Image Segmentation Technique for Cloud Computing Environment Using Morphological Approach

Pinaki Pratim Acharjya, Dibyendu Ghoshal

Abstract— In the business model using software as a service, users are provided access to application software and databases. Cloud providers manage the infrastructure and platforms that run the applications. Cloud computing environment provides a great flexibility and availability of computing resources at a lower cost. In this research article a robust and effective image segmentation approach is proposed using mathematical morphology for cloud computing. The proposed approach will be very effective in a cloud computing environment with minimum processing power and better performance in a centralized way.

Index Terms— image segmentation, cloud computing, markers, watershed algorithm.

1 INTRODUCTION

Cloud computing is one of the most contemporary researched topic. Cloud computing [1-3] provides users many advanced features. It has not only reshaped the field of distributed systems but also fundamentally changed how businesses utilize computing today. In the business model using software as a service, users are provided access to application software and databases. Cloud providers manage the infrastructure and platforms that run the applications [4-7]. It also refers to the delivery of computing and storage capacity as a service to a heterogeneous community of end-recipients. At the bottom of the system is the information infrastructure which is based on the idea of cloud computing and provides information storage, process, delivery and management to satisfy the operators, decision makers and engineers. This layer is the general support basis for most application and operation and provides high performance computing, massive storages and data resource to the layers above. Recently has the hardware and software been available to support the concept of utility computing in a large scale .cloud computing is defined as "a large scale distributed computing paradigm that is driven by economics of scale "in which a pool of abstracted, virtualized dynamically scalable, managed computing power, storage, platforms and services are delivered on demand to external customer over the internet. Cloud application infrastructure [2-4, 6] consists of common operate environment, common service catalog, common calculate platform, data sharing, information dissemination management, security management and communication infrastructure, etc. As an example, in strategic weaponry, like missiles, the telemetry, tale command and tracking are very essential strategies. For these strategies the cloud computing is mostly used.

In this paper a robust and effective approach for image segmentation [8-10] for the colud computing environment is proposed using mathematical morphology with minimum processing power and better performance in a centralized way. In mathematical morphology watershed algorithm is a very efficient tool for image segmentation where the segmentation results are mainly for better analyzing and meaningful understanding images. Several works have been found in mathematical morphology and in watershed algorithm in online or published literature [10-16].It is also found and observed that conservative watershed algorithm provides over segmentation [17-18]. To reduce this problem use of markers is an excellent technique and for that reason a image segmentation approach with marker controlled watershed algorithm is proposed in this paper. This approach

will be very effective in a cloud computing environment as services are delivered on demand to external customer over the internet. This paper is divided into various sections. Section 2 introduces a brief description on Watershed algorithm. Section 3 introduces the marker controlled Watershed algorithm. Section 4 presents the proposed scheme or approach. The experimental results are discussed in section 5 and we finish this paper with some concluding remarks with section 6.

2 WATERSHED TRANSFORM

Instead of working on an image itself, this technique is often applied on its gradient image. Three types of points can arise at that time. First, Points belonging to a regional minimum. Second, Catchment basin or watershed of a regional minimum and third, divide lines or watershed lines. This technique is to identify all the three types of points for segmentation. Watershed algorithm is a segmentation method in mathematics morphology. In geography, a watershed is the ridge that divides areas drained by different river system. The watershed transform is a morphological gradient-based segmentation technique. The gradient map of the image is considered as a relief map in which different gradient values correspond to different heights. If we continue pouring water, the water level will rise over the basins. When two different body of water meet, a dam is built between them. The progress continues until all the points in the map are immersed. Finally the whole image is segmented by the dams which are then called watersheds and the segmented regions are referred to as catchment basins (CB). A catchment basin is the geographical area draining into a river or reservoir. The watershed algorithm applies these ideas to gray-scale image processing in a way that can be used to solve a variety of image segmentation problem.

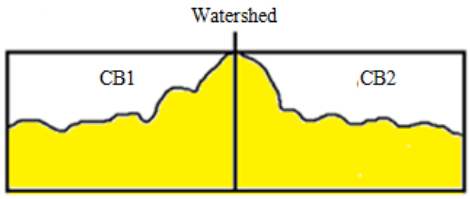


Fig 1. Watershed segmentation-local minima of gray level yield catchment basins, local maxima define the watershed lines.

