‘The effect of spatial resolution and displacement magnitude on accuracy and precision errors: A comparative study using elastic image registration.’

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Background

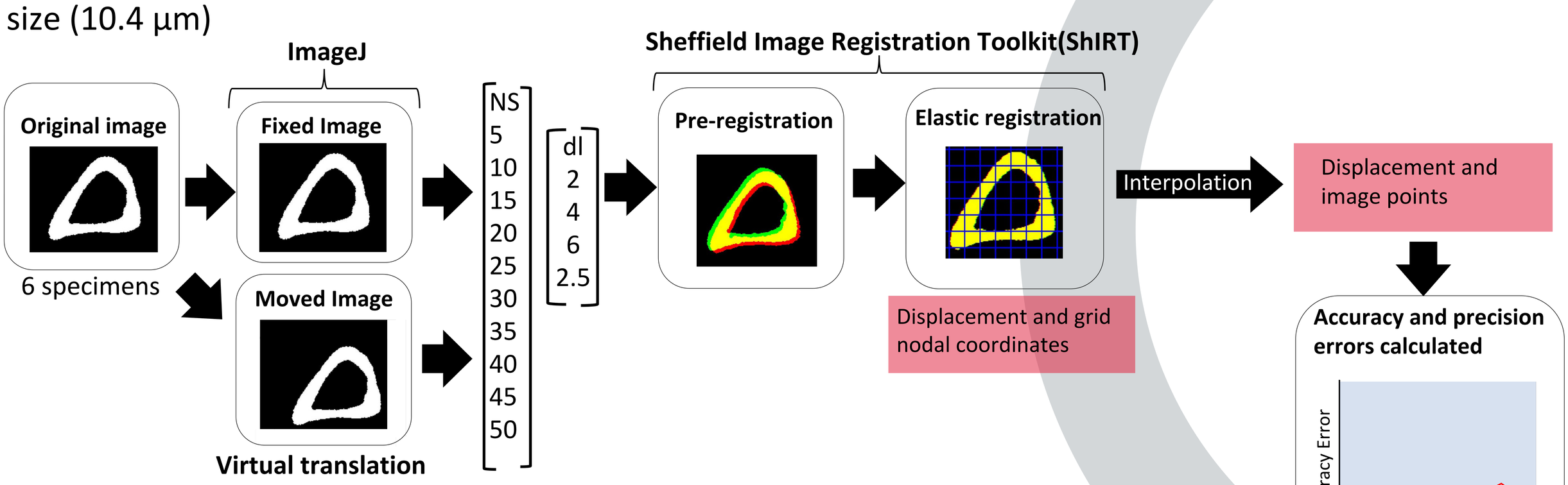
Micro-CT images of murine bone models have been used to investigate effect of osteoporosis and its treatments on bone geometry [1]. To determine the bone geometry variations an elastic registration algorithm (ShIRT) can be used. ShIRT deforms the reference image to map the two compared images. Its performance is of a fundamental importance to accurately describe local differences between specimens.

Aim

To identify the effects of different simulated displacements magnitudes (dl) and spatial resolution(NS) on the precision and accuracy of the algorithm.

