Automated visual tracking of tumour evolution using temporal PET-CT data.

Goodal Nyirenda — *Supervisor : Jinman Kim*

School of Information Technologies

FACULTY OF ENGINEERING & INFORMATION TECHNOLOGIES

AIMS

- Propose and develop a tumour delineation and visual tracking algorithm to analyse the response to treatment in PET/CT image sequence (temporal).
- Evaluate the proposed algorithm using clinical and simulated PET/CT data.

MOTIVATION

- It is necessary to acquire multiple scans of the patient to access response to treatment.
- These temporal scans often exceeds 4 where each scan is a 3D volume (~400 individual slices).
- Such data are difficult to assimilate / quantify / visualise and often not all data are being used for diagnosis.
- The ability to automatically track the changes in tumour amongst the temporal scans could potentially lead to improved diagnosis and greater efficiency.

PROPOSED METHODOLOGY AND APPLICATION FRAMEWORK

Step 1 – Initial tumour delineation

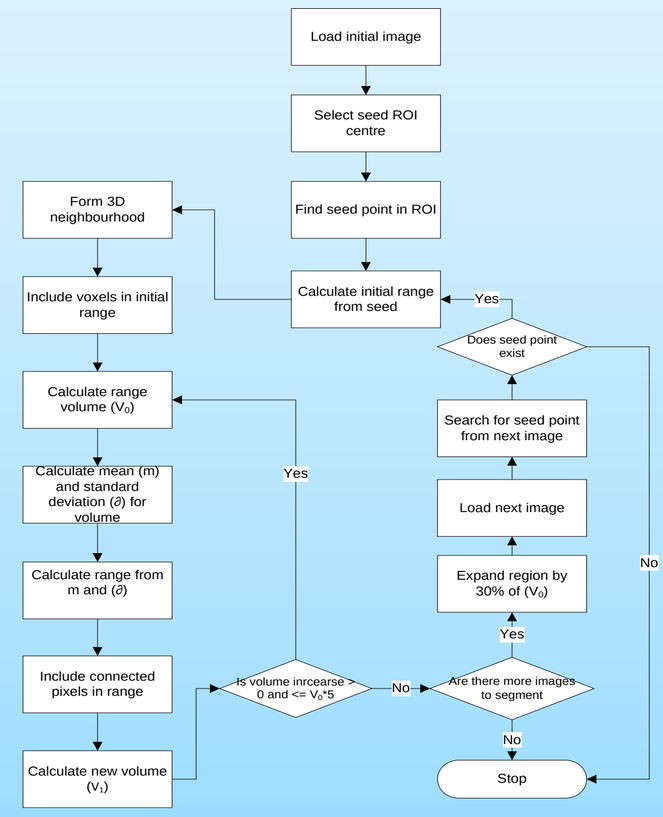
- Select a initial seed point from an ROI created based on the centre specified by user mouse click.
- Adaptively delineate the tumour based on voxel intensity average and standard deviation [1].

Step 2 – Create search ROI

- Calculate the volume of the initial delineated tumour.
- Proportionally expand the initial tumour volume by 30% using image morphology.

