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Review of OAM-MIMO Transmission Technique for 5G Communication Applications

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ABSTRACT: Orbital angular momentum (OAM) with index modulation (IM) (OAM-IM) is a recently proposed line-of-sight wireless communications technique that has been attracting recent attention. OAM-IM utilizes the indices of activated OAM mode combinations to convey additional information per transmission interval. This technology can meet the requirements of the 5G communication that is high bandwidth, low delay and power etc. This paper reviews of the various research work of OAM-MIMO transmission technique for 5G communication applications.

KEYWORDS: OAM, MIMO, Delay, Power, Modulation, Mode.

I. INTRODUCTION

Nowadays, with the rapid development of wireless communication technologies for information exchange, the number of mobile terminals has increased dramatically, and the mobile Internet has shown an explosive development trend. In order to meet the growing demand for mobile data services, there is an urgent need for a new generation of wireless communication technologies with higher speed, greater bandwidth, and higher efficiency. Electromagnetic vortex beam orbital angular momentum (OAM) becomes the fifth new dimension that is expected to improve spectrum efficiency beyond the four dimensions of amplitude, phase, frequency, and polarization that electromagnetic waves have been utilized. It is common knowledge that electromagnetic waves can carry the linear momentum as well as angular momentum, which is divided into spin angular momentum (SAM) and OAM [1].

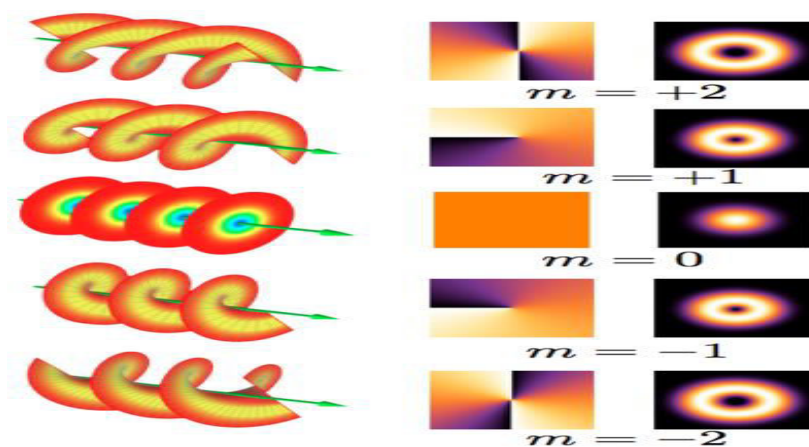


Figure 1: orbital angular momentum modes

The OAM describes the spatial coordinate dimension of the spiral beam transverse rotation mode which is perpendicular to the Poynting vector direction, and the SAM corresponds to the polarization of the electromagnetic

wave. The transmission of information by modulating the OAM of electromagnetic fields is first proposed in the field of optics. Since then, the use of OAM for spatial optical communication has become a hot topic in the world [2].

Recently, the OAM has received great attention in the field of radio frequency wireless communication, since, it is possible to modulate the multiplexed signals in different OAM modes by using the mutual orthogonal characteristics between the OAM modes, and distinguish different channels according to the modes, then multiple signals can be transmitted under the same carrier frequency to achieve the purpose of improving spectrum utilization. The vortex electromagnetic wave is characterized by a helical phase factor $\exp(-il\phi)$ in the expression of the field, where l represents the quantum topological charge that can take any integer value, also called the mode number of OAM, and ϕ represents the azimuth angle [3].

II. RELATED WORK

A. Yamamoto et al.,[1] Orbital angular momentum (OAM) is a physical quantity of an electromagnetic wave which is independent of polarization, and the electromagnetic wave having the OAM becomes a helical wave. A mode of the OAM can be defined according to the number of turns of helix per wavelength distance, and the different modes are mutually orthogonal. In recent years, with growth of the millimeter wave technology and demands for further high-speed large capacity transmission, a new spatial multiplexing transmission scheme using the orthogonality of OAM has attracted attention. In this work, the impact of the ground reflected wave were evaluated by comparing the characteristics of OAM mode multiplexing and eigenbeam-space division multiplexing. As a result, it is found that the inter-mode interference due to the ground reflected wave is not so large and can be reduced with a small amount of degradation.

K. Mofoka et al.,[2] Full-duplex relaying (FDR) may be employed to improve communication range, spectral efficiency or error performance in wireless communication systems. In the interest of improving the error performance of OAM-IM while allowing extended communication range, in this work, we present three variant FDR schemes for single-active mode orbital angular momentum index modulation (FDR-SA-OAM-IM). A transmission mechanism for the proposed schemes is formulated for the link between the source and relay nodes (Link 1) and between the relay and destination nodes (Link 2). Scheme 1 employs OAM mode division multiplexing (OAM-MDM) for Link 1 and Link 2. Scheme 2 employs single-active OAM-IM (SA-OAM-IM) for both Link 1 and Link 2. Scheme 3 employs SA-OAM-IM for Link 1 and OAM-MDM for Link 2. The average bit error probability of the proposed schemes is affirmed by the Monte Carlo simulations, and we reveal that the FDR mechanism displays a generally enhanced error performance.

