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IMAGE REGISTRATION BY MODEL CRITERIA

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OVERVIEW

- Non-rigid registration (NRR)
- Registration and models
- Experiments
  - Models as a similarity measure
  - Toward automatic appearance model construction
- Results
- Conclusions

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NON-RIGID IMAGE REGISTRATION

- ♢ Results in overlap of analogous structures.
- ♢ Does so by transforming (warping) images.
- ♢ Transformations are evaluated by similarity measures.

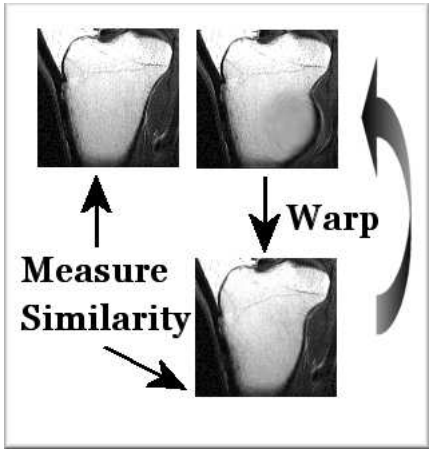

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IMAGE REGISTRATION - PROBLEMS

- Suffers from limitations in certain cases:
  - Inter-subject registration: objects in images are different.
  - Registration of a set (size>2) of images.
- Results are arbitrary (not unique).
- Many sets of warps provide equally good 'solutions'.
- Search method chosen affects the results.

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Registration and Models

- Models of shape and appearance capture variation in sets.
- NRR is closely-related to building these combined models.
- Given registered images, a combined model can be built.
- An approach to finding unique dense correspondence:
  - Find set of warps that lead to best model.
  - Best combined model defined by minimum description length (MDL).
  - MDL approach was developed for shapes, but can be extended.

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MODEL COMPLEXITY

♢ We approximate MDL to gain speed.

♢ Description length Inferred from covariance matrix of model.

♢ We obtain $\sum_{i=1}^{n} log(\lambda_i + \delta)$

♢ $\lambda_{1<i<n}$ are the n Eigen-values of the covariance matrix whose magnitudes are the greatest.

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MODEL COMPLEXITY - CTD.

♢ Note that $\sum_{i=1}^{n} log(\lambda_i + \delta) \equiv log(det(\mathbf{M} + \delta))$.

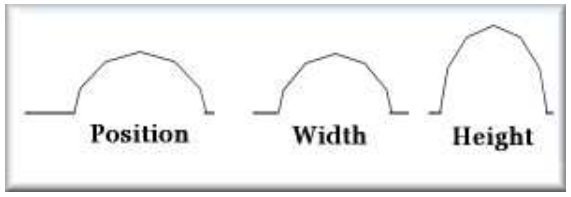
♢ δ is needed to avoid multiplication by 0.

♢ This approximates $det(\mathbf{M} + \delta) \equiv \prod_{i=1}^{n} (\lambda_i + \delta)$.

EXPERIMENTS

♢ To demonstrate feasibility, we registered 1-D data.
♢ In principle, there is no difference between 1- 2-, and 3-D.
♢ We investigated bumps (half-ellipses) that vary in:

- ◇ Horizontal orientation
- ◇ Width
- ◇ Height



♢ Correct solution is known and can be used for validation.

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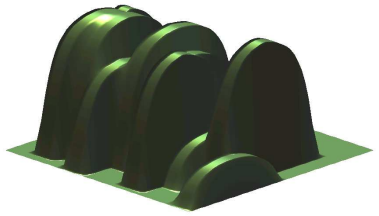
EXPERIMENTS - CTD.

