Improved reliability and efficiency of a myocardial perfusion imaging service through open-source machine learning tools

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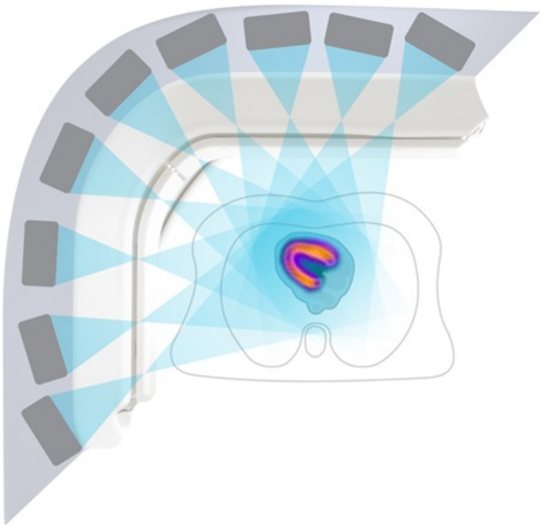
Myocardial Perfusion Imaging (MPI)

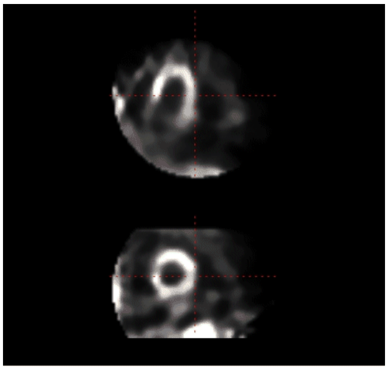
- MPI is a common SPECT test for diagnosis of coronary artery disease
- Two scans are acquired (at stress and rest)
- Comparison between data enables identification of fixed or reversible perfusion reduction
- Scans @ Sheffield acquired on a GE Discovery 530 NM camera (with small, fixed FOV)



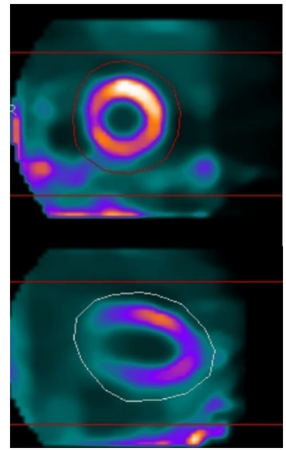
Myocardial Perfusion Imaging (MPI)

- Sensitivity is non-uniform across the FOV
- Positioning must be consistent between stress and rest acquisitions to avoid false interpretation
- A position check is performed after rest scan to ensure absolute difference in position is < 1.0cm
- This requires a 3D registration mask to be drawn manually for every case

Position check



1. Mask stress



2. Register stress to rest

3. Extract mapping (X,Y,Z)

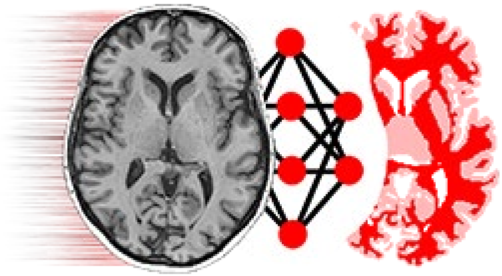
Repeat scan if absolute shift > 1.0cm

Project aim

- Position QC check requires significant staff resources and can get forgotten (leading to service disruption)
- If the mask drawing can be automated, the whole process can be completed without human input!
- Project aimed to:
  - **Create an algorithm capable of drawing registration mask automatically**
  - **Implement the algorithm clinically, assessing reliability and service impact**

Method – algorithm phase (retrospective)

- Convolutional Neural Network (dense V-net) trained using historical data
- All training / testing conducted using open-source niftynet platform
- 9604 previously generated masks extracted from the archive:
  - 80% for training, 10% for validation (selection of network parameters), 10% for hold-out testing
- Performance assessed using overlap measures (Dice) & position measurement differences



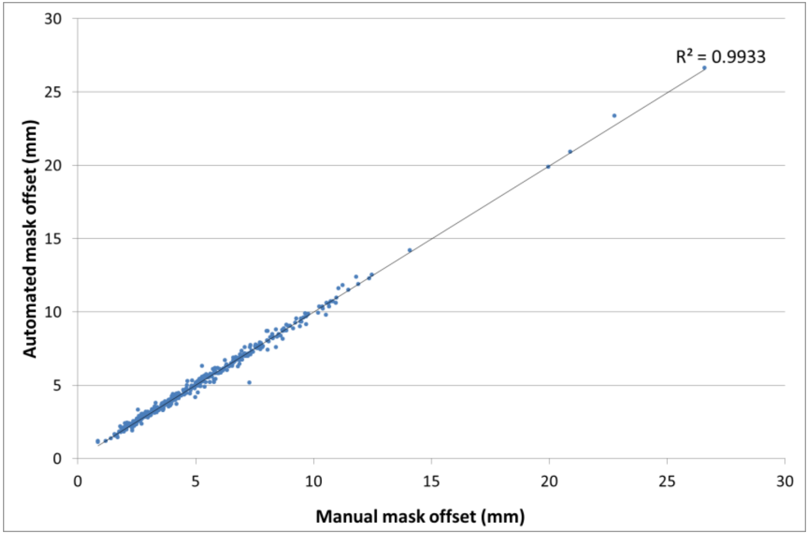
www.niftynet.io

Method – evaluation phase (prospective)

- Evaluation period of 4 months – manual and automatic methods used in parallel
- Time taken for conventional manual mask drawing was captured through staff self-reporting
- Algorithm was integrated into routine workflow:
  - Executed daily through windows scheduled tasks
  - Algorithm output passed to clinical image viewing system (MIM software) for technologists to check
- Performance review at the end of the evaluation period, then moved fully to automated system
- Further review 12 months later

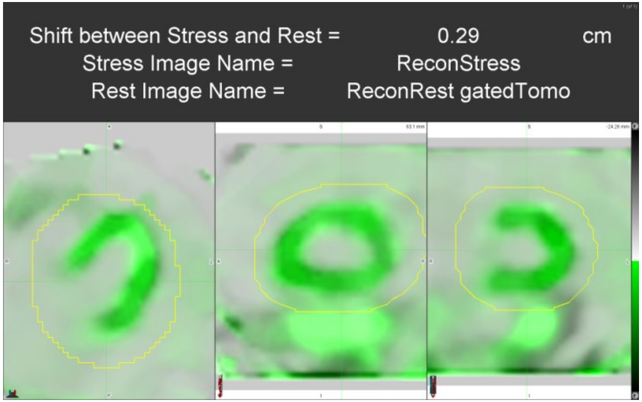
Results – algorithm phase

- Algorithm was highly accurate
- Manual vs automated mask: mean Dice of 0.85, mean difference in offset measurement of -0.006mm



Results – evaluation phase

- Over 4 months (343 cases) there were no automated system failures. Results were available to technologists in all cases (example below)



- Mean time to draw mask manually = 5.2 minutes (per case)
- At 12 months the automated system has saved approx 20 hours staff time (so far)

Discussion

- Open source AI tools can be used within hospitals to:
  - Create accurate, reliable automated segmentation algorithms
  - Reduce staff workload
- This application is similar to many other manual, repetitive tasks in radiology
- Encouraged by these results, similar segmentation projects have started to enable automated:
  - Ejection fraction measurements
  - Kidney volume measurements