A. Almainan et al.,[3] We demonstrate using OAM modes to carry header information of a signal for routing. We show encoding the header on a single OAM mode or a codeword of multiple OAM modes. We observe 0.4–0.8 dB penalty for 10 Gb/s OOK signal switched at 10Mb/s rate.

H. Sukanuma et al.,[4] This work proposes an inter-mode interference suppression method that employs only even-numbered modes for uniform circular array (UCA)-based orbital angular momentum (OAM) multiplexing. Given that interference from adjacent OAM modes becomes severe when the beam axis is misaligned, the proposed method uses only the even-numbered modes while leaving the odd-numbered modes unused, which effectively prevents the inter-mode interference. Moreover, we verify the effectiveness of the proposed method by applying it to multiple-input and multiple-output (MIMO) with zero-forcing (ZF) alone or ZF with successive interference cancellation because severe inter-mode interference is caused by transmitting multiple streams from multiple UCAs in each mode. The effectiveness of the proposed method compared with the traditional method, which uses all OAM modes, is demonstrated in terms of the system capacity through computer simulations.

C. Li et al.,[5] The investigations on generation of OAM waves is significant for the application and advance of OAM multiplexing technology. In this work, a new three-dimensional configuration of array antenna is presented to generate vortex electromagnetic waves carrying orbital angular momentum. The proposed spherical array antenna (SAA), which is made up with M layers uniform circular array antenna (UCA) and each UCA contains N antenna elements, is a spatial expansion based on UCA and all antenna elements are distributed on a spherical surface of the same radius. Different OAM modes are obtained by changing the phase distribution of antenna elements when the amplitudes are uniformly distributed. To demonstrate the feasibility of the array design, the theoretical analysis of the far-field and vector potential expressions are elaborately deduced. Besides, two spherical array antennas with different structures are simulated and the simulation results demonstrate that different OAM modes can be generated, which

further verify the theoretical discussion. This new array pattern performs better in radiation directivity compared with the conventional UCA, so that the beam is more concentrated and beneficial to long-distance transmission and reception for the vortex electromagnetic waves.

Z. Zhang et al.,[6] In this work, a dual-polarized dual-OAM-mode multiplexed antenna system, which can generate x-polarized and y-polarized radio waves with OAM mode $l=+1$ and OAM mode $l=-1$, is proposed. Reflection coefficients, radiation patterns and electric field phase distributions are simulated. Simulation results show that the reflection coefficients of all four ports are lower than -10 dB over a broad bandwidth of 2.1 GHz to 3.2 GHz. Good OAM characteristics of helical wave fronts and low cross-polarization levels of -20 dB are also presented. Furthermore, the isolations between different channels are more than 20 dB over a bandwidth of 2.6 GHz to 3 GHz. All the simulation results prove the orthogonality of OAM mode multiplexing and polarization multiplexing, which can be utilized in future wireless communication.

H. Jing, et al.,[7] Due to the potential capacity-boosting for wireless communications, radio vortex wireless communication (RowComm) over orthogonal states/modes of orbital angular momentum (OAM) has been paid much attention to in recent years. A uniform circular array (UCA), as an efficient and convenient antenna structure, can transmit/receive multiple OAM beams with different OAM-modes simultaneously when the transmitter and receiver are aligned. However, for high-order OAM-modes, the OAM beams are divergent accompanied by severe attenuation. Thus, it is difficult to directly use high-order OAM-modes to achieve high capacity for RowComms. To obtain high capacity potentially offered by OAM-modes, in this work we transform the singular UCA into the concentric UCAs, where high capacity can be achieved using multiple parallel low-order OAM-modes instead of all high-order OAM-modes, to increase the capacity of transmitter-receiver aligned Row-Comms. In particular, we study two cases: 1). concentric UCAs based RowComms without co-mode interference; 2). concentric UCAs based RowComms with co-mode interference.

S. SAITO et al.,[8] This work investigates the influence of the number of uniform circular arrays (UCAs) on the system capacity in orbital angular momentum (OAM) multiplexing. In UCA-based OAM, although multiple UCAs can alleviate the difference in the received signal power among OAM modes, the maximum number of OAM modes is limited. The primary contribution of our work is to evaluate the waterfilling-based system capacity of UCA-based OAM with the number of UCAs at constant transmit power and number of antenna elements, to demonstrate the benefit of multiple UCAs according to the communication distance. Our numerical results show that the multiple UCAs stabilize the system capacity irrespective of the communication distance, whereas the single UCA is effective particularly in short-range communications.

