IEEE 信息论学会广州分会季报

IEEE INFORMATION THEORY SOCIETY GUANGZHOU CHAPTER NEWSLETTER

第五期, 2022 年 1 月 No. 5, Jan. 2022

主编序语

各位学者：

本期《分会季报》集中探讨了通信中非线性元素带来的挑战和机遇，从互信息和信道容量、编译码、以及黎曼几何与信息论等角度探讨科学目标和前沿技术；同时，也探讨了无线网络中的缓存编码设计。9 月 25 日，“粤港澳大湾区信息论与人工智能国际研讨会”在清华大学深圳国际研究生院成功举办，两个方向的学者交流碰撞，分享新成果、启迪新思想。自 2022 年 1 月 1 日起，我荣幸担任 IEEE 信息论学会会议委员会主席，望能更好服务学群。

陈立

From the Editor-in-Chief

Dear Chapter Members,

The current issue investigates the nonlinear elements in communications for its challenges and opportunities in research. Scientific aims and advanced techniques are discussed from the perspectives of mutual information and channel capacity, coding and decoding, and Riemannian geometry and information theory. Meanwhile, coded caching design for wireless networks is also investigated. The GBA International Workshop on Information Theory and Artificial Intelligence took place at Tsinghua Shenzhen International Graduate School on Sept. 25. Scholars from both areas were gathered by the Workshop, sharing new results and inspiring new thoughts. Since Jan. 1, 2022, I am honored to become the Chair of IEEE Information Theory Society Conference Committee, hoping to better serve the community.

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。

The submission should include the title in both Chinese and English, author contacts, and the column that the article belongs to. Content of the article can be both in Chinese or English, and is limited to 800 words.

投稿邮箱/Submission email：

itguangzhou@163.com

目录 •Table of Content •

最新结果 • RECENT RESULTS •

信道线性化的一点再思考
Rethinking Channel Linearization

张文逸，中国科学技术大学
Wenyi Zhang, University of Science and Technology of China
wenyizha@ustc.edu.cn

信息论建立了一般信道的容量表达式，然而，便于计算和分析的情况并不多见。作为重要的特例，线性高斯信道的容量和相应的最优输入分布为大家所熟知；基于此，对于不满足线性高斯特性的信道，信道线性化仍然作为一种方便的近似分析方法，被广泛使用。考虑如图 1 所示的信道模型，我们总是可以将信道输入输出关系表示为[1, Sec. IV-C][1]

$$Y = \frac{\mathbf{E}[X^{*}Y|v]}{P}X + W(v), \tag{1}$$

其中 P 为信道输入 X 的平均功率，余项 $W(v)$ 则与 X 条件不相关[2]，从而在分析中被视为“噪声”进行近似处理。

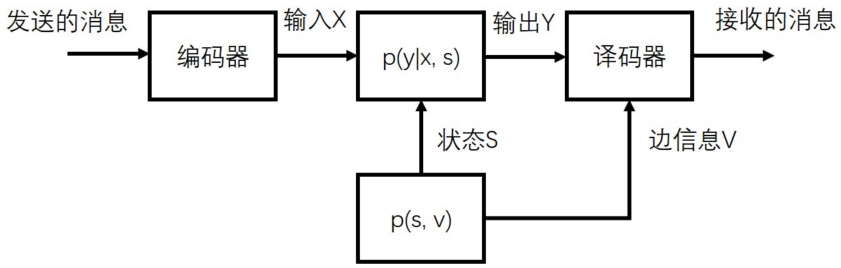


图 1. 具有一般输入输出关系和信道状态/译码端边信息的无记忆信道模型

部分归功于其简单性，上述的信道线性化事实上已成为对于不满足线性高斯特性信道的通用分析方法，重要的实例包括但不限于：

- 考虑了量化、功率放大器特性、剪波限幅、振荡器相位噪声、收发端 I/Q 不平衡等各种器件非理想特性的信道 Bussgang 分解[3][4][5][6][7]，此时的 $W(v)$ 包含了诸如量化误差等器件非理想特性的“残留”效应。
- 时变衰落信道中，由导频获得信道状态估计，译码端将信道状态估计视为真实信道状态的准相干接收机制[8][9][10][11]，此时的 $W(v)$ 包含了由信道状态估计误差作用于发送数据上所导致的干扰。

我们的工作始于对上述信道线性化方法的重新审视。为此，使用失配译码(mismatched decoding)理论中的广义互信息(generalized mutual information, GMI)作为性能指标。失配译码理论[12][13]研究的是当译码端使用与信道转移概率不匹配的译码度量时的信息传输性能，广义互信息则是在给定信道输入分布和给定失配译码器结构下的一个可达信息速率；相对于失配

[1] 这里给出的是当输入 X 为标量，输出 Y、状态 S、边信息 V 为一般矢量时候的表达式；当存在多个码流进行多天线空间复用时，X 为矢量，相应的分析和结果可参见[2]。
[2] 需要注意，根据概率论的基本知识，不相关的两个随机变量一般不满足独立性。

译码理论中的其它可达信息速率，广义互信息具有便于分析和计算的优点，被广泛应用于分析各种失配译码通信模型的性能[9][14][15]。

基于对广义互信息的分析，我们证明了下述结果[1, Prop. 4]：考虑如图 1 所示的信道模型，其中信道输入X来自独立同分布高斯码本，译码端则基于接收到的信道输出序列$(y_1,\ldots,y_N)$和信道边信息序列$(v_1,\ldots,v_N)$求解如下的最近邻距离问题

$$\widehat{m} = \arg\min_{m\in\mathcal{M}} \sum_{n=1}^{N} Q(v_n)|\tilde{\beta}^*(v_n)y_n - \tilde{f}(v_n)x_n(m)|^2, \tag{2}$$

$$Q(v) = \frac{1}{\mathbf{E}[\mathsf{X}^*\mathsf{Y}|v]^*\mathbf{E}[\mathsf{Y}\mathsf{Y}^*|v]^{-1}\mathbf{E}[\mathsf{X}^*\mathsf{Y}|v](P-\mathbf{E}[\mathsf{X}^*\mathsf{Y}|v]^*\mathbf{E}[\mathsf{Y}\mathsf{Y}^*|v]^{-1}\mathbf{E}[\mathsf{X}^*\mathsf{Y}|v])}, \tag{3}$$

$$\tilde{\beta}(v) = \mathbf{E}[\mathsf{Y}\mathsf{Y}^*|v]^{-1}\mathbf{E}[\mathsf{X}^*\mathsf{Y}|v], \tag{4}$$

$$\tilde{f}(v) = \frac{\mathbf{E}[\mathsf{X}^*\mathsf{Y}|v]^*\mathbf{E}[\mathsf{Y}\mathsf{Y}^*|v]^{-1}\mathbf{E}[\mathsf{X}^*\mathsf{Y}|v]}{P}, \tag{5}$$

其中上标*表示共轭转置。上述系统的广义互信息恰好等于按照信道线性化表达式(1)进行形式化的“信噪比”计算之后代入线性高斯信道容量公式得到的“信道线性化容量”，即有关系式

$$I_{\mathrm{GMI,lin}} = \mathbf{E}\left[\log\frac{P}{P-\mathbf{E}[\mathsf{X}^*\mathsf{Y}|\mathsf{V}]^*\mathbf{E}[\mathsf{Y}\mathsf{Y}^*|\mathsf{V}]^{-1}\mathbf{E}[\mathsf{X}^*\mathsf{Y}|\mathsf{V}]}\right]. \tag{6}$$