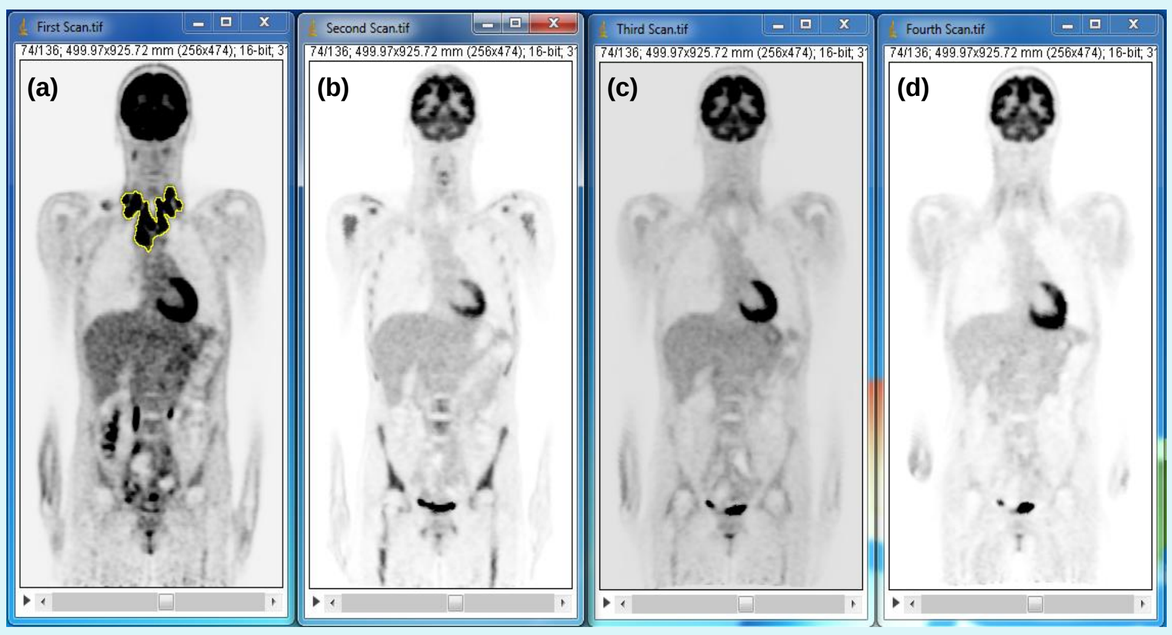
Step 3 – Successive tumour delineation

- Automatically align the temporal scans using non-rigid Bspline registration [2].
- Select a seed point from the successive temporal images within the expanded ROI.
- Adaptively delineate the tumour
- Repeat step 3 for all temporal PET-CT images



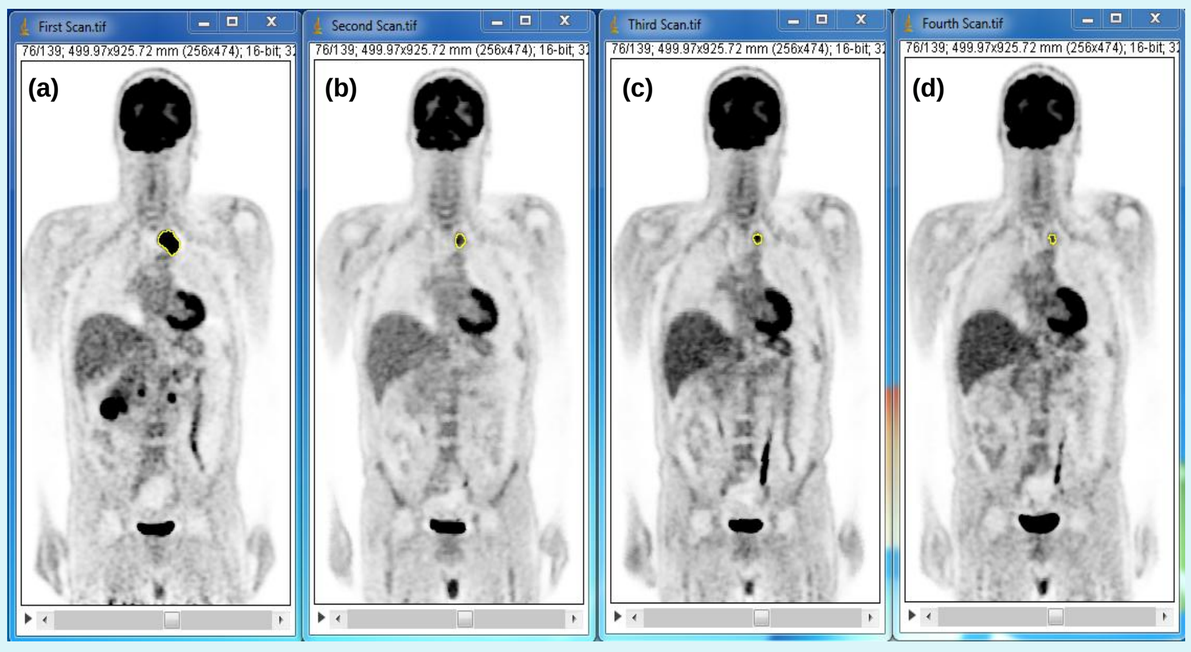
Flow diagram showing major processes and flow of processing required for the tumour tracking algorithm.

