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CSpA-DN: Channel and Spatial Attention Dense Network for Fusing PET and MRI Images

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1 Abstract

In this paper, we propose a novel fusion framework based on a dense network with channel and spatial attention (CSpA-DN) for PET and MR images. In our approach, an encoder composed of the densely connected neural network is constructed to extract features from source images, and a decoder network is leveraged to yield the fused image from these features. Simultaneously, a self-attention mechanism is introduced in the encoder and decoder to further integrate local features along with their global dependencies adaptively. The extracted feature of each spatial position is synthesized by a weighted summation of those features at the same row and column with this position via a spatial attention module. Meanwhile, the interdependent relationship of all feature maps is integrated by a channel attention module. The summation of the outputs of these two attention modules is fed into the decoder and the fused image is generated. Experimental results illustrate the superiorities of our proposed CSpA-DN model compared with state-of-the-art methods in PET and MR images fusion according to both visual perception and objective assessment.

2 Proposed CSPA-DN Model

- The network architecture of our proposed CSpA-DN fusion model consists of an encoder network, an attention network and a decoder, as shown in Fig. 1.

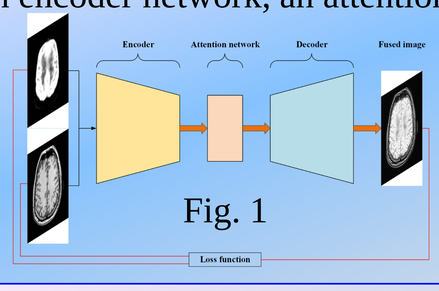


Fig. 1

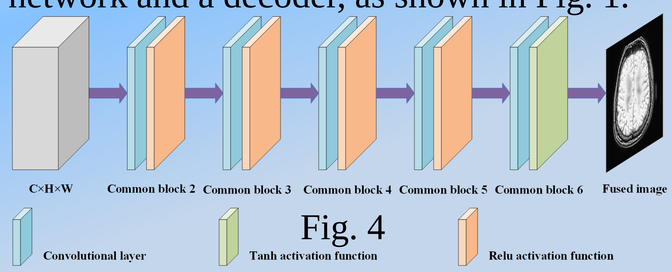
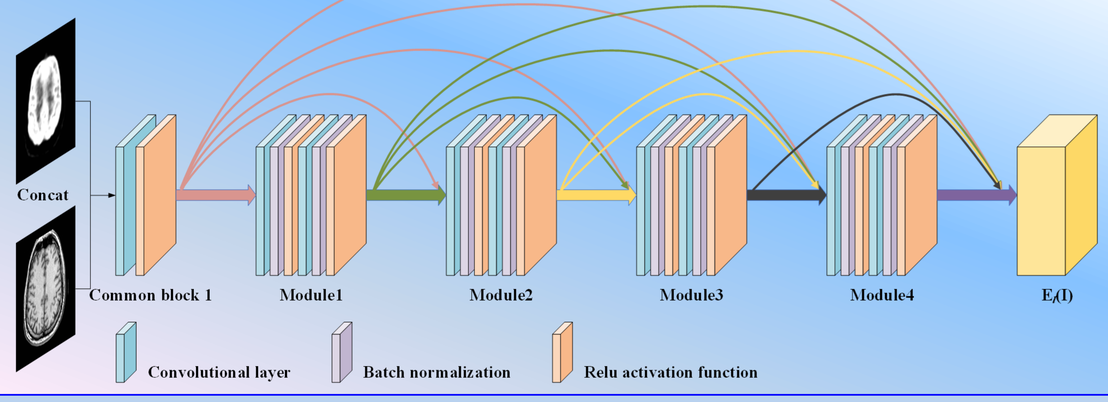
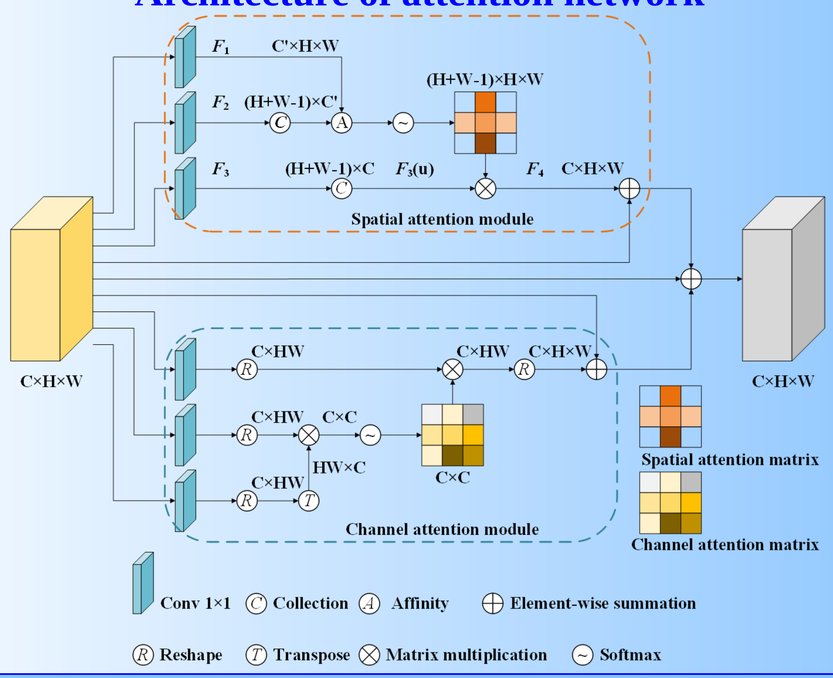