熟悉线性估计理论[16]的话，不难进一步看出(6)可以简记为

$$I_{\mathrm{GMI,lin}} = \mathbf{E}\left[\log\frac{P}{\mathsf{lmmse}_{\mathsf{V}}}\right], \tag{7}$$

这里的分母$\mathsf{lmmse}_{\mathsf{V}}$正是在条件V下，通过观测Y，对X进行线性最小均方误差估计的最小均方误差值。

如何理解上述的数学结果？这一结果的意义在于从信息论角度严格阐明了通过由(2)-(5)给出的最近邻译码器，可以达到基于信道线性化模型(1)开展近似分析所描述的性能。

注意到由(2)-(5)给出的仅仅是一种具有特殊线性结构的最近邻译码器，进一步的思考就自然地引出新的问题：是否可能通过对最近邻译码器的适当推广，获得性能的提升？具体地，我们考虑

$$\widehat{m} = \arg\min_{m\in\mathcal{M}} \sum_{n=1}^{N} |g(y_n,v_n) - f(y_n,v_n)x_n(m)|^2, \tag{8}$$

优化其中的处理函数g和缩放函数f，来最大化所得到的广义互信息。对这个问题进行求解，得到最优解如下[1, Sec. III]：最优的处理函数为

$$g(y,v) = \frac{1}{\sqrt{(P-\omega(y,v))\omega(y,v)}}\mathbf{E}[\mathsf{X}|y,v], \tag{9}$$

最优的缩放函数为

$$f(y,v) = \frac{\sqrt{P-\omega(y,v)}}{P\sqrt{\omega(y,v)}}, \tag{10}$$

这里的$\omega(y,v)$函数是$\mathbf{E}[\mathsf{X}|y,v]$的条件均方误差，即

$$\omega(y,v) = \mathbf{E}\left[|\mathsf{X}-\mathbf{E}[\mathsf{X}|y,v]|^2\middle|y,v\right], \tag{11}$$

最大化的广义互信息为

$$I_{\mathrm{GMI,opt}} = \mathbf{E}\left[\log \frac{P}{\omega(\mathrm{Y},\mathrm{V})}\right]. \tag{12}$$

我们称(8)的形式为广义最近邻译码(generalized nearest neighbor decoding rule，GNNDR)，其对应的等效信道可以用图 2 表示。广义最近邻译码器寻找使得图 2 中w'具有最小平均功率的码字。

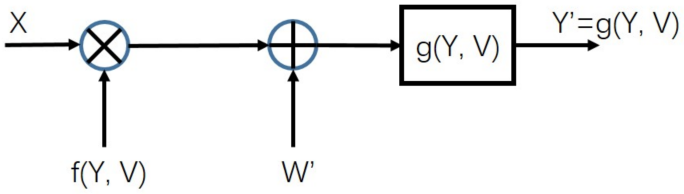


图 2. 广义最近邻译码(8)对应的等效信道表示

至此，简要介绍了我们对信道线性化再思考的出发点、关键思路和核心结果。详细的推导、讨论、对广义互信息(12)和(7)进一步的分析和比较结果可参见[1][2]。对于器件非理想特性较为显著、信道快速变化、或者有多个码流进行多天线空间复用等应用场合，广义最近邻译码能够获得显著优于传统信道线性化方法的广义互信息性能。

参考文献：

[1] Y. Wang and W. Zhang, “Generalized nearest neighbor decoding,” 2021, [online] https://arxiv.org/abs/2010.06791.
[2] S. Pang and W. Zhang, “Generalized nearest neighbor decoding for MIMO channels with imperfect channel state information,” in *Proc. IEEE Inf. Theory Workshop (ITW)*, Kanazawa, Japan, Oct. 2021.
[3] J. J. Bussgang, “Crosscorrelation functions of amplitude-distorted Gaussian signals,” Massachusetts Inst. Technol., Cambridge, MA, USA, *Tech. Rep*. TR 216, Mar. 1952.
[4] H. E. Rowe, “Memoryless nonlinearities with Gaussian inputs: elementary results,” *Bell Syst. Tech. J.*, vol. 61, no. 7, pp. 1519-1525, Sep. 1982.
[5] H. Ochiai and H. Imai, “Performance analysis of deliberately clipped OFDM signals,” *IEEE Trans. Commun.*, vol. 50, no. 1, pp. 89-101, Jan. 2002.
[6] E. Bjornson, J. Hoydis, M. Kountouris, and M. Debbah, “Massive MIMO systems with non-ideal hardware: energy efficiency, estimation, and capacity limits,” *IEEE Trans. Inf. Theory*, vol. 60, no. 11, pp. 7112-7139, Nov. 2014.
[7] O. Orhan, E. Erkip, and S. Rangan, “Low power analog-to-digital conversion in millimeter wave systems: impact of resolution and bandwidth on performance,” in *Proc. Inf. Theory Appl. Workshop (ITA)*, pp. 191-198, San Diego, CA, Feb. 2015.
[8] M. Medard, “The effect upon channel capacity in wireless communications of perfect and imperfect knowledge of the channel,” *IEEE Trans. Inf. Theory*, vol. 46, no. 3, pp. 933-946, May 2000.
[9] A. Lapidoth and S. Shamai (Shitz), “Fading channels: how perfect need ‘perfect side information’ be?” *IEEE Trans. Inf. Theory*, vol. 48, no. 5, pp. 1118-1134, May 2002.
[10] B. Hassibi and B. Hochwald, “How much training is needed in multiple-antenna wireless links?” *IEEE Trans. Inf. Theory*, vol. 49, no. 4, pp. 951-963, Apr. 2003.
[11] L. Tong, B. M. Sadler, and M. Dong, “Pilot-assisted wireless transmissions: general model, design criteria, and signal processing,” *IEEE Sig. Proc. Mag.*, vol. 21, no. 6, pp. 12-25, Nov. 2004.
[12] A. Lapidoth and P. Narayan, “Reliable communication under channel uncertainty,” *IEEE Trans. Inf. Theory*, vol. 44, no. 6, pp. 2148-2177, Oct. 1998.

[13] J. Scarlett, A. G. i Fabregas, A. Somekh-Baruch, and A. Martinez, “Information-theoretic foundations of mismatched decoding,” *Foundations and Trends in Commun. and Inf. Theory*, vol. 17, no. 2-3, pp. 149-401, 2020.
[14] H. Weingarten, Y. Steinberg, and S. Shamai (Shitz), “Gaussian codes and weighted nearest neighbor decoding in fading multiple antenna channels,” *IEEE Trans. Inf. Theory*, vol. 50, no. 8, pp. 1665-1686, Aug. 2004.
[15] W. Zhang, “A general framework for transmission with transceiver distortion and some applications,” *IEEE Trans. Commun.,* vol. 60, no. 2, pp. 384-399, Feb. 2012.
[16] H. V. Poor, *An Introduction to Signal Detection and Estimation*, 2nd ed., Springer, 1994.

