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IEEE INFORMATION THEORY SOCIETY
GUANGZHOU CHAPTER NEWSLETTER

第九期, 2024 年 2 月 No. 9, Feb. 2024

主编序语

各位学者：

本期《分会季报》介绍针对大规模链接网络的容量最优接收机设计及多用户编码方案，循环码的导数码及其求导译码，和针对 NAND 闪存的编译码设计；同时，介绍一种面向 6G 网络的可编辑语义通信系统。8 月 10 日和 13 日，分会分别成功举办了”第二届 IEEE/CIC ICCC 面向未来无线网络的信息论与编码研讨会”和“中山大学代数编译码理论与应用前沿沙龙”。分会学者的信息论本科教育工作取得喜人成绩，中山大学的《信息论与编码》和暨南大学的《信息论与编码理论基础》均获广东省一流本科课程认定。

陈立

From the Editor-in-Chief

Dear Chapter Members,

This issue introduces the capacity optimal receiver design and the multiuser coding schemes for networks with large scale connections. It also introduces the derivative descendants and the implied decoding for cyclic codes, the design of coding schemes for NAND flesh memory and an editable semantic communication system for 6G networks. On Aug. 10, the Chapter co-hosted the 2nd IEEE/CIC ICCC Workshop on Information Theory and Coding for Future Wireless. On Aug. 13, the Chapter further hosted the SYSU Workshop on the Frontiers of Algebraic Coding Theory and Applications. Scholars of the Chapter have done remarkably in the undergraduate education of information theory. The undergraduate courses of Information Theory and Coding of SYSU and Fundamentals on Information Theory and Coding Theory of JNU were both enlisted as the first-class undergraduate courses of Guangdong Province.

Li Chen

来稿请包含中英文题目、联系人、联系方式、拟投稿栏目，正文可以是中文或英文，不超过800字。
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目录 •Table of Contents •

喜讯 • GOOD NEWS •

新锐风采 • NEW TALENTS •

征稿启事 • CALL FOR PAPERS•

最新结果 • RECENT RESULTS •

容量最优且低复杂度的迭代接收机和多用户编码方案
Capacity-Optimal and Low-Complexity Iterative Receiver and Multi-User Coding Scheme

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随着无线通信技术的快速发展，各种新兴的通信业务应运而生，如异构车联网、移动无人机系统等，预计在未来 6G 中无线终端连接数量达到每平方公里 1000 万。为支持海量设备在复杂环境下的可靠通信，本文聚焦于实际通信假设下的大规模离散 MU-MIMO[1]，即包括海量天线数与用户数、实用的信道编译码、任意输入分布、仅接收机已知信道状态信息、一般右酉不变信道矩阵 (涵盖瑞利衰落，某些病态和相关信道矩阵)。这些实际的假设也给大规模离散 MU-MIMO 系统设计带来了新的挑战：

- **大规模离散 MU-MIMO 系统的实际多用户码的设计原理仍不清楚**：传统单用户编码是专门为克服信道噪声而设计的，忽略了大规模天线和多用户的影响，因此不能应用于大规模离散 MU-MIMO。
- **如何在低复杂度下实现大规模离散 MU-MIMO 的最佳性能是一个巨大挑战**：全局最大后验接收机是最佳解决方案，但其复杂性过高，无法用于大规模系统。同时，现有的贝叶斯最优接收机并未考虑信道编码的影响, 难以保证可靠恢复信号。

为解决上述挑战，我们提出了适用于大规模离散 MU-MIMO 的容量最优 MU-OAMP / VAMP 接收机并给出最优多用户编码原理。此外，为进一步降低接收机复杂度，我们给出了容量最优的 MU-MAMP 接收机。

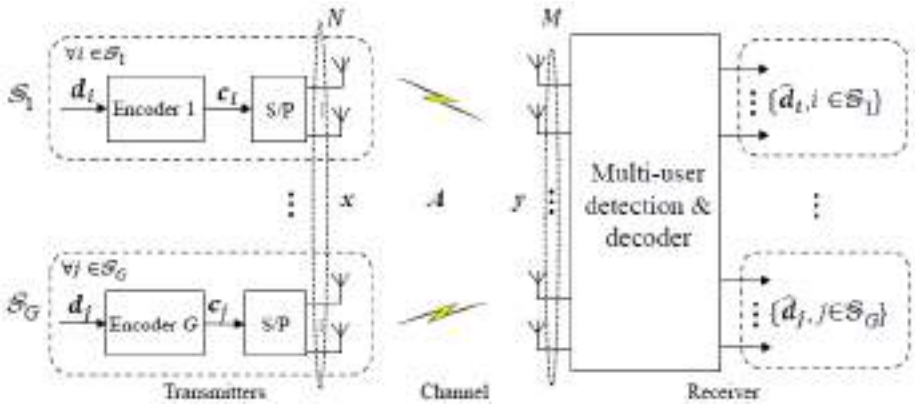


图 1 大规模离散 MU-MIMO 系统

如图 1 所示，所有用户根据不同编码速率分为 G 组，所有用户发送信号表示为$\boldsymbol{x}$, 经过信道后，基站根据接收信号$\boldsymbol{y}=\boldsymbol{A}\boldsymbol{x}+\boldsymbol{n}$，采用多用户检测和译码算法恢复所有用户信息，其中$\boldsymbol{A}$为右酉不变信道矩阵，$\boldsymbol{n}$为加性高斯白噪声。如图 2 所示，MU-OAMP / VAMP 接收机[1]由线

性检测器 (LD) 和非线性检测器 (NLD) 组成：

$$\text{LD: } \boldsymbol{r} = f(\boldsymbol{s}), \qquad \text{NLD: } \boldsymbol{s} = \eta(\boldsymbol{r}).$$

进一步根据状态演进(SE)分析 MU-OAMP / VAMP 接收机的约束容量最优性和最优编码原理。

MU-OAMP / VAMP 接收机的约束容量最优性[1]：根据 I-MMSE 引理[2]可知，检测器和解调器的状态演化 (SE) 转移曲线围成的面积为接收机的信息理论极限 (即最大可达速率)，进一步可证明其等于大规模离散 MU-MIMO 的约束容量:

$$R_{\text{MU-OAMP/VAMP}} = C_{\text{MU-MIMO}}.$$

最优多用户编码准则[1]：在无差错恢复信号的前提下，以最大化可达速率和为目标，如图 3 所示，最优多用户编码的准则为：最优译码器的 SE 曲线为检测器和解调器的 SE 曲线下界。

MU-OAMP / VAMP 接收机的约束容量域最优性[1]：通过设计速率分配准则，获得不等速率译码器的 SE 曲线，则得出不同用户组的最优编码准则，经过优化后的非对称多用户码可以达到大规模离散 MU-MIMO 约束容量域。

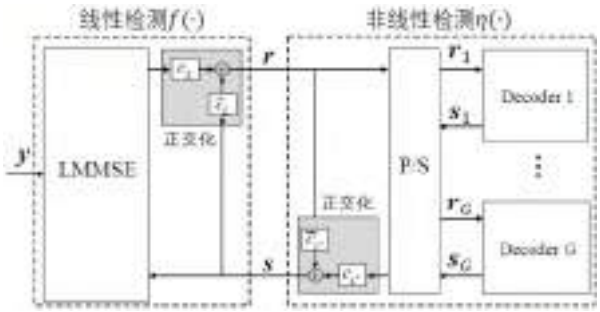


图 2 MU-OAMP / VAMP 接收机

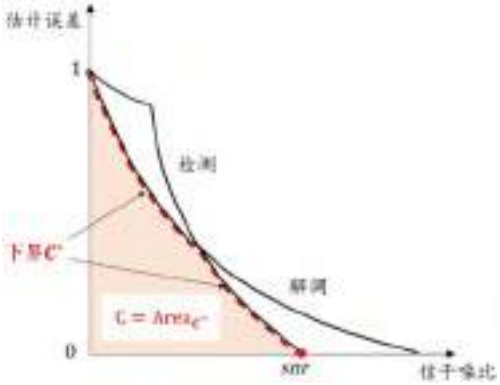
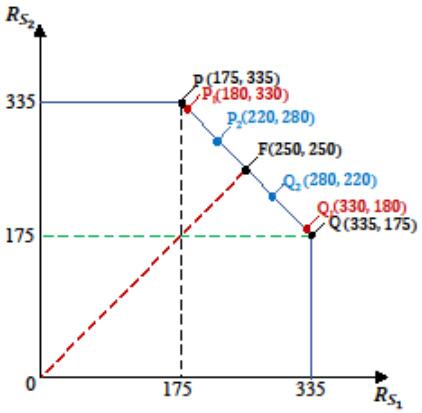


图 3 大规模离散 MU-MIMO 约束容量

低复杂度且容量最优 MU-MAMP 接收机[3]：由于 MU-OAMP / VAMP 接收机的线性检测中采用的 LMMSE 估计器，导致在大规模系统中接收机检测复杂度较高。为此，我们提出一种低复杂度 MU-MAMP 接收机，通过在线性检测中采用记忆匹配滤波器来降低复杂度。然而，MU-MAMP 的状态演进 (SE) 是基于复杂多维的协方差矩阵实现的，导致现有的通过单输入单输出 SE 推导出的可达率分析和最优编码原理[1,4,5]无法直接推广至 MU-MAMP。为克服这一困难，根据 MU-MAMP 与 MU-OAMP / VAMP 的 SE 不动点一致性，得出 MU-MAMP 的单输入单输出变分 SE 函数[7]，从而推导出 MU-MAMP 与 MU-OAMP / VAMP 能够达到相同的最大可达速率与具有相同多用户编码原理，进而证明了 MU-MAMP 的约束容量最优性[7]。