Fig. 4

3 Encoder network

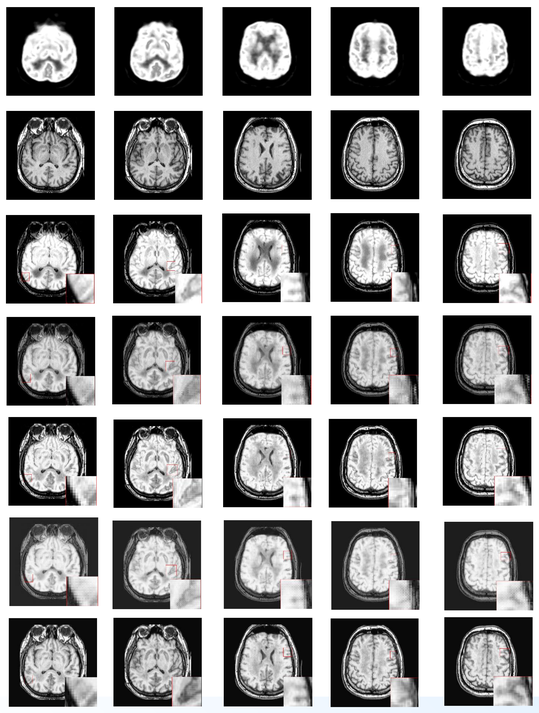


4 Architecture of attention network



5 Experimental Results

- *Qualitative experiments*



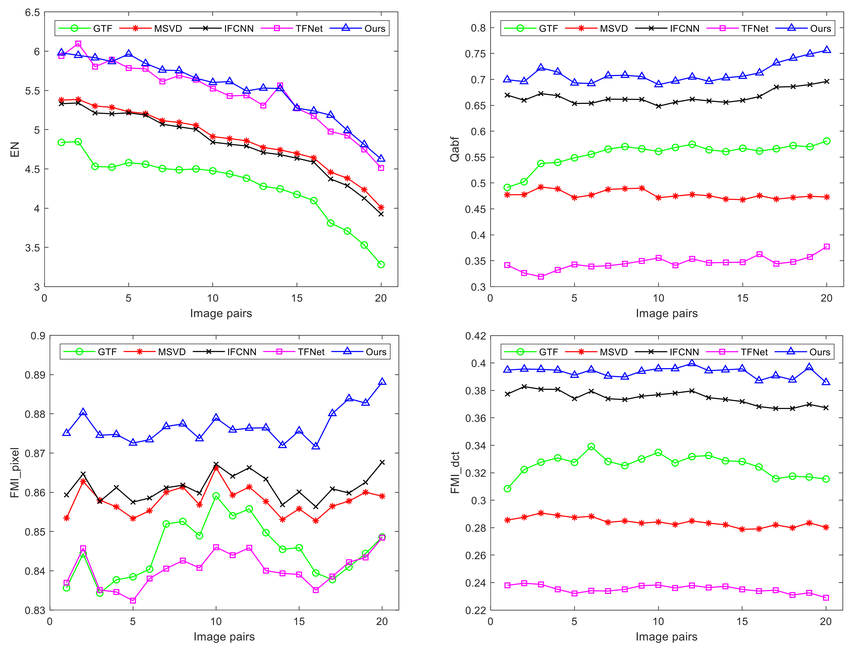
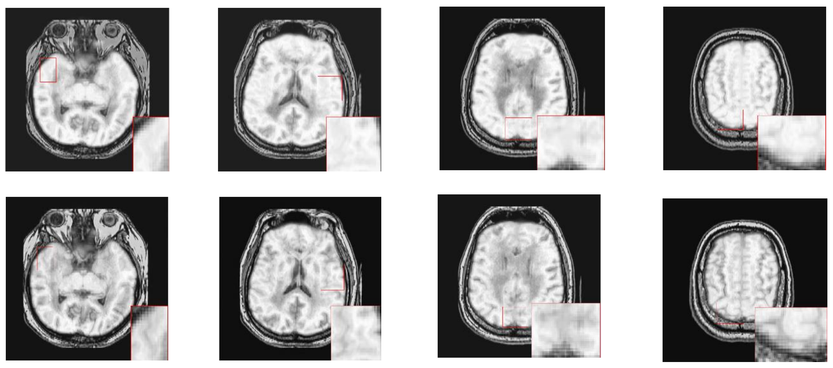


Fig. 6 Objective assessment scores of four fusion metrics using five methods on twenty pairs of PET and MRI images.

- *Quantitative analysis*

	EN	Q_{abf}	FMI_pixel	FMI_dct
GTF	4.2897	0.5562	0.8453	0.3256
MSVD	4.8821	0.4776	0.8578	0.2841
IFCNN	4.8187	0.6663	0.8613	0.3746
TFNet	5.4555	0.3457	0.8404	0.2353
Ours	**5.5289**	**0.7111**	**0.8770**	**0.3933**

- *Ablation study*



6 Conclusion

- We propose a novel fusion framework, named CSpA-DN, based on a densely connected network with channel and spatial attention for PET and MR images.
- Experimental results demonstrate the better performance of our proposed CSpA-DN fusion model compared with other four fusion approaches.
- The ablation experiments illustrate that the self-attention mechanism in our fusion model can effectively preserve more structural information from the source images.