最新结果 • RECENT RESULTS •

黎曼几何与非线性信息论
Riemannian Geometry and Nonlinear Information Theory

沈八中[1], 陈兵龙[2], 陈立[2]
1 西安电子科技大学, 2 中山大学
Ba-Zhong Shen[1], Binglong Chen[2], Li Chen[2]
1 Xidian University, 2 Sun Yat-sen University
bzshen@xidian.edu.cn; mcscbl@mail.sysu.edu.cn; chenli55@mail.sysu.edu.cn

众所周知无论是有线还是无线通信系统，都需要将信号的功率放大后再发送。随着传输频率的不断提高和信号所载比特数的不断增加，功放输出信号将在复杂的非线性空间“流动”，形成了通信中所谓的“非线性系统”。因此，一般认为功放器件特别是当今的半导体功放器件造成了通信信道的非线性性。但从数学的角度出发，信号放大本质上需要非线性的突破。可以说，功放在现代和未来通信中的真正功能在于非线性放大，这就意味着非线性功放把原有的线性信号空间转换成了弯曲空间。

从另一方面来看，香农对无干扰信道容量的最初定义是在一定时间里的信号序列集势(cardinality)的对数和时间的比值。被功放非线性放大后的信号空间变成了弯曲空间，在弯曲空间内，一定时间里的信号序列集势将比在线性空间的信号序列集势大，至少呈多项式倍增加。由此可见，弯曲空间信道所具备的信息传输能力，即信道容量，将有可观的提高。我们猜测即使在有干扰传输情况下，弯曲空间信道容量也将会是线性空间信道容量的至少两倍，可额外带来 3dB 传输增益。可以预测：非线性信道容量将超越香农在七十四年前提出的线性信道容量[1]。为了证实这一论断，我们首先证明了一个实际存在的由三次调和多项式功放所产生的非线性信道是一个在四维空间里的二维黎曼流形，同时，我们给出了用来计算该流形上的内蕴距离的微分方程组，这些前期论证为我们的进一步研究奠定了基础。随后，我们将考虑：第一，干扰在黎曼流形上的描述；第二，弯曲信道里信息熵和互信息的定义、以及容量的计算；第三，弯曲信道里纠错编码的定义、构造和译码方法；第四，提出与香农线性信道编码定理所对应的非线性信道编码定理、及它的可达性。

参考文献:
[1] C. E. Shannon, A mathematical theory of communication, *The Bell Syst. Tech. J.* vol. 27, pp. 379-423, 623-656, Jul., Oct., 1948.

最新结果 • RECENT RESULTS •

无线网络中的可靠编码缓存设计
Reliable Coded Caching Design over Wireless Networks

王慧[1]，陈庆春[2]，黄勤[3]，唐小虎[4]
1 西南石油大学，2 广州大学，3 北京航空航天大学，4 西南交通大学
Hui Wang[1], Qingchun Chen[2], Qin Huang[3], Xiaohu Tang[4]
1 Southwest Petroleum University, 2 Guangzhou University, 3 Beihang University, 4 Southwest Jiaotong University
wanghui_07@126.com; qcchen@gzhu.edu.cn; qinhuang@buaa.edu.cn; xhutang@swjtu.edu.cn

As an effective caching scheme, coded caching has received significant attention in reducing the backhaul requirement for serving a large volume of content to multiple users. By carefully designing network coded signal during delivery phase according to the content stored at each user in placement phase, coded caching can simultaneously fulfill multiple demands by different users with one coded multicast transmission, which significantly reduces the required transmission load. The original coded caching scheme by Maddah-Ali and Niesen in [1] is supposed to operate over noise-free shared link. However, in realistic wireless network, the shared link is capacity-constrained, and different users may suffer different impairments, which will impose challenges on the coded caching design over wireless networks. More seriously, recent results showed that, the multiplicative caching gain tends to diminish for a large range of vanishing outage probability, which highlight the importance of reliable coded caching design over wireless networks. Feedback was considered in [2] to characterize the achievable rate as a function of feedback statistics as well as cache size. A joint cache-channel coding scheme was addressed in [3] for two disjoint sets of receivers in the context of erasure broadcast channel, where part of the message intended for the strong receiver can be piggybacked on part of the message intended for the weaker receiver. All these efforts tried to match the wireless channels by modifying the original coded caching scheme in either decentralized or centralized manner. The reliable transmission issue of each multicast message will be handled by a separate error control coding scheme. However, any error control code has limited error correction ability. When the number of errors in one packet is beyond the error correction ability of the applied error control code, those errors cannot be corrected, and the erroneous packet will become useless for the coded caching scheme.

In this work [4], we provide a new perspective on coded caching and error control coding problems. We presented an angle where the coded caching problem can be formulated as an error coding problem. Firstly, we will show how to interpret the coded caching design from error control coding perspective. It is shown that, when the cached and non-cached contents in the placement phase is thought of as the shortened system packets and the punctured system packets, respectively, while those coded contents transmitted in the delivery phase specify the parity packets, the coded caching design can be reformulated as a collaborative error control coding problem. The challenges for arbitrary user requests and noncooperative decoding nature at every user will be highlighted to address the design criteria in order to exploit the coding gain residing in the coded caching. Our analysis unveils that, with some *supplementary parity packets* (*SPPs*) included in either the placement phase or the delivery phase, noticeable transmission reliability improvement can be realized. It is shown that the proposed design is able to flexibly fulfill the asymmetric reliable transmission requirement by placing or transmitting some *SPPs* only for those users in adverse conditions. It is also shown that the proposed reliable coded caching and channel coding can be further integrated into the joint network-channel coding (JNCC) framework to fully exploit the benefits of those two schemes.

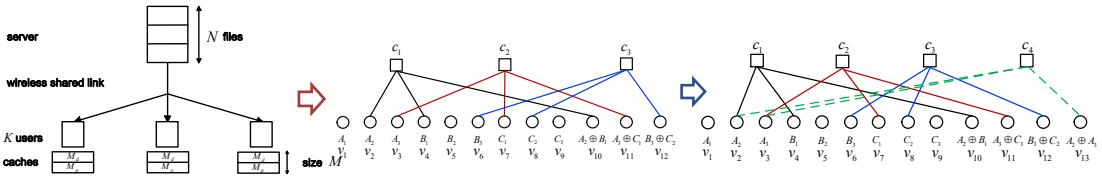


Fig. 1 Reliable coded caching design illustration: mapping the coded caching $(N = 3, K = 3, M_d = 1,$ and the three users' requests $(d_1, d_2, d_3) = (1, 2, 3))$ into an LDPC codes, improving the file reconstruction reliability by adding one SPP $(A_2 \oplus A_3)$ at user 1.

References:

[1] M. A. Maddah-Ali and U. Niesen, "Fundamental limits of caching," *IEEE Trans. Inf. Theory*, vol. 60, no. 5, pp. 2856–2867, May 2014.

[2] A. Ghorbel, M. Kobayashi, and S. Yang, "Content delivery in erasure broadcast channels with cache and feedback," *IEEE Trans. Inf. Theory*, vol. 62, no. 11, pp. 6407–6422, Nov. 2016.

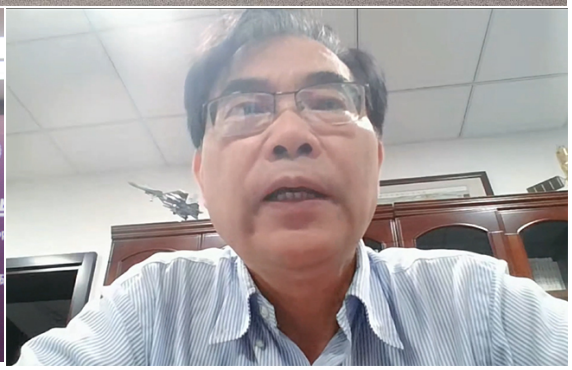
[3] S. S. Bidokhti, M. Wigger, and R. Timo, "Noisy broadcast networks with receiver caching," 2016, arXiv:1605.02317.