仿真结果：假设用户数和发射天线的总数 $N = 500$ 和 5000，信道负载 $N / M = 1.5$, 信道矩阵 $\boldsymbol{A}$ 的条件数 $\kappa = 10$ 或 50。每个用户采用 QPSK 调制，根据最优编码原理设计的多用户 MU-LDPC 码的码率均为 0.5。当 N 为 500 和 5000 时，MU-LDPC 的码长分别为 1×10^5 和 2×10^5。如图 4 所示，在非对称离散 MU-MIMO 系统 (即不同用户组速率不同) 下，MU-OAMP / VAMP 误码率 (BER) 均优于 Turbo-LMMSE[4,5]，且有 2.5~3.4dB 增益。如图 5 所示，在对称离散 MU-MIMO 系统 (即所有用户相同速率) 下，采用相同 MU-LDPC 码，MU-MAMP 与 MU-OAMP / VAMP 的 BER 性能相同。此外，采用相同的 MU-MAMP，MU-LDPC 比单用户 SU-LDPC 有 3.7~5dB 增益，证实了贝叶斯最优检测算法和最优的单用户码是严格次优的方案。如图 6 所示，在取得相同 BER 性能时，MU-MAMP 比 MU-OAMP / VAMP 复杂度更低，且当 $N = 5000$ 时，

MU-MAMP 时间复杂度降低至约 0.4%。



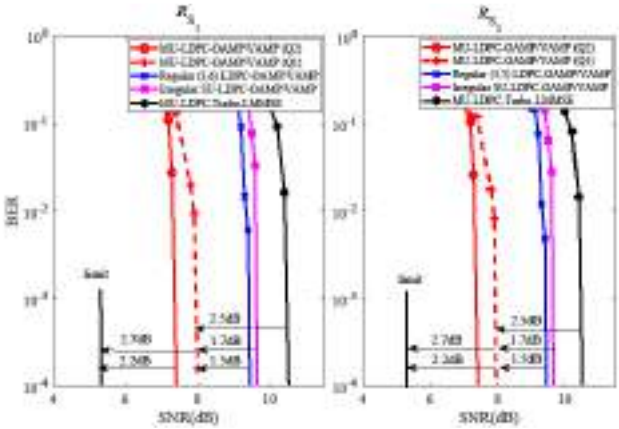


图 4 MU-OAMP / VAMP 的可达速率域和 MU-OAMP / VAMP 与 Turbo-LMMSE 接收机性能比较

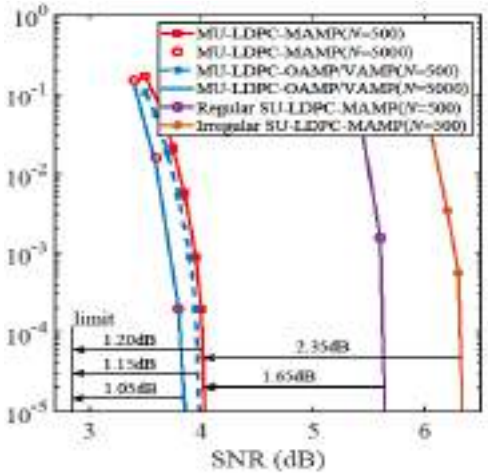


图 5 MU-OAMP / VAMP 与 MU-MAMP BER 性能比较

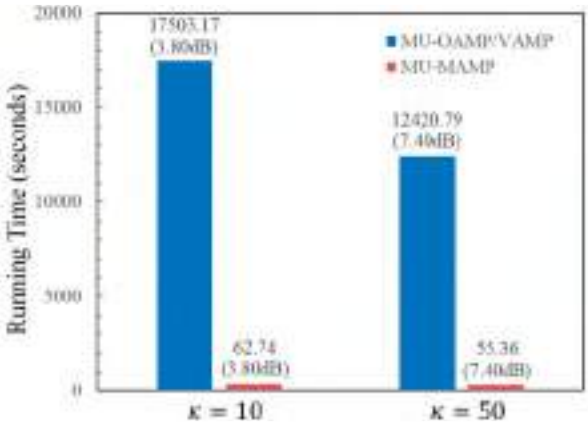


图 6 MU-OAMP / VAMP 与 MU-MAMP 时间复杂度比较

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最新结果 • RECENT RESULTS •

循环码的导数码与求导译码
Derivative Descendants of Cyclic Codes and Derivative Decoding

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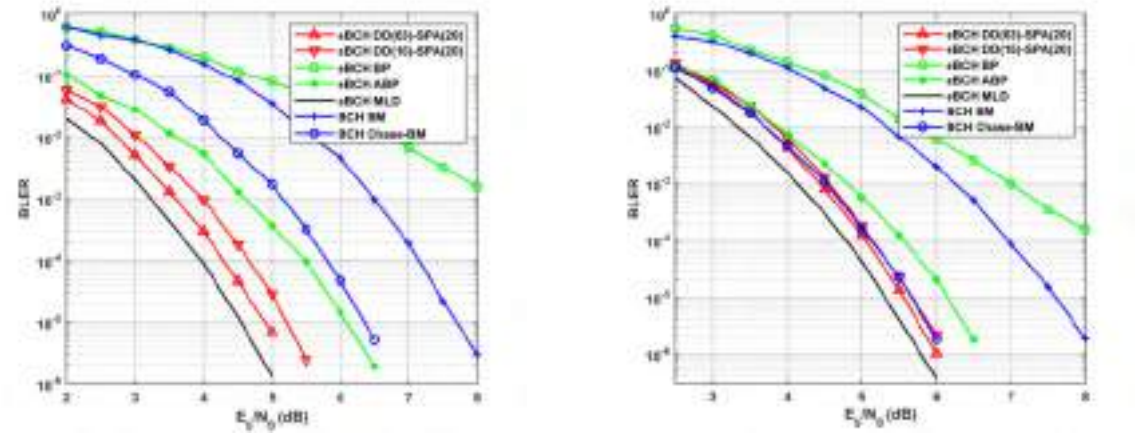
Cyclic codes form an important class of linear codes obtained by imposing a cyclic structure. Thanks to this structure, many well-known codes have been discovered, such as Bose-Chaudhuri-Hocquenghem (BCH) codes, Reed-Solomon codes, Reed-Muller (RM) codes, and Euclidean geometry (EG) codes. Their encoding can be implemented efficiently by employing shift registers, while their decoding has been challenging and attractive for several decades. In the process of discovering decodings for these codes, the polynomial description leads to many efficient algorithms. In this paper, we investigate the derivative structure of extended cyclic codes beginning with representing codewords by Mattson-Solomon (MS) polynomials.

We define two types of derivative descendant (DD), cyclic DDs and minimal DDs, of an extended cyclic code with different focuses. The first type is defined as the linear subspace containing the derivatives of all codewords in a direction, while keeping the cyclic structure. The second type is defined as the linear subspace containing the derivatives of all codewords in a direction with the smallest dimension.

For cyclic DDs, we determine their roots by analyzing the exponent set of MS polynomials and demonstrate that the cyclic DDs in different directions are the same code. Based on this, a derivative decoding algorithm for extended cyclic codes is proposed. It consists of three steps: calculating log-likelihood ratios (LLRs) of cyclic DDs, decoding cyclic DDs, and voting for the decision. In particular, for RM codes, the derivative decoding can be viewed as a generalization of the recursive projection-aggregation decoding for RM codes. We reveal that the cyclic DDs of the (64, 24) eBCH code and the (64, 45) eBCH code are the EG codes. As a result, we can decode these eBCH codes using the derivative decoding based on sum-product algorithm (DD-SPA). Simulation result shows that, DD-SPA with 63 directions and the maximum iteration number for the component SPA of 20, denoted by DD(63)-SPA(20), outperforms the conventional belief propagation (BP), the adaptive belief propagation (ABP), the Berlekamp-Massey (BM) algorithm and Chase-BM at the block error rate (BLER) of 10^{-5}. The gaps between the performance of DD(63)-SPA(20) and the performance of the maximum likelihood decoding (MLD) are 0.4 dB and 0.2 dB for the (64, 24) eBCH code and the (64, 45) eBCH code, respectively.

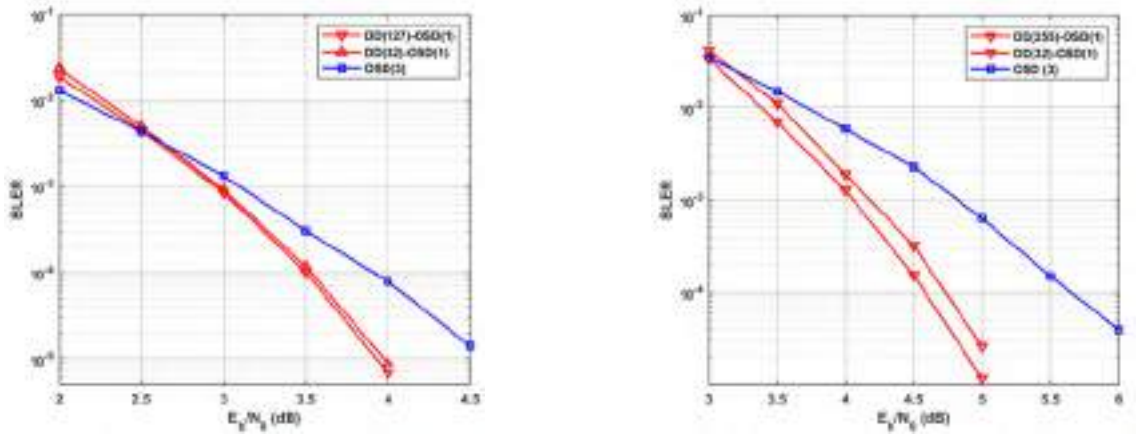
For minimal DDs, we demonstrate that the minimal DDs in different directions are equivalent. More precisely, the cyclic shift of a codeword in one minimal DD is also a codeword in another minimal DD. Together with the equality of cyclic DDs and the fact that a minimal DD is a subcode of a cyclic DD, we reveal that the minimal DDs in all directions consist of a cyclic DD. Moreover, the derivative decoding can be carried out based on the decodings for minimal DDs with cyclic shifting. Due to the small dimension of minimal DDs, it is attractive to perform derivative decoding based on the ordered statistics decoding (OSD) (DD-OSD). Simulation result shows that the derivative decoding based on the OSD with order-1, DD-OSD(1), can outperform the OSD with order-3, OSD(3).

