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SPACE SHIFT KEYING FOR STRAIGHT AND SHORT COMMUNICATION IN MIMO CHANNEL USING MMWAVE FREQUENCIES

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Abstract**:**
We use space shift keying (SSK),which is the simplest form of spatial modulation (SM), to present and analyze the idea of spatial modulation in line-of-sight (LOS) conditions. We show that SSK can operate effectively in LOS conditions provided that the antennas are properly placed at TX and RX such that a high-rank LOS MIMO channel is constructed. The operating conditions for LOS-SSK with parallel uniform linear arrays are established and two schemes, namely orthogonal SSK and bi-orthogonal SSK, are introduced. The bit error probabilities for both methods are derived and given in closed form. It is shown that LOS-SSK (more generally LOS-SM) is a promising technique and might especially be attractive in millimeter-wave communications which due to its high frequency and small wavelength inherently prefers LOS transmission and also enables packing of a large number of antennas in terminals.

Keywords:line-of-sight,millimetre wave(mmWave),space Shift keying

INTRODUCTION
GENERAL
1.1.1 MIMO

The wireless system designers are faced numerous challenges to fulfill the demand of the wireless communication for higher data rates, better quality service, fewer dropped calls , higher network capacity including limited availability of radio frequency spectrum and transmission problems caused by various factors like fading and multipath distortion.(MIMO) technology promises a cost effective and to improve the communication performance. MIMO technology has attracted attention in wireless communications, because it is significant increases in data throughput and link range without additional bandwidth or transmit power. It achieves this by higher spectral efficiency (more bits per second per hertz of bandwidth) and link reliability or diversity (reduced fading). It operates at the physical layer, below the protocols used to carry the data, so its channels can work with virtually any wireless transmission protocol. For example, MIMO can be used with the popular IEEE 802.11 (Wi-Fi) technology. For these reasons, MIMO eventually will become the standard for carrying almost all wireless traffic.

SYSTEM MODEL

We consider an $Nt \times Nr$ LOS-MIMO system, as uniform linear arrays at TX and RX which are parallel to each other, where Nt and Nr are the number of TX and RX antennas, respectively. The inter-antenna separation of the TX array and RX array are $s1$ and $s2$, respectively, and the array distance from the TX to the RX is D. The transmission coefficient from the i-th TX antenna to the j-th RX antenna is denoted by $hji = |hji|\exp(-\mathrm{j}kdji)$ where upright j is the imaginary unit, $k = 2\pi/\lambda$ is the wave number, dji denotes the propagation path length, and $|hji|$ is the transmission "gain" of the channel which, for LOS conditions, can be calculated from the Friis transmission equation. The small change of $|hji|$

for different i and j is ignored. We can thus collapse $|hji|$ into the transmit power and have a simplified channel model as

where Ei is the energy allocated to the i-th symbol, and $\mathbf{x}i$ denotes the i-th TX symbol for which—due to the usage of SSK—only the i-th TX antenna is activated and the other TX. antennas are left silent. The actually received symbol would be noise-corrupted as given by $\mathbf{y} = \mathbf{y}i + \mathbf{n}$, where $\mathbf{n}$ is an Nr-element vector of i.i.d (independent and identically distributed) circularly symmetric complex additive white Gaussian noise variables with variance 2σ2 and power spectral density.We are expecting to establish a high-rank MIMO channel, in which the antenna separations in general should be larger than half wave length, i.e., $s1$, $s2 > \lambda/2$. Establishment of a high capacity LOS-MIMO channel relies on proper placement of the antennas.

OPTIMAL DETECTION

Since in SSK the information is solely conveyed in the index of the transmitting antenna, the optimal detector, given that the symbols are equally probable, would be the maximum-likelihood (ML) detector given by

$$\hat{\imath} = \underbrace{argmax}_{i}\, p_y(y|x_i,\mathrm{H}) = \underbrace{argmax}_{i}\, ||\mathrm{y}-y_i||$$

OPERATING CONDITIONS*:*

We first consider a simple case with only two TX antennas, i.e., a $2\times Nr$ LOS-MIMO, and seek to maximize the Euclidean distance of the two received symbols. The optimization problem is formulated as: In addition, $\mathbf{H}$ is constrained by the distance D, antenna separations $s1$ and $s2$, and even the array structure itself. Based on the understanding of how to maximize the Euclidean distance between symbols for SSK with dual TX antennas, we now consider the general case with $Nt \geq 2$. We wish to maximize the Euclidean distances between all possible pairs of received symbols, and, even more importantly the smallest Euclidean distance.

$$s_1 s_2 \approx nD\lambda/\mathrm{Nr}$$

Bit Error Probability for OSSK*:*

In the current context, all possible $i \rightarrow i\_$ detection errors are equally likely, so the symbol-to-constellation mapping can be chosen arbitrarily. The bit error probability can be found to be

$$P_b = \frac{\sum_{k=1}^{\mathrm{N}} \mathrm{k}\binom{n}{k}}{\mathrm{N(M-1)}}[1-(1-\mathrm{Q}(\sqrt{\mathrm{NrN}\gamma 0}))^{M-1}]$$

where Pi denotes the probability of i being successfully detected, $M \Delta= Nt$, $N = \log 2Nt$ and $\gamma 0\Delta=Em/N0/N$ being the $Eb/N0$ per RX branch.