[4] Hui Wang, Qingchun Chen, Qin Huang, Xiaohu Tang, Reliable Coded Caching Design over Wireless Networks, *IEEE J. Sel. Areas Inf. Theory*, vol.2, issue 4, pp.1224-1239, 2021.

交流活动 • RESEARCH ACTIVITIES •

粤港澳大湾区信息论与人工智能国际研讨会
Greater Bay Area (GBA) International Workshop on Information Theory and Artificial Intelligence

The Guangdong-Hong Kong-Macau Greater Bay Area (GBA) International Workshop on Information Theory and Artificial Intelligence took place at Tsinghua Shenzhen International Graduate School (SIGS) on Sep. 25, 2021. This workshop was jointly organized by the IEEE Information Theory Society Guangzhou Chapter and Tsinghua SIGS, co-sponsored by Huawei Technologies Co., Ltd. More than 90 scholars and industry partners from mainland China participated in the Workshop on the day. Due to travel restriction, a few others participated online, including the invited speakers En-Hui Yang, Professor of University of Waterloo and Wei Yu, Professor of University of Toronto.



Many methods and ideas developed in information theory (IT) have been adopted to explain and reveal the internal mechanism in modern deep neural networks. Progress regarding an information-theoretic understanding of deep neural networks has often been driven by the deep-learning-based application and induced phenomenon and is yet to be explored further. Moreover, the use of artificial intelligence (AI) techniques to study and improve the classical source coding and channel coding problems in IT is to be explored. This workshop aims to provide an opportunity for academic exchanges on novel progress regarding the connection between IT and AI and promotes the academic and industrial applications in the GBA.

This one-day workshop invited 10 IT and AI experts to deliver in-depth talks. It also contains a poster session with 20 student posters. Welcoming speeches were given by Li Chen, Chair of the Guangzhou Chapter and Professor of Sun Yat-sen University, Jianmin Lu, Director of Huawei 2012 Wireless Lab, Lan Ma, the Vice President of SIGS, and Shu-Tao Xia, a Co-chair of the Workshop and Professor of Tsinghua SIGS. The daily program was hosted by Shu-Tao Xia and Bin Chen, Assistant Professor of Harbin Institute of Technology (Shenzhen). In the morning session, Zongben Xu, Academician of the Chinese Academy of Sciences and Professor of the Xi'an Jiaotong University started the session by a talk on a theoretical approach to automatic machine learning and his exploration based on learning methodology. Then, En-Hui Yang introduced a general framework and algorithms for designing the watermarking for protecting deep image classifiers against adversarial attacks. Wei Yu presented some novel learning-based techniques to beamform and to reflect without explicit channel estimation. The morning session ended with the talk by Shu-Tao Xia and Bin Chen, who showed the quantization applied in a semantic communication system for the Internet of Things. The afternoon session started with the talk by Delivered by Pinyi Fan, Professor of Tsinghua University, with an overview of federated learning for mobile edge computing. Then, Wenyi Zhang, Professor of the University of Science and Technology of China, presented a tractable theory for non-ideal wireless communication models. Dr. Mengyao Ma of Huawei shared some promising future directions on wireless communication and basic research on IT. Dr. Qianqian Yang of Zhejiang University shared the latest research results on the theory and practice for semantic-oriented communications in 6G. The last talk was presented by Han Qiu, Assistant Professor of Tsinghua University, who presented his latest research results on deep learning-based image transmission for resource-constrained networks.

Finally, Li concluded the Workshop by pointing out that the IEEE Information Theory Society Guangzhou Chapter holds its mission in Promoting Exchanges and Serving the Community. It will always advocate consolidating fundamental research, which in return accumulates the indispensable elements for developing new information technology. At the same time, He called on more scholars who are interested in IT to join the Society as the progress of the Chinese IT research requires the efforts of everyone.

The Workshop Agenda

Speaker	**Tittle**
Zongben Xu	A Theoretical Approach to Automatic Machine Learning: Exploration Based on Learning Methodology
En-Hui Yang	Watermarking for Protecting Deep Image Classifiers against Adversarial Attacks: A Framework and Algorithms
Wei Yu	Learn to Beamform and to Reflect Without Explicit Channel Estimation
Shu-Tao Xia & Bin Chen	Quantization in Semantic Communication System for Internet of Things
Pinyi Fan	Federated learning for mobile edge computing
Wenyi Zhang	Towards a tractable theory for non-ideal wireless communication models
Mengyao Ma	Basic research on Information Theory in Future Wireless Communication
Qianqian Yang	Semantic-oriented communications for 6G: Theory and Practice
Han Qiu	Deep Learning-based Image Transmission for Resource-constrained Networks

交流活动 • RESEARCH ACTIVITIES •

中山大学 ICCC 2022 筹备工作会议
ICCC 2022 Preparatory Meeting at Sun Yat-sen University

11 月 22 日下午，ICCC 2022 筹备工作会议在中山大学召开，商讨会议组织与准备工作。ICCC 是由 IEEE 通信学会和中国通信学会共同主办的国际学术会议，是国内举办的通信领域旗舰会议。第 11 届 ICCC 将于 2022 年 8 月在广东佛山召开，承办单位包括中山大学、佛山市三水区政府、以及广东工业大学等。基于会议主题“智慧互联 未来通信 (Connecting Intelligence, Communications for Future)”，此次会议将助力佛山市转型“数字化城市”。而中大与三水区政府联合承办，将开启高校和地方政府合作的新模式，共同促进湾区经济发展。

在筹备会上，ICCC 技术程序委员会共同主席陈立教授向与会人员介绍了会议筹备工作的进展情况以及时间计划表，佛山市三水区政府领导介绍了预算、场地、会务等方面的准备情况。接着，参会各单位就会议筹备中的一些细节问题进行了深入的商讨，拟定了近期筹备工作的重点。与会人员还集思广益，针对如何将本次大会办出水平、办出特色开展了热烈的讨论，形成了一些创新思路，将在接下来的筹备过程中逐步细化并实施。

通过本次筹备会，承办各方掌握了会议筹备工作的进展情况，明确了接下来的工作计划，同时增进了相互了解，为大会的顺利召开打下了良好的基础。

交流活动 • RESEARCH ACTIVITIES •

东莞理工学院举办 2021 年广东省研究生计算机通信与编码理论研究论坛
Dongguan University of Technology holds the 2021 Guangdong Province Graduate Computer Communication and Coding Theory Forum

12 月 11 日，2021 年广东省研究生学术论坛——计算机通信与编码理论研究论坛在东莞理工学院松山湖校区顺利举办。本次论坛由广东省学位委员会办公室主办、东莞理工学院承办，依托东莞理工学院研究生处、计算机科学与技术学院、电子工程与智能化学院，由东莞理工学院电子工程与智能化学院编码理论及应用团队组织。本次论坛以线上线下相结合的形式，分为上午的专家场报告及下午的学生场报告。累计 376 人次参与了论坛，其中 328 人参加线上直播。