We first introduced the cyclic derivative descendants and the minimal derivative descendants at GlobeCom 2022 and ISIT 2023, respectively. Please refer to [1] and [2].

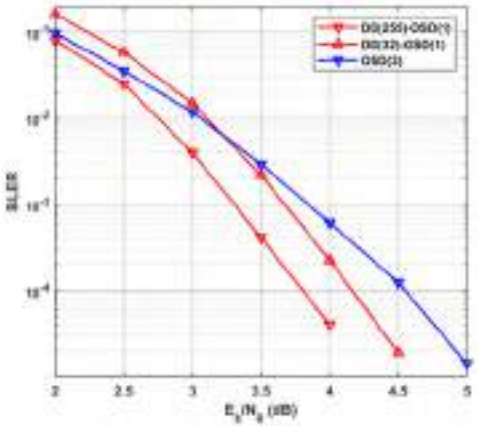


(a) (64, 24) eBCH (b) (64, 45) eBCH

Fig. 1. Performance of decoding eBCH codes using DD-SPA, BP and ABP, decoding BCH codes using BM and Chase BM.



(a) (128, 36) eBCH (b) (256, 37) eBCH



(c) (256, 79) eBCH

Fig. 2. Performance of decoding eBCH codes using DD-OSD(1) and OSD(3).

References:

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最新结果 • RECENT RESULTS •

NAND 闪存自适应编译码方案的设计
Design of Adaptive Dynamic Codec Scheme for NAND Flash Memory

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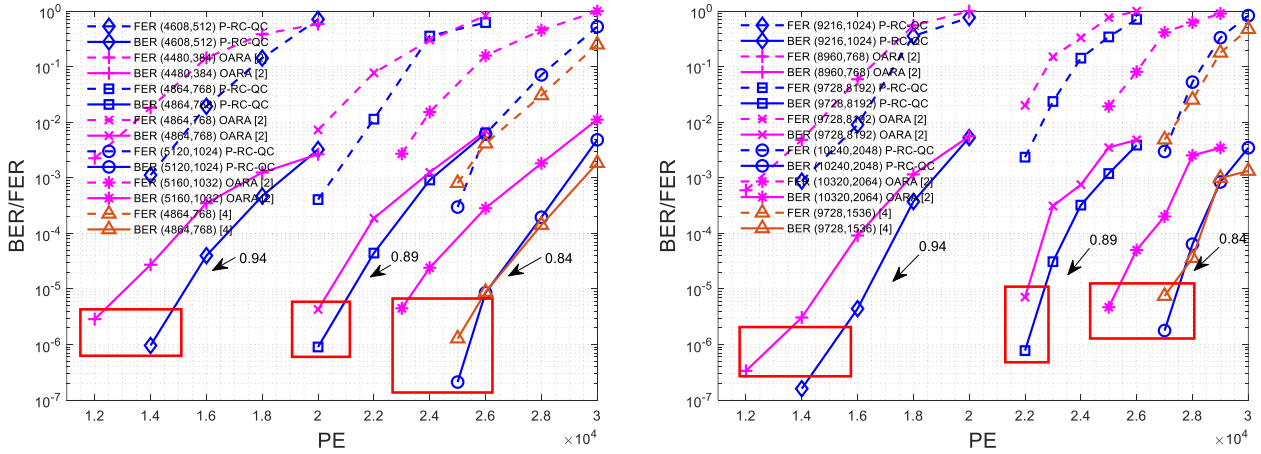
With the advancement of storage technology, the reduction in manufacturing processes and the advent of 3D stacking have brought about substantial storage capacities. However, the intricate circuitry and intensified channel noise have diminished the fault-tolerance capability of storage units, impacting data reliability [1]. For solving such problems, a rate-compatible optimized accumulated-repeat-accumulate (OARA) code based on accumulate-repeat-by-4-accumulate (AR4JA) is proposed [2]. A protograph low-density parity-check (P-LDPC) code is proposed [4]. Additionally, a rate-adaptive protograph LDPC (RAP-LDPC) code with fixed information bit length of 39z is presented, specifically designed for cross-page storage [3]. Notably, these outcomes are constructed for scenarios necessitating specific frame lengths without specific requirements for information bit lengths.

This work will integrate the storage transmission characteristics of flash memory systems to research code construction, establishing a configurable LDPC encoding system in terms of rate and information bit length. This approach aims to better align with the actual attributes of flash memory storage, optimizing both reliability and transmission efficiency. Firstly, based on a channel quality model, the relationship between LDPC code rate, specific information bit length, and fundamental check matrix size is defined, and a protograph based rate-compatible-quasi-cyclic low-density-parity-check (P-RC-QC LDPC) code is proposed. This enables compatibility with specific UNIT size requirements of the file control module while ensuring reliability across different leftspan. Additionally, the work introduces non-transmission bits into the codeword structure and design an adaptive dynamic codec (ADC) scheme, which can dynamically adjust the actual transmission codeword length, reducing the proportion of occupied storage space and enhancing effective data throughput.



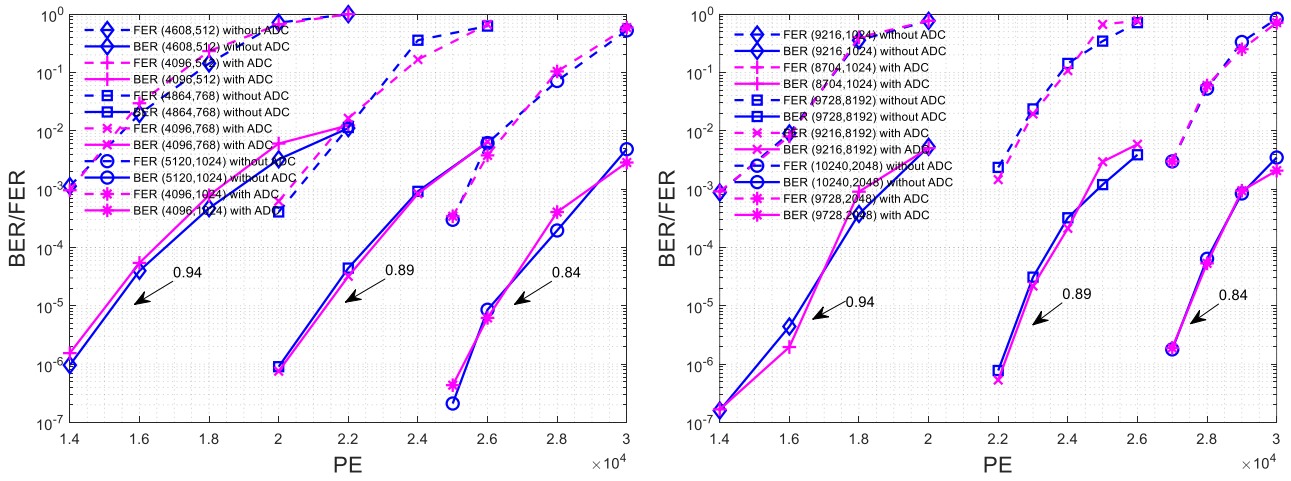
(a) the information length is set to 512B (b) the information length is set to 1KB

Fig.1 Comparison of FER/BER performance over three different code lengths under different PE cycles, where the retention time is set to 5×10^3

Fig.1 illustrates the comparison of the proposed P-RC-QC LDPC code with other prototype codes in terms of bit error rate (BER) / frame error rate (FER) performance. In Fig.1(a), one can observe that when the error rate reaches 10^{-5}, at a rate of 0.94, the P-RC-QC LDPC code is compatible with 15250 PE, exhibiting an increase of nearly 2000 PE compared to the 13100 PE compatibility of the code in [2]. At a rate of 0.89, the P-RC-QC LDPC code is compatible with 21250 PE, showing an increase of nearly 750 PE compared to the 20500 PE compatibility of the code in [2]. At a rate of 0.84, the P-RC-QC code is compatible with 26000 PE, displaying an increase of nearly 2500 PE compared to the 23500 PE compatibility of the code in [2]. At 25000 PE, the BER obtained by the P-RC-QC LDPC code is lower compared to the BER of the code in [4], with enhanced performance in the waterfall region. Experimental results indicate the proposed P-RC-QC LDPC codes yield superior reliability. Moreover, similar results can be observed from Fig.1(b), where the information length is set to 1KB.

