DATA COMPOUNDING FOR EXTENDED FIELD OF VIEW

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Abstract

Echocardiography with its high frame rate capability has the potential to become a useful tool for intra-operative guidance [1] during procedures such as EP ablation and CRT placement. However, the field of view for intra-operative probes such as TEE and ICE is limited, and echocardiography may suffer from regional signal dropouts.
Data compounding is intended to overcome these challenges by utilising the data from several images to form an extended field of view.

Methodology

There are two parts of data compounding:

- Registration: maps images to a common coordinate system
- Fusion: set rules to combine voxels at overlapping location

The implemented registration method utilises Farnebäck optic flow [2] method in iterative multi scale scheme to obtain the global rigid transformation map. Maximum intensity fusion rule is applied afterwards.

Farnebäck Optic Flow

Farnebäck optic flow [2] method uses polynomial expansion method to convert the image into polynomial bases.

$$f(x) \sim x^T \mathbf{A} x + \mathbf{b} x + \mathbf{c}$$

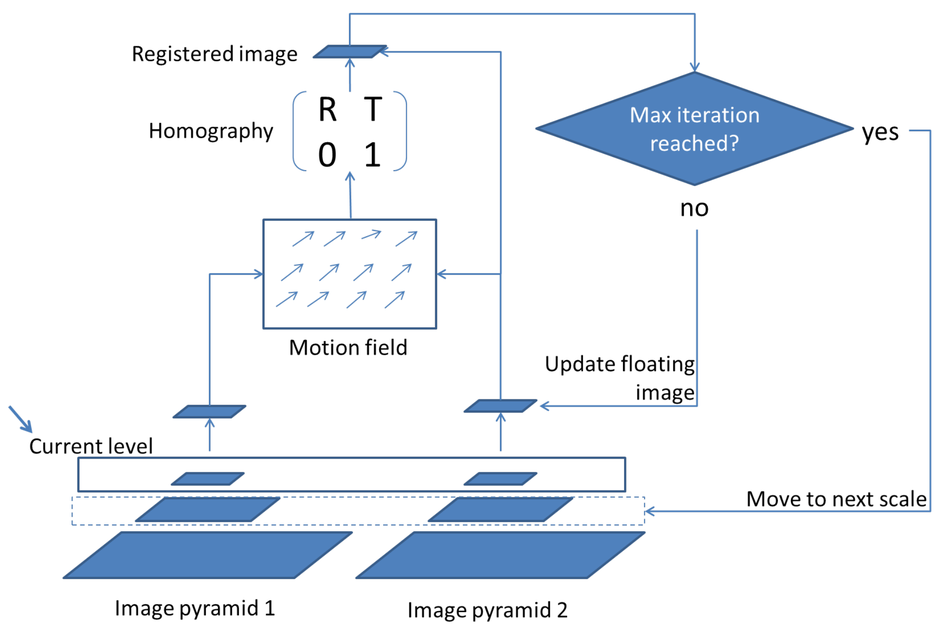
It assumes that in the second image, there exist the same image data with a displaced position

$$f_2(x) = f_1(x - \mathbf{d})$$

The motion between the images is computed as:

$$\mathbf{d} = -\tfrac{1}{2}\mathbf{A}_1^{-1}(\mathbf{b}_2 - \mathbf{b}_1)$$

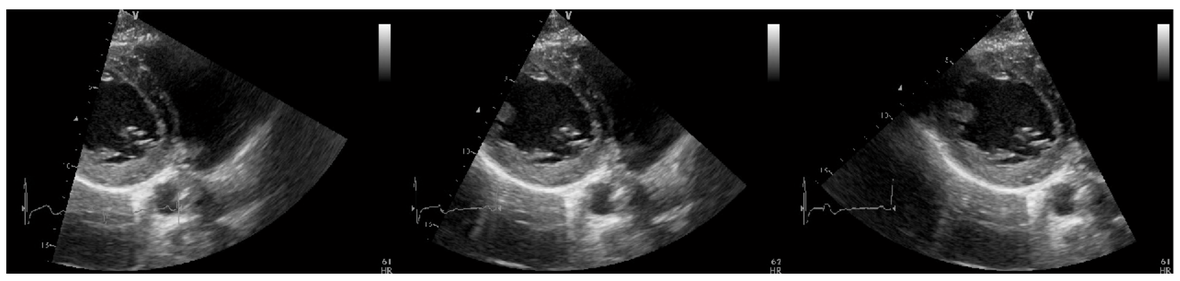
Iterative Multiscale Optic Flow



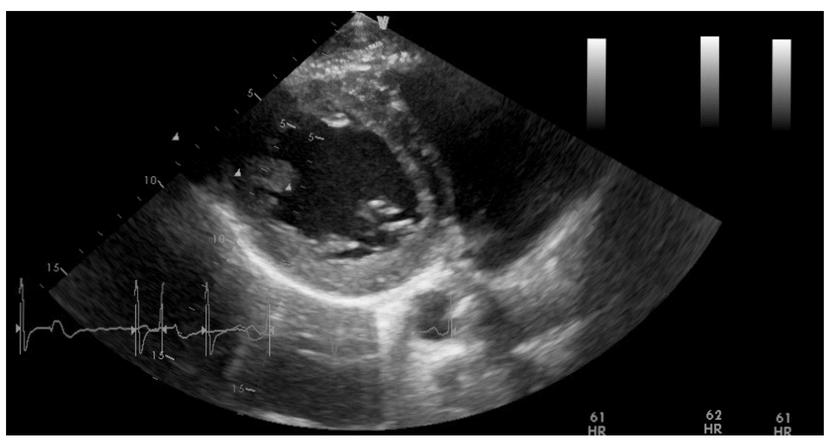
- Build image pyramid for fixed and floating image.
- Starting from the coarsest level, compute motion field using the Farnebäck optic flow method.
- Compute a regularised rigid transformation matrix and apply it to the current floating image to get the current registered image.
- If maximum number of iteration is reached, move to the next level and initialise the floating image with the cummulative rigid transformation, else update the current floating image with current registered image and recompute motion field.

Results

3 cardiac ultrasound images taken from the same probe position with varying heading:



Compounded image showing extended field of view:



Computation time (s)	Error (pixels)
3.50	0.77±0.35

Future Work

Current results show potential of data compounding for creating wider field of view for cardiac ultrasound which can be useful in imaging large structures such as a dilated heart in one consolidated frame. For future work, focus should be put on:

- Handling non temporally aligned images by for example temporal interpolation or incorporation of local non-rigid registration.
- Investigation of various fusion method such as wavelet based fusion [3] for the improvement of image quality.
- Developing a strategy to handle compounding of large data set.

Acknowledgement

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References

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