Compensation of periodic cardiac motion and non-periodic abdominal motion in cone-beam CT

Alfonso A. Isola[1,2], Colas Schretter[1,3], Michael Grass[1], Matthias Bertram[1], Georg Rose[3], Wiro J. Niessen[4,5]

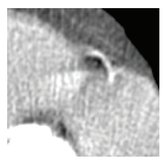
INTRODUCTION

The impact of organ motion on image quality is investigated for two different applications, using two different technical approaches:

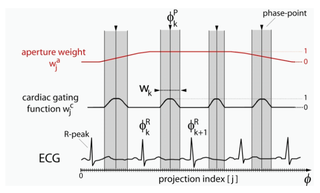
- **Alfonso A. Isola**: Improving **4D dynamic** images of the myocardium, assuming **periodic** motion. The reconstruction uses an **accurate**, but **slow iterative** method
- **Colas Schretter**: Improving **3D static** images of the abdomen, assuming **non-periodic** motion. The reconstruction uses an **approximate**, but **fast analytical** method

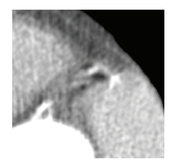
1. MOTIVATION

- In cardiac CT, due to the heart beating motion, we get a blurred image

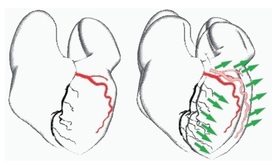


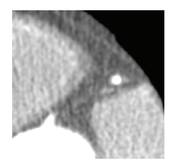
- Solution 1: ECG-gated cardiac iterative reconstruction





- Solution 2: Motion-compensated iterative reconstruction



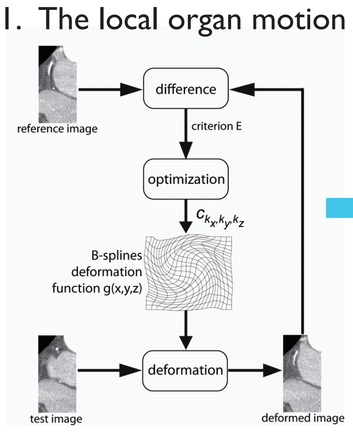


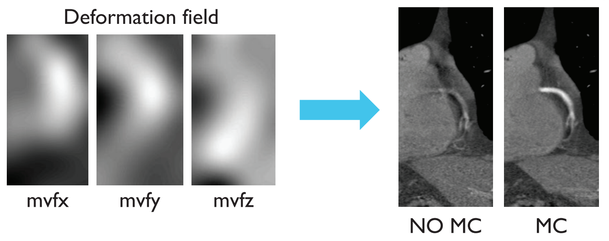
1. MOTIVATION

- In CT, the reconstructed image is frequently degraded by uncontrolled patient motion during data acquisition
- To improve image quality, we developed a method for joint motion estimation and motion segmentation
- The segmentation is used within the image reconstruction algorithm to compensate locally the perceived motion

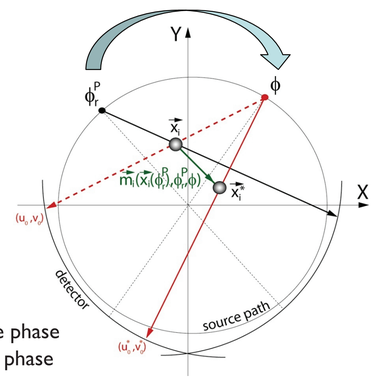
2. MOTION ESTIMATION AND COMPENSATION

1. The local organ motion is estimated by elastic image registration



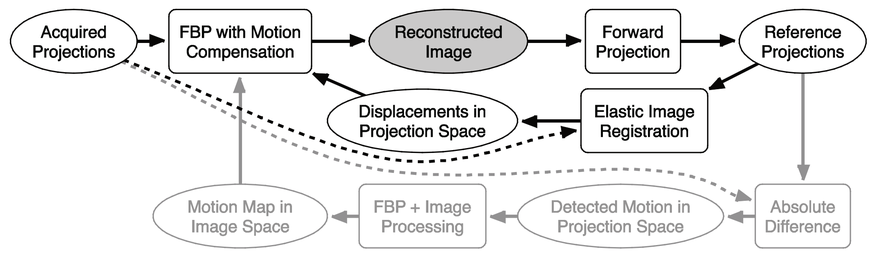


2. The pre-computed motion vector field is used for motion compensated (MC) cardiac reconstruction by displacing the centers of image elements (blobs)