P. You, et al.,[9] We propose and design a fiber with logarithmic-index profile for orbital angular momentum (OAM) transmission. The designed fiber shows favorable performance of low mode crosstalk and tensile invariance property of mode field diameter (MFD).

A. Saitou et al.,[10] Eight-channel multiplexing Orbital Angular Momentum (OAM) communication at the 5-GHz band is demonstrated, exploiting dual OAM polarizations and four OAM modes. OAM polarizations are analytically shown to be exploited for multiplexing by controlling the port directions of loop antennas. With four kinds of fabricated 4-element loop arrays, transmissions between the transmitting and receiving arrays were measured at a distance of 3 cm, and the desired signal transmission between antennas of the same radius and the corresponding port direction is shown to be larger than that from other interfering antennas by more than 5 dB.

III. CONCLUSION

Data transmission brings new challenges for the capability of wireless network due to the rapid developments of wireless communication technology. Since different orbital angular momentum (OAM) modes are orthogonal to each other and multiple signals can be transmitted at the same frequency, OAM multiplexing technology is an effective method to increase the capacity of wireless channel, which has attracted much attention in recent years. This paper presents the various researches in the field of the orbital angular momentum techniques in 5G communication applications.

REFERENCES

1. A. Yamamoto, T. Nishimura, T. Ohgane, T. Tandai and D. Uchida, "Evaluation of OAM Mode Multiplexing Considering Ground Reflection," 2019 IEEE International Conference on Communications Workshops (ICC Workshops), Shanghai, China, 2019, pp. 1-5, doi: 10.1109/ICCW.2019.8756856.
2. K. Mofoka, N. Pillay and H. Xu, "Full-Duplex Relaying for Single-Active Mode Orbital Angular Momentum Index Modulation," 2019 IEEE AFRICON, Accra, Ghana, 2019, pp. 1-5, doi: 10.1109/AFRICON46755.2019.9133744.
3. A. Almain et al., "Demonstration of using multiple orthogonal spatial modes for channel header information and channel encoding," 45th European Conference on Optical Communication (ECOC 2019), Dublin, Ireland, 2019, pp. 1-4, doi: 10.1049/cp.2019.0929.
4. H. Sukanuma, S. Saito, K. Ogawa and F. Maehara, "Inter-Mode Interference Suppression Employing Even-Numbered Modes for UCA-Based OAM Multiplexing," 2019 IEEE Globecom Workshops (GC Wkshps), Waikoloa, HI, USA, 2019, pp. 1-6, doi: 10.1109/GCWkshps45667.2019.9024598.
5. C. Li and D. Shi, "A Novel Spatial Three-dimensional Spherical Array Antenna for OAM Waves Generation," 2019 Photonics & Electromagnetics Research Symposium - Fall (PIERS - Fall), Xiamen, China, 2019, pp. 373-377, doi: 10.1109/PIERS-Fall48861.2019.9021544.
6. Z. Zhang et al., "A Dual-polarized Dual-OAM-Mode multiplexed Antenna System," 2019 International Conference on Microwave and Millimeter Wave Technology (ICMMT), Guangzhou, China, 2019, pp. 1-3, doi: 10.1109/ICMMT45702.2019.8992853.
7. H. Jing, W. Cheng, Z. Li and H. Zhang, "Concentric UCAs Based Low-Order OAM for High Capacity in Radio Vortex Wireless Communications," in Journal of Communications and Information Networks, vol. 3, no. 4, pp. 85-100, Dec. 2018, doi: 10.1007/s41650-018-0036-z.
8. S. SAITO, H. SUGANUMA, K. OGAWA and F. MAEHARA, "Influence of the Number of Uniform Circular Arrays on System Capacity in OAM Multiplexing," 2018 21st International Symposium on Wireless Personal Multimedia Communications (WPMC), Chiang Rai, Thailand, 2018, pp. 268-272, doi: 10.1109/WPMC.2018.8712929.
9. P. You, S. Li, Z. Xu, R. Zhao, L. Shen and J. Wang, "Design of Logarithmic-Index Fiber for Orbital Angular Momentum (OAM) Transmission," 2018 Conference on Lasers and Electro-Optics Pacific Rim (CLEO-PR), Hong Kong, Hong Kong, 2018, pp. 1-2.
10. A. Saitou, H. Otsuka, R. Yamagishi, R. Ishikawa, H. Suzuki and K. Honjo, "Double Multiplicity Exploiting Orthogonal Polarizations of OAM Wave for OAM Communication with Loop Arrays," 2018 Asia-Pacific Microwave Conference (APMC), Kyoto, 2018, pp. 494-496, doi: 10.23919/APMC.2018.8617476.



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