Fig.2 displays the error rate performance of three different rates of P-RC-QC LDPC codes with and without the use of the ADC scheme. In Fig.2(a), the information length is set to 512B, under the ADC scheme, the transmission length of one encoded frame reduces by 256 bits. Assuming a total space of 10GB (10×2^{33}), for an information length of 512B and a code rate of 0.94, the maximum number of codewords storable is $\frac{10\times2^{33}}{4608}$, while it increases to $\frac{10\times2^{33}}{4352}$ (approximately 5.9% space savings) using the proposed ADC scheme. For rates of 0.89 and 0.84, the space savings achieved by the proposed P-RC-QC LDPC codes under the ADC scheme are 5.3% and 5%, respectively. Using the code in [2], the codeword length is reduced by 128 bits under the ADC scheme. The maximum number of codewords that can be stored increases to $\frac{10\times2^{33}}{4352}$ from $\frac{10\times2^{33}}{4480}$, representing a space saving of 5.5%. This is comparable to the space savings achieved using the proposed P-RC-QC LDPC codes. However, the information length of the code in [2] increases with the increase of the code rate, making the file control module more complicated. The written length in the flash memory channel remains unchanged for the other two codes [3-4], because non-transmission nodes are not included.

Moreover, similar results can be observed from Fig.2(b), where the information length is set to 1KB. Under the ADC scheme, the transmission length of one encoded frame reduces by 512. As a consequence, the proposed ADC scheme not only enhances throughput but also ensures performance comparable to that without the ADC scheme.



(a) the information length is set to 512B (b) the information length is set to 1KB

Fig.2 Comparison of FER / BER performance over three different rate proposed RC protograph codes with and without the ADC scheme under different PE cycles, where the retention time is set to 5×10^3

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一种对话交互式的可编辑语义通信系统
Editable-DeepSC: Cross-Modal Editable Semantic Communication Systems

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语义通信侧重于传输原始数据背后所蕴含的语义信息，在实现更极致数据压缩的同时提升语用任务的执行准确率，有望进一步释放通信潜能，克服经典语法通信所面临的香农极限约束、优质频谱资源稀缺、硬件能耗成本大等瓶颈，已经引发了国内外广泛研究关注。

然而，目前还少有语义通信研究工作探索了所传输的语义信息需要根据用户需求进行动态调整的场景。如图 1 所示，随着 6G 时代的加速到来，用户在通过社交平台上传多媒体数据的同时，往往希望能根据其个人需要对原始数据进行动态编辑 (例如给人脸添加笑容、更改眼镜透明度等)，然后才将其传输给远端的中央服务器。另一方面，ChatGPT 等生成式 AI 的涌现让人与机器之间的交流更加流畅和自然，用户还可以将其编辑需求以对话的方式传输给远端的中央服务器，从而获得更好的交互式体验。在该过程中，如何对跨模态的语义信息进行高效的编码和处理，同时抵抗信道噪声的干扰？解决这些广泛应用场景下的语义通信问题具有重要意义，而这正是当前已有研究工作所忽视的。

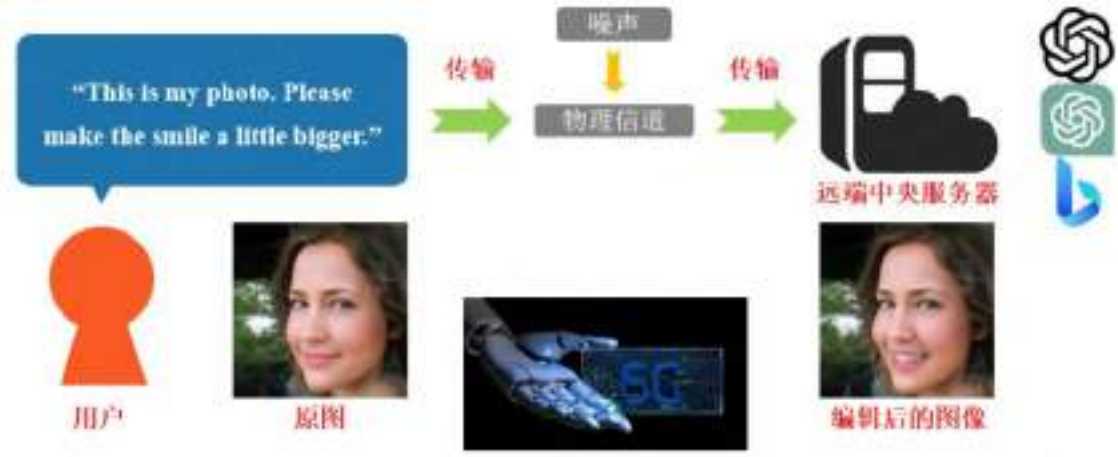

图 1 语义信息动态编辑、对话交互式的应用场景

如图 2 所示，我们实现了一种跨模态的可编辑语义通信算法，允许用户在传输原始图像的同时，一并传输相应的编辑指导文本，接收方可以获得编辑后的图像，由此既能实现高效的细粒度语义编辑、取得令人满意的编辑效果，又能具备较高的通信效率、抵抗信道噪声的污染。

我们利用生成模型反演[1-2]的方法，基于 StyleGAN 先验[3]对原始图片进行解耦表示，即特征向量不同位置元素的值可以解纠缠地表征图片不同属性的程度(如头发长度、笑容大小、年龄等)，从而通过细粒度地修改目标属性的程度以实现语义信息的细粒度编辑，而不影响其它非相关的属性。

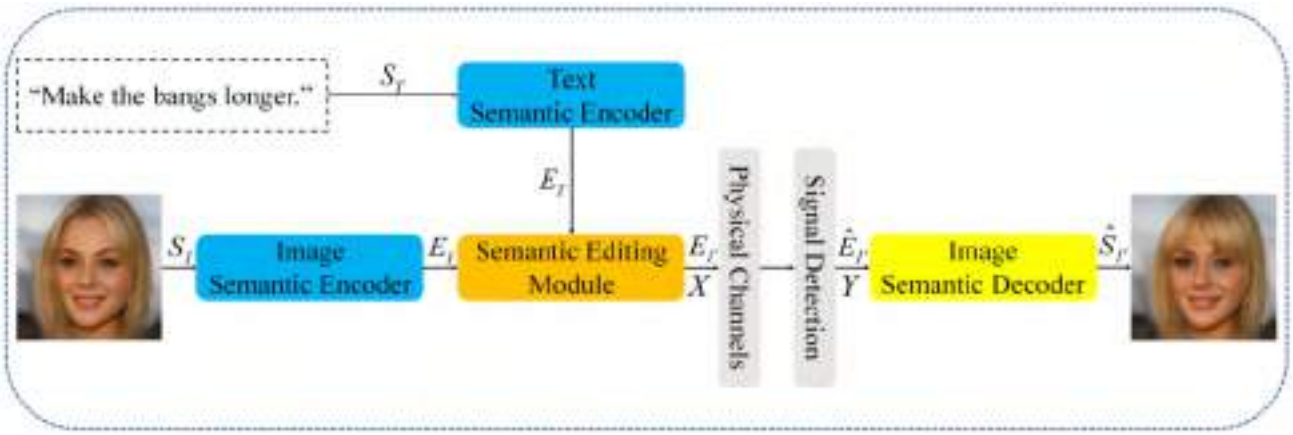

图 2 所实现算法的整体架构图

为了更好地提供对话交互式体验，我们使用 LSTM 网络[4]对文本进行编码，获取相应的目标属性、编辑方向、编辑程度等语义信息，从而指导语义编辑模块对已被解耦表示的图片特征向量进行细粒度编辑，实现文本描述和图像内容的有意义关联。

我们在 CelebA-Dialog 数据集[5]上进行了广泛的实验测试，并与数据导向型的语法通信方法进行了性能对比，包括 DeepJSCC 深度联合信源信道编码方法[6]、JPEG 信源编码方法[7]、Huffman 信源编码方法[8]、LDPC 信道编码方法[9]、RS 信道编码方法[10]等。各个信噪比下的编辑效果定量对比结果如图 3 所示，编辑效果定性对比结果如图 4 所示，压缩程度定量对比如表 1 所示。

