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Rosa Image Subtraction Based New Image Background Subtraction Algorithm for Improving Software Reliability

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Abstract: The present researche proposes a new background subtraction algorithm (Rolling Sphere Algorithm ROSA) intended to implement 'background subtraction using spherical coordinate system based sphere rolling which is a vector application technology for separation between objects and backgrounds in digital images. This ROSA can be largely divided into a pre-treatment stage where target images are processed for the sphere rolling and a stage where the sphere is rolled on the pre-treated target image to subtract the actual background. This algorithm groups the edges of the subject of extraction in the image to divide the image into areas, processes the areas as if they are 3D images by making the areas into layers and make a sphere roll over the layers to subtract the backgrounds. Experiments were conducted to compare the ROSA with the Codebook (CD) and the Gaussian Mixture Model (GMM). The total numbers of successful or failed pixels of backgrounds and objects were counted. In terms of pixel removal accuracy, results that were improved by 15% compared to the CD and the GMM. Since, a process to make the target image into a reduced or compressed image filled with average values between adjacent pixels is necessary and vector sphere rolling is applied on the compressed image to apply the ROSA, it could be seen that flexibility in image magnification/reduction and the accuracy of background subtraction are improved compared to existing algorithms.

Key words: Codebook, vector coordinate sphere, sphere rolling, background remover, Gaussian Mixture Model (GMM)

INTRODUCTION

In the case of digital image background subtraction, despite the long period of research and development, there have been many difficulties in separating objects and backgrounds from each other. The division between backgrounds and objects is obscure and even if they are identified it is not easy to find the boundary between them. In addition, technical algorithms are required to determine whether various objects included in a background should be recognized as the background or object (Winter, 2004; Wu and Dai, 1987).

Despite these difficulties various studies on background subtraction exist. The most representative techniques include subtraction using clustering based vector quantization, subtraction using vector based object extraction and feature vectors, pixel unit figure element based background subtraction.

Among them, the most frequently used algorithms are vector quantization based codebook algorithms and EM (Expectation Maximization) algorithm based Gaussian Mixture models. Codebook algorithms use color similarity and have a shortcoming that the speed and accuracy decrease as image sizes increase. Gaussian mixture models analyze differences between dynamic images and use the results to extract certain objects and have shortcomings that the processes are mathematically complicated and that the effects of variables on the results are large (Wu and Dai, 1987; Tossavainen *et al*., 2006; Qiu *et al*., 2016a, b)

Accordingly in the present study, a new algorithm for subtraction of backgrounds distinguished from foregrounds in digital images that is ROSA is proposed. This algorithm is based on 'background subtraction using spherical coordinate system based sphere rolling which is a vector application technology.

Literature review: Although, there are various algorithms for subtraction of backgrounds of images in the present study, background extraction techniques that include vector based object extraction will be introduced as related works. Vector based object recognition involves geometric elements and it is frequently used in face recognition and writing style and dynamic object

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extraction. Representative vector based algorithms are codebook algorithms that show excellent performance in using vector quantization (Kim and Shin, 2017; Kim and Kim, 2015). However, although the accuracy is high, these algorithms have a shortcoming that the speed becomes very low in the processes of binary division using vector quantization and the LBG algorithm and clustering with K-means, etc. Differences in the application between the algorithms of related works necessary for background subtraction that will be introduced in this chapter and the developed ROSA will be studied.

MATERIALS AND METHODS

Codebook algorithm: Vector quantization is a quantization method that maps vectors having many input values into simple forms of vectors. Here, vectors are used as sub images and blocks. Figure 1 shows the concept of codebooks, in which vector quantization is explained using 8 bit 256×256 images as shown under (a) as examples.

Representative vectors of individual classes may be selected and when an arbitrary input vector has been given the input vector may be approximated using the representative vector. For instance, if 4×4 blocks are organized for one 256×256 sized image and each block is assumed to have 16-dimensional vectors, 4,096 vectors will be formed for one image. If this vector group is clustered as shown in (Fig. 1) to make and use 256, representative vectors, data compression to approximately 1/16 will be realized (Kim and Kim, 2015; Kim, 2011).