上午由来自香港中文大学（深圳）沈颖祺教授，西南交通大学唐小虎教授，以及中山大学马啸教授进行专家报告。下午分别进行“物联网、区块链”、“计算机科学、人工智能、网络安全”、“信息论与编码，存储编码”、“无线通信与网络”四个分会场的学生报告，来自 16 所高校的 45 名同学作了精彩的汇报。

本次论坛共设 10 个奖项，分别是优秀论文奖 1 名，一等奖论文 3 名，二等奖 6 名。经论坛学术委员会评审，来自中山大学的王千帆同学获得优秀论文奖；来自广东工业大学的彭泽鑫同学、华南理工大学的牛畅同学、暨南大学的何红雨同学获得一等奖；来自深圳大学的吴丹洲同学、清华大学的姜峥艺同学、华南理工大学的蔡伟杰同学、北京科技大学的苏日娜同学、北京工业大学的苏玉钊同学、东莞理工学院的杨锦同学获得二等奖。

本次论坛活动气氛活跃，学术氛围浓厚，为计算机科学与技术、通信与信息系统领域的研究生搭建一个高层次、大范围的前沿学术成果分享和创新思维交流平台，强化培养了研究生的创新意识、创新能力和创业精神。

喜讯 • GOOD NEWS •

中山大学陈立教授担任 IEEE 信息论学会会议委员会主席
Professor Li Chen of Sun Yat-sen University Takes on the Post of the IEEE Information Theory Society Conference Committee Chair

IEEE 信息论学会广州分会主席、中山大学陈立教授自 2022 年 1 月 1 日至 2024 年 12 月 31 日将担任 IEEE 信息论学会会议委员会主席。该委员会的主要职责包括向理事会提出各学会技术会议赞助建议、审视和评估即将召开的技术会议提案、征求新提案并根据需要协调组织团队、为提案的编制提供有用的指导建议、举办技术会议并编写最终报告，以及确保组织者遵守理事会批准的技术会议政策。

据了解，陈立教授成为第三位进入 IEEE 信息论学会理事会的中国教授，此前两位教授分别为来自香港中文大学的杨伟豪(Raymond Yeung)教授和香港城市大学的李坪(Ping Li)教授，也是大陆学者参与信息论学会工作的新突破。陈立教授曾作为共同主席成功举办 2018 年 IEEE 信息论研讨会(ITW 2018)，继而于 2019 年成立 IEEE 信息论学会广州分会并成功举办了多次有重要影响力的学术会议和活动，包括中大网络信息论与编码研讨会、中大数学与编码国际研讨会、中大极化编码与技术研讨会、粤港澳大湾区人工智能与信息论研讨会等。2022 年 8 月将在深圳举办 IEEE 信息论学会东亚信息论学校、在佛山举办中国通信国际会议(ICCC)等重量级学术活动。在陈立教授带领下，IEEE 信息论学会广州分会成功获得学会颁发的 2021 年最佳分会奖(Chapter-of-the-Year Award)，这是自该奖设立 20 年来首次颁发给中国大陆的分会。

陈立教授倡导主办的《IEEE 信息论学会广州分会季报》自创刊以来在宣传学者最新研究结果、促进国内外信息论学者交流、以及提高国内信息论研究的国际影响力等方面发挥了积极作用。相信陈立教授将以此次任职为契机，带领广州分会继续乘风破浪，使分会的工作更上一层楼，继而更好的促进国内信息论的发展。

喜讯 • GOOD NEWS •

深圳大学刘凌老师课题组李金升同学获得 IEEE WCSP 2021 最佳论文奖
Jinsheng Li from Shenzhen University Ling Liu's Research Group Received the IEEE WCSP 2021 Best Paper Award

2021 年 10 月 20 日至 22 日，第 13 届无线通信和信号处理国际会议(WCSP)在互联网上以虚拟会议的形式召开，该会议旨在提供一个国际论坛，将学术界的研究人员和工业界的从业人员聚集在一起，交流无线通信和信号处理各个方面的最新研究进展。深圳大学计算机与软件学院智能技术与系统集成研究所硕士研究生李金升与其导师刘凌老师完成的论文《基于极化码的可抗攻击的信息隐写技术》(Robust Steganography Based On Polar Codes)获本届会议最佳论文奖(Best Paper Award)。

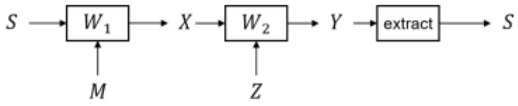


Fig. 2. Illustration of the blind watermarking problem.

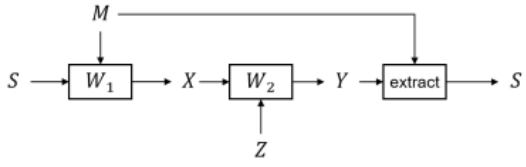


Fig. 4. Illustration of the non-blind watermarking problem.

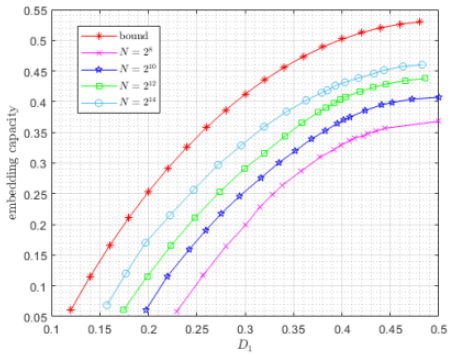


Fig. 3. Simulation of steganography corresponding to D_1 for blind watermarking.

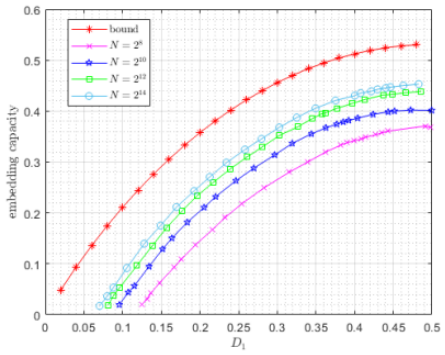


Fig. 6. Simulation of steganography corresponding to D_1 for non-blind watermarking.

水印加密或者信息隐写技术在信息加密和网络安全中有广泛的应用，该技术在人眼感受不出差别的情况下，将秘密信息嵌入到图像、视频或者音频等多媒体信息中，使得只有知道特定方法者才能将秘密信息提取出来。在实际应用中，敌对者在无法获取秘密信息的情况下，会选择对载体信息进行破坏来阻止合法接收者提取信息。目前基于极化码所设计的水印加密技术虽然能较好地达到指定失真下的嵌入容量，但难以对抗来自敌对者对载体信息的干扰。

可抗攻击的水印加密分为盲水印（合法接收者只知道水印提取方法）以及非盲水印（合法接收者除了水印提取方法外，还拥有嵌入水印前的载体信息）两种。针对盲水印问题，论文结合基于极化码的信道编码以及有损信源编码方法，设计了一套水印加密方案；而针对非盲水印问题，论文则是结合基于极化码的信道编码以及无损信源编码方法，设计了另一套水印加密方案。这两套水印加密方案都能保证在干扰情况下的秘密信息可以被可靠传递，论文也从信息论和仿真实验两方面证明了所提方案的最优性。

喜讯 • GOOD NEWS •

中山大学陈立教授课题组王千帆同学获得广东省研究生学术论坛优秀论文奖

Qianfan Wang from Sun Yat-sen University Li Chen's Research Group Received the Best Paper Award of Guangdong Graduate Academic Forum