3 MARKER CONTROLLED WATERSHED TRANSFORM

Watershed algorithm is a very good method for image segmentation, but this technique suffers from over segmentation problem. An approach used to control over segmentation is based on the concept of controlled marker. The concept of markers is a good approach to control over segmentation. The markers are connected component of an image. There are internal markers and external markers where internal markers are associated with object of interest and external markers are associated with the background. This is a very useful technique for improvisation of watershed transform to overcome the over segmentation problem. In this technique, the set of the catchment basins of the grayscale image function f with values in $[l_{min}, l_{max}]$ is equal to the set $Y_{l_{max}}$ obtained after the following recursion: $Y_{l_{min}} = T_{l_{min}}(f)$, where T_l is the threshold set at level l

$$Y_{l+1} = \cup\{MIN_{l+1}, IZ_{T_{l+1}(f)}\}, l_{min} \le 1 \le l_{max} \quad (3)$$

Where, MIN_l is the union of all regional minima at altitude l

$$\text{And } IZ_A(b) = U_{x=y}^{m} IZ_A(B_x) \quad (4)$$

$$\text{Where, } IZ_A(B_j) = \{P \in A \mid \forall\forall_k \in [1,m]\{x\}: d_A(P,B_k) < d_A(P,B_k)\} \quad (5)$$

$$D_A(a,b) = \min_{b\in B} d_A(a,b) \quad (6)$$

$d_A(a,b)$ represents the geodesic distance between a and b within A.

Let us note in the set of markers we can define a function r as:

$$r(p) = \begin{cases} l_{min-1} \text{ if } p \in M \\ f(p) \text{ otherwise} \end{cases} \quad (7)$$

Where p represents pixel coordinates and l_{min-1} denotes a new value dedicated for initial markers. Now the recursion definition will be:

$$Y_{i_{min-1}} = T_{l_{min-1}}(r)$$
$$Y_{l+1} = IZ_{T_{l+1(r)}}(x), l_{min} \le 1 \le l_{max} \quad (8)$$

4 APPROACH

An effective approach has been tried for obtaining better result in image segmentation with marker controlled watershed algorithm. The flowchart shown in figure 2 describes the proposed method. In the proposed approach, firstly a color image is chosen, and converted to grayscale image. The next steps are to enhance the contrast of the grayscale image. And finally watershed algorithm has been

applied to the image to get the final segmented image or the desired result.

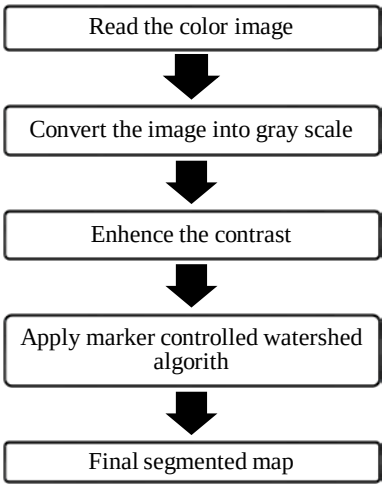
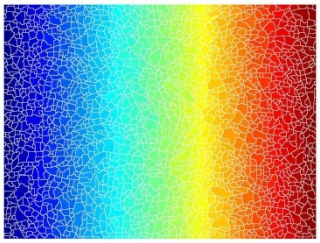


Fig 2. Flowchart of the proposed approach.

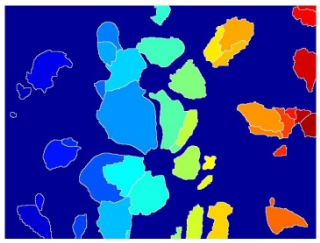
5 EXPERIMENTAL RESULTS

The proposed methodology has been applied on two real life images of Flowers and Pears of dimensions of 640 x 480, and 730 x 486 accordingly. The performance of proposed methodology by comparing it with conservative watershed algorithm has been evaluated. The original images are shown in figure 3(a) and 4(a) respectively. Final segmented images acquired by conservative watershed algorithm are shown in 3(b) and 4(b), final segmented images acquired by proposed approach using marker controlled watershed algorithm are shown in figure 3 (c) and 4(c) respectively. It has been observed from the segmented images acquired by applying conservative watershed algorithm that they are extremely over segmented. The use of marker controlled watershed segmentation algorithm has achieved the objective of reducing the problem of over-segmentation when applied to images. The Entropy, PSNR and MSE of the final segmented images applying conservative watershed algorithm and by applying proposed approach have been calculated and the values have been shown in the table 1.

(a)



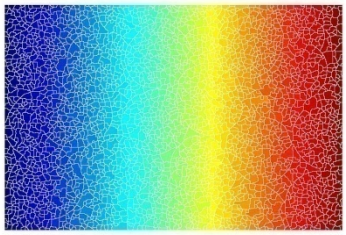
(b)



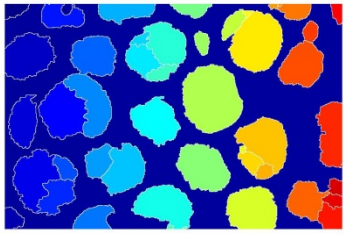
(c)

Fig 3. (a) Original image of flowers, (b) segmented image of flowers by applying conservative watershed algorithm, (c) segmented image of flowers by applying proposed approach with marker controlled watershed algorithm.

(a)



(b)



(c)

Fig 4. (a) Original image of pears, (b) segmented image of pears by applying conservative watershed algorithm, (c) segmented image of pears by applying proposed approach with marker controlled watershed algorithm.