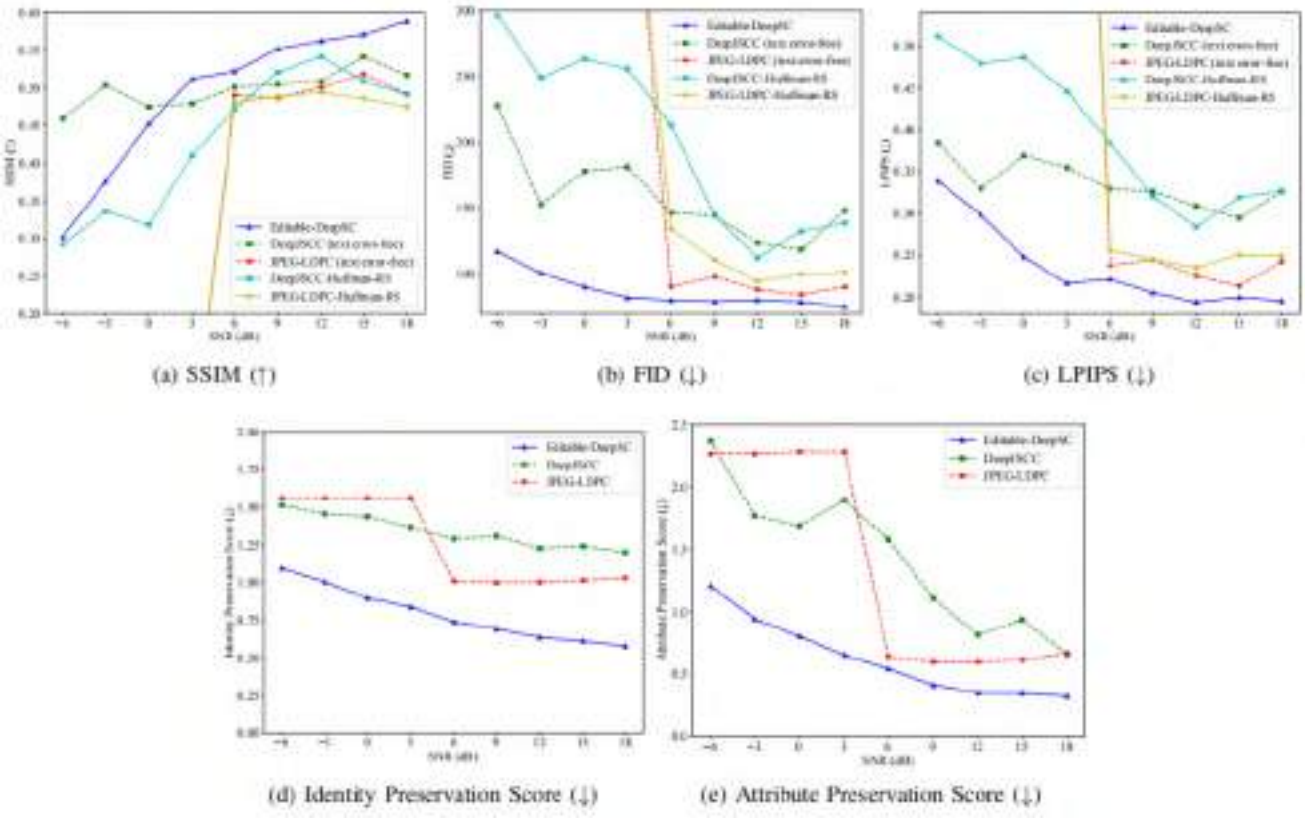

图 3 编辑效果定量对比

图 4 编辑效果定性对比

表 1 压缩程度定量对比

Method	bpp (↓)
DeepJSCC	0.070313
JPEG-LDPC	0.885795
Editable-DeepSC	**0.046875**

从以上结果不难看出，我们所提出的算法可以取得比数据导向型语法通信方法更逼真、自然的编辑效果，同时显著节省通信开销。我们的工作扩展了语义通信方法的应用场景，为用户提供交互性强的对话驱动式编辑体验和高效可靠的多媒体数据传输方案，也为通信社区的发展提供了新思路、新角度、新活力。

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交流活动 • RESEARCH ACTIVITIES •

第二届 IEEE/CIC ICCC 面向未来无线网络的信息论与编码研讨会
The 2nd IEEE/CIC ICCC Workshop on Information Theory and Coding for Future Wireless

The 2nd Workshop on Information Theory and Coding for Future Wireless, was held on Aug. 10 in conjunction with the 2023 IEEE/CIC International Conference on Communications in China (ICCC), in Dalian, China. The workshop was sponsored by the IEEE Information Theory Society Guangzhou Chapter. The workshop returned to fully in-person format and provided the community experience through on-site technical presentations, panels and posters.

The workshop was co-organized by the general co-chairs Dr. Wen Tong (Huawei Technologies), Prof. Li Chen (Sun Yat-sen University, SYSU), Prof. Guojun Han (Guangdong University of Technology, GDUT); and TPC co-chairs Prof. Baoming Bai (Xidian University), Prof. Kai Niu (Beijing University of Posts and Telecommunications), Dr. Huazi Zhang (Huawei Technologies) and Prof. Yi Fang (GDUT). Prof. Xijun Wang (SYSU) and Prof. Chang Liu (GDUT) served as the publicity co-chairs in the organizing committee.




The workshop was a half day event, started with four warm opening speeches given by Prof. Baoming Bai on behalf of the organizing committee of the workshop, Prof. Li Chen on behalf of the IEEE Information Theory Society Guangzhou Chapter, Prof. Guojun Han on behalf of the TPC co-chairs. During the sessions, and Mr. Jianmin Lu on behalf of Huawei Technologies.

The workshop featured two outstanding keynote speeches:

- Prof. Yong Liang Guan (Nanyang Technological University) on BEM (Basis Expansion

Model) Receivers for Severe Doubly Selective Fading Communication Channels

- Dr. Yingquan (Cody) Wu (TenaFe Inc.) on High-Speed LFSR Decoder Architectures for BCH and GII Codes

The workshop included 19 technical papers that were presented by both oral presentations and posters. They cover a wide range area in information theory and channel coding, with authors from both the academia and industry. The topics include polar codes, LDPC codes, algebraic codes, HARQ, and decoder implementations. Three technical sessions were organized. They include: the "channel coding" session which included work on encoding and decoding schemes; the "wireless communications" session which focused on coding applications in wireless communications, such as HARQ and the "from theory to implementation" session which emphasized on decoder architecture and hardware complexity. The sessions began with short 5-min oral presentations for each paper, and followed by panels and discussions with the posters, The combined format provided a better interacting experience for the workshop participants. The authors are from both the academia and industry.

Overall, the workshop was a great success. The organizers put together a half day event with excellent presentations, posters and face-to-face interactions. We would like to sincerely thank all the participants. Last but not least, our special thanks go to the IEEE Information Theory Society Guangzhou Chapter, along with Huawei Technologies and Guangdong University of Technology, and the organizing committee for their support. In the future, we plan to make this an annual workshop for the Information Theory community to better engage with the Communications community.

交流活动 • RESEARCH ACTIVITIES •

中山大学研讨会之代数编译码理论与应用前沿沙龙
The Sun Yat-sen University Workshop on the Frontiers of Algebraic Coding Theory and Applications

The Sun Yat-sen University (SYSU) Workshop on the Frontiers of Algebraic Coding Theory and Applications took place at the SYSU Guangzhou South Campus on Aug. 13, 2023. It was jointly organized by the IEEE Information Theory (IT) Society Guangzhou Chapter and the School of Electronics and Information Technology of SYSU, and co-sponsored by the 2023 High-Level Academic Conference Fund from the University Office of Scientific Research and Development. More than 50 scholars and industrial practitioners participated in the workshop. They came from over 10 academic institutions / companies, including SYSU, Tsinghua University, Shanghai Jiao Tong University (SJTU), Beihang University, The Chinese University of Hong Kong (Shenzhen), Huazhong University of Science and Technology, Xidian University, Guangdong University of Technology (GDUT), Huawei Technologies Co., Ltd., TenaFe Inc., etc. The workshop was chaired by Prof. Li Chen of SYSU, who is also the chair of the IEEE IT Society Guangzhou Chapter.

With the features of large codeword length, randomness and capacity polarization, modern channel codes can approach and even achieve channel capacity. However, future communications and storage systems demand more advancements in terms of latency, power efficiency and flexibility. Recalling the art of classic channel codes, algebra is the indispensable element. Classic channel codes rely on good algebraic structure to exhibit good error-correction capability and efficient decoding algorithms. With the spirit of revisiting the classics, benefiting the moderns and envisioning our futures, this workshop aimed to focus on the state-of-the-art in algebraic coding theory, techniques and their industrial impacts. Opposite to the iterative decoding techniques for turbo codes and low-density parity-check (LDPC) codes, algebraic decoding techniques often operate in a one-shot manner, inheriting the advantages in both the decoding latency and efficiency. On the other hand, future wireless networks may rely on short-to-medium length channel codes to realize the vision of ultra-reliable low-latency communications (URLLC). They do not have the above-mentioned capacity-

approaching (or achieving) enabling features. Instead, they need to have good algebraic structure that reflects on the code's weight spectrum and also enables their efficient decoding. Therefore, it is envisioned that algebraic coding theory and techniques may have their renaissance and play an important role again in the near future. It is hoped that this workshop can rediscover the significance of algebra in coding theory, promote more research ideas and endeavors, and further benefit the industry.

The workshop was featured by seven in-depth talks with its agenda given below. Prof. Li Chen delivered the opening speech, welcoming the participants and emphasizing the aim of the workshop. In the morning session, Dr. Yingquan Wu, chief scientist of TenaFe, gave the first talk. He systematically introduced the generalized integrated interleaved codes with Reed-Solomon codes and BCH codes as the component codes. Then, Prof. Bazhong Shen from Xidian University offered insights into the challenges of maximum likelihood decoding and its possible trendy artificial intelligence (AI) solutions. Prof. Chaoping Xing, the Associate Dean of the School of Cyber Science and Engineering at SJTU, presented a unified framework for fast Fourier transform via algebraic function fields. Afterwards, Prof. Li Chen shared the idea of using algebra to reduce the ordered statistics decoding latency for BCH codes. At the end of the morning session, Dr. Yingquan Wu further shared another work - a novel Chase Kötter-Vardy decoding algorithm. The afternoon session talks were delivered by researchers from Huawei. Dr. Huazi Zhang started this session with a spectrum

analysis of polar codes via their algebraic properties. Then, Dr. Jiongyue Xing introduced a novel shift-sum decoding method for cyclic codes. The last talk was presented by Dr. Yunqi Wan, who shared the re-encoding transform in algebraic list decoding of algebraic-geometric codes.

