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A Survey in Recent Trends and Techniques in Image Segmentation

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Abstract- Splitting up an image into multiple segments in order to change the representation of an image into something that is more meaningful and easier to analyze is known as image segmentation. For image segmentation many algorithms and techniques have been developed. This paper analyses different segmentation techniques to reduce the computational complexity of processor in the field of image segmentation, we are specially focusing on Mean Shift Algorithm. The composition of segmentation methodologies proposes for digital image processing is explained briefly. Various techniques are mentioned in this paper that are applied in very advance mission of identification of object or region image.

Index Terms- Finding modes, Image segmentation, Image processing, Space analysis & Object tracking, Visual tracking.

I. Introduction

Dividing images into multiple parts is the sole objective of image segmentation, and it is basically used to detect objects or other pertinent information in digital images. In other words, we can say that image segmentation is a process that prepares an image to be understandable to computers. Figure 1 shows an example of image segmentation.

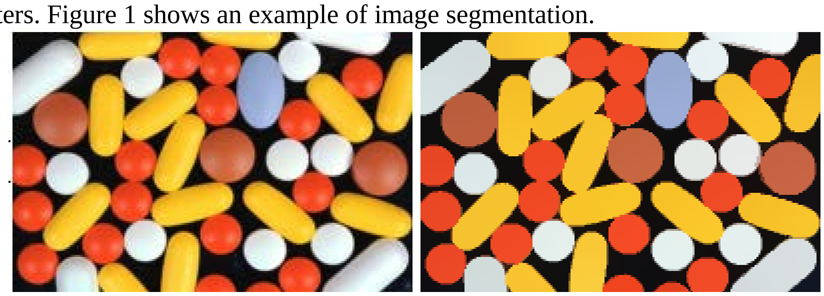


Figure 1: Input Image (left) and Segmented Image (right)

We used mean shift algorithm for image segmentation. Mean shift is a multi-used tool for feature space analysis that provides solution for many vision tasks. We have chosen mean shift over the other method, because mean shift procedure inherits an interesting property, its path towards the mode follows a smooth trajectory, the angle between two consecutive mean shift vectors being always less than 90 degrees which provides a smooth result for image segmentation. However, it is observed that the full process of mean shift algorithm is very time consuming. To decrease the run time of the algorithm we have used the multicore programming system [1], [2].

II. DIFFERENT METHOD OF IMAGE SEGMENTATION

A. CLASSIFICATION.

1. Histogram-Based Methods
2. Edge Detection Methods
3. Region Growing Methods
4. Clustering.

1) Histogram-Based Methods

In image segmentation technique, histogram-based methods are very efficient because generally it iterates the pixels through one pass technique. In this technique, a histogram is produced from all the pixels in the image and the high and low points from the histogram are then locates the segments in the image [4], [5].

2) Edge Detection Methods

Edge detection is a well-proportioned field by itself in image processing. There is a sharp adjustment of intensity at the region boundaries. So, region boundaries and edges are submerged together.

In image segmentation, edge detection is considered as the base technique. The edges, calculated by edge detection, are sometimes separated. For segmenting an object form an image it is necessary to have closed boundaries [5].

3)Region Growing Methods

In this process image and a set of seeds are taken as input. The objects that are to be segmented are then marked by the seeds. The regions are gradually grown by each iteration analyzing all unassigned adjacent pixels to the regions. [5], [6].

4)Clustering

In image segmentation process clustering is needed to find the neighboring data. Cluster analysis or clustering is the assignment of the objects into clusters which makes the objects from a particular cluster more similar to themselves by differing themselves from the objects of other clusters. This similarity between the objects of the same cluster often assessed according to a distant measure. For statistical data analysis, clustering is an often-employed technique. Moreover, this technique is used in many fields including machine learning, data mining, image analysis, pattern recognition, and bioinformatics. It is the process to divide data elements into diverse clusters or classes so that items of a same class areas become as similar as possible; on the other hand, items of the different classes become dissimilar according their disparity. Different measures of similarity could be used to place items into classes depending on the nature of the data and of the purpose for which clustering is used. Similarity measure determines how the clusters are to be formed. It is to say that there are different types of clustering techniques which are described below [5], [11], [12].

