Two-Step Transmit Antenna Selection Algorithms for Massive MIMO

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Abstract—In this paper, we propose a two-step algorithm that can achieve any tradeoff point between antenna selection complexity and performance for a massive multiple-input multiple-output (M-MIMO) system. The first and second steps target low complexity and high performance, respectively, in the antenna selection. For the first-step antenna selection, we propose a correlation-based best-first selection algorithm that selects the least spatially correlated antennas. For the second-step selection, we consider a performance-aware algorithm that maximizes the singular values of a selected channel matrix. By adjusting the number of selected antennas in each step, we can actively balance the complexity and performance of the M-MIMO system. The computational complexity and the bit-error-rate performance of various antenna selection algorithms have been analyzed and compared. The investigation in the paper provides a good reference for further study for an antenna selection-based M-MIMO system.

Index Terms—Massive MIMO, antenna selection, algorithms.

I. INTRODUCTION

For massive multiple-input multiple-output (M-MIMO) systems, a few tens or hundreds of transmit antennas are possibly employed. To gain downlink channel state information (CSI) of the massive antennas at a transmitter, huge amount of feedback is required through uplink for a frequency division duplex (FDD) system. To resolve the feedback overhead issue, CSI compression methods have been studied [1], [2]. On the other hand, time division duplex (TDD) operation can circumvent the overhead issue as the downlink CSI can be obtained from uplink CSI by using the channel reciprocity. However, there is a pilot contamination issue in the estimation of massive uplink channels, which causes CSI uncertainty at the transmitter [3]. The channel uncertainty deteriorates communications performance far from the system’s optimal performance. Thus, many studies consider CSI uncertainty robust strategies, e.g., antenna selection [4]–[7].

Once a transmitter selects a part of transmit antennas, channel re-estimation could be performed for the selected antennas. The estimation accuracy for the partial transmit antennas would be improved as the dimension of the target estimation reduces. Then, with the more reliable CSI, the transmitter can employ various typical MIMO transmission techniques, such as beamforming and multiuser MIMO [8]. An antenna selection strategy can also overcome high system complexity and hardware energy consumption, which are caused from the very large scale of transmit antennas and radio frequency (RF) chains. The partial use of antennas is justified from [4], in which the authors state that some of antennas (channels) may not contribute significantly for the reliable communications. Furthermore, deactivating a part of transmit antennas and the corresponding RF devices may increase the life span of the RF devices. However, one critical issue what we have to address for the antenna selection in M-MIMO system is prohibitively enormous computational complexity at a transmitter (or a receiver when the receiver selects the transmit antenna and feeds back the antenna indices) because of the tremendous combinations of antenna candidates not just because of the computation of selection metrics, such as channel matrix’s singular values [5], channel norm [4], [6], spatial correlation [7], and energy consumption [9].

In this paper, we are focusing on reducing the number of possible antenna combinations. To this end, we propose a two-step algorithm. We divide selection procedure into two steps. In the first step, a transmitter selects \( N_p \) candidate antennas from total \( N \) antennas using a simple (less complex) algorithms, such as norm-based, received-power-based, and random selection algorithms. In the second step, using a performance-aware algorithm maximizing singular values of a channel matrix, the transmitter selects \( N_s \) antennas from the \( N_p \) antennas, which are re-selected in the first step.

From the first-step selection, we can effectively reduce the number of candidate combinations for the subsequent second-step selection. Moreover, we propose a correlation-based best-first (CBF) selection algorithm that selects the best antenna such that the selected antennas are less correlated in spatial domain, which can be employed at the first-step selection. The CBF algorithm requires low computational complexity and achieves better communications performance compared to the existing heuristic algorithms. The proposed low-complexity CBF algorithm allows a receiver to select the transmit antennas and feed back the selected antenna index with their channel gains in a FDD system.

By adjusting \( N_p \), which determines a portion of selected antennas in the first and the second steps, the proposed algorithm can provide a flexible and adaptive solution between the performance and the complexity. The computational complexity of various antenna selection algorithms has been analyzed and their bit-error-rate (BER) performance of them...
has also been compared. The investigated results in the paper would be a good reference for further study of an M-MIMO antenna selection system.

The rest of the paper is organized as follows. In Section II, system model considered in the paper is introduced and a few existing methods for antenna selection are revisited. In Section III, we propose a new two-step antenna selection algorithm based on spatial correlation. Section IV provides comparison of the proposed and the existing antenna selection algorithms in terms of the computational complexity and BER performance. Section V concludes the paper.

