# Dynamic registration of Cardiac MR Images

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**Introduction:** Functional analysis of the heart, especially the analysis of myocardial function, is important for the diagnosis of heart diseases, the planning of therapy and the understanding of the effect of cardiac drugs on regional function.[1] Four-dimensional (3D volume + time) dynamic cardiac imaging modalities like magnetic resonance imaging (Cine MRT) give the possibility to examine the beating heart in a non-invasive way.
This paper proposes an approach for the 4D registration of two different Cine MRT Data of the same patient to combine datasets in rest with those under the influence of Dobutamin. The ability to register and combine information from those datasets could improve the detection and understanding of abnormal wall motion.

## Methods:

**Data:** Modern dynamic image acquisition techniques allow for a non-invasive imaging of the beating heart. Thus, ischemic areas of the heart's wall can be detected by analyzing the left ventricular myocardial function. The functional analysis is even more promising when putting the heart cycle under stress. Due to pharmacologic and physical stress, the heart circulates three to four time as much as in resting state. Therefore abnormal wall motion can be detected easier under stress[2]. The patient data were therefore acquired with and without the influence of Dobutamin.

**Temporal Adaptation**: Temporal adaptation is necessary to obtain volume data sets representing the heart at the same point in the cardiac cycle. A new virtual Cine MRT dataset was created from the dataset including less time steps. As corresponding point in the cardiac cycle we used the end diastole, since at this point the changes in the volume are minimal. This data was then used as starting point for recalculating a new cardiac cycle using the Level Set Method proposed by Vermuri et al.[3] The deformation field between each step in the cardiac cycle was then either calculated using the whole dataset or based on an automatic region of interest including the left ventricle as proposed by Nowak[4]. Depending on the temporal resolution of the second dataset a new cardiac cycle was then created based on this deformation fields.

**Spatial Registration:** After creating the new Cine MRT, the registration of each corresponding point in the cardiac cycle was performed using the mutual information criterion[5]. The results were then fused for visual verification.

**Results:** Based on the outcome of the registration one dataset was reformatted and fused with the other. The spatial registration showed that it was not necessary to perform the registration for each step separately, but the Transformation was calculated once and then transferred to the other points of the cardiac cycle. Results of the registration are displayed in Figure 1.

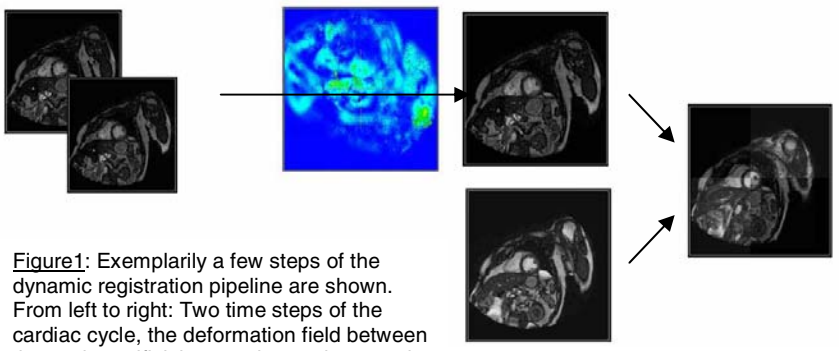

Figure1: Exemplarily a few steps of the dynamic registration pipeline are shown. From left to right: Two time steps of the cardiac cycle, the deformation field between those, the artificial created new phase and one time step of the second Cine MRT and one of the fused volumes

**Discussion:** The results presented in this paper show that the 4D registration of Cine MRT data is possible and features extracted from both datasets can be fused into a single representation. Herewith functional analysis of the left ventricle can be improved.
However the methodology has to be further tested and evaluated. Future work will concentrate on developing further methods for the visualization of registered dynamic data and establishing methods to quantify and evaluate the results.

## Literature:

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