A. K-Means Clustering Algorithm

K-Means clustering method is a widely used method for clustering analysis. The main target of K-Means algorithm is to find the best distribution of *n* entities in *k* groups, so that the total distance between the group's members and its corresponding centroid, is minimized. Generally, the target of the algorithm is to partition the *n* entities into *k* sets S_i, $i=1, 2, ..., k$ in order to minimize the within-cluster sum of squares [6].

B. Fuzzy C Means Clustering Algorithm

Fuzzy C means clustering is a group of algorithms for cluster analysis in which the distribution of data points to clusters is "fuzzy" in the same sense as fuzzy logic. In fuzzy clustering every point has an amount of acceptance to clusters rather than acceptance absolutely to just one cluster. The, credibility on the bend of a cluster may be in the cluster to a bottom amount than credibility in the centermost of cluster [6].

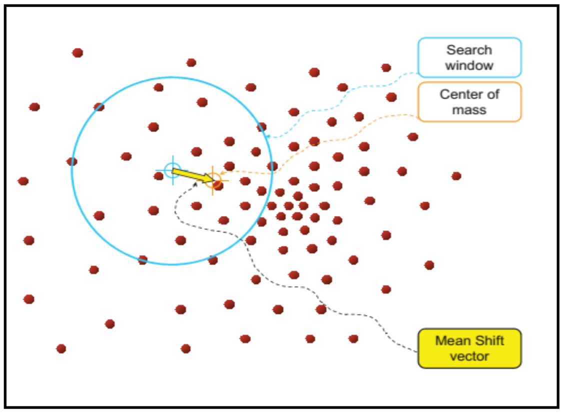
C. Hierarchical Clustering Algorithm

Building a hierarchy of clusters is a well-known method of clustering which is known as Hierarchical clustering. In the first step, it is built by constructing a distance matrix where the numbers in the i-th row and j-th column indicates the distance between the i-th and the j-th elements. After that, as the clustering progresses, the clusters are merged, that is, rows and columns are merged so that the distances are updated. Above-mentioned procedure is a common means of implementing the Hierarchical clustering [6].

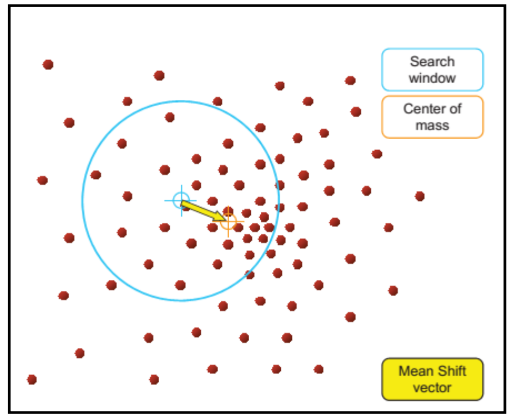
D. The Mean Shift Algorithm

Feature space is considered as an empirical probability density function by Mean shift. When a set of points is the input then these points or input are considered as sampled from the underlying probability density function by mean shift. Dense regions can be present in the feature space, and when it happens they both correspond to the local maxima of probability density function. Mean shift is associated with the peak, close at hand, of the data set's probability density function. At this stage, it shifts, and it shifts the window centre to the mean and repeats the algorithm as long as it converges. And then, after each iteration, it is considered that the window shifts to a denser region of the data set. At the high level, we can specify mean shift as follows [2], [3], [9].

