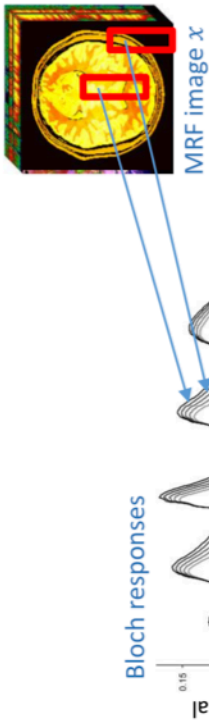# Compressive MR Fingerprinting Reconstruction with Neural Proximal Gradient Iterations *(accepted to MICCAI'20)*

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Proximal Gradient Descent Network (PGD-Net)

(b) Encoder: G — ReLu 64,3×3 · ReLu 64,3×3 · ReLu 64,3×3 ⊕ · ReLu 10,3×3 ⊕ · ReLu 64,1×1 · ReLu 64,1×1 · 10, 1×1 → $m^{(t)}$

(c) Decoder: Bloch — $m^{(t)}$ · 300,1×1 · ReLu · 10,1×1 → $x^{(t)}$

(a) PGD-Net · Prox

$y = H(x) + \xi$ where, for each voxel $x_v \approx \dfrac{\rho_v \mathcal{B}(T1_v, T2_v)}{m}$

$$\arg\min_{x,m} \|y - Hx\|_2^2 + \phi(x, m)$$

$$\text{PGD}:\begin{cases} g^{(t+1)} = x^{(t)} + \alpha^{(t)} H^H(y - Hx^{(t)}) & \rightarrow \text{Gradient with step size } \alpha \\ \{x^{(t+1)}, m^{(t+1)}\} = \text{Prox}_\phi(g^{(t+1)}) & \rightarrow \text{Proximal update} \end{cases}$$

Deep Neural Network

$$\text{Prox} := \textsc{Bloch} \circ \mathcal{G}$$

$$\mathcal{L} = \gamma \sum_{i=1}^{N} \ell\left(x_i, x_i^{(T)}\right) + \sum_{j \in \{T_1, T_2, \rho\}} \beta_j \sum_{i=1}^{N} \ell\left(m_{ij}, m_{ij}^{(T)}\right) + \lambda \sum_{t=1}^{T} \sum_{i=1}^{N} \ell\left(y_i, Hx_i^{(t)}\right)$$

Bloch responses · Signal · Repetition time · MRF image x · Subsampled Fourier transformation
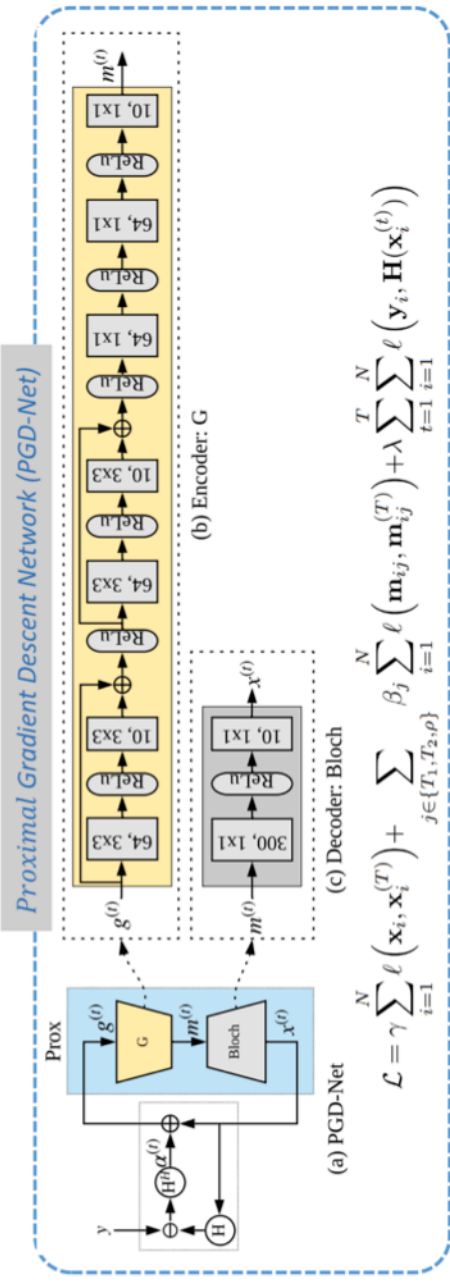
Table 1: Average errors (NRMSE, SSIM, MAE), memory (for storing a dictionary or a network) and runtimes (per image sclice) required for computing T1, T2 and PD maps using the MRF baselines and our PGD-NET algorithm.

	NRMSE			SSIM			MAE		time (msec) (sec)	memory (MB)
	T1	T2	PD	T1	T2	PD	T1	T2		
FGM	0.475	0.354	1.12	0.614	0.652	0.687	350.0	14.6	1.29	8.81
BLIP+FGM	0.230	0.545	0.073	0.886	0.880	0.984	91.7	8.0	79.28	8.81
MRFCNN	0.155	0.158	0.063	0.943	0.972	0.987	80.3	5.4	0.083	4.72
SCQ	0.172	0.177	0.064	0.929	0.967	0.984	91.7	6.1	0.132	464.51
$\mathcal{G}$ (encoder alone)	0.142	0.155	0.065	0.948	0.973	0.987	77.1	5.6	**0.067**	**0.55**
PGD-NET ($T=2$)	0.104	0.138	0.050	0.973	0.979	0.991	59.9	5.0	0.078	0.57
PGD-NET ($T=5$)	**0.100**	**0.132**	**0.045**	**0.975**	**0.981**	**0.992**	**50.8**	**4.6**	0.103	0.57

The proposed *PGD-Net*:
- ☐ State-of-the-art MRF reconstruction
- ☐ interpretable and Physics-engaged
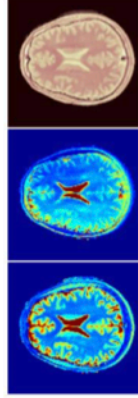- ☐ Cheaper computation
- ☐ Cheaper memory

T1 (sec) · T1 error · T2 (sec) · T2 error · PD (a.u.) · PD error