REGISTRATION EXPERIMENTS - CONTINUED

24th November 2004

1 General Notes

- `wtd_def_energy` in shape is apparently not implemented.

- Many experiments have identified better and worse objective functions, based on very limited data which was registered in a pair-wise fashion.

2 Experiments

2.1 Experiments 24112004-2-15:

increase knot-points (see one file for information on all parameters; 10 NRR iterations; shape OF is `def_energy`*)*

```
/////////////////////////////////////////////////////////
// 24/11/2004: Investigating the increase in number of knot-points
// Number will increase in each experiment
```

Then look at animation of final results, compared and shown as function of number of knot-points. All results were put in a collective directory and can be animated.

Conclusion: It is not as easy as one would expect to see the improvements made by increasing the number of knot-points. It is vaguely visible, but only vaguely.

See: KNOT_POINT_INCREASE–24112004 in experiments archive

2.2 Experiments 24112004-16-24

Checking different texture OF's

```
/////////////////////////////////////////////////////////
// 24/11/2004: Trying to see how texture OF's behave
// Comparison with various other methods
// 20 intensive iterations of NRR, two levels
// of affine.
```

The 9 OF's are:

1. 24112004-16: `zero`

2. 24112004-17: `ssd`

3. 24112004-18: `dot`

4. 24112004-19: `abs_diff`

5. 24112004-20: `wtd_abs_diff`

6. 24112004-21: `eigen`

7. 24112004-22: `mi`

8. 24112004-23: `nmi`

9. 24112004-24: `res_info`

Conclusion: See individual results in the directory which collects RESULTS from all; Quality depends on type of analysis. However, the good results are reached by using:

- `ssd`
- `abs_diff`
- `wtd_abs_diff`

Some methods go completely in the wrong direction, e.g. `res_info`, `eigen` and `zero`.

For all results in brief See: INTENSITY_OFs—24112004 in experiments archive where all final results have been put.

2.3 Experiments 24112004-25-32

Checking different shape OF's, texture remains `abs_diff`

```
//////////////////////////////////////////////////////
// 24/11/2004: Trying to see how shape OF's behave
// Comparison with various other methods
// 20 intensive iterations of NRR, two levels
// of affine.
```

1. 24112004-25: `zero`

2. 24112004-26: `ssd`

3. 24112004-27: `abs_diff`

4. 24112004-28: `wtd_abs_diff`

5. 24112004-29: `eigen`

6. 24112004-30: `def_energy`

7. 24112004-31: `wtd_def_energy` (NOT IMPLEMENTED?)

8. 24112004-32: `shape`

Conclusion: See individual results in the directory which collects RESULTS from all; Quality depends on type of analysis.

`zero`, `ssd` and `abs_diff` give different yet apparently equally good results. something goes quite wrong with `wtd_abs_diff` because there appears to be a very fuzzy results where the images are unaligned. `eigen` causes the image to disappear, `def_energy` gives a very good answer if not the best. No results have yet been returned for `shape`. it is very time-consuming.

For all results in brief see: SHAPE_OFs–24112004 in experiments archive where all final results have been put.

3 Next Experiments

1. Look at results for intensity OF's.

2. For better intensity OF's, choose all possible shape OF's and see results.

3. Maybe also do the reverse: choose shape OF's that work well and try the full range of intensity OF's. (1), (2) and (3) have been implicitly done already. Some of the better methods for shape/intensity have been used while 'scanning' for another complementary objective function.

4. Try to see how weight affects the *different* registration methods. Does it have optimal values that differ depending on the objective function devised?