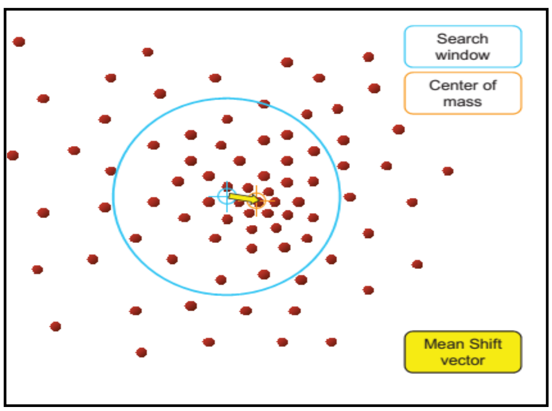
- Define a window around each data point.
- Compute the mean of data within the window.
- Shift the center of the window to the mean and repeat till convergence, i.e., the center of the window no longer shifts.



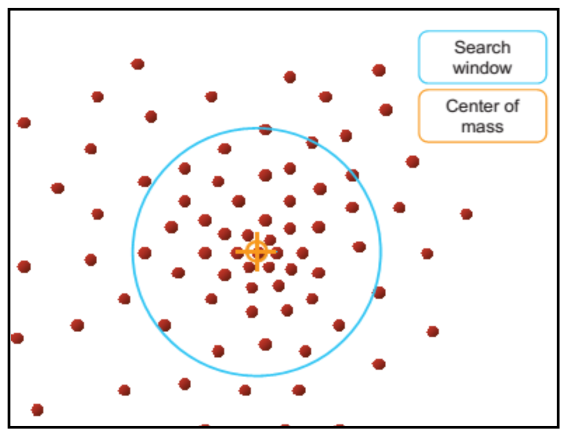
(a) Step 1.



(b) Step 2.



(c) Step 3.



(d) Step 4.

Figure 2: The steps in Mean Shift Algorithm using mass as an example [9]

III. IMAGE SEGMENTATION USING MEAN SHIFT

For the identification of different discrete objects within an image, Common Vision Processes are used. These processes convert a single-pixel representation of the image data into geometric descriptors, and these geometric descriptors, also known as objects, represent groups of pixel elements; they also take different forms: points, lines, regions, polygons, or other unique representations [4].

There are two basic divisions of segmentation techniques: edge-based and region-based. Edge-based segmentation technique is, for the most part, used to look for image discontinuities; and is generally concerned where changes of gray-level intensity occur in the image. The basic postulation is that changes (of gray-level intensity) occur in the data on the verge of objects and interests. The output of this technique can be X and Y gradient two images that are used to represent edges found, one in the direction of X and another in the direction of Y.

On the other hand, Region-based segmentation is used to look for resemblance between adjacent pixels. Moreover, Pixels with similar attributes are clustered into distinctive and unique regions with the assumption that each and every region should represent one object of interest. In this process of assigning similarity, for grouping them accordingly, gray-level intensity is used as the most common means. Moreover, apart from gray-level intensity, there are other possibilities in this case, such as variance, color, and multispectral features. But commercial vision systems largely use a region-based segmentation scheme which is based on pixel intensity values.

All these segmentation techniques take it for granted that the objects of interest have uniform shading; they also presuppose that a considerable and constant gray-level change occurs between the objects of interest and the background. Nevertheless, these assumptions have proven erroneous in many vision applications; as a result, these techniques are considered fragile; so that they require controlled conditions or human supervision [3], [4].

Two stages are combined in mean shift image segmentation. Defining a kernel of influence for each pixel is the first stage. This kernel formulates measure of intuitive distance between pixels, whereas distance engulfs spatial as well as color distance.

Manually selecting the size and shape of the kernel can create satisfactory results on general image segmentation. Despite that satisfactory result, it is more helpful to determine local bandwidth with the aid of Parzen windows for imitator local density. In the second iterative stage of the mean shift procedure, for each pixel a mean shift point is assigned, $M(x_i)$, initialized to harmonize with the pixel. So, mean shift points are iteratively moved upwards along the gradient of the density function defined by the sum of all the kernels as long as they reach a stagnant point (a mode or hilltop on the virtual terrain defined by the kernels). The pixels associated with the set of mean shift points that transfer to the (approximately) same stationary point are considered to be members of a single segment [5].

IV. EXISTING APPROACH TO IMAGE SEGMENTATION

Image segmentation is a long challenging problem in computer vision. To cope with the upgraded system and technology there are many procedures of image segmentation invented, which has pave the way in computer vision. Some of them are described below.

