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Parallelizing Video Frame Segmentation using Region Growing Technique on Multi-Core Processors

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Abstract. Image Segmentation is to simplify and /or change the representation of an image into something that is more meaningful and easier to analyze. Pre-processing of the image makes it more clear and visible, while parallelizing of the algorithm optimizes the speed at which the image/video is processed. This paper presents the parallel segmentation on video frames generated form a real time video, using region-growing technique. Region growing Technique is also classified as a pixel-based image segmentation method since it involves the selection of initial seed points. This approach to segmentation examines neighboring pixels of initial “seed points” and determines whether the pixel neighbors should be added to the region. The process is iteratively carried out and the region is correspondingly grown for each image. The proposed approach takes real time videos, which are, converted frames that are processed in parallel on multicore processor. The time taken for serial and parallel implementation is analyzed and the parallel implementation has shown encouraging results.

Keywords: Segmentation, Parallelizing, Region growing, Seed points

1 Introduction

Image Processing with parallel computing is an alternative way to solve image-processing problems that require large times of processing or handling large amounts of information in "acceptable time"[1]. Image Segmentation is done using region growing technique. This method takes image as an input. The seeds mark each of the objects to be segmented. The regions are iteratively grown by comparing all unallocated neighboring pixels to the regions. The difference between a pixel's intensity value and the region's mean is used as a measure of similarity. The pixel with the smallest difference measured this way is allocated to the respective region. This process continues until all pixels are allocated to a region. The main idea of parallel image processing is to divide the problem into simple tasks and solve them concurrently, in such a way the total time can be divided between the total tasks. There are so many types of images having different characteristics and are used as per

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requirements of the application at hand. In many applications, the size of the image data/video to be processed is very large, which is a concern. Accuracy plays a major role here. If executed serially, as the size of the image data increases, processing time correspondingly increases. In order to get the accurate results, the image is segmented into blocks and given to different processors thus parallelizing the process[4]. Thus for large images, time taken for processing is less in parallel compared to serial implementation. But in case of traffic applications, series of frames are to be considered where accuracy is not a concern but speed of processing plays a major role. Thus instead of segmenting a single image into blocks and giving it to different processors, series of frames are distributed accordingly to different processors/cores. This makes the process efficient by reducing the processing time. In the work done as proposed in this paper, processing speed is given importance.

2 Methodology

2.1 Region Growing Technique

Region growing is a simple image based segmentation method. It is also classified as pixel-based image segmentation method since it involves selection of initial seed points. Neighboring pixels of initial seed points are examined. Determining whether the neighboring pixels of those initial seed points should be added to the region or not is done. This process is iteratively carried out until the regions are grown.

2.2 Implementation

Frames are extracted from the real time video. Different lengths of videos are taken and corresponding frames are extracted in order to analyze the results. Each frame is subjected correspondingly to region growing technique. In the region growing technique, the initial seed pixels are determined as shown in fig.1. The initial region begins at this location of seeds. The region is hence grown from these seed points to adjacent points. The region is iteratively grown by comparing all unallocated neighbouring pixels to the region. The difference between a pixel's intensity value and the region's mean is used as a measure of similarity. The pixel with the smallest difference measured this way is allocated to the respective region. This process stops when the intensity difference between region mean and new pixel become larger than a certain threshold (t). The processed images are stored. Fig 2 shows the segmented images for the corresponding given video frames. Region based segmentation is a technique for determining the region of interest directly. The basic formulation for region-based segmentation is as given by many researchers [3] and is given once again:

(a) $U^{n}_{i=1} Ri=R$

Means that the segmentation must be complete, that is, every pixel must be in a region

(b) *R*i is a connected region, i=1,2,...,n
Requires that points in a region must be connected in some predefined sense

(c) *R*i∩ *R*j=∅ for all i=1,2...,n
Indicates that the regions must be disjoint

(d) *P*(*R*i) =*TRUE* for i=1,2....,n
Deals with the properties that must be satisfied by the pixels in a segmented region

