PROSTATE MR IMAGE SEGMENTATION

Ang Li
Supervisor: Dr. Changyang Li, Dr. Xiuying Wang
School of Information Technologies

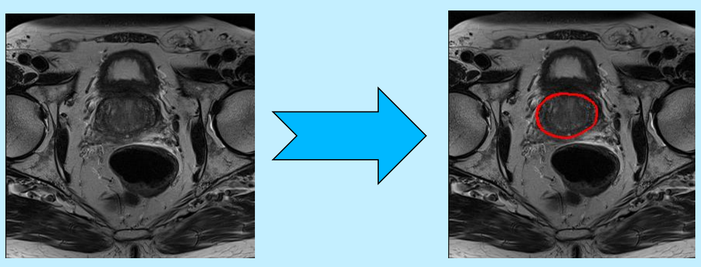
FACULTY OF ENGINEERING & INFORMATION TECHNOLOGIES

1. Project objectives

Propose and implement an effective algorithm for prostate MR image segmentation

2. Background

MR imaging is widely used for the detection and diagnosis of prostate cancer for its precise presentation of prostate's anatomic structures.



Medical image segmentation aims to find the most accurate contours of specific areas (known as the foreground) from the image.

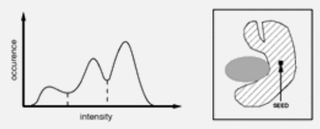
Accurate segmentation of prostate MR images is required for facilitation of diagnosis and treatment such as radiation therapy.

The accurate localization of certain organs or tissues is essential in radiation therapy.

3. Prior Work and Restrictions

Traditional Segmentation approaches

Include thresholding (left), region growing (right), classification, etc.

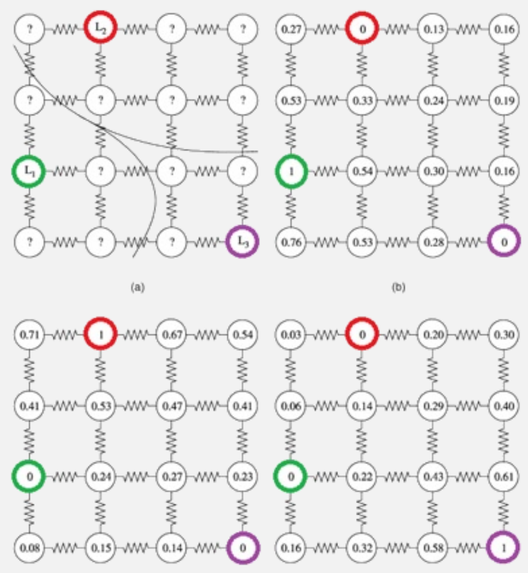


- Sensitive to noise
- Sensitive to inhomogeneity

Graph Based approaches

E.g. Random Walker (RW) algorithm

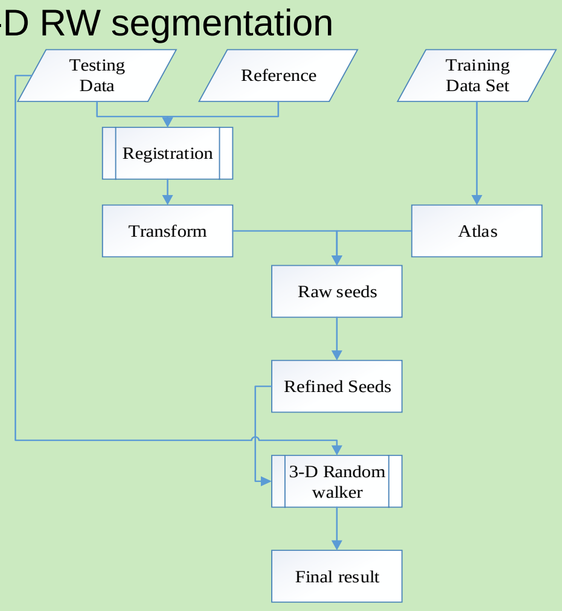
- Sensitive to seed placement
- No confinement on shape and position