1.Normalized Cuts and Image Segmentation

This is an original and innovative approach to solve the perceptual grouping problem in vision. This approach focuses on extracting the global impression of an image eliminating and skipping the local features and their consistencies in the image data.
This process proposes a new global criterion for segmenting the graph, also known as the normalized cut, as it considers image segmentation as a graph partitioning problem. The normalized cut criterion measures both the similarities within groups and dissimilarities between different groups [21].

2.Efficient Graph-Based Image Segmentation

This method involves an efficient segmentation algorithm. In spite of this algorithm's flaw of making greedy decisions, it produces segmentations to satisfy global properties. Basically, this algorithm is applied to image segmentation, and it uses two different kind of local neighborhoods in constructing the graph. It also illustrates the results with both real and synthetic images. Moreover, it runs in time nearly linear in the number of edges. Above all, it is fast in practice. A salient feature of this method is its ability to preserve details in low-variability image regions and its ability of ignoring detail in high-variability regions [14].

3.Contour and Texture Analysis for Image Segmentation

This method offers a valid and versatile algorithm for partitioning grayscale images into disjoint regions of coherent brightness and texture. As natural images have both textured and non-textured regions so in this method the cues of contour and texture differences are exploited simultaneously. Each of these cues has domain applicability and for this to assist cue combination a gating operator is used. Attaining a local measure of how probable two close-by pixels belong to the identical region, spectral graph theoretic framework of normalized cuts is applied to find partitions of the image into regions of coherent texture and brightness [22].

4.Adaptive Perceptual Color-Texture Image Segmentation

The knowledge of human perception with an understanding of signal traits in order to segment natural scenes into semantically uniform regions is merged in this approach. It is formulated from two types of spatially adaptive low-level feature.
The first describes the local color composition in terms of spatially adaptive dominant colors, and the second elucidates the spatial features of the gray scale component of the texture. These two provide a straight-forward and effective characterization of texture that the proposed algorithm uses to obtain precise and accurate segmentations [23].

5.Image Segmentation by Data-Driven Markov Chain Monte Carlo

This approach of image segmentation branches into three aspects. First of all, it designs an effective and well-balanced Markov chain dynamics that is to explore the solution space and makes the split and merges process reversible at a middle level vision formulation. Hence, it achieves a optimal solution globally independent of initial segmentations. Secondly, it recommends a mathematical principle for computing multiple distinct solutions to incorporate intrinsic ambiguities in image segmentation. Thirdly, it utilizes data-driven or bottom-up technique (such as clustering and edge detection) to compute important proposal probabilities [24].

6.Iterated Graph Cuts for Image Segmentation

This method originates from the sub-graph and encompasses the user labeled foreground/background regions and works iteratively to label the surrounding un-segmented regions. In iterations, only the local neighboring regions and the labeled regions are involved in the optimization so that interference from the unknown regions can be radically reduced. To heighten the segmentation efficacy and robustness mean shift method is applied to partition images into homogenous regions; and then it implements the proposed iterated graph cuts algorithm by taking each region (instead of each pixel) as the node for segmentation [25].

V. EXISTING APPROACH TO PARALLEL MEAN SHIFT ALGORITHM

A number of parallel mean shift approaches could be found in literature. Several mean shift-based segmentation algorithms are well-known for their superior performance against the classical approaches. Some of these approaches are described briefly.

1.Parallel Mean Shift for Interactive Volume Segmentation

This system presents a parallel dynamic mean shift algorithm on the basis of path transmission for medical volume data segmentation. At first, the algorithm translates the volume data into a joint position-color feature space subdivided homogeneously by bandwidths, and secondly clusters points in feature space in parallel by iteratively finding its peak point. By iterating it develops the convergent or similarity rate by updating data points dynamically by the use of path transmission; besides, it lessens the amount of data points by collapsing overlapping points into a single point. Using an NVIDIA GeForce 8800 GTX card for interactive processing, the GPU implementation of the algorithm segments 256×256×256 volume in 6 seconds. This GPU implementation of the algorithm is many times faster (grossly hundreds time) than its CPU implementation [3].

