Low Compute and Fully Parallel Computer Vision with HashMatch

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1. Pseudocode for Least squares

For completeness, we report here the pseudocode for the algorithm proposed in Sec. 3.2 and used in the experiments of this work where we used least-squares as both the loss function $\mathcal{L}$ and the dissimilarity $\mathcal{D}$ in Eq. (7). In this setting, Eq. (7) becomes

$$\min_{W,Z,B} \quad \|BZ - Y\|^2 + \lambda|W|_1 + \eta\|Z\|^2 + \gamma \, \|XW - B\|^2 \quad \text{s.t. } \|B\|_\infty \leq \mu. \tag{1}$$

We can therefore apply the PALM implementation of HashMatch described in Sec. 3.2 to optimize over (W_t, B_t, Z_t) by iteratively performing the descent steps at Eq. (8,9,11), updating one variable at the time while keeping the other fixed. The pseudocode for HashMatch considered in this work is reported in Alg. 1 in MATLAB notation.

Algorithm 1 HASHMATCH

Input: $\mathbf{X} \in \mathbb{R}^{m \times n}, \mathbf{Y} \in \mathbb{R}^{m \times d}, \lambda, \eta, \gamma, \mu > 0.$
Stopping Conditions: max iterations T, step threshold ϵ

Initialize:
$\mathbf{B}_1$ uniform random sample entries from $\{-\mu, \mu\}$
$\mathbf{W}_1$, $\mathbf{Z}_1$ initialization from a random distribution
Step Sizes:

$$\sigma_1 = \frac{1}{2\gamma\|X\|_{op}^2}, \sigma_2 = \frac{1}{2\eta^2\mu + 2\gamma}, \sigma_3 = \frac{1}{2\mu^2 m^2 + 2\eta}$$

For $t = 0$ **to** T

Update $\mathbf{Z}$

$$Z_{t+1} = Z_t - 2\sigma_3(B_t^\top(B_t Z_t - Y) + \eta Z_t)$$

Update $\mathbf{W}$

$$W_{t+1} = W_t - 2\sigma_1\gamma(X^\top X W_t - X^\top B_t)$$
$$W_{t+1} = W_{t+1} - \sigma_1\lambda \, \text{SIGN}(W_{t+1})$$
$$W_{t+1}(\text{ABS}(W_{t+1}) \leq \sigma_1\lambda) = 0$$

Update $\mathbf{B}$

$$\widetilde{B} = B_t - 2\sigma_2(B_t Z_{t+1} Z_{t+1}^\top - Y Z_{t+1}^\top) + 2\sigma_2\gamma(XW_{t+1} - B_t)$$
$$\bar{B} = \widetilde{B} - \mu \, \text{SIGN}(\widetilde{B})$$
$$\bar{B}(\text{ABS}(\bar{B}) \leq \mu) = 0$$
$$B_{t+1} = \widetilde{B} - \bar{B}$$

If $\|(W_t, B_t, Z_t) - (W_{t+1}, B_{t+1}, Z_{t+1})\| \leq \epsilon$
BREAK
End

End

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