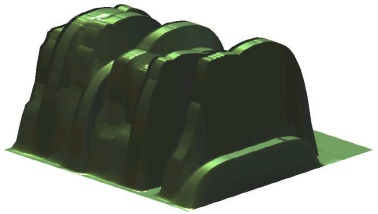
♢ Optimisation of the model-based objective function:

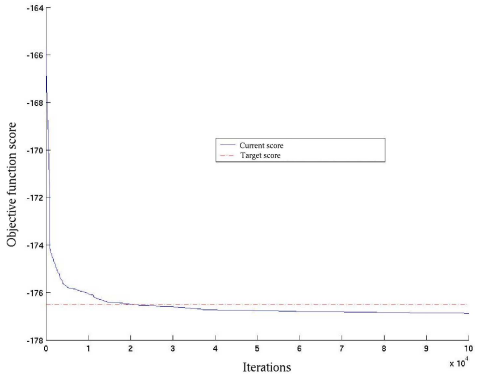
- ◇ carried out by applying clamped-plate splines.
- ◇ Localised, random warps are applied to one image at a time.
- ◇ Objective function is optimised w.r.t. magnitude of warps.
- ◇ Experiments performed under:

Autonomous appearance-based registration test-bed (AART)
`http://www.schestowitz.com/AART`

RESULTS OF REGISTRATION - CTD.







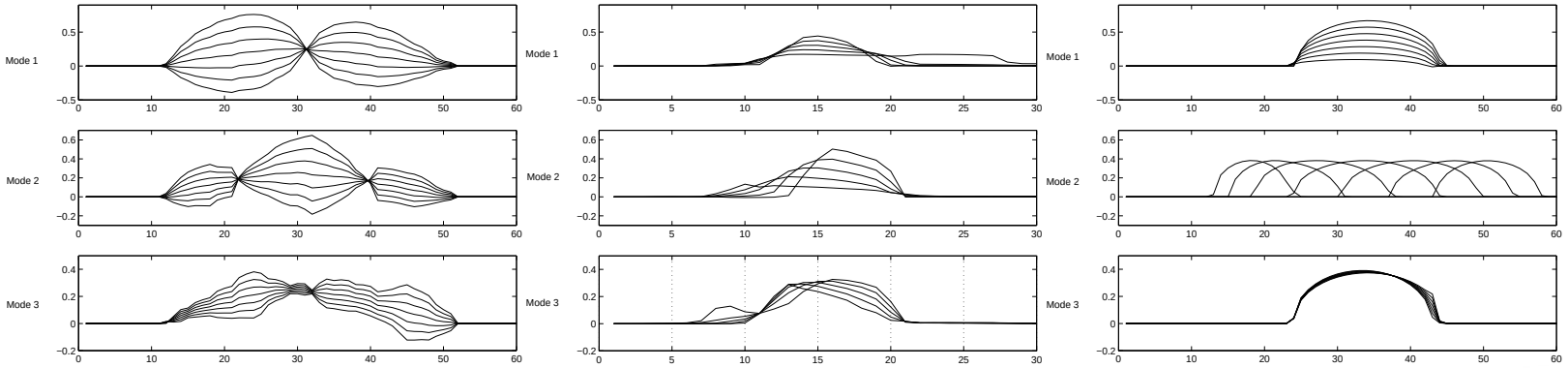
Before registration *After registration* *Objective function*

♢ Result is approaching the solution as defined by a model.

Resulting Models

♢ The combined model captures the set variability.

♢ Decomposition into the 3 dimensions of variation.

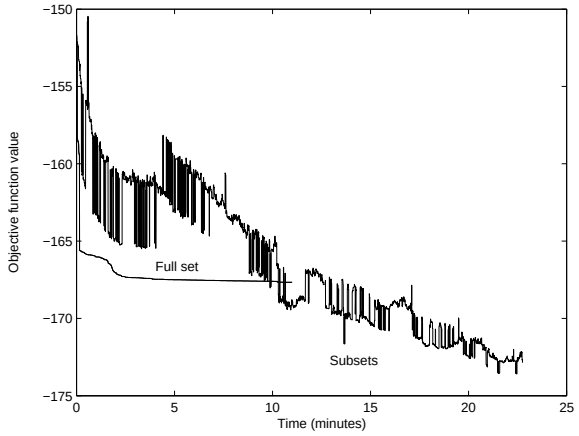


Before registration *After registration* *At correspondence*

A Subset Approach

♢ By stochastically choosing subsets:

- ◇ Optimisation becomes more robust.
- ◇ Solution is reached more quickly.



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CONCLUSIONS

♢ Modelling need not be independent of registration.

♢ Registration driven by model provides unique solutions.

♢ Correspondence in the set is identified in this process.

♢ Appearance models are refined without human intervention.

♢ The process benefits from treating subsets.