143.474 Parallel Programming

THE PARALLEL WATERSHED ALGORITHM FOR IMAGE SEGMENTATION

OUTLINES

- INTRODUCTION
- DISCUSSION
- PROCEDURE
- EXPERIMENTS AND RESULTS (1)
- EXPERIMENTS AND RESULTS (2)
- APPLICATIONS
- PHOTO
- VIDEO
- REFERENCES

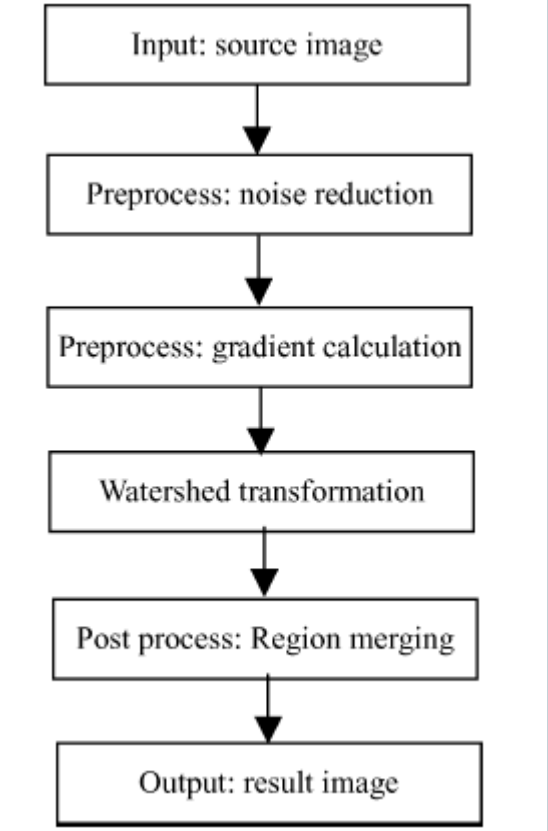
INTRODUCTION

- Watershed algorithm is an image processing segmentation algorithm that splits an image into areas based on the topology of the image.
- Also we have a watershed transformation, which is a mid-level operation used in morphological image segmentation.
- The watershed transformation when applied to a gray-scale image detects and labels objects, which are connected components of similar gray-level.
- It is used mainly in industrial, biomedical, and computer vision applications.
- In the initial stages, parallel realisation was based on image segmentation and sequential raster which was very expensive due to repeated scanning's.
- As a result of the recursive nature of the watershed transformation, the parallelisation is not an easy task.
- Interactive water transformations always allows us to determine include and exclude points to create artificial watersheds, which can enhance the result of the segmentation.

DISCUSSION

- One of the most common watershed algorithm we have is known as Meyer's watershed algorithm.
- This algorithm works on a gray scale image, where we choose a set of markers, and each marker is given a different label.
- The neighbouring pixels of each marked area are then inserted into a priority queue with a priority level corresponding to the gray level of the pixel.
- Then, the pixel with a highest priority level is extracted from the priority queue, and if the neighbours of the extracted pixel have all the same labels, then the pixel is labelled with their label, and plus all the non-marked neighbours that are not yet in the priority queue are placed in the priority queue.
- This process is repeated over and over again until the priority queue is empty.
- The non-labelled pixels are called the watershed lines.

PROCEDURE


Input: source image
Preprocess: noise reduction
Preprocess: gradient calculation
Watershed transformation
Post process: Region merging
Output: result image

EXPERIMENTS AND RESULTS(1)

