REGISTRATION EXPERIMENTS - CONTINUED

25th November 2004

1 General Notes

The experiments performed today produced excellent and useful results. They also led to many conclusions as the next section shall explain.

2 Experiments

2.1 Longer Registration

Experiments 25112004-1 to 25112004-3

Here I tried to see the effect of longer registration, with a greater number of knot-points towards the end. I am curious to see if the results continue to improve at a finer resolution and, if so, how long it takes.

- 25112004-1: uses `ssd`
- 25112004-2: uses `abs_diff`
- 25112004-3: uses `wtd_abs_diff`

All settings files are in the appendix.

Results: See /Long_Optimisation–25112004.

Conclusions: better results are obtained by running the longer (~2 hours versus about 15 minutes in most of the previous experiments) optimisation. However, results are not optimal or stunningly good. The three objective functions used give unique yet similar results. It is not obvious to the eye which objective function works best.

2.2 Testing Texture/Shape Weighting for Different Objective Functions

The assumption here is that weighting was suited to work well with a certain type of objective functions (`ssd, abs_diff wtd_abs_diff`). Therefore, it is interesting to see if other methods don't work or perhaps just weighting is not correct. It would be interesting to see if MI and NMI work, as they should.

MI with varying weights was attempted.

- 25112004-4: weight is set to 0.05 (note that 0.5 was tried yesterday and was not successful)
- 25112004-5: weight is set to 0.005

- 25112004-6: weight is set to 0.0005
- 25112004-7: weight is set to 0.00005

The experiment was not as long as 2.1, but as the parameters in the appendix indicate, it was long enough to allow good results.

Results: the comparison which can be found under /MI_Weight–25112004 shows no change at all. The weight does not seem to affect the result. There *is* a change during MI registration though.

Conclusions: MI is not affected by shape/intensity weighting. It does not get good results in any of the weight settings at this moment.

2.3 Changing Data

I decided to use a strong combination of objective function and see if it still performs well when faced with a different set of data. The settings for the experiment were the *same as in 2.1*, but instead of using the same data, several different datasets are taken into consideration. `ssd` was used as the shape OF (objective function) and `def_energy` as the intensity OF.

- 25112004-8: `abra*` and `bowl*`
- 25112004-9: `abra*` and `burr_r*`
- 25112004-10: `abra*` and `clar_e_*`
- 25112004-11: `abra*` and `daws_k*`

Results: fortunately, the same good results hold for different data.

Conclusions: This result means that the parameters were not adjusted only to fit a certain couple of images.

2.4 Changing Checkerboard Size

Following the experiments above, the checkerboard grid size was increased. The results were impressive because they showed rapid alignment of 3-D data. In only 15 minutes or so, pair-wise registration gave a decent result.

2.5 Looking at All Slices

The option for 'output of all slices at the end' was used. It was particularly re-assuring that good registration is obtained not only at slice 25, but also in the rest of the brain.

3 Next Experiments

- None to list at the moment. See yesterday's notes.

A Setting Files

A.1 Longer Registration

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

matcher: comp_region_matcher
sampler: raw_intensity
pair_tex_objective_fn: ssd {  }
pair_shape_objective_fn: def_energy { }
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
}

pairwise_stage: {
  warper: bilin_grid { ni: 6 nj: 6 nk: 6 }
  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
}

pairwise_stage: {
  warper: bilin_grid { ni: 7 nj: 7 nk: 7 }
  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
}

pairwise_stage: {
  warper: bilin_grid { ni: 8 nj: 8 nk: 8 }
  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
```

A.2 MI and Weighting

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

matcher: comp_region_matcher
sampler: raw_intensity
pair_tex_objective_fn: mi {  }
pair_shape_objective_fn: def_energy { }
pair_tex_weighting: 0.00005
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
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  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 }
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  region_picker: all { }
  levels: 2 2
  optimisation_method: downhill_search
  param_tol: 0.001
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  n_per_dim: 5
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}

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

```
}
```