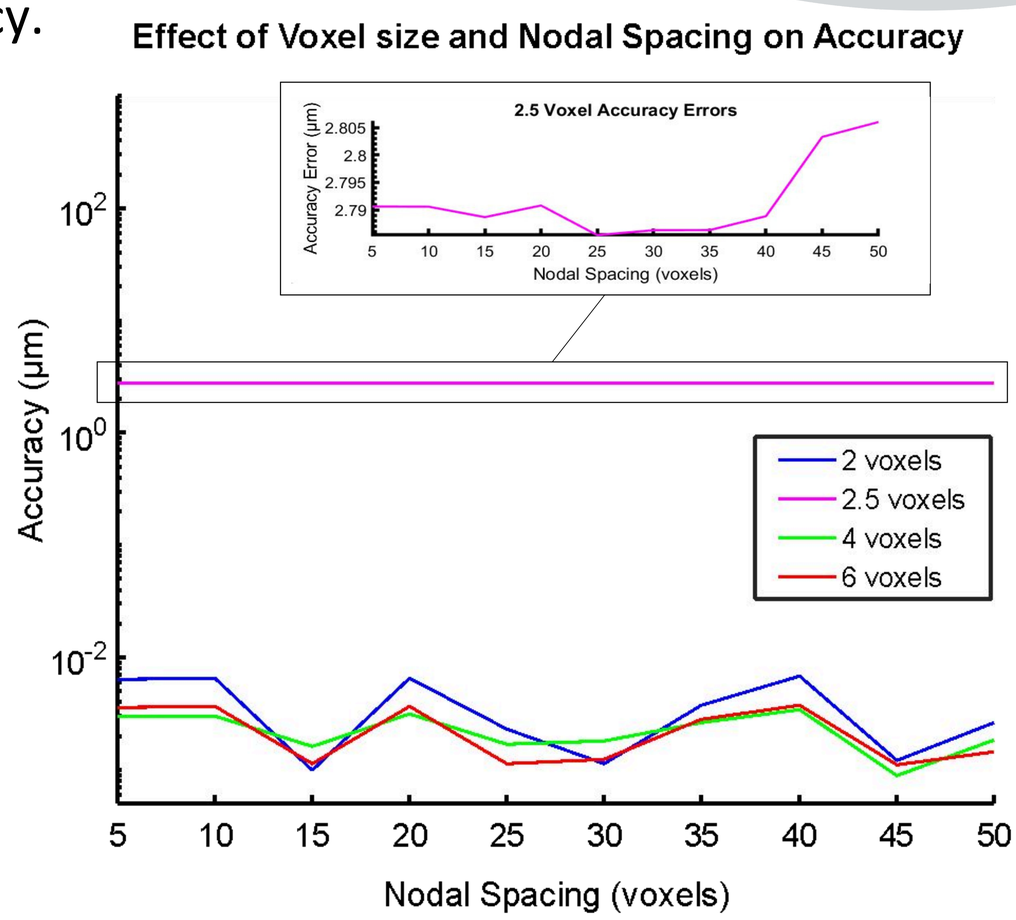
Method

Case study 1: Uses dl 2, 4 & 6 voxel size. Cases have a **uniform displacement field.**
Case study 2: Uses dl 2 & 2.5 voxel size. The dl 2.5 case is translated by 2.5 voxels in the x & y coordinate direction and 2 voxels in the z direction making it a **non-uniform displacement field** and adding **an interpolation error** due to the image resampling.
Each case is run for 6 specimens while altering the ShIRT grid density, i.e., nodal spacing (NS): 5 – 50 voxel size (10.4 µm)



Results

- The displacement errors were constant over different NS consistent with results in [2].
- The accuracy errors are significantly higher for the case where the displacement.
- magnitude is a non integer number of voxel size, i.e., 2.5.
- All errors are very low in comparison to the voxel size.
- There is no significant difference between dl 2, 4 & 6 accuracy.
  There is no significant difference between dl 2, 2.5, 4 & 6. precision.



Conclusions

The fluctuations of the errors are negligible.
Non-uniform translations with magnitude of a **non integer** voxel size values lead to **lower accuracy**.
A uniform translation with an integer voxel size value translation produces negligible errors.

References

[1]M.Giorgi *et al.* ,“Prenatal growth map of the mouse knee joint by means of deformable registration technique,” *PLOS ONE* ,vol. 14, no. 1, p. e0197947, Jan. 2019, doi: 10.1371/journal.pone.0197947.

[2]E. Dall’Ara, D. Barber, and M. Viceconti, “About the inevitable compromise between spatial resolution and accuracy of strain measurement for bone tissue: A 3D zero-strain study,” *Journal of Biomechanics*, vol. 47, no. 12, pp. 2956–2963, Sep. 2014, doi: 10.1016/j.jbiomech.2014.07.019.

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