Before the end, a panel discussion on the significance of algebra in coding theory and techniques was joined by Dr. Yingquan Wu, Prof. Bazhong Shen, Prof. Chaoping Xing, Prof. Guojun Han (GDUT), and Dr. Huazi Zhang, and moderated by Prof. Li Chen. They exchanged their opinions with other workshop participants, with more insights shared and yet more challenges unfolded. Finally, Prof. Li Chen summarized the workshop by thanking all participants. He also traced the origin of the term "algebra" and its later Chinese translation "daishu" (代数), which helped reflect the essence of algebraic coding.

The Workshop Agenda

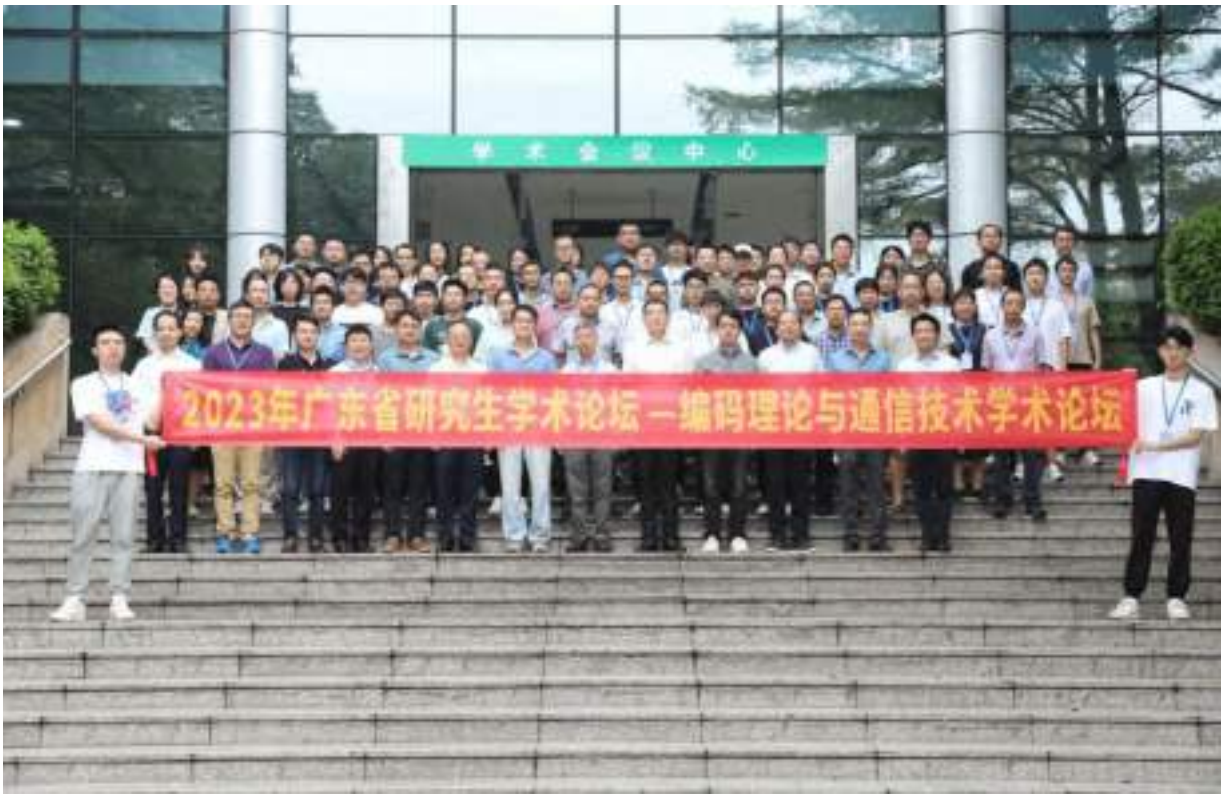
Speakers	Talks
Yingquan Wu	Generalized Integrated Interleaved Codes
Bazhong Shen	Exploration of ML Decoding Using AI Techniques
Chaoping Xing	Fast Fourier Transform via Automorphism Groups of Rational Function Fields
Li Chen	Low-Latency OSD of BCH Codes
Yingquan Wu	A Novel Chase Kötter-Vardy Algorithm
Huazi Zhang	New Algebraic Properties of Polar Codes
Jiongyue Xing	Shift-Sum Decoding of Cyclic Codes
Yunqi Wan	The Re-Encoding Transform in Algebraic List Decoding of Algebraic-Geometric Codes

交流活动 • RESEARCH ACTIVITIES •

2023 年广东省研究生编码理论与通信技术学术论坛和国家重点研发项目年度总结会

2023 GD Postgraduate Workshop on Coding Theory and Computer Communication Technology Academic Forum and the Annual Meeting of National Key R&D Project

10 月 27 - 29 日，2023 年广东省研究生学术论坛--编码理论与通信技术学术论坛和国家重点研发项目“隐私保护数据处理的数学方法”年度总结会在东莞理工学院松山湖校区学术会议中心举办。本论坛由广东省学位委员会办公室主办，东莞理工学院研究生院和电信工程与智能化学院承办，IEEE 通信学会、西安电子科技大学、广东工业大学和华为技术有限公司协办，由东莞理工学院电信工程与智能化学院编码团队组织，共吸引 127 名师生参与。



27 日进行国家重点研发项目组青年学者报告，主题分别为分布式编码、安全多方计算、全同态加密、轻量级隐私保护。上午分别由中科院张志芳教授和上海交通大学邵硕教授主持。下午分别由中科院李洪波教授、华东师范大学张磊博士和周俊博士主持。下午，同步进行了研究生论坛学生分会场报告。本次论坛共收到来自国内多所高校投稿论文 40 多篇，评选出学生报告一等奖 3 名，二等奖 6 名和三等奖 9 名，由香港城市大学宋林琦教授宣布获奖名单。

28 日进行专家报告，上午，由上海交通大学刑朝平教授，中国科学院李洪波教授，中山大学马啸教授，西南交通大学唐小虎教授作专家报告。下午，由香港城市大学宋林琦教授，澳门大学徐欢乐教授，香港中文大学（深圳）杨升浩教授，清华大学电子工程系周盛副教授作专家报告。

29 日上午进行国家重点研发计划“隐私保护数据处理的数学方法”项目年度总结会。重点项目组老师分别对分布式数据存储的理论和方法、安全多方计算与私人信息提取的理论及应用、全同态加密的理论和方法、轻量级隐私保护方法作汇报。本次项目总结会的责任专家为上海交通大学邢朝平教授、山东大学徐秋亮教授、北京大学冯荣权教授、中科院信工所林东岱教授、中科院系统所高小山教授和西南交通大学唐小虎教授。

本次论坛获华为技术有限公司赞助，29 日上午主题为高速低复杂度编译码研讨会分论坛在华为公司松山湖溪村同步举行。下午，参会人员参观华为公司溪村。会议闭幕式由侯韩旭教授发表致谢词并感谢各位专家学者。

交流活动 • RESEARCH ACTIVITIES •

2026 IEEE 国际信息论年会场地考察
Investigation of the Venue for ISIT 2026

11 月 24 日，ISIT 2026 大会共同主席范平志教授、陈立教授，大会财务主席王玺钧副教授，以及广州科奥信息技术股份有限公司（简称“科奥”）团队一行对会场选址开展了实地考察。在科奥的协助下，大会从众多的会场与酒店名单中挑选出广州越秀国际会议中心(GYICC) 、东方宾馆、中国大酒店和广州花园酒店作为候选方案。此次考察重点关注会场设施、周边环境、酒店服务与价格等问题。

方案一：GYICC 为大会会场、东方宾馆和中国大酒店为晚宴会场及会议酒店

广州越秀国际会议中心毗邻东方宾馆和中国大酒店，三者之间的步行距离仅 3 分钟。从广州白云国际机场至会场，仅需 40 分钟的车程，交通十分便捷。酒店均为五星级别，位于广州市老城区，紧邻地铁口，出行十分方便。周边越秀公园的五羊雕塑和流花湖公园的自然风光，为参会者提供了丰富的游玩选择。

针对会场硬件设施，团队着重考察位于 3 楼的主会场以及位于 6 楼的各分会场，并现场测试了会场的隔音效果，效果理想。




方案二：广州花园酒店，会场与酒店一体

广州花园酒店为中国首批、华南地区唯一的“白金五星级”酒店，位于广州市中心繁华商业区，交通十分便利，毗邻市内各大观光购物和休闲娱乐场所，深受国内外商旅客人喜爱。酒店设计充满中华传统文化底蕴，可让参会者在开展学术活动之余，感受独特而丰富的岭南

文化氛围。

针对分会场数量及容量的问题，团队与酒店交流了应对方案。同时，广州花园酒店以一流的设施、优质的服务、独特的岭南文化氛围和繁华的位置著称，各项费用均较高，团队需对此进一步讨论。




11 月 29 日，经过了两轮的实地考察，以及进一步和大会共同主席 -- 香港中文大学杨伟豪教授的商讨，三位共同主席对会场硬件设施、地理位置及住宿条件等因素进行综合评估，最终确定了方案一为 ISIT 2026 的举办地点。ISIT 2026 组委会团队后续将进一步与广州越秀国际会议中心商讨细节，并开始签署合同的相关工作。

交流活动 • RESEARCH ACTIVITIES •

2023 年度全国信息论学术会议暨中国电子学会第三十届信息论学术年会
The 30th Annual Symposium on CIE Information Theory Society

