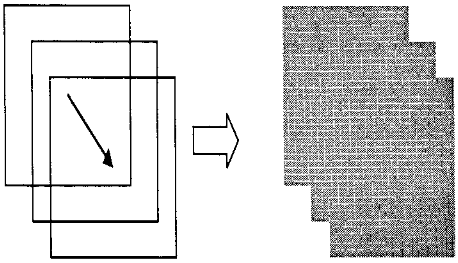

Fig. 1. Captured images and stitched images

Image is divide to 3x3 grid block, each block is compute correlation to all pixels. At this time, the CCD sensor image has an error by environment like illumination, a property of sensor and lens. The property error might be disregarded. The captured image is calculated a correlation processing using a nonzero mean difference detection function given by the following equation (1).

$$C_{i,j} = \sum_{m=1}^{M} \sum_{n=1}^{N} \left| r_{m,n} - c_{m-i,n-j} \right|^{k}, \tag{1}$$

where $r_{m,n}$ $c_{m,n}$ is the digitized value of the reference image and comparison image at pixel{m,n}, and $i,j \in Z$ represent the shift of the comparison frame relative to the reference frame, measured in unit of pixels.

The result of correlation value by equation(2) is presented the displacement of pixel for the two image in time and position. that is, comparing image is moved.

$$C_{rc} = \frac{\sum_{i=0}^{m*n-1} (r_i - \overline{r_i})(c_i - \overline{c_i})}{\sqrt{\sum_{i=0}^{m*n-1} (r_i - \overline{r_i})^2 \sum_{i=0}^{m*n-1} (c_i - \overline{c_i})^2}} \tag{2}$$

where r_i, c_i is reference image and comparing image, $\overline{r}, \overline{c}$ is average value of continues pixels. and, i means the order of pixels transformed to 1D array.

III. MOVING PATH TRACING

A general second order two dimensional Taylor series of x and y as an initial idealized three-dimensional model representation of the correlation surface by considering a simple elliptic paraboloid is described by equation (3).

$$z' = f'(x', y') = q_{20}x'^2 + q_{02}y'^2 \tag{3}$$

If $q_{20,}q_{02} > 0$, then the surface has a unique minimum z'=0 at {x',y'}={0,0}. In this case, the major and minor axes of the ellipse formed by the intersection of $f'(x', y')$ with a particular contour plane $z' = z_0 \equiv constant$ are given by $\sqrt{z_0/q_{20}}$ and $\sqrt{z_0/q_{02}}$, respectively.

Two-dimensional affine transformation is applied in the {x',y'} plane to the surface $z' = f'(x', y')$, and that the inverse of that transformation can be represented in the cartesian basis by the matrix

$$c = \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} \tag{4}$$

In the case of a rotation about the z' axis by an angle Φ, c has the form

$$c \equiv R(\Phi) = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \tag{5}$$

However, that (4) also represents 2D transformations such as shears and reflections, as well as arbitrary compositions of subsequent rotations, shears and reflections.

Next, the 2D affine transformation is converted to 3D translation by the vector $\{x_{0,}y_{0,}z_0\}$, carrying into the sample reference frame specified by the coordinates $\{x, y, z\}$. By inverting both the translation and the affine transformation in order, the original coordinates of the unperturbed correlation surface produced in terms of the reference coordinates as

$$x' = c_{11}(x - x_0) + c_{12}(y - y_0) \tag{6}$$

$$y' = c_{21}(x - x_0) + c_{22}(y - y_0) \tag{7}$$

$$z' = z - z_0 \tag{8}$$

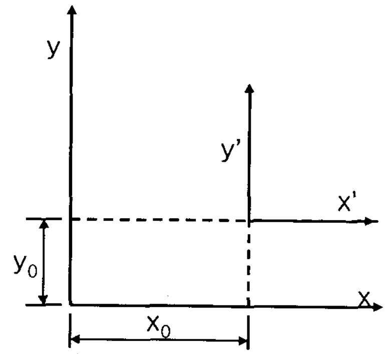

Fig. 2 Geometry of 2D affine transformation

Figure 2 illustrates the 2D affine transformation given by (6) and (7), a subsequent translation by the vector $\{x_0, y_0\}$.

