



Memory-Augmented Model-Driven Network for Pan-sharpening

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Contributions

Our main contributions are summarized in the following three aspects:

- By extending the iterative algorithm into a multistage solution that combines the benefits of both model-based and data-driven deep learning techniques, we present a novel interpretable memory-augmented model-driven network (MMNet) for Pan-sharpening. The interpretation of the deep model is enhanced by such a design.
- To address the significant information loss problem in the signal flow, we suggest a new memory mechanism which is orthogonal to signal flow and develop a non-local cross-modality module. Such a design enhances the deep model's capacity for representation.
- Extensive experiments over three satellite datasets demonstrate that our proposed network outperforms other state-of-the-art algorithms both qualitatively and quantitatively.

Proposed approach

Model formulation:

The degradation process by using the maximum a posterior principle can be reformulated as:

$$\max_{\mathbf{H}} \frac{1}{2} ||\mathbf{L} - \mathbf{DKH}||_2^2 + \eta \Omega_l(\mathbf{H}|\mathbf{P}) + \lambda \Omega_{NL}(\mathbf{H}|\mathbf{P})$$

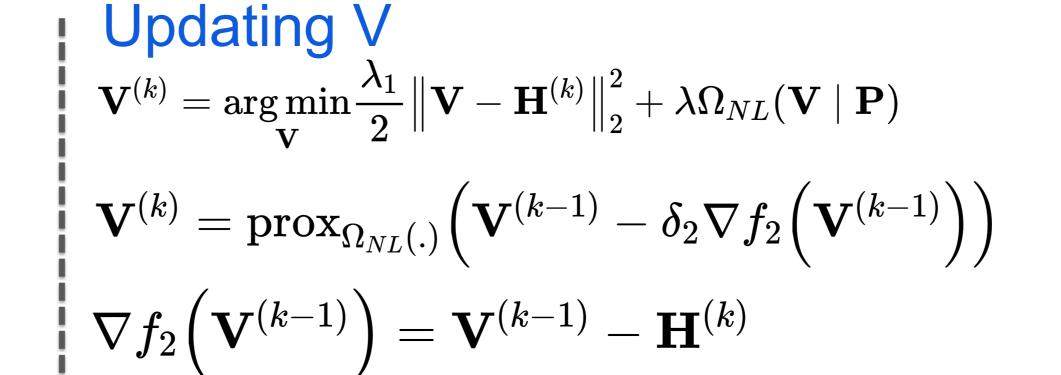
We solve the optimization problem using half-quadratic splitting (HQS) algorithm:

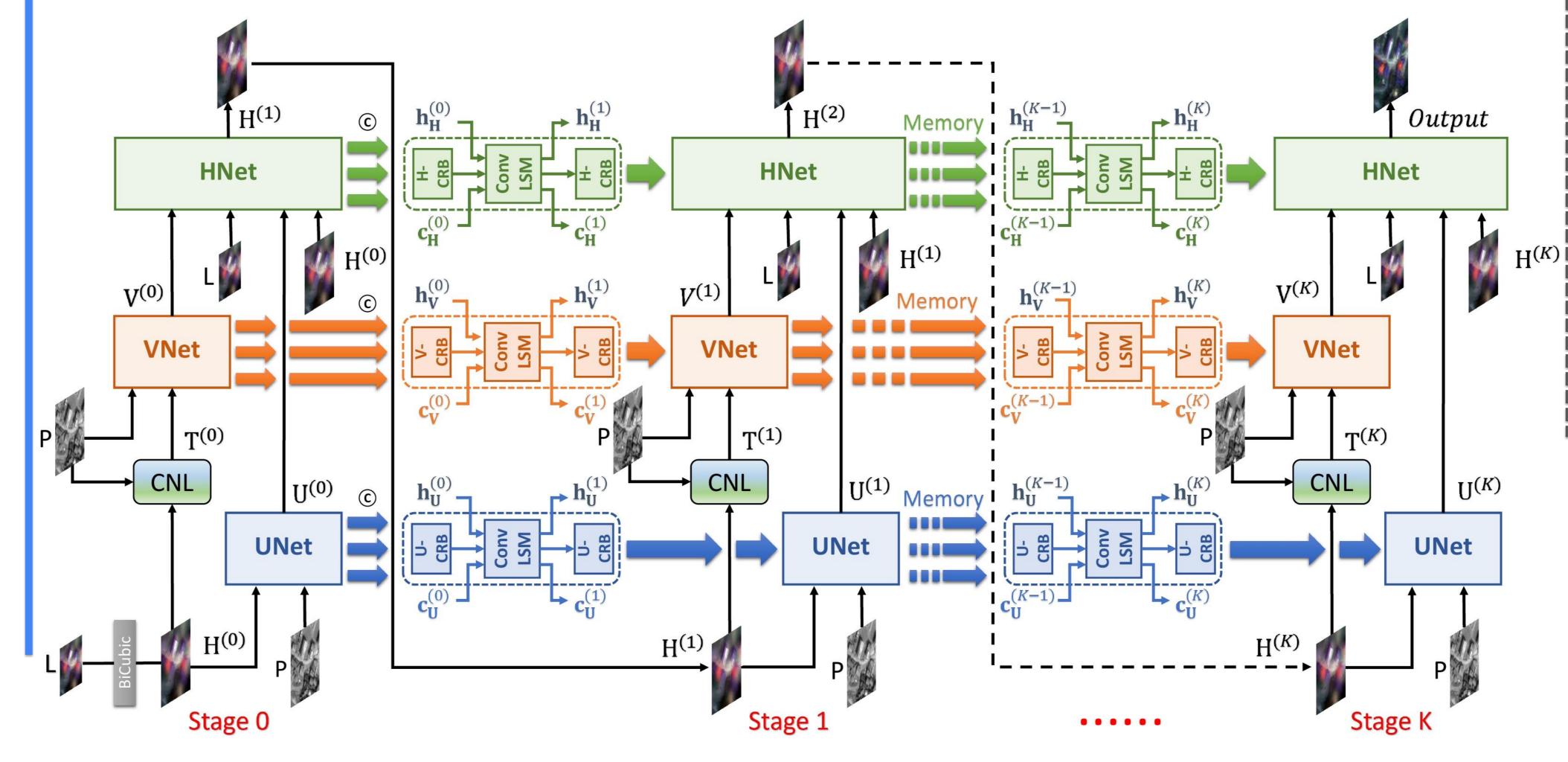
$$\min_{\mathbf{H},\mathbf{U},\mathbf{V}} rac{1}{2} \|\mathbf{L} - \mathbf{D}\mathbf{K}\mathbf{H}\|_2^2 + rac{\eta_1}{2} \|\mathbf{U} - \mathbf{H}\|_2^2 + \eta \Omega_l(\mathbf{U} \mid \mathbf{P}) + rac{\lambda_1}{2} \|\mathbf{V} - \mathbf{H}\|_2^2 + \lambda \Omega_{NL}(\mathbf{V} \mid \mathbf{P})$$

Updating U, V, and H alternately:

Updating U

$$egin{aligned} \mathbf{U}^{(k)} &= rg \min_{\mathbf{U}} rac{\eta_1}{2} ig\| \mathbf{U} - \mathbf{H}^{(k)} ig\|_2^2 + \eta_2 \Omega_l(\mathbf{U} \mid \mathbf{P}) \ \mathbf{U}^{(k)} &= \operatorname{prox}_{\Omega_l(.)} \Big(\mathbf{U}^{(k-1)} - \delta_1
abla f_1 \Big(\mathbf{U}^{(k-1)} \Big) \Big) \
abla f_1 \Big(\mathbf{U}^{(k-1)} \Big) &= \mathbf{U}^{(k-1)} - \mathbf{H}^{(k)} \end{aligned}$$





Updating H

$$egin{aligned} \mathbf{H}^{(k+1)} &= rg \min_{\mathbf{H}} rac{1}{2} \|\mathbf{L} - \mathbf{D} \mathbf{K} \mathbf{H}\|_2^2 \ &+ rac{\eta_1}{2} \|\mathbf{U}^{(k)} - \mathbf{H}\|_2^2 \ &+ rac{\lambda_1}{2} \|\mathbf{V}^{(k)} - \mathbf{H}\|_2^2 \end{aligned}$$

$$\mathbf{H}^{(k+1)} = \mathbf{H}^{(k)} - \delta_3
abla f_3 \Big(\mathbf{H}^{(k)} \Big)$$

$$egin{aligned}
abla f_3 \Big(\mathbf{H}^{(k)} \Big) &= (\mathbf{D}\mathbf{K})^T \Big(\mathbf{D}\mathbf{K}\mathbf{H}^{(k)} - \mathbf{L} \Big) \ &+ \eta_1 \Big(\mathbf{H}^{(k)} - \mathbf{U}^{(k)} \Big) \ &+ \lambda_1 \Big(\mathbf{H}^{(k)} - \mathbf{V}^{(k)} \Big), \end{aligned}$$