

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

NON-RIGID IMAGE REGISTRATION

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

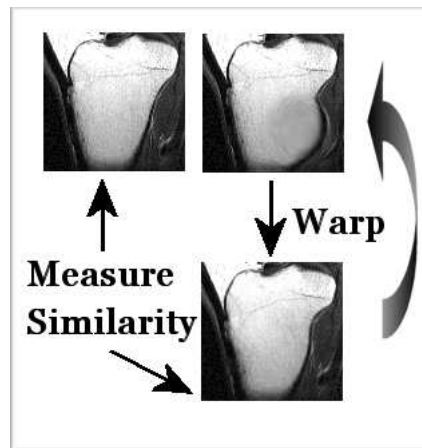


IMAGE REGISTRATION - PROBLEMS

- ◇ 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.

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.

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.

MODEL COMPLEXITY - CTD.

◇ It is proportional to $\sum_{i=1}^n \log(\lambda_i + \delta) \equiv \log(\det(\mathbf{M} + \delta))$.

◇ δ is needed to avoid multiplication by 0.

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

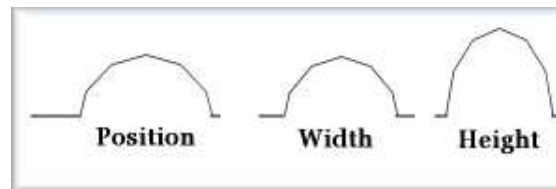
EXPERIMENTS

- ◇ 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



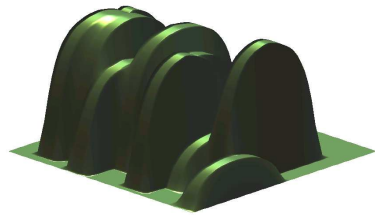
- ◇ Correct solution is known and can be used for validation.

EXPERIMENTS - CTD.

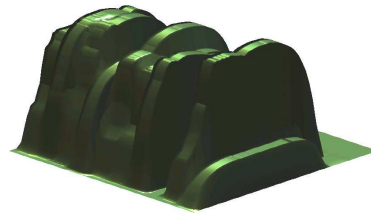
- ◇ Optimisation of the model-based objective function:
 - ◇ carried out by applying clamped-plate splines.
 - ◇ Localised, random warps are applied to one image at a time.
 - ◇ Objective function is optimised w.r.t. magnitude of warps.
 - ◇ Experiments performed under:

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

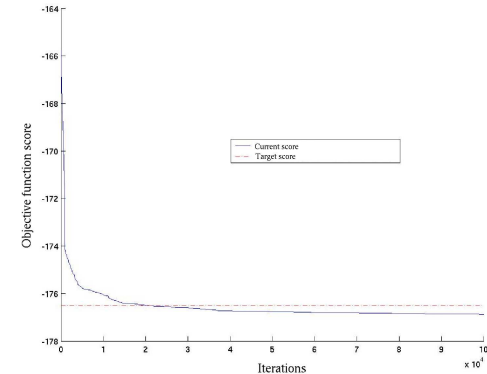
RESULTS OF REGISTRATION - CTD.



Before registration



After registration

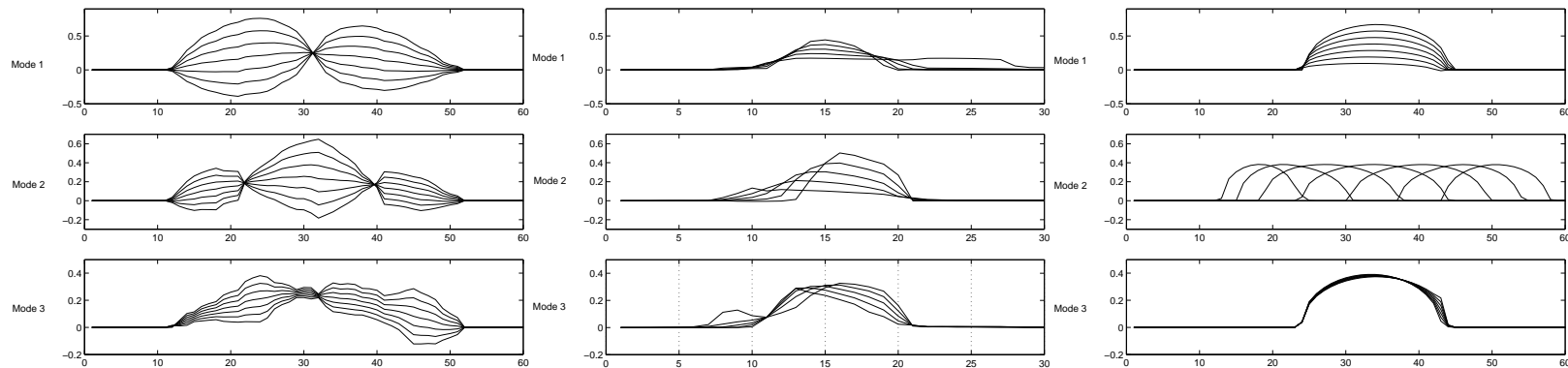


Objective function

◇ 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.



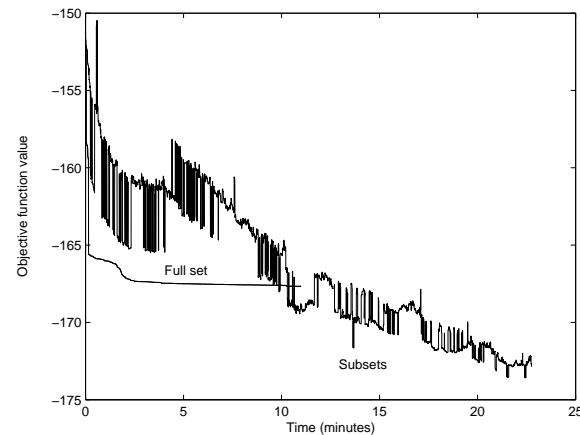
Before registration

After registration

At correspondence

A SUBSET APPROACH

- ◇ By stochastically choosing subsets:
 - ◇ Optimisation becomes more robust.
 - ◇ Solution is reached more quickly.



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.