Gaussian mixture model: Gaussian mixture models are a method that shows input data as the sum of multiple Gaussian distribution functions. Computing quantities

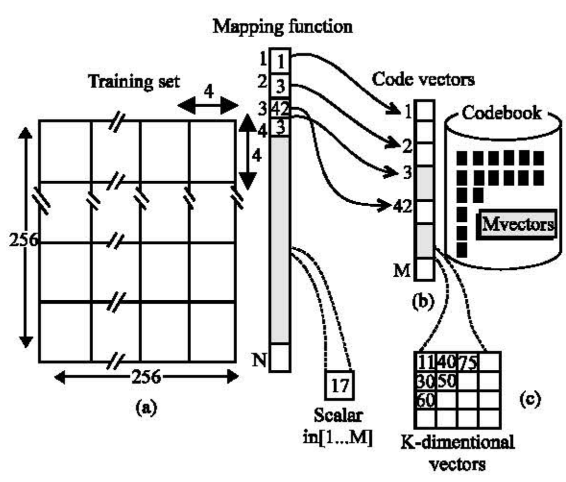

Fig. 1: Concept of codebooks

may be reduced by modeling complicated input data into the mean and variance values of individual Gaussian distribution functions.

ROSA for background image subtraction

Existing algorithm problem: Before measuring the accuracy of the proposed algorithm, existing background subtraction algorithms should be analyzed first to identify problems. Three images with simple backgrounds and three images with complicated backgrounds were selected as experimental images for derivation of problems. Thereafter, a vector quantization based codebook and an EM algorithm based Gaussian Mixture model among existing algorithms were used in the experiment.

The experiments conducted to derive problems in existing algorithms are as follows. The >30 diverse background colors for basis images to be used in codebooks as threshold values or mean values were learned and stored. Individual basis images were stored. Using the implemented application, the codebook and the Gaussian Mixture model were applied to the original images.

RESULTS AND DISCUSSION

In the case of images with simple backgrounds, it could be seen that all background colors were well subtracted through existing algorithms. Since, several ten different (at least 30 kinds in the experiments) basis images were stored and learned, those basis images that had the most similar backgrounds to the mean of the background to be subtracted were automatically selected and the backgrounds were subtracted. Therefore, simple colored backgrounds were well subtracted. In particular, from the abovementioned results, it could be seen that the results obtained using the codebook were more excellent between the two algorithms (Fig. 2).

Fig. 2: Results of application of existing algorithms to images with simple backgrounds

ROSA: Problems in existing algorithms were examined through analysis of those algorithms. In this study, the ROSA developed to solve those problems is examined (Fig. 3).

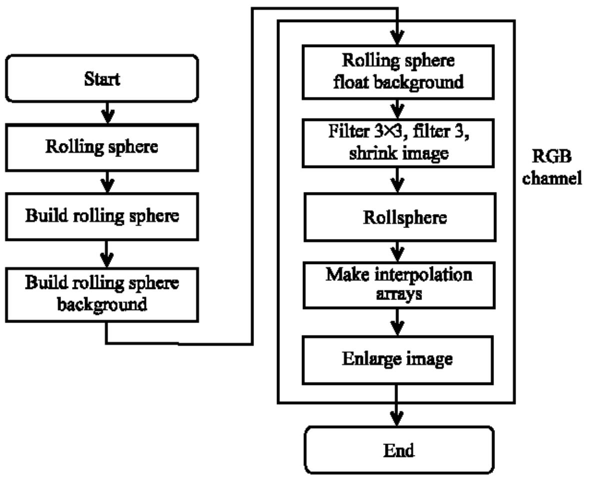

Fig. 3: Sphere generation and a flow chart for sphere rolling

Experiment

Experimental method: To prove the excellent performance of the new proposed algorithm, experiments were conducted to compare the new proposed algorithm with codebooks and Gaussian mixture models. In the experiment, the numbers of pixels remaining in the result images were compared to quantitatively judge and measure the degrees to which the background colors were subtracted as success rates. In addition, the degrees to which the object that should not be subtracted was subtracted were judged as error rates. Thereafter the success rates and error rates were separately compared. The well-known pixel count comparing method was used as the series of processes and method of the experiments. The experimental method is as follows:

- Firsthand separate the original image into the background and the object manually
- Count the numbers of pixels in the manually completed background area and object area
- To see how accurately similar pixels in the background area were found and subtracted; calculate the success rate as shown by Eq. 1:

$$\text{Success (\%)} = (P_{bg}/P_{bgtot})\times 100 \qquad (1)$$

Where:

P_{bg} = Excluding the object number of pixels substracted from the background

P_{bgtot} = Excluding the object total number of pixels substracted from the background

Experimental result: Figure 4 shows the original images and Fig. 5-7 show the resultant images derived from the

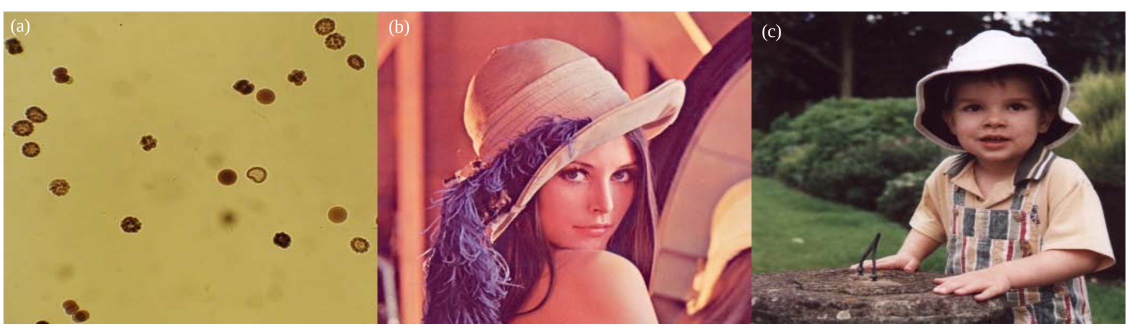

Fig. 4: Original image (768×768)