(e) *P*(*R*i U *R*j)=*FALSE* for any adjacent region *R*i and *R*j
Indicates that region *Ri* and *Rj* are different in the sense of predicate *P*
P(Ri) is a logical predicate defined over the points in set *R*i and ∅ is the null set

Fig. 1. Determination of seed pixels for the given image

The process is carried out serially as well as in parallel. Serial implementation of region growing segmentation uses only one core and single frame is processed at a time. Hence this takes more time to process all the frames and the total video. As the video size increases that is, the number of frames increases, serial processing time also increases. The proposed parallel implementation makes use of all the cores present in the processor. The frames are processed in parallel on the cores available on the multicore processor. As shown parallel processing time is lesser than serial processing time as the number of frames to be processed increases. Time taken for both serial and parallel implementation is recorded and discussed in the section below.

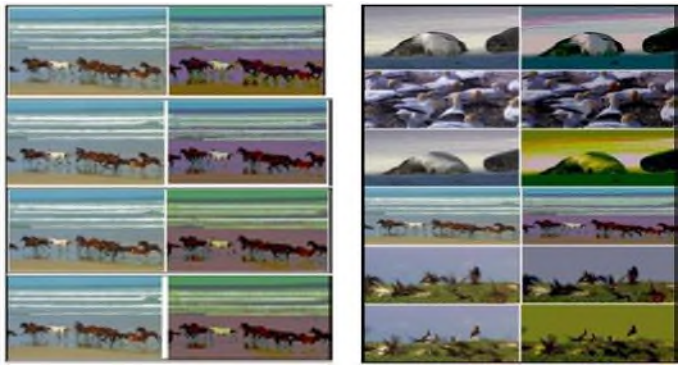

Fig. 2. Shows the original frame in the first column and corresponding processed image using Region Growing Technique in the second column

3 Experimentation and Results

The algorithm of serial region growing technique is used to run independently on each frame of the video and this is done in parallel on the cores available on the multicore processor on which the program is run. The videos are of various lengths and the number of frames varies from 100 to 900 frames. The Program is written in Matlab and uses parallel computing toolbox. The results for the various frame sizes are discussed below in the Table 1. Fig 3 shows the comparative analysis of the performance of the approach with the serial region growing technique.

Table 1. Serial and Parallel processing time for different number of video frames.

Video size (no of frames)	Parallel Processing time (minutes)	Serial Processing time (minutes)
100	7	12
200	17	24
300	28	35
500	50	58
600	48	77
900	97	106

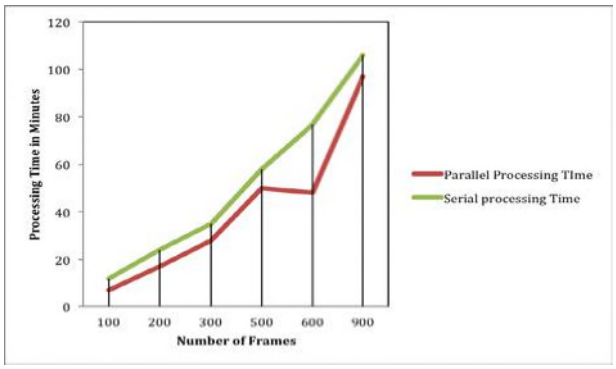

Fig. 3. Comparison of serial and parallel processing time w.r.t number of frames.

4 Conclusion

This work presents the comparative study of serial as well as parallel implementation of segmenting a video frame using Region Growing Technique. Different lengths of video frames are taken. Processing of frames is done and the resultant images are stored. Serial as well as parallel implementation time is recorded. As the video size increases i.e. the number of frames increases, processing time taken is less in parallel implementation. The focus of this implementation is to increase the performance on

multicore processors. Due to load balancing among different processors, encouraging results are obtained from the parallel implementation.