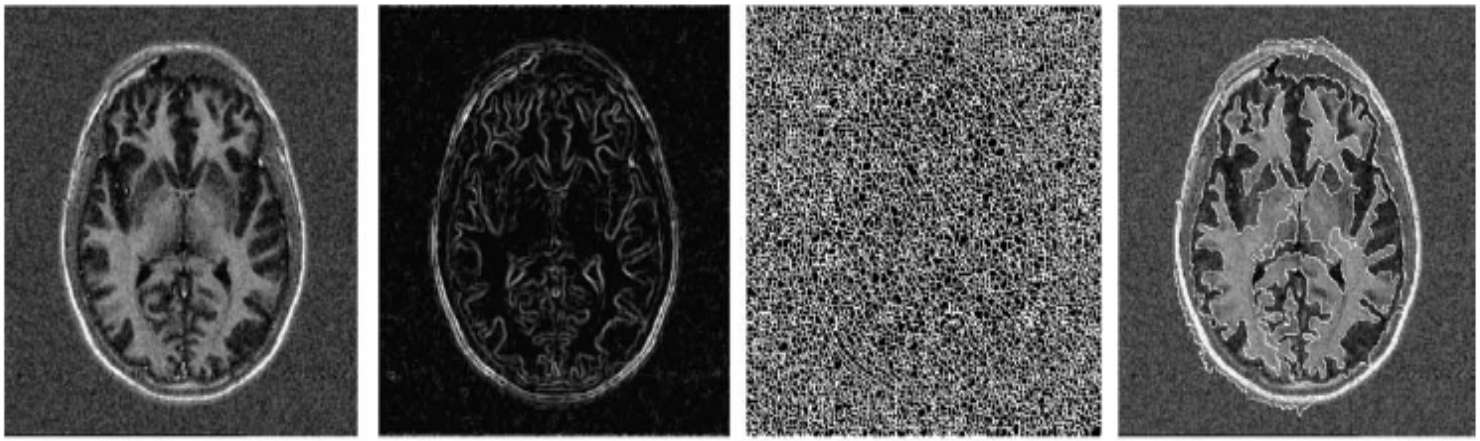
- **Watershed transformation and region merging (brain):**

  (a) brain (388 · 395);

  (b) gradient image, m = 3;

  (c) watershed results (6227 regions);

  (d) merging results (11 regions);



EXPERIMENTS AND RESULTS(2)

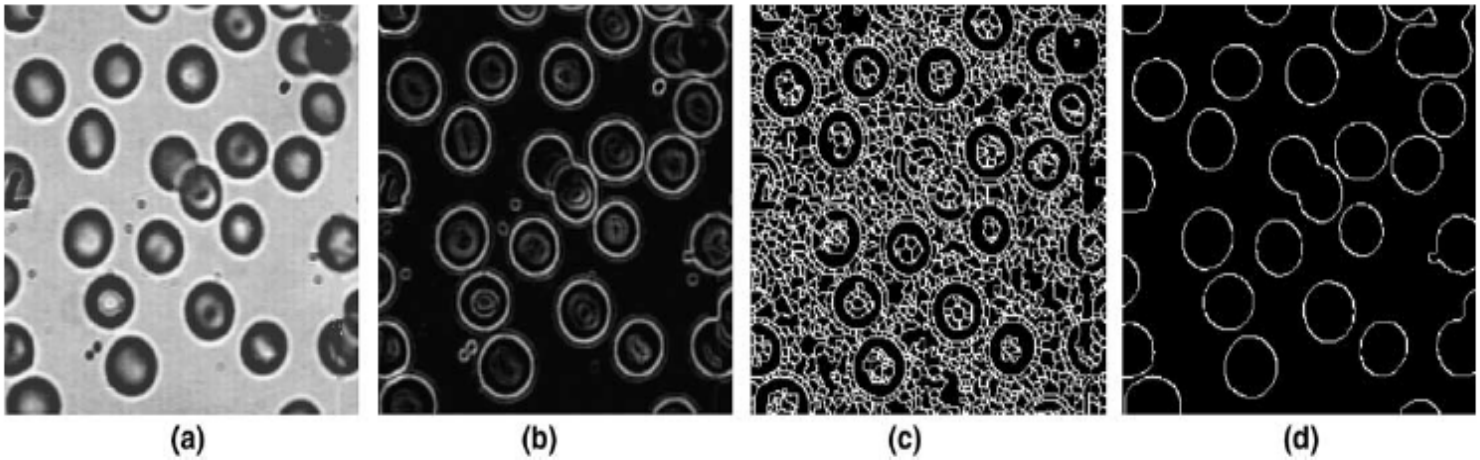
- **Watershed transformation and region merging (blood):**

  (a) blood (272 · 265);

  (b) gradient image, m = 3;

  (c) watershed results (1644 regions);

  (d) merging results (27 regions);