12 月 11 日，2021 年广东省研究生学术论坛——计算机通信与编码理论研究论坛以线下和线上相结合的方式在东莞理工学院松山湖校区学术会议中心成功举行。论坛由广东省学位委员会办公室主办、东莞理工学院承办。来自中山大学的博士研究生王千帆与其导师陈立教授、马啸教授合著的论文《A Throughput-Enhanced HARQ Scheme for 5G System via Superposition Retransmission》获本次论坛优秀论文奖。


荣誉证书

HONORARY CREDENTIAL

2021 年广东省研究生学术论坛——

计算机通信与编码理论研究论坛优秀论文奖

王千帆，陈立，马啸

A Throughput-Enhanced HARQ Scheme for 5G System via Superposition Retransmission

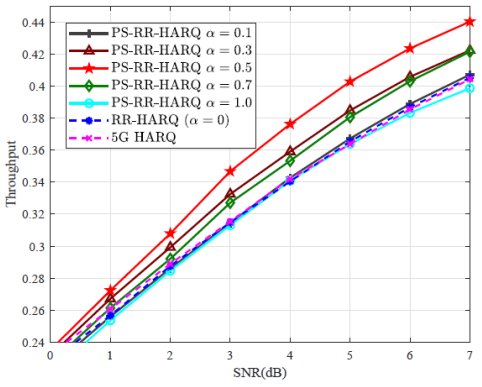
广东省学位委员会办公室

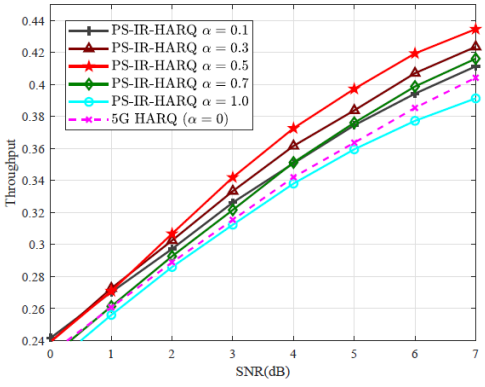
计算机通信与编码理论研究论坛组委会

（东莞理工学院）

2021 年 12 月

论文针对 5G HARQ 协议，基于叠加重传思想，设计了一种吞吐量增强型 HARQ 传输方案。方案的首次重传是将上一时刻传输失败的编码比特交织后叠加（异或）到当前时刻即将传输的编码比特上，接收端通过联合译码来恢复目标帧。若联合译码失败，则切换为原始协议传输。一旦译码成功，则上一时刻的叠加影响将被完全消除，获得一个当前时刻数据的噪声版本，用以译码当前时刻数据。由此可以看出，叠加构造的首次重传没有消耗任何额外带宽与传输能量，但可以帮助目标帧联合译码，从而提升吞吐量性能。仿真显示，相比于 5G 标准中的 HARQ 设计，所提方案在中高信噪比区域可以获得 10%的吞吐量增益。最终该论文在论坛报告的近 50 篇论文中脱颖而出，获得了优秀论文奖。相关工作已发表在 ISIT，TVT，CL 等会议或期刊上。



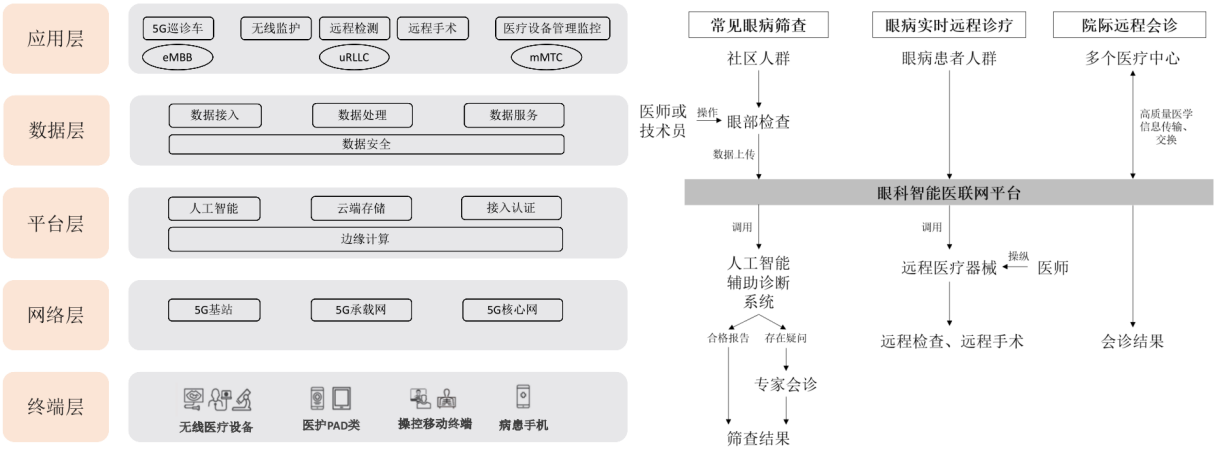


喜讯 • GOOD NEWS •

中山大学陈翔团队参与的 5G 眼科智能医疗标准正式发布并获列今年首批粤港澳大湾区标准

Sun Yat-sen University Xiang Chen's Team Participated in Announcing the 5G Ophthalmic Intelligent Medical Specifications and Enlisted in the First Set of the 2021 GBA Standards

近日，中山大学电子与信息工程学院陈翔团队参与、中山大学中山眼科中心牵头起草的**《基于 5G 技术的眼科智能医联网平台建设规范》**（下称《规范》）正式发布，该标准规范同时被粤港澳大湾区标准化研究中心列入 2021 年第一批湾区标准。



该标准共包括《基于 5G 技术的眼科智能医联网平台建设规范第 1 部分：平台架构》（标准编号：T/GDMA 001-2021）以及《基于 5G 技术的眼科智能医联网平台建设规范第 2 部分：运营规范》（标准编号：T/GDMA 002-2021）两部分内容，旨在为利用 5G 通信技术搭建具备远程会诊、移动会诊，实时诊疗、智能诊疗等功能的眼科智能医疗平台系统提供规范。《规范》定义了基于终端层、网络层、平台层、数据层和应用层的医疗平台架构，明确定义了各层的功能和性能要求；同时规定了服务场景、服务对象，人工智能辅助诊断系统的接入规范等平台运营标准。

据悉，该标准由中山大学中山眼科中心牵头主持撰写，陈翔、王玺钧两位老师代表中山大学电子与信息工程学院（第二完成单位）参与标准文件的起草。陈翔老师团队近年来在 5G 新技术研发与应用领域持续深耕，目前正在负责多项国家级/省部级 5G 研发项目，团队长期致力于开放网络架构、室分小基站、垂直行业应用等关键技术攻关，并以智慧农业等领域为代表积极寻求 5G 技术的落地和推广。本次标准的发布，标志着团队 5G 技术的应用场景进一步拓宽、产业示范的步伐正式迈入医疗领域。

标准是构建医疗健康产业生态并打造成熟产业链的基础，此次《规范》发布并成为湾区标准将加快医疗行业尤其是眼科医疗的数字化、网络化和智能化转型；标准撰写团队表示，将立足于粤港澳大湾区的信息产业优势，继续对 5G 乃至 B5G 技术展开深入研究，为医疗行业的现代化发展贡献更多的力量！

机会信息 • OPPORTUNITIES •

博士生招聘，俄亥俄州立大学
Research Assistant Openings, The Ohio State University

Prof. Xinmiao Zhang is looking for highly-motivated Ph.D. students to join her lab (vlsiArc.engineering.osu.edu) at the Department of Electrical & Computer Engineering of The Ohio State University. Our graduate program is ranked at 22nd in the most recent US News ranking.