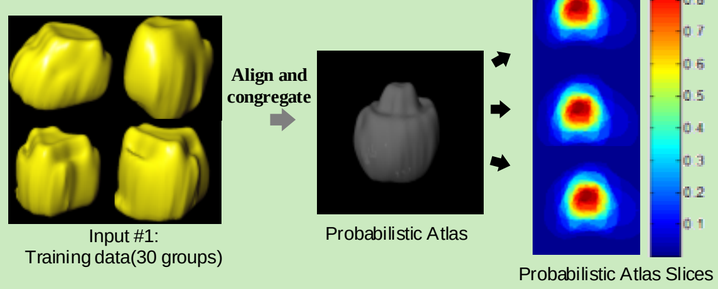
4. Proposed Method

Incorporate prior knowledge into random walker for estimation and confinement of shape.

- Atlas construction
- Registration and mapping
- 3-D RW segmentation

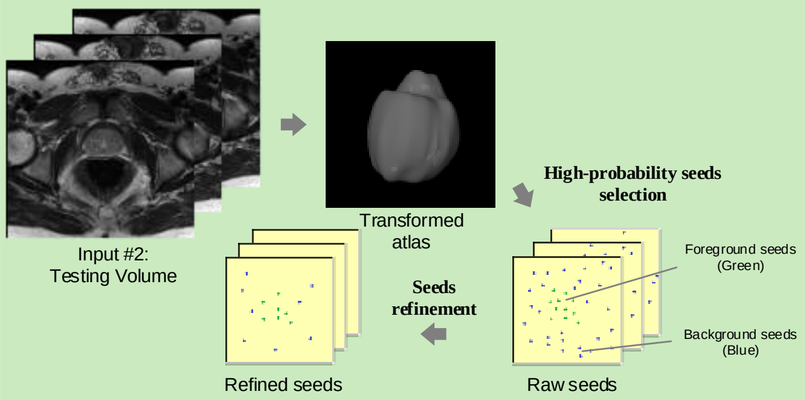


- **Step 1**: Atlas construction



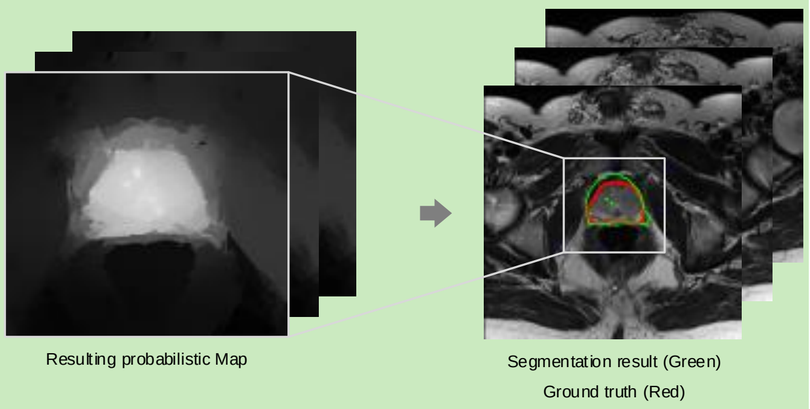
The probabilistic atlas that reflects the global shape information of the prostate is derived from aligning the ground truth.

Step 2: Rigid Registration and Mapping



The global probabilistic atlas is mapped to the testing volume to be segmented via demons rigid registration to estimate the probability of an individual testing voxel belonging to the prostate.