ϕ_r^P = reference phase
ϕ = arbitrary phase

2. JOINT MOTION ESTIMATION AND SEGMENTATION



Workflow for iterative motion correction

1. A displacement field is estimated in projection space by elastic image registration
2. In parallel, the motion is detected and reconstructed in image space
3. Finally, the image is reconstructed again with local motion compensation

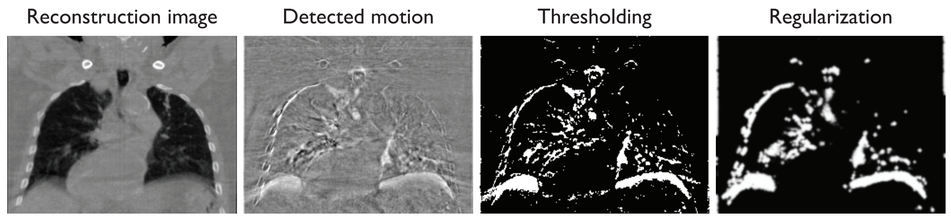
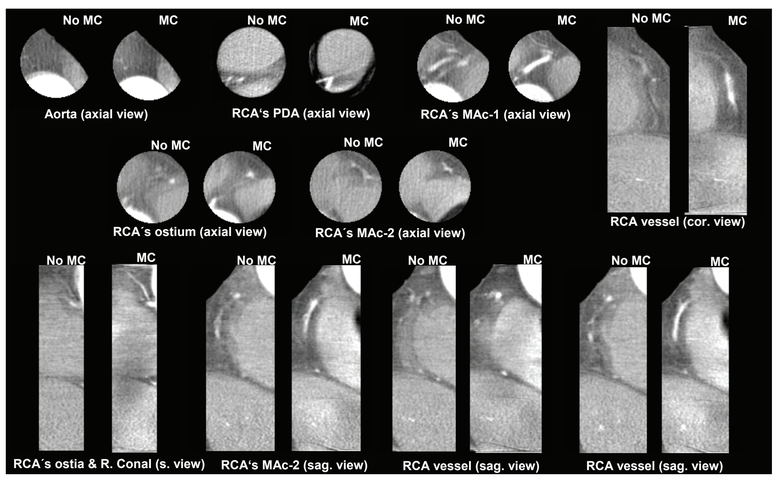
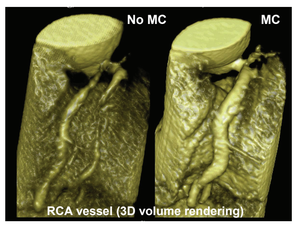


Image formation of the reconstructed motion map

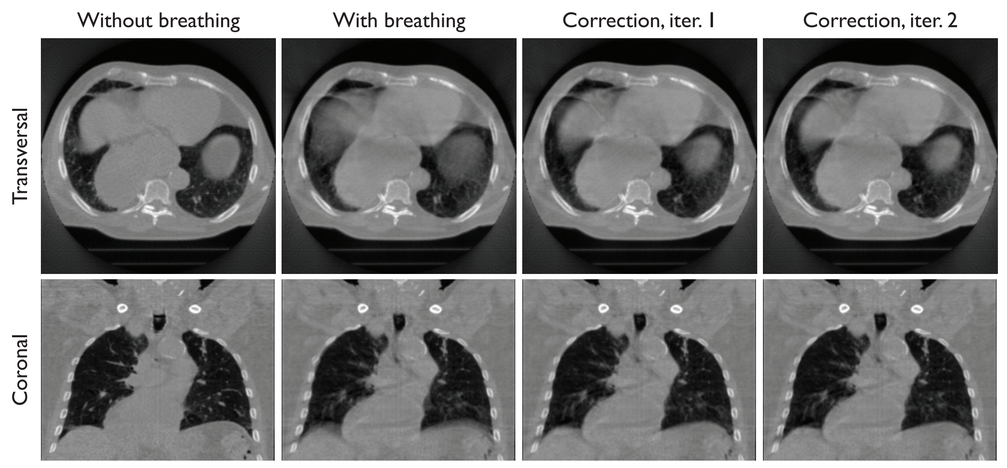
3. RESULTS





Reconstructions w and w/o motion compensation (MC), 15 iterations

3. RESULTS



The image quality improves progessively with motion correction

CONCLUSION

- Motion compensation for iterative and analytical reconstruction improves image quality for both gated (4D) and static (3D) reconstructions
- The movements of organs are estimated by an elastic image registration technique
- A motion compensation is applied locally within the image reconstruction, in a region of interest

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