In particular, 2 RA positions are available in Fall 2021 for error-correcting codes, cryptography, and their hardware accelerator design. These projects are in collaboration with high-tech companies. Internships may also be available through the project. Good math and analytical background are required. Prior experience on error-correcting coding, digital communications, or related topics is preferred. These research does NOT require advanced knowledge on circuit design. Basic understanding of digital logic design from a sophomore course is sufficient.

The research of our group spans the areas of coding schemes and system architecture design for next-generation memories and digital communications, hardware security, post-quantum cryptography, and machine learning. Our research translates theoretical advancements to highly efficient practical implementations through integrated algorithmic and architectural optimizations. Students interested in these research areas are also encouraged to apply.

Interested students may send the CV and transcripts in PDF to Prof. Zhang (zhang.8952@osu.edu). Applications can be submitted through https://gpadmissions.osu.edu/apply/grad.html to apply our Ph.D. program, and the deadline can be extended.

机会信息 • OPPORTUNITIES •

副教授/助理教授/博士后招聘，中山大学
AP/Postdoc Positions Opening, Sun Yat-sen University

Li Chen, Sun Yat-sen University
陈立，中山大学
chenli55@mail.sysu.edu.cn

The Information Coding and Intelligent Transmission (ICIT) Laboratory of the School of Electronics and Information Engineering, Sun Yat-sen University is recruiting *Associate Professors and Research Associates* at home and abroad, and sincerely invites young talents to join. The lab is directed by Prof. Li Chen.

1. Recruit Field
Information theory and coding, computation for information theory, intelligent networks

2. Recruit Positions
- *Associate Professor:* The applicant should have a PhD degree from a well recognized University or research institute, a strong independent research capability and high academic achievements. Applicants should demonstrate their potential in academia, and have at least 3 years working experience at home or abroad. In general, the applicant should not exceed 40 years old.
- *Research Associate:* The applicant should have a PhD degree and an appropriate amount of publications. They should not exceed 35 years old.

3. How to Apply
- Applicants should first send their CV (including date of birth, education history, working experience, publications, awards, and etc.) to Prof. Li Chen.
- The lab and the school will review the applications and if suited, the applicants will be contacted. They will be sent the application form, and guided the preparation of other application materials, including references.
- A school interview will be further arranged. If approved, a University interview will be needed for *Associate Professor* applicants.

新锐风采 • NEW TALENTS •

Yunqi Wan (万韫琦) received the B.Sc. degree in mathematics and applied mathematics and the M.Sc. degree in probability and statistics from Northwest Normal University, Lanzhou, China, in 2011 and 2017, respectively. From 2017 to 2021, he pursued the Ph.D. degree in Information and Communication Engineering from Sun Yat-sen University, under the supervision of Prof. Li Chen.

He is a newly graduated Ph.D. in the area of channel coding. He took the Ph.D. Dissertation Defence on Nov. 21th, 2021 at Room 403 of New Mathematica Building, Sun Yat-sen University. The Defence Committee includes Prof. Bazhong Shen, Prof. Binlong Chen, Prof. Jin Li, Prof. Xianhua Dai, Prof. Fangguo Zhang.

His thesis is entitled "Algebraic List Decoding of Elliptic Codes", which focuses on algebraic decoding of elliptic codes using the Gröbner basis theory of module. The thesis first establishes an effective algebraic list decoding mechanism for elliptic codes. The basis reduction interpolation and Kötter's interpolation are used for hard-decision and soft-decision algebraic list decoding. Re-encoding transform is further introduced to facilitate the interpolation. The thesis also proposes two interpolation-based low-complexity Chase decoding for elliptic codes. He will work as a coding theory researcher at Theory Lab, Huawei Technologies Co., Ltd.

His key publications include:

[1] **Y. Wan**, L. Chen, F. Zhang, "Guruswami-Sudan decoding of elliptic codes through module basis reduction," *IEEE Trans. Inf. Theory*, vol. 67(11), pp. 7197-7209, Nov. 2021.
[2] **Y. Wan**, J. Xing, "Low-complexity Kötter's interpolation for list decoding of elliptic codes," *IEEE Commun. Letters*, vol. 25(11), pp. 3473 - 3477, Nov. 2021.

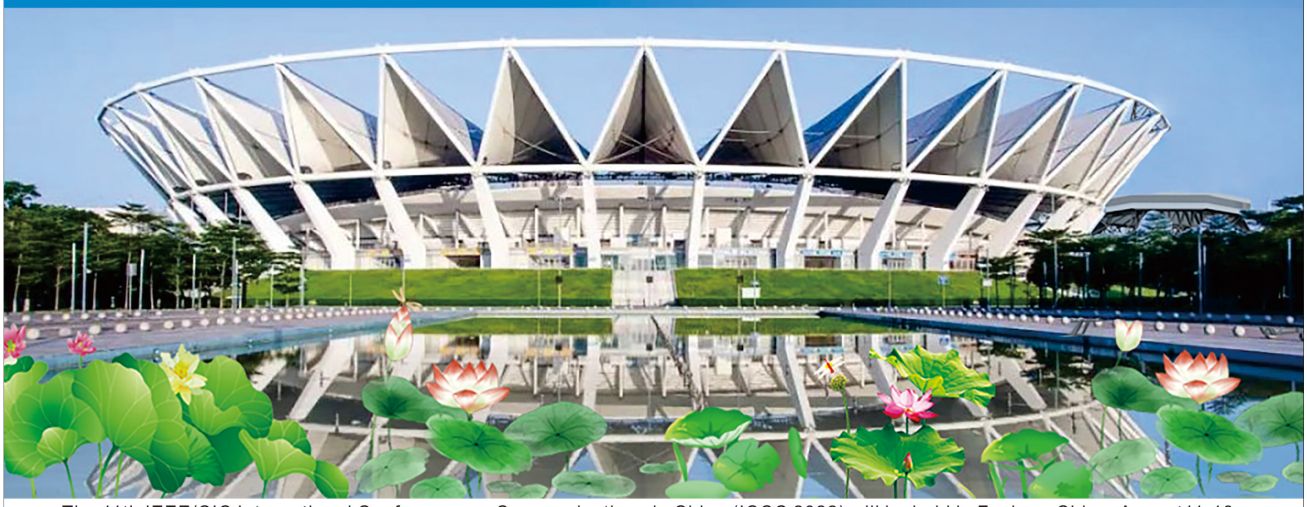
[3] **Y. Wan**, L. Chen and F. Zhang, “Algebraic soft decoding of elliptic codes”, *IEEE Trans. Commun.*, 2022. Accepted.
[4] **Y. Wan**, L. Chen and F. Zhang, “Algebraic soft decoding of elliptic codes”, *IEEE Int. Symp. Inf. Theory (ISIT),* Melbourne, Victoria, Australia, Jul. 2021.
[5] **Y. Wan**, L. Chen and F. Zhang, “Design of Guruswami-Sudan list decoding for elliptic codes”, *IEEE Inf. Theory Workshop (ITW),* Visby, Sweden, Aug. 2019.