Bit Error Probability for BiSSK:

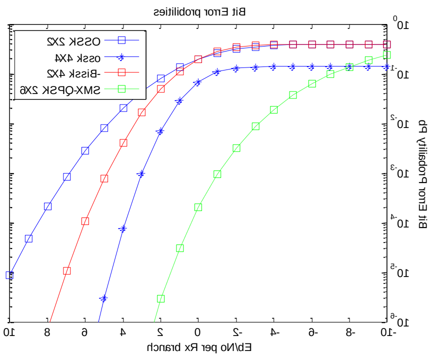
$$P_b = \frac{\sum_{k=1}^{\mathrm{N-1}} \mathrm{k}\binom{n}{k}}{\mathrm{N(M-2)}}[1-(1-\mathrm{Q}(\sqrt{\mathrm{NrN}\gamma 0}))^{M-2}]$$

To compare $2Nr \times Nr$ BiSSK and $Nr \times Nr$ OSSK with $Nr \times Nr$ M-QAM1: in a larger size MIMO system, BiSSK and OSSK have significant gain (in $Eb/N0$) over M-QAM. In a smaller size MIMO system, on one hand, BiSSK and OSSK have lower gain than M-QAM. On the other hand, we should note that BiSSK and OSSK use one PA and are constant envelope. However, M-QAM uses Nt PAs and is in general non-constant envelope implying a lower PA efficiency. To compare with spatial multiplexing (SMX)MIMO, we also considered SMX-QPSK 2 × 16, which has the same rate of 4 bits/symbol as 16-QAM 16 × 16, OSSK 16 × 16 and BI-SSK 16 × 8. We see that OSSK and BI-SSK significantly outperform SMX-MIMO in this comparison. While having its simplicity and performance, the price to pay with SSK is much larger TX array size, 16 vs. 2 in this comparison. The enormous gain and simplicity being exhibited by LOSSSK makes spatial modulation an attractive MIMO solution in LOS conditions To compare $2Nr \times Nr$ BI-SSK and $Nr \times Nr$ OSSK with $Nr \times Nr$ M-QAM1: in a larger size MIMO system, BI-SSK and OSSK have significant gain (in $Eb/N0$) over M-QAM. In a smaller size MIMO system, on one hand, BI-SSK and OSSK have lower gain than M
QAM. On the other hand, we should note that BI-SSK and OSSK use one PA and are constant envelope. However, M-QAM uses Nt PAs and is in general non-constant envelope implying a lower PA efficiency. To compare with spatial multiplexing (SMX)MIMO, we also considered SMX-QPSK 2 × 16, which has the same rate of 4 bits/symbol as 16-QAM 16 × 16, OSSK 16 × 16 and BI-SSK 16 × 8. We see that OSSK and BI-SSK significantly outperform SMX-MIMO.

CONCLUSION:

We have shown that SSK can operate efficiently in LOS conditions. Two operating conditions, namely OSSK and Bi-SSK, are established. A system setup with dual TX arrays and single RX array is proposed to achieve Bi-SSK. The BEP for both schemes are derived and given in closed form. Under the same framework, similar schemes for generalized spatial modulation can be established. Ongoing research is concerned with the sensitivity of LOS-SSK to practical issues such as array misalignment, displacement, and multi-path propagation.

SIMULATION RESULTS



REFERENCES

[1] M. Di Renzo, H. Haas, A. Ghrayeb, S. Sugiura, and L.Hanzo, “Spatial modulation for generalized MIMO: Challenges, opportunities, implementation, ”Proc. IEEE, vol. 102, no. 1, pp. 56–103, Jan. 2014.

[2] A. Younis, D. A. Basnayaka, and H. Haas, “Performance analysis for generalised spatial modulation,” in Proc. Eur. Wireless 20th Eur. Wireless Conf., May 2014, pp. 1–6.

[3] M. Di Renzo and H. Haas, “Space shift keying (SSK) MIMO over correlated rician fading channels: Performance analysis and a new method for transmit-diversity,” IEEE Trans. Commun., vol. 59, no. 1, pp. 116–129, Jan. 2011.

[4] M. Di Renzo and H. Haas, “Improving the performance of space shift keying (SSK) modulation via opportunistic power allocation,” IEEE Commun. Lett., vol. 14, no. 6, pp. 500–502, Jun. 2010.

[2] J. Jeganathan, A. Ghrayeb, L. Szczecinski, and A. Ceron, “Space shift keying modulation for MIMO channels,” IEEE Trans. Wireless Commun., vol. 8, no. 7, pp. 3692–3703, Jul. 2009.

[5] A. Maltsev, R. Maslennikov, A. Sevastyanov, A. Khoryaev, and A. Lomayev, “Experimental investigations of 60 GHz WLAN systems in office environment,” IEEE J. Sel. Areas Commun., vol. 27, no. 8, pp. 1488–1499, Oct. 2009.

[6] F. Bohagen, P. Orten, and G. Oien, “On spherical vs. plane wave modeling of line-of-sight MIMO channels,” IEEE Trans. Commun., vol. 57, no. 3, pp. 841–849, Mar. 2009.