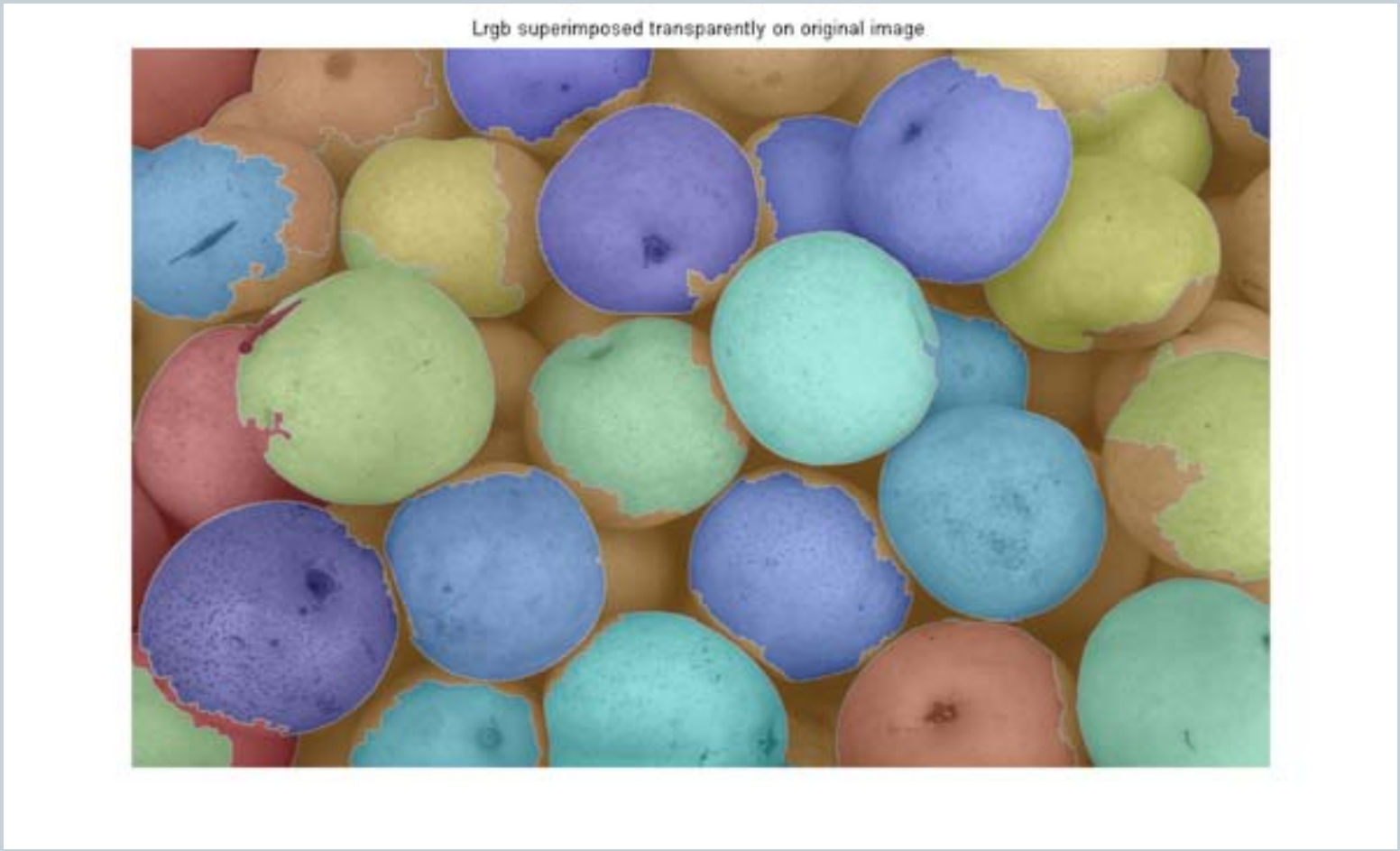
GENERAL APPLICATIONS

- Medical Imaging
- Semi-conductor Technology
- Traffic Monitoring
- Face Recognition
- Identifying Fractures in Steel

PARALLEL IMPLEMENTATIONS

- It can be based on sequential scanning, or we can have a parallelization strategy, we have is based on the distribution of the image in a chessboard fashion into *m x n* subimages, corresponding to a mapping of the application to *m x n* processes. Now, in order to perform computation in all pixel locations within the distribution subimages for this strategy, each subimage is extended within an area of one grid-point width, such that the underlying subgrids are overlapping (one row/column/point from the adjacent subimage, if any, otherwise, fictious pixels with very high intensity – 255).
- The parallel watershed algorithm for sequential scanning performs in four stages which are as follows:
  - (1) Detection of the minima pixels
  - (2) Computation of the lower-complete image
  - (3) Labelling the minima
  - (4) Flooding by image integration

PHOTO



VIDEO

- http://www.youtube.com/watch?v=3imS_9EeNhU

REFERENCES

- http://images.google.com
- http://youtube.com
- http://en.wikipedia.org
- http://sciencedirect.com

THANK YOU