CLINICAL RESULTS – GOOD TRETMENT RESPONSE



- Patient ID 3. In (a) the patient has multiple heterogeneous tumour in the upper torso.
- There are no tumours detected by our algorithm in (b), (c) and (d), consistent to clinical reports, indicating 100% treatment response

CLINICAL RESULTS – POOR TREATMENT RESPONSE



- Patient ID 1. In (a) patient has a tumour in the superior mediastinum. The tumour though decreasing in size, shows persistence in (b), (c) and (d) with sizes 650, 353 and 263 voxels respectively.
- Our segmented results show persistent disease with poor response to treatment, as diagnosed in our clinical report.

SIMULATION RESULTS TABLE

Image number	Size of tumour	Delineation result	Response	Comment
1a	4voxels	4voxels		Detected and segmented correctly
1b	2voxels	2voxels	Positive	Accurate with tumour partially outside original location
1c	1voxels	1voxels	Positive	Tumour decreased to size of 1 pixel but still detected
2a	3voxels	3voxels		Detected and segmented correctly
2b	3voxels	3voxels	Negative	No response, size remains constant
2c	4Voxels	4Voxels	Negative	Negative response, tumour is bigger than initial size
2d	1voxels	1voxels	Positive	Tumour remains in same location

- Results from 2 simulation data (1a-1c) and (2a-2d)
- Initial threshold was set at 10% with range factor set at 2.5. Size of the tumour was calculated for a single slice.

CLINICAL RESULTS TABLE

Patient ID	Response for scans 1 - 4	Observation for scans 1 - 4
1	**Tumour 1.** Persistent though size decrease through 1 to 4	Successfully detected and delineated the tumours in scans1 – 4 decrease in size for each successive scan
	Tumour 2. Persistent with no tumour detected in 2 and 3 small tumour detected in 4	Failed to pick up tumour in scan 2 because of very low intensity. Successfully delineated tumours in scan 1 and 4 with tumour in 4 slightly outside the original tumour location.
2	**Tumour 1.** Good response with no tumours detected in 2 - 4	Successfully segmented tumour in scan 1 and found no tumours in 2-4 (100% treatment response)
	Tumour 2. Good response with no tumours detected in 2 - 4	Successfully segmented tumour in 1 and algorithm found no tumours in 2 – 4 (100% treatment response)
3	**Tumour 1.** Good response with no tumours detected in 2 - 4	Successfully segmented in scan 1 and no tumours were found in 2-4 (100% treatment response)
4	**Tumour 1.** Partial response with small lesions detected in 2 – 3, no tumour detected in 4.	Successfully detected and delineated the tumours in 1-3. patient shows good response in scan 4 with no tumours detected

- 4 clinical patient data, each with 4 scans, were evaluated for tumour response to treatment. 2 patients had multiple tumours.
- Initial threshold was empirically set to 20% for clinical images which were observed to have bigger variation in pixel intensity. Range factor was set at 2.5. Size of the tumour was calculated as the full volume.

COMPUTATION TIME

- 1st scan average (4 patients) was 56.8 seconds (s); 2nd scan was 15.4 s; 3rd scan was 8.2 s; and 4th scan was 8.0 s. All 4 scans average was 100.2 s.

REFERENCES

[1] Day, E., et al., A region growing method for tumour volume segmentation on PET images for rectal and anal cancer patients. Medical Physics, 2009. 36(10): p. 4349-4358.

[2] Kim, J., et al., Visual tracking of treatment response in PET-CT image sequences. IJCARS, 2011. 6: p. S17-S18.

CONCLUSION

- An accurate segmentation of PET images for cancer treatment response analysis was researched and developed
- Our results demonstrate positive outcome from the algorithm both on clinical and simulation data with good processing time.
- Future work will further test the accuracy and robustness of the algorithm.