A level-set approach to 3D statistical shape modelling of nasal cavity for airflow analysis

Robin Huang
Supervisor: Jinman Kim
School of Information Technologies
FACULTY OF ENGINEERING & INFORMATION TECHNOLOGIES

MOTIVATION
There is a clear need in the research community for good 3D models of the nasal cavity. A 3D nasal model can be used to:

- model breathing patterns for airflow analysis [2]
- diagnose sleeping disorder, respiratory issues and cardiovascular problems [2]
- Simulate drug decomposition for brain drug delivery via nasal cavity [1]

AIMS
- Develop optimal method for 3D statistical shape models creation of nasal cavity
- Construct normalised statistical model based on proposed method
- Measure accuracy and efficiency of constructed models
- Evaluate optimal parameters for nasal statistical shape model creation

METHOD

50 head CT images used as training data
Aligned and registered to a common frame
Segmented using geodesic active contours method [4]

3D visualisation of normalised nasal model
Mean distance map generated via PCA [3]
Level-set representation using signed distance function was computed on segmented data [3]

RESULTS

(a) \( -3.0\sqrt{\lambda_0} \) (-.125 SD)
(b) Mean shape
(c) \( +3.0\sqrt{\lambda_0} \) (+.125 SD)

\[ \sum \lambda = 2.86542 \times 10^8 \]
\[ \sum \chi = 1.52307 \times 10^9 \]
\[ \sum \chi = 6.55254 \times 10^9 \]

CONCLUSION
- Robust statistical shape model creation of nasal cavity using level-set is achievable
- Accuracy of the model is dependent on the amount of training data used
- Early alignment using affine + rigid registration before segmentation results in the most optimal outcome

FUTURE WORK
- 3D printing and construction of physical nasal model for airflow analysis
- Simulation and modelling of nasal model for nasal drug delivery
- Statistical Shape Model segmentation of nasal cavity

REFERENCES