5. Try different optimisers. There are still optimisation duration issues which might be addressed.

6. Continue trying a multi-resolution approach and an increase in knot-points.

7. Change knot-points number at different stages of NRR instead of keeping it constant.

8. Try different data for all the experiments above.

9. Look at different slices together, for example by moving up and down while showing the discrepancy image.

10. Try some group-wise regimes and see effects.

A Setting Files

A.1 Knot-Points

In the knot-point experiments, the following file was used with variation in the number of knot-points.

```
//////////////////////////////////////////////////////
// GENERAL ARGUMENTS

matcher: comp_region_matcher
sampler: raw_intensity
pair_tex_objective_fn: abs_diff { }
pair_shape_objective_fn: def_energy { } // Typical values 0.001
pair_tex_weighting: 0.5
group_tex_objective_fn: wtd_abs_diff { }
group_shape_objective_fn: def_energy { }
group_tex_weighting: 0.00005
points_selector: all { border: 1 fi_lo: 0.10 fi_hi: 0.9 fj_lo: 0.1 fj_hi: 0.9 }
pyr_builder: gaussian
warps_affect_warp_regions: false
images: {
/home/S00/schestr0/NRR/BrainExperiments/DemBrains/abra_l_auto
/home/S00/schestr0/NRR/BrainExperiments/DemBrains/bowl_i_auto
}

//////////////////////////////////////////////////////
// TRANSLATION STAGE
```

```
pairwise_stage: {
warper: translation
warp_penalty_fn: zero { }
region_picker: all { }
levels: 1 2
optimisation_method: simplex
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}

//////////////////////////////////////////////////////
// SCALING STAGE

pairwise_stage: {
warper: scale
warp_penalty_fn: zero { }
region_picker: all { }
levels: 1 2
optimisation_method: simplex
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}

//////////////////////////////////////////////////////
// TRANSLATION STAGE

pairwise_stage: {
warper: translation
warp_penalty_fn: zero { }
region_picker: all { }
levels: 1 2
optimisation_method: simplex
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}

//////////////////////////////////////////////////////
// SCALING STAGE

pairwise_stage: {
warper: scale
warp_penalty_fn: zero { }
region_picker: all { }
levels: 1 2
optimisation_method: simplex
param_tol: 0.001
```

```
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}

///////////////////////////////////////////////////////
// AFFINE STAGE

pairwise_stage: {
warper: affine
warp_penalty_fn: zero { }
region_picker: all { }
levels: 2 2
optimisation_method: simplex
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}
///////////////////////////////////////////////////////
// NON-RIGID STAGE

pairwise_stage: {
warper: bilin_grid { ni: 1 nj: 1 nk: 1 }
warp_penalty_fn: zero { }
region_picker: all { }
levels: 2 2
optimisation_method: downhill_search
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
n_opt_its: 10
}
```

A.2 Objective Functions

In the OF experiments, the following file was used with variation in the objective functions used.

```
///////////////////////////////////////////////////////
// GENERAL ARGUMENTS

matcher: comp_region_matcher
sampler: raw_intensity
pair_tex_objective_fn: mi { }
pair_shape_objective_fn: def_energy { } // Typical values 0.001
pair_tex_weighting: 0.5
group_tex_objective_fn: wtd_abs_diff { }
group_shape_objective_fn: def_energy { }
group_tex_weighting: 0.00005
points_selector: all { border: 1 fi_lo: 0.10 fi_hi: 0.9 fj_lo: 0.1 fj_hi: 0.9 }
```

```
pyr_builder: gaussian
warps_affect_warp_regions: false
images: {
/home/S00/schestr0/NRR/BrainExperiments/DemBrains/abra_l_auto
/home/S00/schestr0/NRR/BrainExperiments/DemBrains/bowl_i_auto
}

//////////////////////////////////////////////////////////
// TRANSLATION STAGE

pairwise_stage: {
warper: translation
warp_penalty_fn: zero { }
region_picker: all { }
levels: 1 2
optimisation_method: simplex
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}

//////////////////////////////////////////////////////////
// SCALING STAGE

pairwise_stage: {
warper: scale
warp_penalty_fn: zero { }
region_picker: all { }
levels: 1 2
optimisation_method: simplex
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}

//////////////////////////////////////////////////////////
// TRANSLATION STAGE

pairwise_stage: {
warper: translation
warp_penalty_fn: zero { }
region_picker: all { }
levels: 1 2
optimisation_method: simplex
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}
```

```
//////////////////////////////////////////////////////
// SCALING STAGE

pairwise_stage: {
warper: scale
warp_penalty_fn: zero { }
region_picker: all { }
levels: 1 2
optimisation_method: simplex
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}

//////////////////////////////////////////////////////
// AFFINE STAGE

pairwise_stage: {
warper: affine
warp_penalty_fn: zero { }
region_picker: all { }
levels: 2 2
optimisation_method: simplex
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}

pairwise_stage: {
warper: affine
warp_penalty_fn: zero { }
region_picker: all { }
levels: 1 1
optimisation_method: simplex
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
}

//////////////////////////////////////////////////////
// NON-RIGID STAGE
pairwise_stage: {
warper: bilin_grid { ni: 4 nj: 4 nk: 4 }
warp_penalty_fn: zero { }
region_picker: all { }
levels: 2 2
optimisation_method: downhill_search
param_tol: 0.001
use_exhaustive_search: false
```

```
n_per_dim: 5
optimise_many_warps: false
n_opt_its: 10
}

pairwise_stage: {
warper: bilin_grid { ni: 5 nj: 5 nk: 5 }
warp_penalty_fn: zero { }
region_picker: all { }
levels: 1 1
optimisation_method: downhill_search
param_tol: 0.001
use_exhaustive_search: false
n_per_dim: 5
optimise_many_warps: false
n_opt_its: 10
}
```