7-page Thesis Summary
(prospective, under review)

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1   Mandatory TOC's and misc. pages (~20 pages)

2   Introduction (totalling 6-7 pages)

2.1   Opening Notes...

♦ Medical imaging

♦ Analysis of images

♦ Comparing images

2.2   Purpose of Registration

♦ Align images

♦ Analyse change

♦ Make comparisons

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2.3   The Correspondence Problem

♦ Align structures

♦ Compare like-with-like

♦ Model structures

♦ Explain variation

2.4   Registration and Correspondence

♦ Registration leads to correspondence

♦ Models require correspondence

♦ Models benefit from registration

♦ Registration can be build models

2.5   Optimal Shapes and Shapes Assessment

♦ Idea put in practice before

♦ Find corresponding points in contour

♦ Identify points of interest

♦ Describe shape using points

♦ Optimal descriptor of shape

2.6   Aims

2.7   Extending the Existing Framework (shape)

2.8   Assessment of Registration

♦ Benchmark existing registration methods

2.8.1   Build models

2.8.2   Data-driven analysis

♦ Models without human intervention

♦ Registration assessment without annotation

2.9 Contributions

- Rapid evaluation of registrations
- Reason about registration algorithms quality
- Build models automatically
- Evaluate models
- Complete framework for autonomous data analysis

2.10 Report Overview (Thesis Organisation)

3 Models (totalling 7-10 pages)

3.1 Statistical Models

3.1.1 Describe variation in data

3.1.2 Rationale:

- Analysis
- Synthesis
- ...

3.2 Shape

3.2.1 Correspondence

- Need corresponding points
- Vectorisation

3.2.2 PCA

- The principle
- Mathematics
- Issues (e.g. banana-shaped distribution)

3.2.3 Model Construction

- Relation to PCA
- Equations

3.2.4 Shape Models (learning)

♦ Construction

♦ Visualisation

3.3 Appearance models

3.3.1 Intensity Models

♦ Construction

♦ Visualisation

3.3.2 Combined Models

♦ Formulation

3.4 Active Models and fitting (very brief)

♦ Matching using *synthesis*

♦ Discrepancy

♦ Distance from a match (relating to shuffle distance, to be discussed later)

4 MDL Shape Models (totalling 7-12 pages)

4.1 Deformable Models

♦ The principle

♦ Bending energy

♦ Practical example/s

4.2 Shapes and Correspondence

♦ Example models where correspondenc is bad

4.3 Learning Shapes

♦ Principled approach

♦ Determinant

♦ Minimum description length

4.4   Objective Function and Optimisation

♦ Variety of function

♦ Optimising correspondences

♦ Results (visual)

5   Non-rigid Registration (totalling 6-9 pages)

5.1   Warps

♦ Rigid, affine, non-rigid

♦ Methods (functions, deformation fields, etc.)

5.2   Similarity

♦ MSD/SSD

♦ Correlation ratio

♦ Mutual information

♦ Model-based - to be described

5.3   Group-wise versus Pair-wise

♦ Flaws associated with pair-wise

♦ Examples/results

♦ Previous work on group-wise registration

6 Model building - introduce and validate before next section (10-20 pages)

6.1 3-D Registration Framework (group work)

6.2 Automatically Building Appearance Models (group work)

6.3 Placeholder for personal extension or contribution to model-building (yet to talk to TFC)

7 MDL Appearance Models and Registration (large, fragment it?, 40-50 pages) - see subsequent chapters that supersede this one

7.1 Model-based Registration

(get 1-D working better)

- Data
- Determinant
- CPS, warps
- MDL objective function
- Experiments
- Results

7.2 Evaluating Appearance Models

- Automatic model building revised
- Synthesis
- Clouds in space
- Specificity and Generalisation
- Euclidean, Shuffle distance
- Models compared
- Results

7.3 Evaluating Non-rigid Registration

♦ Brain data

♦ Perturbation Framework (warps, figures)

♦ Overlap - Tanimoto and Dice (in brevity)

♦ Comparison with Overlap-based Evaluation

♦ Sensitivity - errors in sensitivity too

8 Evaluating Models and Non-Rigid Registration

9 Results (Generalisability and Specificity)

10 Entropy-Based Meausres for Assessment

11 Results (Entropy-based)

12 Extending the Method to 3-D

13 Future Exploration (3-4 pages)

13.1 Pitfalls

♦ Long to synthesise and compute Sensitivity and Generaliation

13.2 Extending the Scheme

♦ Normalisation

♦ Improving the range of displacements where results can be differentiated

♦ Improving sensitivity

14 Summary, Discussion and Conclusions (4-6 pages)

♦ Building models without human intervenetion

♦ Developed a model-based objective function

♦ Model evaluation scheme

♦ Registration evaluation scheme

♦ Group-wise registration better than pair-wise

15 Appendices (10-20 pages)

♦ Pertubation

♦ Formulation of error bar calculations

♦ Objective function for model-based registration