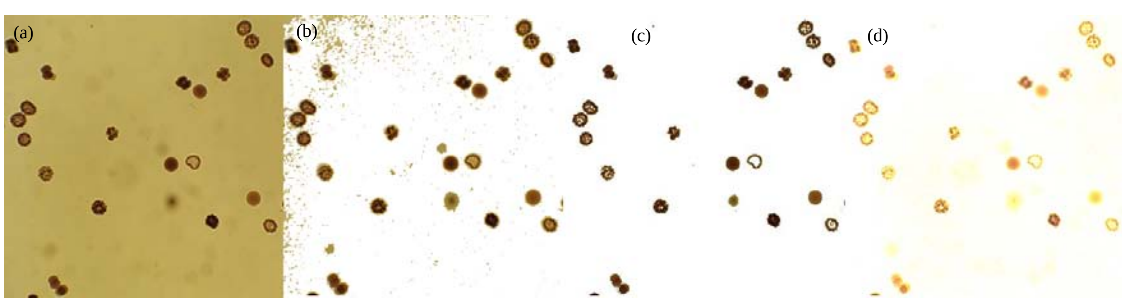

Fig. 5: Results from image #1: a) Original image; b) GMM; c) CB and d) ROSA

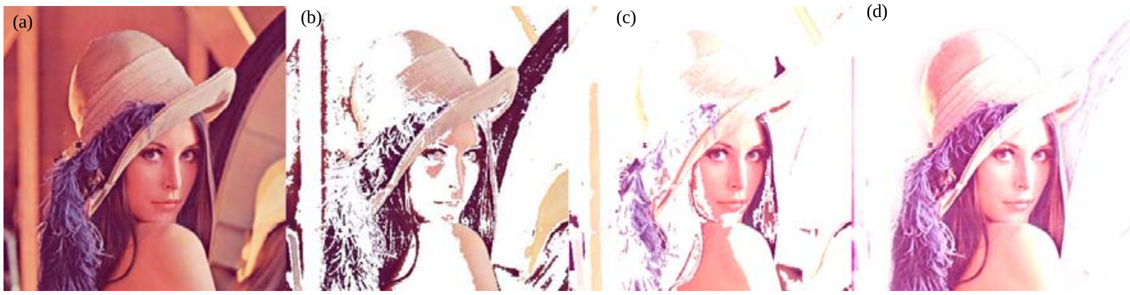

Fig. 6: Results from image #2: a) Original image; b) GMM; c) CB and d) ROSA

Fig. 7: Results from image #3: a) Original image; b) GMM; c) CB and d) ROSA

Table 1: Comparison of the sizes and pixel counts of individual images (Unit: piece)

Image #	Size	Object pixel count	Background pixel count	Total pixel count
1	768×768	147,456	442,368	589,824
2	768×768	265,421	324,403	589,824
3	768×768	325,127	264,697	589,824

original images using the Gaussian Mixture model, the codebook, and the proposed algorithm for comparison of the algorithms with each other.

ROSA evaluation: The evaluation method quantitatively evaluated the resultant images from the experiments applied with the proposed algorithm. That is how many pixels of the background colors were subtracted and how well the desired object was preserved are demonstrated with the pixel counts. Table 1 shows information on the images used as experimental samples.

CONCLUSION

Although, various existing algorithms for digital image's background image subtraction are well applied to simple objects or backgrounds or images with clear perspective, images in the real world are not so simple leading to many limitations and difficulties in background image subtraction.

To overcome such limitations, the present paper developed and proposed a new algorithm ROSA. Whereas existing algorithms require separate learning images the ROSA does not require any separate learning image but generates spheres from the value of the radius to make sphere vectors in the vector sphere coordinate system, rolls the spheres on target images to map the contact points between the spheres and target images in order to subtract the background through subtraction computing.

Elements improved compared to existing algorithms are the shortened computing time and the enhance layer precision that enable more precise background subtraction. Existing algorithms and the ROSA were compared with each other through experiments to demonstrate the excellence of the performance of the ROSA. In the experiment, the backgrounds and foregrounds to be extracted from original images were separated using the image tools, the pixels of individual results were counted, and the accuracy levels were calculated. Consequently, the accuracy was improved by 15% and backgrounds were well subtracted from images with so complicated colors to the extent that objects could be hardly identified. As future research projects, studies will be conducted to improve the ROSA to maximally reduced image pixel losses.

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REFERENCES

Kim, J.L. and K.D. Kim, 2015. Presentation of budge sonance with small action on the body motion. Intl. J. Adv. Smart Convergence, 4: 35-39.

Kim, J.L. and M.S. Shin, 2017. Study of the dangle effect function on the matter. Adv. Appl. Convergence Lett., 9: 46-48.

Kim, J.L., 2011. Analysis of posture balance system of using multi-parameter after exercising. J. Inst. Internet Broadcasting Commun., 11: 145-150.

Qiu, Y., I. Vlassiouk, P. Hinkle, M.M.E. Toimil and A.J. Levine *et al*., 2016. Role of particle focusing in resistive-pulse technique: Direction-dependent velocity in micropores. ACS. Nano, 10: 3509-3517.

Qiu, Y., I. Vlassiouk, Y. Chen and Z.S. Siwy, 2016. Direction dependence of resistive-pulse amplitude in conically shaped mesopores. Anal. Chem., 88: 4917-4925.

Tossavainen, T., E. Toppila, I. Pyykko, P.M. Forsman and M. Juhola *et al*., 2006. Virtual reality in posturography. IEEE. Trans. Inf. Technol. Biomed., 10: 282-292.

Winter, D., 2004. Biomechanics and Motor Control of Human Movement. 3rd Edn., Wiley, New York, USA., ISBN:9780471449898, Pages: 344.

Wu, J.S. and C.W. Dai, 1987. Dynamic responses of multispan nonuniform beam due to moving loads. J. Struct. Eng., 113: 458-474.