References

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Appendix: Results of various frames from real time video and the results using the proposed approach

Figure A-1. First Three rows show the input video frames and next three rows are results of the proposed algorithm on the input frames

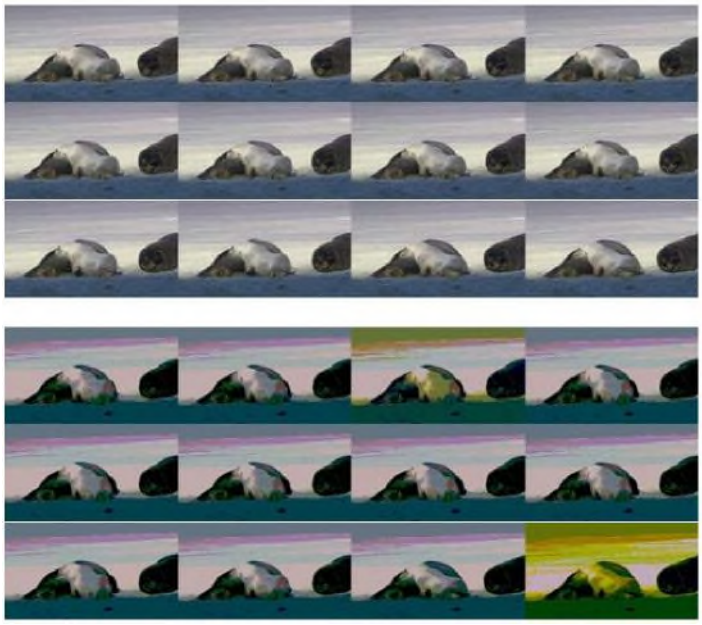

Figure A-2. First Three rows show the input video frames and next three rows are results of the proposed algorithm on the input frames

Figure A-3. First Three rows show the input video frames and next three rows are results of the proposed algorithm on the input frames

Figure A-4. First Three rows show the input video frames and next three rows are results of the proposed algorithm on the input frames

Figure A-S. First Three rows show the input video frames and next three rows are results of the proposed algorithm on the input frames

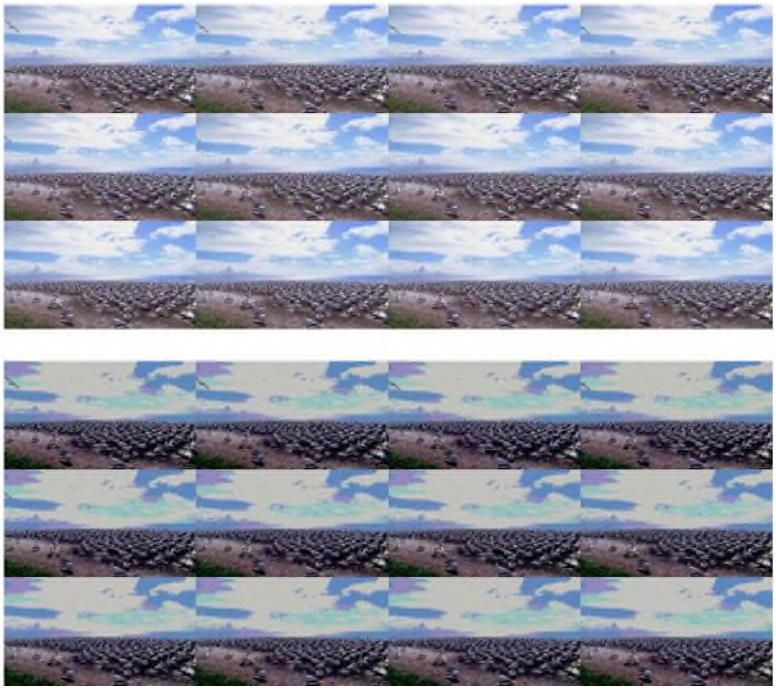

Figure A-6. First Three rows show the input video frames and next three rows are results of the proposed algorithm on the input frames

Figure A-7. First Three rows show the input video frames and next three rows are results of the proposed algorithm on the input frames