II. SYSTEM MODEL AND REVIEW ON EXISTING ANTENNA SELECTION ALGORITHMS

Consider a transmitter with \( N_t \)-transmit antennas and a receiver with \( N_r \)-receive antennas. Using \( N_s \) transmit antennas selected from \( N_t \) transmit antennas, the transmitter sends \( N_d \) independent data streams to the receiver. Herein, for simple linear precoding and decoding at the transmitter and receiver, we assume \( N_d \leq \min\{N_r, N_s\} \). With CSI at the transmitter, singular-value-decomposition (SVD) based precoding and postprocessing are employed at the transmitter and the receiver, respectively. Denoting an \( N_d \)-stream data symbol vector as \( x \in \mathbb{C}^{N_r \times 1} \), a received signal vector \( y \in \mathbb{C}^{N_r \times 1} \) is represented as follows:

\[
y = H x V x + n,
\]

where \( H \) is an \( N_r \times N_s \) submatrix consisting of \( N_s \) selected column vectors from an \( N_r \)-by-\( N_t \) MIMO channel matrix \( H = [h_1 \cdots h_{N_s}] \) according to an antenna selection index in a set \( \mathcal{X} \); the MIMO channel \( H \) obeys spatially-correlated Rayleigh model in [1] and it is assumed to be perfectly estimated at a transmitter; \( V \) is an \( N_r \)-by-\( N_d \) precoding matrix that consists of \( N_d \) column vectors each of which is a row vector of right singular matrix of \( H \) corresponding to the \( N_d \) largest singular values, i.e., spatial multiplexing with eigen beamforming; herein, we assume equal power allocation across the antennas for simplicity [5]; and \( n \in \mathbb{C}^{N_r \times 1} \) is an additive white Gaussian noise (AWGN) at the receiver.

A. Singular Value Based Selection

After SVD-based receive processing, namely postprocessing with a left singular matrix \( U^H \in \mathbb{C}^{N_r \times N_r} \) and equalizing with the corresponding singular value matrix \( D \in \mathbb{R}^{N_s \times N_d} \) whose diagonal elements are the \( N_d \) largest singular values of \( H \), the estimate \( \hat{x} \) of \( x \) is obtained as

\[
\hat{x} = x + D^{-1} U^H n.
\]

Noting that the effective noise power depends only on the singular values in \( D \) and the \( D \) varies according to the transmit antenna selection \( \mathcal{X} \), the optimal selection criterion in terms of bit-error-rate (BER) is to maximize the \( N_d \)th largest singular value (denoted by MaxMinSV) in \( D \). Denoting a function to find all nonzero singular values of \( H \) by \( \text{sv}(H) \), the MaxMinSV algorithm is summarized at Algorithm 1.

Algorithm 1: MaxMinSV-based selection

1. input: channel matrix \( H \) and \( N_s \)
2. output: selected antenna set \( \mathcal{S} \subseteq \mathcal{A} \) where \( \mathcal{A} = \{1, \ldots, N_t\} \)
3. find a candidate set of all combination of antenna sets: \( \mathcal{C} = \{\pi_1, \ldots, \pi_{|\mathcal{C}|}\} \), where \( |\mathcal{C}| = \binom{N_t}{N_s} \) is the combination number;
4. \( \mathbf{S} = \pi_m^* \), where \( m^* = \arg \max_{\pi \in \mathcal{A}} \{\min [\text{sv}(H_{\pi_m})]_{N_d}\} \), where \( \min[\cdots]_a \) takes the \( a \)th largest element.

Algorithm 2: Gerschgorin circles based (GC) selection

1. input: channel matrix \( H \) and \( N_s \)
2. output: selected antenna set \( \mathcal{S} \subseteq \mathcal{A} \)
3. setup: \( \mathcal{S} = \emptyset \)
4. select the first antenna based on channel gain as follows:
5. \( \mathcal{S} \cup \{i^*\} \) where \( i^* = \arg \max_{i \in \mathcal{A}} \|h_i\| \) and \( \mathcal{A} \}\{i^*\} \)
6. for \( k = 2 : N_s \) do
7. \( \mathcal{S} \cup \{n^*\} \) where \( n^* = \arg \max_{\alpha \in \mathcal{A}} \{\alpha \} \) and \( \mathcal{A} \}\{n^*\} \)
end for