Step 3: Enhanced Random Walker Segmentation



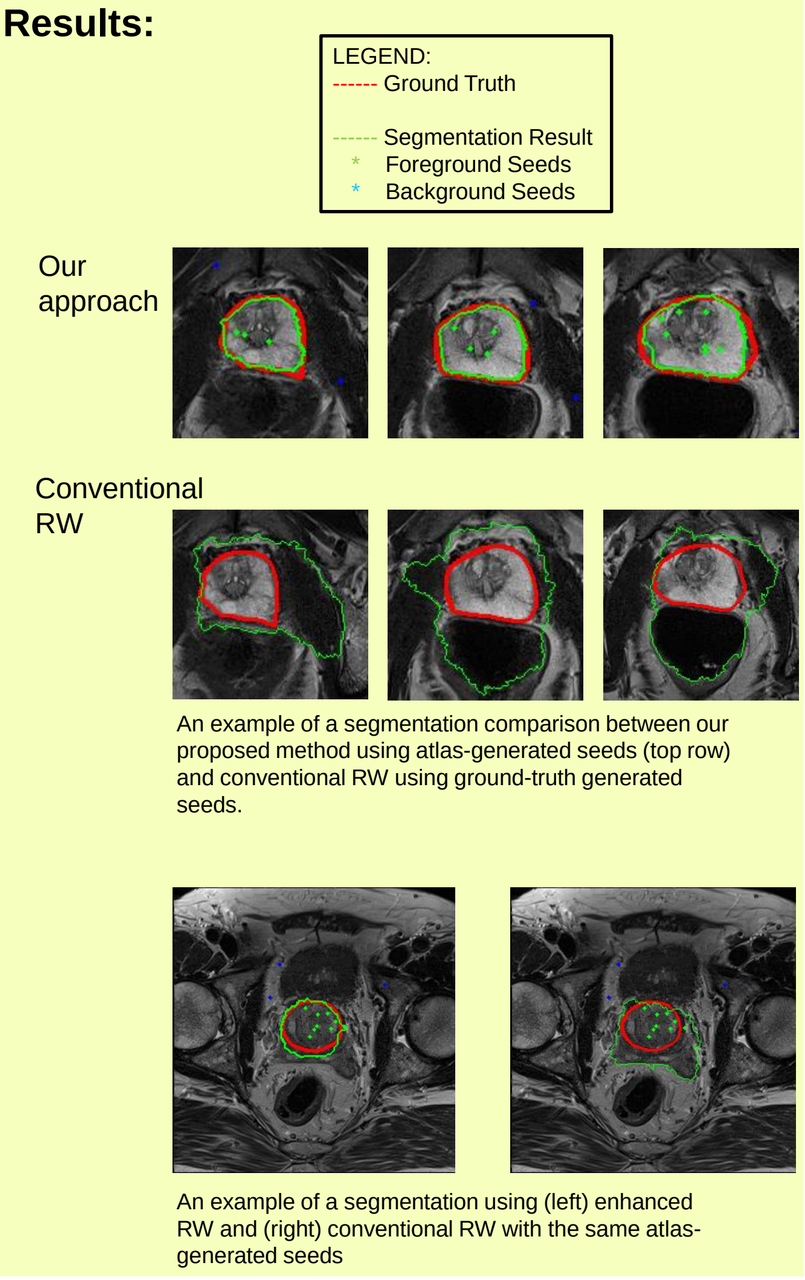
The algorithm is improved by reformulating the core image weight function to reflect the general confinement of the global shape of prostate from the transformed atlas. Finally, the segmentation results from the enhanced RW are smoothed to avoid jagged contours.

5. Experimental Results

Measurement:

$$\mathrm{DSC} = \frac{2\mathrm{TP}}{\mathrm{TP}+\mathrm{FP}+\mathrm{TP}+\mathrm{FN}}$$

Results:



An example of a segmentation comparison between our proposed method using atlas-generated seeds (top row) and conventional RW using ground-truth generated seeds.

An example of a segmentation using (left) enhanced RW and (right) conventional RW with the same atlas-generated seeds

Conclusion and Future work

Our proposed method in the project:

- is able to perform segmentation on prostate MR images with satisfactory accuracy
- enhances the original RW algorithm by incorporating prior knowledge into seeds selection as well as weight calculation
- better handles challenges of noise, inhomogeneity and weak boundaries.

Future Work:

- Apply more complex, yet appropriate statistical models for general shape modelling and variation representing.
- Classification tools like support vector machine, relevance vector machine, etc.

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