Table 1

Statistical Measurement

Image	Technique Used	Entropy	PSNR	MSE
Flower	conservative watershed algorithm	5.4543	10.8627	5.3310e+003
Flower	Proposed approach	5.0482	12.7308	3.4674e+003
Pears	conservative watershed algorithm	5.5740	11.4866	4.6176e+003
Pears	Proposed approach	4.2191	11.0165	5.1455e+003

6 CONCLUSION

An effective approach for image segmentation has been presented in this paper. This method makes use of the observation that image segmentation results using marker controlled watershed algorithm is a good form of segmentation technique. The experimental results had shown that the proposed method is very effective for detection of objects irrespective of clarity and sharpness with lesser over segmentation. The statistical measurement analysis assures the effectiveness of the proposed algorithm. This algorithm will be very effective in a cloud computing environment where the load will be on remote machines rather than clients with minimum processing power and better performance for image segmentation as services are delivered on demand to external customer over the internet. In strategic weaponry, like missiles, the telemetry, tale command and tracking are very essential strategies. For these strategies the cloud computing is mostly used. This approach for image segmentation [8-10] for the colud computing environment will give better performance in a centralized way for strategic weaponry also.

DEDICATION

One of the others (Dibyendu Ghoshal) dedicates the entire study to the loveliest and loving memory of his only one and younger sister Kumari Sumita Ghoshal who herself was a gem of the scholars, a symbol of wisdom and art, peerless beauty and simplicity, unfathomable knowledge and generosity.

REFERENCES

[1] GTSI Group, "Cloud Computing - Building a Framework for Successful Transition," White Paper, GTSI Corporation, 2009.

[2] L. Vaquero, L. Rodero-Merino, J. Caceres, and M. Lindner, "A Break in the Clouds: Towards a Cloud Definition", ACM SIGCOMM Computer Communication Review, Volume 39 Issue 1, pages 50-55, January 2009.

[3] M. Armbrust, A. Fox, R. Griffith, A. Joseph, R. Katz, A. Konwinski, G. Lee, D. Patterson, A. Rabkin, I. Stoica, and M. Zaharia, "A View f Cloud Computing", Communication of the ACM, Vol. 53, No. 4, April 2010.

[4] Kresimir Popvoic and Zeljko Hocenski, "Cloud Computing Security Issues and Challenges", MIPRO, Opatijia, Croatia, May 24-28, 2010.

[5] K. Chard, S. Caton, O. Rana and K. Bubendorfer, "Social Cloud: Cloud Computing in Social Networks", 3rd IEEE International Conference on Cloud Computing, Miami, FL, USA, July 5-10,2010.

[6] Y. Luo,"Network I/O Virtualization for Cloud Computing",IEEE Computer Society,Oct. 2010.

[7] W. Tsai, X. Sun, J. Balasooriya, "Service-Oriented Cloud Computing Architecture", 7th IEEE International Conference on Information Technology, 2010.

[8] C. Gonzalez, Richard E. Woods, Digital Image Processing, 2nd Edition, Addison Wesley Pub. Co, 2002.

[9] A.K.Jain, Fundamentals of digital image processing, Second Edition, Prentice Hall, 2002.

[10] L. Vincent and P. Soille, "Watersheds in digital spaces: an efficient algorithm based on immersion simulations," IEEE Trans. Pattern Anal. Mach. Intell., vol. 13, no. 6, pp. 583-598, Jun. 1991.

[11] S. Beucher, "Watersheds of functions and picture segmentation," in Proc. IEEE Int. Conf. Acoustic, Speech, Signal Processing, pp. 1982-`931, 1982.

[12] C. Gonzalez, Richard E. Woods, Digital Image Processing, 2nd Edition, Addison Wesley Pub. Co, 2002.

[13] A.K.Jain, Fundamentals of digital image processing, Second Edition, Prentice Hall, 2002.

[14] K.Hari Krishna, R.V.S.Sathyanarayana,"Medical Image Segmentation using Marker Controlled Watershed Algorithm", IJEEE, Vol.1(1), pp 92-96, 2009.

[15] M.I. Rajab, M.S. Woolfson, and S.P. Morgan, –Application of regionbased segmentation and neural network edge detection to skin lesions,‖ Computerized Medical Imaging and Graphics, vol. 28, pp. 61–68, 2004.

[16] J.C. Bezdek, L.O. Hall, L.P. Clarke, "Review of MR image segmentation techniques using pattern recognition", Medical Physics, Vol. 20(4), pp. 1033-1048, 1993.

[17] S. Thilagamani, N.Shanthi, "A Novel Recursive Clustering Algorithm for Image Oversegmentation", European Journal of Scientific Research, Vol.52, No.3, pp.430-436, 2011.

[18] Peter Eggleston, "Understanding Oversegmentation and Region Merging", Vision Systems Design, December 1, 1998.