Though the Algorithm 1 provides the optimal BER performance, its computational complexity would be an issue due to the enormous combinations for the antenna selection, especially, when there are large number of transmit antennas. Formally, the number of candidate sets is \( \binom{N_t}{N_s} \). From an each candidate set, we construct an effective channel matrix \( H_{\pi_m} \) and find the singular values, where \( \pi_m \) is a set of \( m \)th combination of \( N_s \) selected antennas from \( \mathcal{A} \). This procedure requires \( \mathcal{O}(N_t^2 N_d^2) \) [10], which is the bottleneck computation of the algorithm as the computational complexity to find a minimum value increases linearly as the number of compared elements increases. Thus, the total complexity is roughly \( \mathcal{O}(N_t^4 N_d^2) \).

To compute the computational complexity of singular values (equivalently, eigen values), a Gerschgorin circles based (GC) algorithm was proposed to approximately maximize a minimum eigenvalue of the Hermitian matrix of channel matrix in [5]. The GC algorithm is summarized at Algorithm 2.

The computational complexity of a GC algorithm is analyzed as follows. For the first antenna selection, \( \mathcal{O}(N_t^2 N_d^2) \) and \( \mathcal{O}(N_t \log N_t) \) computational complexity is required to compute the channel gains and to find the maximum gain, respectively. To select the remaining \( N_s - 1 \) antennas, we select one antenna sequentially from \( k = 2 \) to \( k = N_s \).
Algorithm 3: Norm-based (NB) antenna selection

1. input: channel matrix $H$ and $N_s$
2. output: selected antenna set $S \subseteq A$
3. setup: $S = \emptyset$
4. for $k = 1 : N_s$ do
5. $n^* = \operatorname{arg\ max}_{n \in A} \|h_n\|$, where $h_n = H(\{n\})$
6. $S = S \cup \{n^*\}$ and $A = A \setminus \{n^*\}$
7. end for

Algorithm 4: Correlation-based worst-first (CWF) discarding

1. input: channel matrix $H$ and $N_s$
2. output: selected antenna set $S \subseteq A$
3. setup: $S = A$
4. discard $N_t - N_s$ antennas from $S$ as follows:
5. for $k = 1 : N_t - N_s$ do
6. Select two transmit antennas $i$ and $j$ which are most correlated and have low channel gain as $\{i, j\} = \operatorname{arg\ max}_{i,j\in S} \|h_i h_j^T\|$
7. Update antenna set by discarding one antenna which has smaller channel gain. If $\|h_i\| \leq \|h_j\|$, $S = S \setminus \{i\}$, and otherwise, $S = S \setminus \{j\}$
8. end for

Since $|S'|$ increases, yet $|A|$ decreases in each iteration of Algorithm 2, we scale the complexity when $k = 2$ by $(N_s - 1)$ and get the rough complexity of the whole sequential step. Consequently, the rough complexity of the GC algorithm is derived to $O(N_t N_s^2 + N_t \log N_t) + O((N_s - 1)(2N_t - 3)N_s^2 + (N_t - 1) \log (N_t - 1)) \approx O(N_t N_s^2 + N_t \log N_t) + O(N_t N_s N_t^2 + N_t \log N_t)$.

B. Power Based Selection

To reduce the computational complexity of the SVD-based algorithm, a norm-based (NB) selection has been considered. From reciprocity between uplink and downlink wireless channels in TDD systems, the norm of the channel column vector of $H$ represents the received power at the transmit antennas [4]. The heuristic norm-based (or power based [6]) algorithm selects a transmit antenna that has the largest norm in each greedy step as summarized in Algorithm 3.

To compute $\|h_n\|$ for all $n = 1, \ldots, N_t$, the required computational complexity is $O(N_t N_t^2)$. Then, the transmitter selects $N_s$ transmit antennas who are associated to the $N_s$ largest norm. To this end, the transmitter needs to sort the $N_t$ norms, which requires additional $O(N_t \log N_t)$ computational complexity. Though the NB selection algorithm can significantly reduce the computational complexity, performance degradation is nonnegligible.