11 月 24 - 26 日，2023 年度全国信息论学术会议暨中国电子学会第三十届信息论学术年会在广州市长隆国际会展中心成功举办。此次会议由中国电子学会信息论分会主办，广东工业大学承办，西安电子科技大学广州研究院、广东技术师范大学、华为技术有限公司、江波龙电子、浩洋电子、置富科技、力合微电子等公司为本次活动提供了大力支持。大会邀请了包括张平院士、范平志教授、盛敏教授、唐小虎教授、宋令阳教授、陶梅霞教授、蔡葵教授、陈立教授、牛凯教授、王琳教授、樊平毅教授、殷柳国教授、光炫教授、黄勤教授、秦志金副教授、胡杰教授、刘楠教授、万凯教授、刘鲲教授、黄绍伦副教授、邵硕副教授等在内的 20 余名资深专家和青年学者做主旨和特邀报告，收到 100 余篇高质量论文投稿，吸引了来自全国 100 多家高校、研究机构、企业的近 400 位专家学者、技术人员、研究生参加，注册和参会人员均创历史新高，盛况空前。大会包括主会场、会员日报告会场及三个分会场，并设有大会主旨报告、会员日与分会场特邀报告、口头报告、海报展示等多个环节。

大会开幕式由大会共同主席信息工程学院院长韩国军教授主持。广东工业大学党委书记胡钦太教授在大会开幕式上致辞，期待能够借助此次会议与专家学者开展广泛深入的学术交流与合作，共同推动国内信息论与编码学科的研究与发展。中国电子学会信息论分会主任委员西安电子科技大学白宝明教授、副主任委员清华大学樊平毅教授、协办方代表广东技术师范大学校长戴青云教授、通感融合光子技术教育部重点实验室主任秦玉文教授、信息工程学院党委书记邵际珍、西安电子科技大学沈八中教授分别做了大会致辞。中国科学技术大学张文逸教授、香港中文大学（深圳）许杰副教授等作为特邀嘉宾分别主持了会员日和大会主旨报告。信息工程学院副院长方毅教授代表组委会介绍了会议筹备情况。组委会宣布并颁发了最佳论文奖、最佳报告奖、最佳海报奖、青年新星奖和最佳博士论文奖。

此外，中国电子学会信息论分会和 IEEE 信息论学会广州分会对本次会议的筹备和举办提供了有力支持，广东工业大学信息工程学院研究生会牵头组织的志愿者服务团队也为本次大会的顺利举办提供了全方位保障服务，展现了学校师生良好的精神面貌和风采。

本次大会是近 4 年首次线下举办的信息论学术年会，学术气氛浓厚。与会专家学者就信息论、编码、通信、存储、人工智能等相关领域的学术前沿内容做了广泛而深入的交流与探讨，共商信息论领域的未来发展，为相关领域学者的科学研究工作指引了新方向，有效地提升信息论学群的凝聚力和广东工业大学信息学科的影响力，大会取得了圆满成功。

交流活动 • RESEARCH ACTIVITIES •

IEEE 信息论杰出讲师讲座 -- 信息论密码学
IEEE Information Theory Society Distinguished Lecture on Information-Theoretic Cryptography

On Dec. 11, 2023, Professor Shun Watanabe visited Sun Yat-sen University (SYSU) and gave an IEEE Information Theory (IT) Society distinguished lecture on Information-Theoretic Cryptography. Shun is an Associate Professor of Tokyo University of Agriculture and Technology and the Society's Distinguished Lecturer for the years of 2023 and 2024. He had also been an Associate Editor for the IEEE Transactions on Information Theory, and a General Co-chair of the 2021 IEEE Information Theory Workshop. He is a Board of Governor of the Society. This lecture was hosted by the Society's Guangzhou Chapter and the School of Electronics and Information Technology of SYSU. More than 40 scholars and students participated the lecture. The participants also included several industrial experts from Huawei and Shanghai AI Lab.

The lecture was moderated by Professor Li Chen of SYSU, Chair of the Society's Guangzhou Chapter. Li gave an opening speech, welcoming the lecturer and all participants. This distinguished lecture addressed the information-theoretic cryptography. Although the computational cryptography has been widely used in practice, its security relies on certain computational assumptions. The information-theoretic cryptography seeks to build protocols that are secure without any assumptions on adversary's computational power. This has been actively studied since the landmark paper by Shannon. In fact, some of the information-theoretic concepts and tools have been used in the computational cryptography that is more often seen in practice. During the lecture, Shun first provided an overview for information-theoretic cryptography, followed by a few technical tools including the min-entropy, universal hash family and leftover hash lemma. He then introduced secure computation and oblivious transfer and showed how to realize the simulation based security against active adversary. Finally, he shared some open problems in the area. More details could be found in his recently published textbook (Himanshu Tyagi and Shun Watanabe, "*Information-theoretic Cryptography*,"

Cambridge University Press, 2023).

This lecture has shown the deep insights and challenges in the area of information-theoretic cryptography. It has inspired active discussions between the lecturer and the participants. Before the lecture concluded, a group photo was taken in commemorating this Society event in East Asia.

喜讯 • GOOD NEWS •

IEEE 信息理论学会哈尔滨分会成立
Founding of the IEEE Information Theory Society Harbin Chapter

IEEE 信息论学会已经正式在哈尔滨工业大学（HIT）成立了哈尔滨分会。这一里程碑旨在促进学术交流，推动创新，并推动哈尔滨乃至东北地区的信息理论领域的发展。

作为 IEEE 信息论学会中国区的新成员，哈尔滨分会将致力于促进信息理论领域在东北地区的学术研究和技术发展。哈尔滨分会将积极组织学术研讨会、特别讲座、技术论坛等活动，以促进学术交流和知识分享。此外，它还将考虑组织各种学术竞赛、项目合作和青年学者培训计划，鼓励和支持年轻学者在信息理论领域进行创新研究。此外，哈尔滨分会还将与 IEEE 信息论学会其他分会的国际合作伙伴合作，促进国际合作，推动信息理论研究的全球化。

哈尔滨是中国东北地区一座充满活力的城市，以丰富的文化遗产、迷人的建筑和多样化的美食而闻名。它是黑龙江省的省会，也是中国最北部的省份之一，拥有超过 1000 万的人口。哈尔滨以其冬季景点而闻名，特别是每年举办的哈尔滨国际冰雪雕塑节，游客可以欣赏到用冰雪制成的精致雕塑。此外，哈尔滨还有许多其他历史和文化景点，如圣索菲亚大教堂，它融合了拜占庭的建筑风格。

我们诚挚欢迎专家、教授和同行们前来参观，并在哈尔滨分会进行交流。

喜讯 • GOOD NEWS •

《信息论与编码》课程获广东省一流本科课程认定
Information Theory and Coding was Recognized as A First-class Undergraduate Course of Guangdong Province

近日，IEEE 信息论学会广州分会主席、中山大学电子与信息工程学院陈立教授建设的《信息论与编码》课程，获批广东省 2023 年度省线上线下混合式一流本科课程。

该课程于 2016 学年秋季学期首次开设了，至今已经累计达到 640 学时，并吸引了 690 名学生选课。为打造可持续发展的课程体系，团队于 2022 学年秋季学期推出了线上课程《信息论与编码》，为广大学生提供更多元化和个性化的学习模式，优化课前预习的效果，提高课堂学习的质量，强化课后温故的效果，有效提升通信工程专业的人才培养质量。

广 东 省 教 育 厅

广东省教育厅关于公布 2023 年度省级一流本科课程认定结果的通知

二、线上线下混合式一流课程

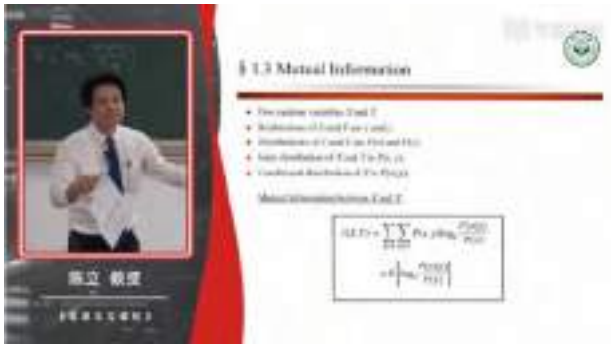
学校	课程名称	负责人

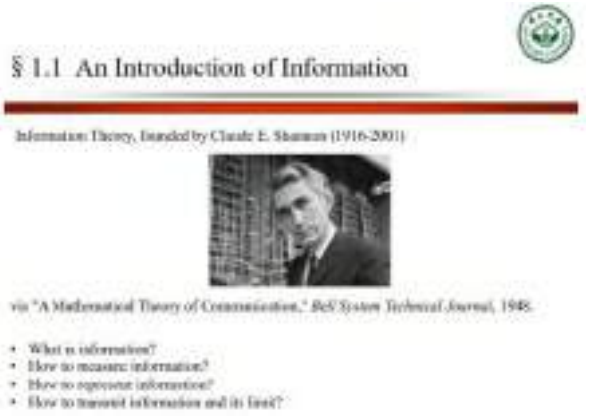
课程负责人陈立教授、博导，任 IEEE 信息论学会理事会理事、会议委员会主席、广州分会主席，IEEE Transactions on Communications 副主编（2018-2023），中国电子学会信息论分会委员，中国通信学会青年工作委员会、通信理论与信号处理委员会、信息通信及安全数学理论委员会委员。发表高质量 SCI 期刊及顶级会议文章百余篇，主持多项国家及省部级项目。曾获 2014 年中国首届“信息论青年新星”荣誉称号。

《信息论与编码》课程以线上与线下融合的模式，将现代信息技术与课堂教学有机融合，使课堂教学更加高效，学生不仅可以在课堂上获得传统的互动式教学，还可利用现代信息技术在多媒体环境中进行丰富的课外学习，学生可以利用线上教学视频与课程讲义提前学习基础知识，通过课堂讲解和板书加深理解，并进一步在课后利用线上习题加以巩固并与教师互动，实现良好的学习效果。