A functional form for the transformed model surface produced in the reference coordinate system {x,y,z}. By substituting equations (6)-(8) into (3), $z = f(x,y)$ is obtained, where

$$f(x,y) = a_{00} + a_{10}x + a_{01}y + a_{20}x^2 + a_{11}xy + a_{02}y^2 \tag{9}$$

$$a_{20} = q_{20}c_{11}^2 + q_{02}c_{21}^2 \tag{10}$$

$$a_{02} = q_{20}c_{12}^2 + q_{02}c_{22}^2 \tag{11}$$

$$a_{11} = 2(q_{20}c_{11} + q_{02}c_{21}c_{22}) \tag{12}$$

$$a_{10} = -(a_{11}y_0 + 2a_{20}x_0) \tag{13}$$

$$a_{01} = -(a_{11}x_0 + 2a_{02}y_0) \tag{14}$$

$$a_{00} = z_0 + a_{11}x_0y_0 + a_{20}x_0^2 + a_{02}y_0^2 \tag{15}$$

Note that the transformed surface in the s coordinate system has six terms of the form $a_{mn}x^m y^n$, where $\{m,n\} \in \{0,1,2\}$ and $0 \le m+n \le 2$. Furthermore, the two coefficients a_{10} and a_{01} can be uniquely expressed in terms of the displacements $\{x_0, y_0\}$, allowing to invert (13) and (14) to find

$$x_0 = \frac{a_{01}a_{11} - 2a_{10}a_{02}}{4a_{20}a_{02} - a_{11}^2} \tag{16}$$

$$y_0 = \frac{a_{10}a_{11} - 2a_{01}a_{20}}{4a_{20}a_{02} - a_{11}^2} \tag{17}$$

In other words, if the five coefficients $a_{10}, a_{01}, a_{20}, a_{11}, a_{02}$ enable to determine numerically, then compute the components of the translation vector $\{x_0, y_0\}$ without explicitly finding either the elements of the inverse transformation matrix c or the two coefficients $q_{2,0}$ and $q_{0,2}$.

Ⅳ. EXPERIMENTS

In the experiment, 256x256 size and gray image is used. The reference image captured from CCD sensor and made the comparing image with the reference image moving under 10%. Fig 3. shows reference image, Fig 4. is comparing image. Correlation error is calculated using the proposed algorithm. A correlation block size is 3x3, correlation an operation whereby each pixel in a two arrays are compared against one another. The difference between corresponding pixels is squared and summed up over the entire array, resulting in a single summation value. When two arrays closely match, the correlation value is near zero. When the arrays differ, the correlation output will be much greater than zero. The minimum value indicates the most probable point for a match. The result of simulation, a distance of two image is 25 pixels. The stitched image is shown in Fig. 5

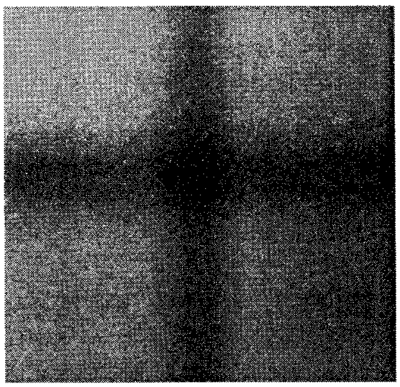

Fig 3. Referenced image

Ⅴ. CONCLUSIONS

The moving path tracing algorithm of image central position with autocorrelation functions is presented in this paper. To stitch a continues image cuts for one stitched panoramic image from CCD imaging sensor is required to search for directions of two images. The autocorrelation function is used to decide whether an image is moved or not. The error difference squire rate for referencing image and comparing image is calculated by correlation coefficients, and is compared the maximum values.

Fig 4. Comparing image

Fig 5. Stitched image

A producing the maximum difference get suggested a moving symptom each others, and then convert to moving vectors. This moving vectors enable to stitch a coordinate coefficients for image composition for sure. The experimental result has a success rate of 85% for path tracing of moving vector as continuous images are moved to 10% low of image central position. CCD viewfinder enable to rotate an image with depending on capturing conditions, however this result is limited to vertical and horizontal captures. Thus, In future a rotating viewfinder capture is required to study for stitching image composition.

REFERENCES

[1] Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Prentice-Hall, 2002.

[2] James Davis, "Mosaics of Scenes with Moving Objects", in Proc. Conf. Computer Vision and Pattern Recognition, 1998, pp.354-360.

[3] Assaf Zomet, Anat Levin, Shmuel Peleg, Yair Weiss, "Seamless Image Stitching by Minimizing False Edges", Transactions on Image Processing, 2006. 4, Vol.15, No:4, pp.969-977.

[4] Jong-Woong Choe, Tae-Kyun Kim "A Study for Enhancement of Fluid Flow Image Strained By CCD's Characteristic", Korea Informatin Science Society, 1996. 10, Vol.23, No:2, pp.387-390.

[5] Ma B, Zimmermann T., Rohde M., Sinkelbach S., He F., Lindenmaier W., Dittmar K.E., "Use of Autostitch for automatic stitching of microscope images", Micron, 2007. 7, Vol.38, No.5, pp.492-499.