C. Correlation Based Selection

To circumvent the severe performance degradation sustaining low computational complexity, we can consider a correlation-based algorithm. For receive antenna selection, correlation among the receive antennas has been quantified by an inner product of the vector channels, and accordingly receive antennas are selected, so as to the selected channels are not highly correlated and to sustain the large gain [7]. Since spatial correlation is severe at a transmitter of an M-MIMO system, we slightly modify the correlation based algorithm in [7] for transmit antenna selection as follows. First, a transmitter selects one pair of two antennas who are most highly correlated, and then, discard one of them which has lower channel gain. The transmitter repeats selecting a pair and discarding one antenna until there are $N_s$ antennas remained, so that the remaining $N_s$ antennas are correlated as less as possible and their channel gains are sustained as large as possible. Since the algorithm discarding the worst conditioned antenna, which has high correlation with other selected antenna and low channel gain, in greedy manner, we call this method a correlation-based worst-first (CWF) discarding algorithm, and summarize it in Algorithm 4.

For the correlation computation of one pair of two transmit antennas, $O(N_t^2)$ complexity is required. Since $\binom{N_t}{2}$ pairs exist, the complexity order would be $O(\binom{N_t}{2} N_t^2)$. For normalization, all the norm of $N_t$ channel column vectors should be computed, and it requires $O(\binom{N_t}{2} N_t^2)$. Finally, to select $N_s$ transmit antennas who are least correlated to one another, we need to sort the $\binom{N_t}{2}$ correlation values, which requires $O(\binom{N_t}{2} \log N_t)$ complexity.

III. PROPOSED TWO-STEP SELECTION ALGORITHM

In this section, we propose a two-step algorithm to achieve any tradeoff operation point between computational complexity and performance. The first step is a pre-selection step, in which a transmitter selects $N_p$ transmit antennas ($N_s \leq N_p \leq N_t$) to form a pre-subset $S_p$. The first pre-selection step should be able to effectively reduce the candidate antenna sets, so that total computational complexity can be effectively reduced with marginal performance degradation. The second step is a post-selection step, in which the transmitter selects $N_s$ transmit antennas from the $N_p$-preslected antennas in the first step for transmission.

A. Pre-Selection of Antennas

As mentioned earlier, the pre-selection should be performed by low complexity algorithms, such as NB and CWF. For the effective pre-selection of $N_p$ antennas, we proposed a new low-complexity algorithm, called a correlation-based best-first (CBF) selection algorithm. The new CBF algorithm uses also the spatial correlation similarly to a CWF algorithm, yet it selects the best antenna first. Concretely, in each greedy step, a transmitter selects one antenna which is the most less correlated with precisely selected antennas and at the same time has larger channel gain. The CBF algorithm selects up to $N_s$ antennas and the parameter $N_p$ is designed according to channels’ correlation characteristics. The CBF algorithm is summarized at Algorithm 5.

For the first antenna selection, a transmitter compares just channel gains $\|h_n\|$, $n = 1, \ldots, N_t$, which requires $O(N_t N_t^2)$
**Algorithm 5**: Correlation-based best-first (CBF) selection

**Input**: channel matrix $H$ and $N_p$

**Output**: selected antenna set $S_p \subseteq A$

**Setup**: $S_p = \emptyset$

Select the first transmit antenna who has the largest channel gain as follows:

$n^* = \arg\max_{n \in A} \|h_n\|$, where $h_n = H_{(n)}$;

$S_p = S_p \cup \{n^*\}$ and $A = A \setminus \{n^*\}$;

Select $N_p - 1$ antennas based on the spatial correlation as follows:

for $k = 1 : N_p - 1$

$S_p = S_p \cup \{n^*\}$, such that $n^* = \arg\min_{n \in A} \sum_{i \in S_p} \|h_i \cdot h_n\|$

Update sets: $A = A \setminus \{n^*\}$ and $S_p = S_p \cup \{n^*\}$.