2.High-Resolution Image Segmentation Using Fully Parallel Mean Shift

Fully parallel mean shift is an approach that follows a bottom-up approach first. First, using a nonparametric clustering the image is decomposed; then, similar classes or groups are joined by merging algorithm that uses color, and adjacency information to obtain consistent image content.

A parallel version of the mean shift algorithm works concurrently on multiple feature space kernels that make up the core of the segmented. This system was first applied on a many-core GPGPU platform to experiment and observe the performance gain of data parallel construction. The accuracy of segmentation had been assessed on a public benchmark, and it was proven performing well among other data-driven algorithms. A numerical analysis confirmed that as the utilized processors number increases, the segmentation speed of the parallel algorithm gets better. This is obviously indicating the scalability of the scheme. This improvement keeps its marks also on the real life high-resolution images [2].

3.A Scalable RC Architecture for Mean-Shift Clustering

FPGA, field-programmable gate array architecture centers on creating scalable hardware architecture that should be fine-tuned to the computational requirements of the mean-shift clustering algorithm.

FPGA can efficaciously cluster hundreds of pixels autonomously by efficiently parallelizing and mapping the algorithm to reconfigurable hardware. In this process, each pixel benefits from its own pipeline and each pixel can move independently of all other pixels towards its respective cluster. A speedup of three orders of magnitude can be achieved by using mean-shift architecture [19].

4.Image Object Tracking System Using Parallel Mean Shift Algorithm

This implementation of parallel mean shift algorithm is a real-time image object tracking system empowered with PTZ cameras. Mean shift algorithm is efficient for real-time tracking, because it is fast and stable in performance. Nevertheless, in the image tracking system for PTZ cameras the speed is not satisfactory according to the expectations. That is why the system is structured on the basis of parallel mean shift algorithm which uses the color image distribution of detected images.

5.Mean Shift Parallel Tracking Using GPU

This particular approach uses K-Means clustering to partition the object color space. It facilitates us to represent color distribution with a few numbers of bins. All key components of the MS algorithm are mapped onto GPU on the basis of this compact histogram.

Six kernel functions make up the resultant parallel algorithm involving the parallel computation of the candidate histogram and calculation of the mean shift vector. An experiment on publicly available CAVIAR videos asserts that the proposed parallel tracking algorithm achieves larger speedup as well as its tracking performance is comparable to that of traditional serial MS tracking algorithm [20].

VI. CONCLUSION

We have tried to compare various image segmentation techniques and compared it with Mean Shift Algorithm. We have taken fallowing four parameters Histogram-Based Methods, Edge Detection Methods, Region Growing Methods Clustering. And found that Mean Shift Algorithm is better in Finding modes, Image segmentation, Image processing, Visual tracking, Space analysis & object tracking.

REFERENCES

[1] T. Perciano, D. M. Ushizima, E. W. Bethel, Y. D. Mizrahi, D. Parkinson, J. A. Sethian. Reduced-Complexity Image Segmentation Under Parallel Markov random Field Formulation Using Graph Partitioning, 2016

[2] B. Varga and K. Karacs. High-resolution image segmentation using fully parallel mean shift. Varga and Karacs EURASIP Journal on Advances in Signal Processing, 2011.

[3] F. Zhou, Y. Zhao, and K-Liu Ma. Parallel Mean Shift for Interactive Volume Segmentation. Wanget al. (Eds.): Springer-Verlag Berlin Heidelberg. MLMI 2010, LNCS6357, pp.67–75, 2010.

[4] D. Comaniciu and P. Meer. Mean shift: A Robust Approach Toward Feature Space Analysis. IEEE Transaction on pattern Analysis and machine intelligence, Vol24No (5), 603-619. May 2002.

[5] K LWu, and M S Yang. Mean shift-based clustering. The journal of the pattern recognition society. February 2007.

