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CORRECTION

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Correction to: Channel estimation for massive MIMO TDD systems assuming pilot contamination and flat fading

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1 Correction

In the original publication [1] were several parts incorrect. The corrected versions can be found below. The original article has been updated to rectify these errors.

Equation 3:

$$\mathbf{Y}_i = \underbrace{\sqrt{q}\mathbf{G}_{ii}\mathbf{S}^H}_{\text{Desired pilot signals}} + \underbrace{\sqrt{q}\sum_{l=1,l\neq i}^{L}\mathbf{G}_{il}\mathbf{S}^H}_{\text{Undesired pilot signals}} + \underbrace{\mathbf{N}_i}_{\text{Noise}}.$$

Equation 4:

$$\mathbf{z}_{ik} = \frac{1}{\sqrt{q}N}\mathbf{Y}_i\mathbf{s}_k = \sum_{l=1}^{L}\mathbf{g}_{ilk} + \frac{\mathbf{N}_i\mathbf{s}_k}{\sqrt{q}N}$$
$$= \underbrace{\mathbf{g}_{iik}}_{\text{Desired channel}} + \underbrace{\sum_{l=1,l\neq i}^{L}\mathbf{g}_{ilk}}_{\text{Inter-cell interference}} + \underbrace{\frac{\mathbf{N}_i\mathbf{s}_k}{\sqrt{q}N}}_{\text{Noise}}.$$

Paragraph under Proposed Channel Estimator:

The proposed estimator for _ik makes the acquisition of inter-cell large-scale fading coefficients unnecessary. The task of gaining knowledge of those coefficients may be unjustifiable in practice due to the excessive, e.g., in case there are L cells serving K users in each one of them, each BS needs to acquire (L – 1)K inter-cell large-scale coefficients.

This estimator approaches the ideal MMSE estimator asymptotically with respect to M and has $\mathbb{E}[\hat{\mathbf{g}}_{iik}^{\text{prop}}] = \mathbf{0}_M$ and variance given by

$$\text{Var}[\hat{\mathbf{g}}_{iik}^{\text{prop}}] = \mathbb{E}[\hat{\mathbf{g}}_{iik}^{\text{prop}}(\hat{\mathbf{g}}_{iik}^{\text{prop}})^H] = \left(\frac{M}{M-1}\frac{\beta_{iik}^2}{\zeta_{ik}}\right)\mathbf{I}_M. \tag{13}$$

As can be seen by analyzing equation (13), as $M \to \infty$, $\text{Var}[\hat{\mathbf{g}}_{iik}^{\text{prop}}] \to \frac{\beta_{iik}^2}{\zeta_{ik}}$.

Paragraph and equations under Remark 3:

For the sake of clarity, we reproduce below the closed-form MSE equation (9) presented in [21].

$$\eta_{ik}^{\text{prop(closed-form)}} = \frac{M}{M-1}\frac{\beta_{iik}^2}{\zeta_{ik}} + \beta_{iik} - 2\beta_{iik}\theta_{ik} \tag{15}$$

where

$$\theta_{ik} = \int_0^1\int_{-1}^1 \frac{k_{ik}^2(1-t) + k_{ik}w\sqrt{t(1-t)}}{k_{ik}^2(1-t) + 2k_{ik}w\sqrt{t(1-t)} + t} .f_T(t)f_W(w)dwdt \tag{16}$$

with $k_{ik} = \sqrt{\frac{\beta_{iik}}{\zeta_{ik} - \beta_{iik}}}$, and $f_T(t)$ and $f_W(w)$ are given by

$$f_T(t) = \frac{\Gamma(2M)}{(\Gamma(M))^2}(t(1-t))^{M-1}, 0 < t < 1 \tag{17}$$

$$f_W(w) = \frac{M}{\pi}B\left(\frac{1}{2}, M\right)(1-w^2)^{M-\frac{1}{2}}, |w| < 1. \tag{18}$$

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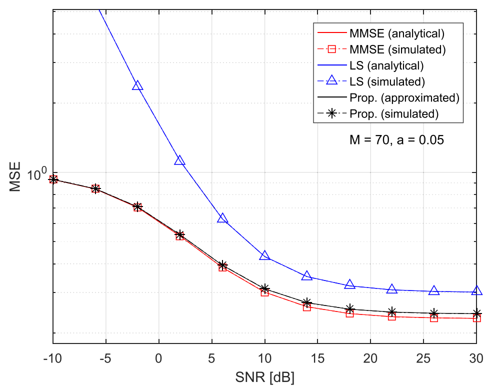
Figure 3



Channel Estimation MSE versus uplink pilot power.

Paragraph under Numerical Results and Discussion.

In Fig. 4, we compare MSE versus the number of BS antennas M under the setting of $a = 0.05$ and TX SNR $q = 10$ dB. With the increase of M, the MSE of the proposed estimator approaches that of

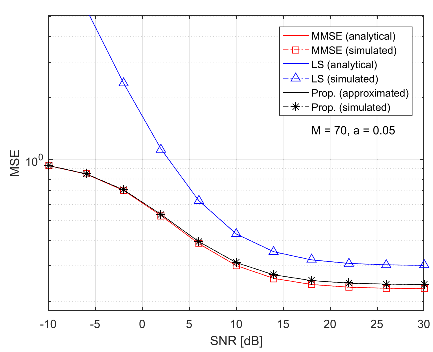


Figure 3 Channel Estimation MSE versus uplink pilot power.

the ideal MMSE, while the MSE of LS estimator does not change. Due to numerical issues, the closed-form MSE expression presented in [21] does not produce values for $M > 85$. During our simulations, comparing the closed-form expression given by equation (15) and the approximated MSE expression given by (14), we noticed that the $\Gamma(2M)$ function in the numerator of equation (16) grows without bound, reaching values that are greater than the largest possible finite floating-point number represented by the IEEE double precision format, i.e., $1.7977e{+}308$ [30], for values of M greater than 85. A double precision variable goes to +Inf after the largest possible number [30]. On the other hand, as can be seen in Fig. 4, the approximate analytical MSE expression (14) does not present the same problem and, therefore, can be used to evaluate the MSE for any number of antennas, M without any numerical issue.

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Reference

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