end for

**Algorithm 6**: Two-step selection algorithm

**Input**: channel matrix $H$, number of selected antennas $N_s$, design parameter $N_p$ ($N_s \leq N_p \leq N_i$);

**Output**: selected antenna index set $S$;

**Setup**: $S = S_p = \emptyset$, and $A = \{1, \ldots, N_i\}$;

**Step 1**: Form a pre-subset $S_p \subseteq A$.

if $N_p = N_i$

$S_p = A$. Go to Step 2;

else

$S_p = \text{PreSelection}(H[A], A, N_p)$;

end if

**Step 2**: Form a subset $S \subseteq S_p$.

if $N_p = N_s$

$S = S_p$;

else

$S = \text{PostSelection}(H[S_p], S_p, N_s)$;

end if

Next, for the subsequent antenna selection of $(N_p - 1)$, a transmitter needs to compute $(N_i - 1)$ correlation factors between the first selected antenna and the remaining $(N_i - 1)$ unselected antennas, and also $(N_i - 1)$ correlation factors between the second selected antenna and the remaining $(N_i - 1)$ unselected antennas. After selecting the third antenna based on the correlation factor, in the subsequent selection, the transmitter needs to compute correlation factors between the selected antenna in the previous selection and the remaining $(N_i - 2)$ antennas. Similarly, in the sequel, the transmitter selects $N_p$ antennas. In total, the transmitter needs to compute correlation between two $N_i$-by-1 vectors $2(N_i - 1) + (N_i - 2) + \cdots + (N_i - N_p + 1)$ times. Normalization can be performed during the first two-antenna selection procedure. Thus, the total computational complexity is roughly $O(N_i N_s^2) + O((2(N_i - 1) + (N_i - 2) + \cdots + (N_i - N_p + 1))N_s^2) \approx O(N_i N_s^2) + O((N_i N_s + N_p - N_i - N_p^2)N_s^2)$.

Note that the required computational complexity for the CBF algorithm is much smaller than a CWF algorithm as there is no combinatorial search for the first two antenna selection.

**B. Post-Selection of Antennas**

For the post-selection, a performance-aware selection algorithm is employed to sustain the selection performance, which is now more tangible because the number of candidate antennas is reduced throughout the pre-selection step. In the paper, we employ an optimal strategy MaxMinSV for the post-selection.

By adapting $N_p$, we can obtain any tradeoff operating point between complexity and performance. Depending on the pre-selection method in the first step, we consider NB-MaxMinSV, CWF-MaxMinSV, and CBF-MaxMinSV. The structure of two-step selection algorithms is shown in Algorithm 6.

**IV. COMPARISON**

In this section, we compare various algorithms in terms of the computational complexity and BER performance.
TABLE I

<table>
<thead>
<tr>
<th>Algorithms</th>
<th>( N_p = N_s )</th>
<th>( N_s &lt; N_p &lt; N_t )</th>
<th>( N_p = N_t )</th>
</tr>
</thead>
<tbody>
<tr>
<td>MaxMinSV [5]</td>
<td>( \mathcal{O}(N_r^3N_s^2 + \log(N_r^2)) )</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GC [5]</td>
<td>( \mathcal{O}(N_tN_s^2 + N_t\log N_t + \mathcal{O}(N_tN_sN_r^2 + \log N_t)) )</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NB [4], [6]</td>
<td>( \mathcal{O}(N_r(N_r^2 + \log N_t)) )</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CBF [7]</td>
<td>( \mathcal{O}(N_rN_s^2 + \mathcal{O}(N_rN_s + \mathcal{O}(\log(N_r^2)) \right) )</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NB-MaxMinSV</td>
<td>NB</td>
<td>( \mathcal{O}(N_t(N_t^2 + \log N_t)) ) + ( \mathcal{O}(N_tN_r^2) )</td>
<td>MaxMinSV</td>
</tr>
<tr>
<td>CBF-MaxMinSV</td>
<td>CBF</td>
<td>( \mathcal{O}(N_tN_r^2 + \mathcal{O}(N_tN_r + N_t - N_t^2N_r^2)) ) + ( \mathcal{O}(\log(N_r^2)) )</td>
<td>MaxMinSV</td>
</tr>
</tbody>
</table>

Fig. 3. BER performance over per receive antenna SNR when \( N_t = 16, N_r = 4, N_s = 6, N_d = 4 \), QPSK modulation, \( \rho_t = 0.6 \), and \( \rho_r = 0.1 \).

Fig. 4. Error bits over per receive antenna SNR when \( N_t = 16, N_r = 4, N_s = 6, N_d = 4 \), QPSK modulation, \( \rho_t = 0.6 \), and \( \rho_r = 0.1 \).

