Correction to "Dynamically regularized RLS-DCD algorithm and its FPGA implementation"

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***Abstract*—The authors wish to correct an error made in a publication submitted to the 2008 42nd Asilomar Conference on Signals, Systems and Computers. The paper entitled: Dynamically regularized RLS-DCD algorithm and its FPGA implementation, has a mistake in one step of the proposed algorithm. This causes the algorithm not to perform correctly in many scenarios.**

THE following corrections are for manuscript [1]. In table 1, step 3; the variable $\beta_0(i)$ is computed incorrectly. This computation is part of a modification to an algorithm described in [2].

Recall equation (6) in [1],

$$\beta_0(i) = R(i)\Delta h(i) \tag{1}$$

Using (4) in [1],

$$\beta_0(i) = r(i-1) + \Delta\beta(i) - \Delta R(i)\hat{h}(i-1) \tag{2}$$

Plugging (5) from [1] in (2),

$$\begin{aligned}\beta_0(i) = r(i-1) + \Delta\beta(i) - ((\lambda-1)R(i-1) \\ + x(i)x^H(i) + (\delta(i) - \lambda\delta(i-1))I)\hat{h}(i-1)\end{aligned} \tag{3}$$

Opening the brackets,

$$\begin{aligned}\beta_0(i) = r(i-1) + \Delta\beta(i) + (1-\lambda)R(i-1)\hat{h}(i-1) \\ - x(i)x^H(i)\hat{h}(i-1) - (\delta(i) - \lambda\delta(i-1))\hat{h}(i-1)\end{aligned} \tag{4}$$

We use the fact that $y(i) = x^H(i)\hat{h}(i-1)$ and $R(i-1)\hat{h}(i-1) = \beta(i-1) - r(i-1)$ and plug this into (4),

$$\begin{aligned}\beta_0(i) = r(i-1) + \Delta\beta(i) + (1-\lambda)(\beta(i-1) - r(i-1)) \\ - x(i)x^H(i)\hat{h}(i-1) - (\delta(i) - \lambda\delta(i-1))\hat{h}(i-1)\end{aligned} \tag{5}$$

The error in [1] is that they used $R(i-1)\hat{h}(i-1) = \beta(i) - r(i-1)$ which is incorrect.
If we continue to develop (5),

$$\begin{aligned}\beta_0(i) = \lambda r(i-1) + \beta(i) - \lambda\beta(i-1) \\ - x(i)x^H(i)\hat{h}(i-1) - (\delta(i) - \lambda\delta(i-1))\hat{h}(i-1)\end{aligned} \tag{6}$$

Adding a regularization term doesn't affect the computation of $\beta(i)$, so we will plug (13) from [2] into (6),

$$\begin{aligned}\beta_0(i) = \lambda r(i-1) + z(i)x(i) \\ - x(i)x^H(i)\hat{h}(i-1) - (\delta(i) - \lambda\delta(i-1))\hat{h}(i-1)\end{aligned} \tag{7}$$

Finally we get,

$$\begin{aligned}\beta_0(i) = \lambda r(i-1) + x(i)e(i) \\ - (\delta(i) - \lambda\delta(i-1))\hat{h}(i-1)\end{aligned} \tag{8}$$

Where $e(i) = z(i) - x^H(i)\hat{h}(i-1)$ which is consistent with (19) in [2].

Finally, for $\delta(i) = 0$, the corrected algorithm coincides with the algorithm in [2] as expected.

REFERENCES

[1] J. Liu and Y. Zakharov, "Dynamically regularized rls-dcd algorithm and its fpga implementation," in *Signals, Systems and Computers, 2008 42nd Asilomar Conference on*. IEEE, 2008, pp. 1876–1880.

[2] Y. V. Zakharov, G. P. White, and J. Liu, "Low-complexity rls algorithms using dichotomous coordinate descent iterations," *IEEE Transactions on Signal Processing*, vol. 56, no. 7, pp. 3150–3161, 2008.