[6] S. Theodorids, and K. Koutroumbas. Pattern Recognition. Fourth Editions pp595-765, Academic Press. October 20, 2008.

[7] C. Compbell, and A. Miller. Parallel Programming with Microsoft visual C++, Publisher: Microsoft Press; 1stEdition April 11, 2011.

[8] Y Cheng, Mean shift, mode seeking, and clustering. IEEE Transaction on pattern Analysis and machine intelligence, vol 17 **No** 8, 790–799. August 1995.

[9] L. Men, M. Huang, and J. Gauch. Accelerating Mean Shift Segmentation Algorithm on Hybrid CPU/GPU Platforms. October 2009.

[10] J. Wang, B Thiesson, Y Xu, and M. Cohen. Image and Video Segmentation by Anisotropic Kernel Mean Shift. Microsoft Research (Aisa and Redmond), 2004.

[11] YJing and Shukui Bo. Image Clustering Using Mean Shift Algorithm. Fourth International Conference on Computational Intelligence and Communication Networks, 2012.

[12] B. Georgescu, I .Shimshoni, and P. Meer. Mean shift based Clustering in High Dimension:A Texture Classifications Example. IEEE International Conference on computer Vision vol set-2 ICCV 2003.

[13] KA. Shah, HK. Kapadia, VA. Shah, and Maurya N. Shah. Application of Mean-Shift Algorithm forLicense Plate Localization. IEEE Digital Objects Identifier Ahmedabad Gujarat, 2011.

[14] P F. Felzenszwalb and D P. Huttenlocher, Efficient Graph-Based Image Segmentation, International Journal of Computer Vision vol 59 Issue 2, pp 167-181 September 2004.

[15] P.N. Happ, R.S. Ferreira, C. Bentes, G.A.O.P. Costa, and R.Q. Feitosa. Multi resolution Segmentati on: A Parallel Approach For High Resolution Image Segmentation In Multi core Architectures. 3rd International Conference on Geographic Object-Based Image Analysis, Brazil, 2010.

[16] W. Khan. Image Segmentation Techniques: A Survey .COMSATS Institute of Information Technology, Wah Cantt, Pakistan Journal of Image and Graphics vol 1, No 4, December 2013.

[17] DS. Hochbaum. An Efficient Algorithm for Image Segmentation, Markov Random Fields and Related Problems. Journal of the ACM, vol. 48, No. 4, pp. 686–701.July 2001.

[18] A.B.M. Faruquzzaman, N. R. Paiker, J Arafat, and M. A. Ali. A survey report on image segmentation Based on split and merge algorithm. IETECH Journal of Advanced Computations, vol. 2, No: 2, 086–101, 2008.

[19] S. Craciun, G Wang, A. D. George, H Lam, and J. C. Principe. A Scalable RC Architecture for Mean-Shift Clustering. IEEEI/UCRC Program of the National Science Foundation under Grant Nos. EEC-0642422 and IIP-1161022. 2013.

[20] P. Li and L. Xiao. Mean Shift Parallel Tracking On GPU. 4th Iberian Conference on Pattern Recognition and Image Analysis, pp120-127. 2009.

[21] J. Shi and J.Mali. Normalized Cuts and Image Segmentation. IEEE transactions on pattern analysis and machine intelligence, vol. 22, No. 8, August 2000.

[22] J. Malik, S. Belongie, T. Leungand, J. Shi. Contour and Texture Analysis for Image Segmentation. International Journal of Computer Vision vol.43, No 1, pp 7–27, Kluwer Academic Publishers. Manufactured in The Netherlands. 2001.

[23] J. Chen and N. Pappas. Adaptive Perceptual Color-Texture Image Segmentation. IEEE transactions on image processing, vol. 14, No. 10, October 2005.

[24] Z Tu and S c Zhu. Image segmentation by data-driven Markov chain Monte Carlo. IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 24, No 5, May 2002.

[25] B. Peng, L. Zhang, and J. Yang. Iterated Graph Cuts for Image Segmentation.9th Asian Conference on Computer Visionvol 5995, pp 677-686, 2010.

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