A. Computational Complexity

Based on the complexity analyses in Sections II and III, the computational complexities are summarized in Table I and shown across \( N_p \) in Fig. 1. As we can see from Fig. 1, the optimal method, i.e., MaxMinSV, requires the highest computational complexity. On the other hand, the computational complexity of existing heuristic algorithms, namely, GC, NB, and CWF, is relatively very low. Obviously, their complexities are independent of \( N_p \). From the comparison, we observe a huge complexity gap between the optimal MaxMinSV algorithm and other heuristic GC, NB, and CWF algorithms. This means that the antenna selection system is highly biased to other performance target, i.e., MaxMinSV, which will be shown in next subsection, or complexity target, namely, GC, NB, and CWF. For futuristic communications system, however, dynamic adaptation achieving broad trade-off between the complexity and the performance is desired. Herein, we can see the clear motivation of the proposed two-step antenna selection algorithms. Adjusting a new design parameter \( N_p \), we can realize any computational complexity between the maximum and minimum of existing methods to realize the systems. Now, we compare the performance of the algorithms to clearly see the tradeoff.

B. Tradeoff between Complexity and BER Performance

For the performance metric, we evaluate BER when quadrature phase shift keying (QPSK) modulation is used. Spatial correlation at the transceiver follows the model in [11] with transmit and receive correlation factors \( \rho_t = 0.6 \) and \( \rho_r = 0.1 \), respectively. In Fig. 2, BER performance is shown across per-receive-antenna signal-to-noise ratio (SNR), simply SNR, where the SNR is defined as \( 10\log_{10}\frac{1}{\sigma_n^2} \) where we normalize the transmit power by one, and \( \sigma_n^2 \) denotes a noise variance at each receive antenna. From the results, we see that our proposed method CBF antenna selection algorithm outperforms existing heuristic algorithms, namely GC, NB, and CWF. Especially, note that the CBF outperforms CWF with lower complexity. The BER performance of the 2-step CBF-MaxMinSV algorithm, which is omitted from in Fig. 2, is between MaxMinSV and CBF and it depends on the new design parameter \( N_p \).

Increasing the new design parameter \( N_p \), the selection complexity increases as shown in Fig. 1, while the communication performance is improved as shown in Fig. 3. In Fig. 3, we show the BER over the complexity reduction amount compared to MaxMinSV algorithm’s complexity.

In Fig. 4, for further clarification of the tradeoff, we show...
the error-bit increase compared to that of optimal MaxMinSV across the complexity reduction. Herein, we also see the proposed CBF outperforms NB and CWF, especially at high SNR regime.

C. Performance of M-MIMO Application

We apply the proposed two-step algorithms to M-MIMO system with $N_t = 256$ and $N_r = 4$. We select six antennas for transmission, i.e., $N_s = 6$. To verify the proposed CBF ($N_p = N_s = 6$) and 2-step CBF-MaxMinSV ($N_p = 10 > N_s = 6$) algorithm, we compare them with NB and random selection algorithms. Note that optimal and other heuristic algorithms introduced earlier, namely MaxMinSV, GC, and CWF, are not comparable as they require tremendous complexity in the M-MIMO setup.

The proposed CBF transmitter selects six transmit antennas, i.e., $N_p = 6$, from 256 antennas using Alg. 5. On the other hand, the proposed 2-step CBF-MaxMinSV transmitter selects 10 transmit antennas from 128 antennas in the first step, i.e., $N_p = 10$, and in the second step, selects six antennas from the 10 preselected antennas.

In Fig. 5, we compare the BER versus SNR performance. As we can see from the results, the proposed CBF outperforms other simple heuristic algorithms with the comparable complexity. The proposed 2-step CBF-MaxMinSV can further achieve performance improvement through the proposed optimal selection in the second step.

In Fig. 6, we observe the BER performance across the spatial correlation factor $\rho_t$. High correlation at the transmit antenna significantly deteriorates the communications performance, especially for the systems with random selection and NB (comparing the BER when $\rho_t$ is between 0.1 and 0.5). From the results, we can verify that the proposed algorithms perform well generally for any environment.

V. CONCLUSION

In this paper, a correlation-based best-first (CBF) selection algorithm has been proposed for a massive MIMO system to effectively select transmit antennas. The proposed CBF has been compared to other existing methods and its efficacy has been verified in terms of complexity with comparable performance. To achieve tradeoff between complexity and performance, we have also proposed a two-step algorithm. The computational complexity and performance of various antenna selection algorithms have been analyzed and compared. The results show that the proposed two-step algorithm can flexibly achieve complexity-and-performance tradeoff.

REFERENCES