征稿启事 • CALL FOR PAPERS•

The 11th IEEE/CIC International Conference on Communications in China

August 11-13 , 2022, Foshan, China

Connecting Intelligence, Communications for Future



The 11th IEEE/CIC International Conference on Communications in China (ICCC 2022) will be held in Foshan, China, August11-13 , 2022. Foshan is within the heart of the Guangdong-Hong Kong-Macau Greater Bay Area, with numerous leading ICT companies and intangible cultural heritages, especially martial arts and pottery. Themed "Connecting Intelligence, Communications for Future", this flagship conference of the IEEE/CIC will feature a comprehensive high-quality technical program including 9 symposia and a variety of tutorials and workshops. ICCC 2022 will also include featured Industry Expos & Forums, which will be held in conjunction with the conference. The technical program chairs invite the submission of original papers. All submissions must be written in English in the standard IEEE two-column conference format and are limited to a maximum paper length of six (6) printed pages (10-point font) including figures and references.

ORGANIZING COMMITTEE

Hononary Co-chairs
Jun Luo, SYSU, China
Victor Leung, UBC, Canada

General Co-chairs
Ping Zhang, BUPT, China
Zengping Chen, SYSU, China
Yanchuan Zhang, CIC, China

TPC Co-chairs
Li Chen, SYSU, China
Xianbin Wang, WesternU, Canada
Xu Chen, SYSU, China
Tong Song, CIC, China

Publication Co-chairs
Xiaoxia Huang, SYSU, China
Jie Wang, DLUT, China

Sponsorship Co-chairs
Xiang Chen, SYSU, China
Jianwen Chen, UESTC, China

Financial Co-chairs
Xinghua Sun, SYSU, China
Yayu Gao, HUST, China

Publicity Co-chairs
Yulan Guo, SYSU, China
Lin Zhang, SYSU, China
Tingting Yang, PCL, China

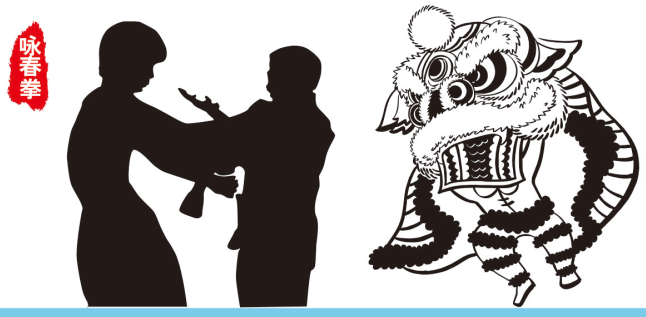
Invited Track Co-chairs
Shaoyong Zheng, SYSU, China
Wonbin Hong, POSTECH, Korea

Workshop Co-chairs
Jie Gong, SYSU, China
Zheng Chang, UESTC, China
Guojun Han, GDUT, China

Tutorial Co-chairs
Xijun Wang, SYSU, China
Jianhua Tang, SCUT, China
Jie Xu, CUHK Shenzhen, China

Industry Chair
Jianmin Lu, Huawei, China

Local Arrangement Co-chairs
Jiahui Tan, Sanshui City, China
Peiran Wu, SYSU, China
Yi Fang, GDUT, China



PLANNED TECHNICAL SYMPOSIA

Communication and Information Theory Symposium
Co-chairs: Feifei Gao, Xin Wang, Yongliang Guan, Sven Puchinger

Signal Processing for Communications Symposium
Co-chairs: Jinhong Yuan, He (Henry) Chen, Zheng Dong

Optical Communication System and Networks Symposium
Co-chairs: Chau Yuen, Yan-yu Zhang, Xingwen Yi

Wireless Communications Systems Symposium
Co-chairs: Qihui Wu, Shun Zhang, Chintha Tellambura

Wireless Networking and Multimedia Symposium
Co-chairs: Burak Kantarci, Wei Feng, Junqing Zhang

Privacy and Security in Communications Symposium
Co-chairs: Yanling Chen, Nan Liu, Deniz Gunduz

Social Networks and Big Data Symposium
Co-chairs: Yan Zhang, Shibo He, Sangheon Pack

MI and AI for Communications Symposium
Co-chairs: Lin Cai, Chuan Huang, Lei Yang

Radio Frequency and Antennas Symposium
Co-chairs: Shaoyong Zheng, Eng Hock Lim, Chow-Yen-Desmond Sim

IMPORTANT DATES

Tutorial Proposals Submission	Mar 1, 2022
Tutorial Proposals Acceptance	Mar 15, 2022
Workshop Proposals Submission	Mar 1, 2022
Workshop Proposals Acceptance	Apr 1, 2022
Symposium Paper Submission	May10, 2022
Symposium Paper Acceptance	Jul 10, 2022
Symposium Paper Camera-ready	Jul 24, 2022
Workshop Paper Submission	Jun 1, 2022
Workshop Paper Acceptance	Jul 10, 2022
Workshop Paper Camera-ready	Jul 24, 2022

CALL FOR PAPERS AND PROPOSALS

IEEE · IEEE ComSoC IEEE Communications Society · 中国通信学会 China Institute of Communications · 中山大学 Sun Yat-sen University · 三水新城 · HUAWEI · Shenglu 盛路

征稿启事 • CALL FOR PAPERS •

2022 IEEE East Asian School of Information Theory (IEEE EASIT 2022)

August 2–5, 2022

Shenzhen, China

The 2022 IEEE East Asian School of Information Theory (IEEE EASIT 2022) is jointly organized by The IEEE Information Theory Society Guangzhou Chapter, Tsinghua Shenzhen International Graduate School, Sun Yat-sen University and The Chinese University of Hong Kong (Shenzhen). It will take place during August 2–5, 2022, at Shenzhen Institute for Talents Development. IEEE EASIT 2022 will feature 8 tutorials delivered by distinguished lecturers and cover the most cutting-edge research in information theory, including information theory and statistics, information theory and machine learning, coding for communications, and coding for storage. The School will include a series of events that provide graduate students the opportunity to interact with senior researchers of the area, which will be a stimulating forum for the sciences in information theory. Participants can also seek for potential collaborations and strengthen their connections with the community.

Venue: Lecture Hall,1F, Block B, Talents Center, Shenzhen Institute for Talents Development.

Location: No. 4589 Qinyuan Rd., Nanshan District, Shenzhen, Guangdong, China.

Registration: The registration platform will open in early 2022.

Website: http://www.itguangzhou.cn/easit

Organizing Committee

General Co-Chairs:

Li Chen, SYSU

Shao-Lun Huang, Tsinghua SIGS

Program Co-Chairs:

Kenneth Shum, CUHK (Shenzhen)

Shenghao Yang, CUHK (Shenzhen)

Publicity Chair:

Min Ye, Tsinghua SIGS

Finance Chair:

Congduan Li, SYSU

Industrial Chair:

Jianmin Lu, Huawei

Local Arrangement Co-Chairs:

Shengnan Li, Tsinghua SIGS

Kangqi Qiu, Tsinghua SIGS

Co-hosts: Guangzhou Chapter · 清华大学深圳国际研究生院 Tsinghua Shenzhen International Graduate School · 中山大学 · 香港中文大學(深圳) The Chinese University of Hong Kong, Shenzhen

Sponsors: IEEE Information Theory Society · HUAWEI