INTRODUCTION

- Online resources included digital phantoms to assist in performing QA tests outlined in the report.
- Physicists recommended to implement TG-132 for all of their clinical registration systems.
- Some vendors provide resources to assist users.
- Most systems have built-in analysis tools for QA.

AIMS

- Learn about registration options and commissioning tools for our systems: MIM Maestro 6.73 & Raystation 5.05.
- Implement TG-132 recommended QA in both systems.
- Compare rigid registration results with expected.
- Compare deformable registration results between the systems using available metrics.
- Gain better understanding of the operation and limitations of registration software in clinical use.

METHOD

- TG-132 virtual phantoms were downloaded & imported.
- Geometric phantom with 5 modalities (CT, T1/T2-MR, PET, CBCT) and known offsets, translation and rotation.
- Anatomical pelvis phantom: 4 modalities with known offsets (CT, T1/T2-MR, PET).
- Two 4D-CT inhale (0%) and exhale (50%) phases.
- Anatomic pelvis phantom: 4 modalities with known offsets.
- MIM tools are quantitative: given a set of reference points or contours, calculates either TRE or DSC, Hausdorff distance, error, and so forth. Both systems performed similarly as shown in the table below.

RESULTS – RIGID

- TG-132 recommended criteria is error < 0.5 voxel dimension.
- Translation only: both systems failed criteria for CT-to-PET.
- Translation and rotation: MIM failed criteria for all modalities, Raystation failed criteria only for CT-to-PET registration.
- Rotations in MIM off by ~1°, causing larger translation errors.
- External contour generation relies on intensity levels and may be less accurate for non-CT images.

RESULTS – DEFORMABLE

- DVF not freely available for any of the available data.
- H&N DVF's available through Oncology Systems Ltd (OSL).
- TG-132 phantom DVF available but in OSL proprietary format.
- Manually contoured organs on TG-132 images to compute DSC.
- Used POPI data with landmarks for TRE analysis.
- Both systems have tools to assist with deformable registration QA.
- MIM tools are quantitative: given a set of reference points or contours, calculates either TRE or DSC, Hausdorff distance, error, and so forth.

CONCLUSIONS

- TG-132 phantoms for rigid registration easy to use.
- But no guidance on how to interpret a failed test.
- TG-132 deformation phantoms less useful without DVF.
- MIM handles DVF in DICOM format, but Raystation does not import or export DVF in DICOM format.
- Manual contours simplest way to judge performance.
- POPI data with landmarks was useful and easy to use.
- All deformable phantoms tested CT-CT or CT-CBCT.
- No phantoms for intermodality deformable registration.
- User education improved registration results.
- Learning about specific tools and options for guiding and evaluating the deformation improved registration.
- Still helpful to go through the exercises to increase awareness of system options and limitations.

REFERENCES

2. TG-132 resources website available to MIM customers: https://www.mimsoftware.com/portal/training/radiation_oncology/tg132

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