ETSIP012 Convolutional Recurrent Neural Networks for Dynamic MR Image Reconstruction

Abstract

Accelerating the data acquisition of dynamic magnetic resonance imaging (MRI) leads to a challenging ill-posed inverse problem, which has received great interest from both the signal processing and machine learning communities over the last decades. The key ingredient to the problem is how to exploit the temporal correlations of the MR sequence to resolve aliasing artefacts. Traditionally, such observation led to a formulation of an optimisation problem, which was solved using iterative algorithms. Recently, however, deep learning based-approaches have gained significant popularity due to their ability to solve general inverse problems. In this work, we propose a unique, novel convolutional recurrent neural network (CRNN) architecture which reconstructs high quality cardiac MR images from highly undersampled k-space data by jointly exploiting the dependencies of the temporal sequences as well as the iterative nature of the traditional optimisation algorithms. In particular, the proposed architecture embeds the structure of the traditional iterative algorithms, efficiently modelling the recurrence of the iterative reconstruction stages by using recurrent hidden connections over such iterations. In addition, spatio-temporal dependencies are simultaneously learnt by exploiting bidirectional recurrent hidden connections across time sequences. The proposed method is able to learn both the temporal dependency and the iterative reconstruction process effectively with only a very small number of parameters, while outperforming current MR reconstruction methods in terms of reconstruction accuracy and speed.

Index Terms—Recurrent neural network, convolutional neural network, dynamic magnetic resonance imaging, cardiac image reconstruction.