课程全面而丰富的内涵、生动有趣的授课方式、多维度融合的教学以及理论实践的深度互动，展现出独特的魅力。本课程的讲义由陈立教授精心编写，以英文呈现，深入浅出，引人入胜。课程内容聚焦于香农信息理论、信道编码定理、信源编码定理，以及各类经典与现

代编码机制，以此构建起全面而前沿的信息论知识体系。陈立教授的授课风格幽默风趣，注重引导学生思考，通过课堂板书呈现关键定理的推导证明，将复杂的知识点以易于理解的方式呈现出来，让学生能够更好地理解和掌握课程内容。融合的教学模式要求学生合作完成基于卷积编码机制的通信系统软件仿真平台搭建并进行性能评估，以答辩方式进行考核。该方式进一步使学生自主学习编码算法，激发其科研的潜能。





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信息论与编码

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长按识别二维码

喜讯 • GOOD NEWS •

《信息论与编码理论基础》课程获广东省一流本科课程认定

Fundamentals on Information Theory and Coding Theory was Recognized as A First-class Undergraduate Course of Guangdong Province

暨南大学《**信息论与编码理论基础**》课程是国家一流本科专业建设点电子信息工程的专业必修课，教学团队包含赵山程教授、项世军教授和周美秀。

经过多年建设，本课程主要成果如下：暨南大学首批“金课”、暨南大学课程思政优秀案例二等奖、广东省高教学会课题、广东省教改、暨南大学课程思政改革示范项目、暨南大学线上线下混合式教学项目、暨南大学在线开放课程、广东省线上线下混合式一流本科课程。

经课情学情分析，该课程存在的真实问题有：怀疑课程设置、理论深度浅、实践能力弱。为解决此问题，暨南大学《信息论与编码理论基础》教学团队建立了“三段-三融”线上线下混合式教学模式，通过教学内容重构，将其分为基础阶段、提高阶段、挑战阶段，并自建“**1+1+4**”资源平台，将思政、科研和实践融入教学全过程，打通“概念-定理-算法-应用”之间的障碍，下图展现了主要教学设计 。

为配合上述模式，教学团队自建了“**1+1+4**”资源平台，具体如下：1 个在线开放课程，1 本自著辅助教材，4 个资源平台，包括：**思政案例库** 含载人航天精神、新时代北斗精神、Shannon 创新精神等 20 余项；**实践案例库** 含 Huffman 码、卷积码、语义通信、DNA 存储等 20 余项；**科研案例库** 含 30 余篇经典论文；**国际化资源库** 选用 MIT、Cambridge 相关课程资源库。

所提教学模式受到行业专家、教学名师好评。该模式实施后，学生学习积极性、实践与科研能力均显著提升：学生获全国信息隐藏大赛二等奖；指导学生获批大创项目 3 项，含省大创重点项目 1 项；学生在顶级期刊 IEEE TIP 发表论文。

教学团队一直追求“新竹高于旧竹枝”。在教学过程中，我们深切感受到教育的活力，需要我们跟紧国家产业需求方向，回应时代呼声。我们一直梦想着，5 到 10 年后，这门课程的学生能成长为信息强国路的排头兵。

新锐风采 • NEW TALENTS •

池育浩 (Yuhao Chi)，西安电子科技大学，华山准聘副教授，硕士生导师。2018 年获西安电子科技大学通信与信息系统博士学位；2016-2017 年，获国家留学基金，获国家留学基金委 (CSC) 资助，在新加坡南洋理工大学 (NTU) 电气与电子工程学院进行博士联合培养，并在新加坡科技与设计大学 (SUTD) 交流学习；2018-2021 年，在华为技术有限公司任高级工程师；2021 年 6 月加入西安电子科技大学通信工程学院。担任第 23 届国际通信技术大会 IEEE ICCT 移动和无线网络分会联合主席。

主要研究多用户编码理论与迭代接收机设计、智能信号处理。主要贡献包括：针对 MIMO-NOMA 场景，首次基于 Turbo-LMMSE 接收机提出多用户码设计[1-3]；针对离散大规模 MIMO 提出可逼近约束容量域的多用户码设计准则和多用户 OAMP / VAMP 接收机[4,5]，进一步设计具有低复杂度且约束容量最优的 MAMP 接收机和最优编码设计准则[6,7]; 考虑实际 MIMO 系统中非线性预处理对收发机的影响，首次给出 OAMP / VAMP 在广义线性系统模型下的可达速率分析及最优码设计[8,9], 在海量通信场景中的信号检测和编码领域具有巨大应用前景。

部分重要学术论文：

[1] **Y. Chi**, L. Liu, G. Song, C. Yuen, Y. L. Guan and Y. Li, Practical MIMO-NOMA: Low Complexity and Capacity-approaching Solution, *IEEE Trans. Wireless Commun.*, vol 17, no. 9, pp. 6251-6264, Sept. 2018.

[2] L. Liu, **Y. Chi,** C. Yuen, Y. L. Guan and Y. Li, Capacity-achieving MIMO-NOMA: Iterative LMMSE Detection, *IEEE Trans. Signal Process.*, vol. 67, no. 7, pp. 1758-1773, Apr. 2019.

[3] **Y. Chi**, L. Liu, J. Guo, G. Song, C. Yuen, Y. L. Guan and Y. Li, Variable-rate Coding with Constant BER for NOMA via Multilevel IRA Coding, *IEEE Trans. Veh. Technol.*, vol. 68, no. 5, pp. 5149-5153, Mar. 2019.

[4] **Y. Chi,** L. Liu, G. Song, Y. Li, Y. L. Guan and C. Yuen, Constrained Capacity Optimal Generalized Multi-user MIMO: A Theoretical and Practical Framework, *IEEE Trans. Commun.*, vol.70, no. 12, pp. 8086-8104, Dec. 2022.

[5] **Y. Chi,** L. Liu, G. Song, Y. Li, Y. L. Guan and C. Yuen, Capacity Optimal Coded Generalized MU-MIMO, *IEEE Int. Symp. Inf. Theory*, pp. 2291-2296, 2022.

[6] Y. Chen, L. Liu, **Y. Chi**, Y. Li, and Z. Zhang, Memory AMP for Generalized MIMO: Coding Principle and Information-Theoretic Optimality, *IEEE Trans. Wireless Commun.*, early access, 2023.

[7] Y. Chen, L. Liu, **Y. Chi**, Y. Li, and Z. Zhang, Low-Complexity and Information-Theoretic Optimal Memory AMP for Coded Generalized MIMO, *IEEE Globecom*, pp. 1-6, 2023.

[8] L. Liu, **Y. Chi**, Y. Li, and Z. Zhang, Achievable Rates of Generalized Linear Systems with Orthogonal/Vector AMP Receiver, *IEEE Trans. Signal Process.*, vol. 71, pp. 4116-4133, 2023.

[9] L. Liu, **Y. Chi**, Y. Li, and Z. Zhang, Achievable Rates of Generalized Linear Systems with Orthogonal / Vector AMP Receiver, *IEEE Int. Symp. Inf. Theory*, pp. 519-524, 2023.

新锐风采 • NEW TALENTS •

Yingge Li（李英阁） received the B.S.degree in Electronic Information Engineering from Zhengzhou University in 2011, followed by the M.S.degree in Test Measurement Technology and Instruments from Guangdong University of Technology in 2014. From 2020 to 2023, she pursued the Ph.D.degree in Information and Communication Engineering from Guangdong University of Technology, under the supervision of Prof. Guojun Han.

She is a newly graduated Ph.D.in the area of coded and decoding. Her thesis is entitled "Research on 3D NAND Flash Channel Detection and Encoding and Decoding Technology", which primarily addresses various aspects such as channel transmission characteristics, read-write scenarios, and space utilization, and proposes corresponding solutions to enhance flash memory reliability and throughput. Addressing issues related to threshold voltage distortion and read voltage failure due to increased lifecycle, she introduced an SSAE optimal read reference voltage model. To tackle reliability concerns in flash memory channels, she proposed a prototype-based rate-compatible quasi-cyclic low-density parity-check code tailored for flash memory channel transmission characteristics. Balancing throughput and reliability considerations, she further introduced an adaptive dynamic codec scheme. Additionally, she addressed the slow iteration speed and high access delay issues in LDPC decoding algorithms. Using global monotonicity of single-symbol LLR information based on a page-oriented binary channel and similar RBER characteristics between frames, she proposed a rapid iterative LDPC decoding algorithm based on inter-frame feedback information to enhance frame iteration convergence speed.

Her key publications include:

[1] **Y. Li**, G. Han, S. Huang, C. Liu, M. Zhang, and F. Wu, Exploiting Metadata to Estimate Read Reference Voltage for 3-D NAND Flash Memory, *IEEE Trans. Consum. Electron.*, vol. 69, no. 1, pp. 9-17, Feb. 2023.

[2] **Y. Li**, G. Han, C. Liu, M. Zhang and F. Wu, Exploiting the Single-Symbol LLR Variation to Accelerate LDPC Decoding for 3-D NAND Flash Memory, *IEEE Trans. Computer-Aided Design of Integrated Circuits and Systems*, vol. 42, no. 12, pp. 5146-5150, Dec. 2023.

[3] **Y. Li**, G. Han, C. Liu and Y. Fang, Design of Adaptive Dynamic Codec Scheme for NAND Flash Memory, *China Commun.*, 2023.