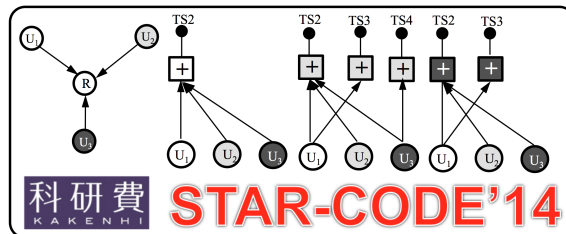


Results of Joint Steering Committee Meeting STAR-CODE and COATNET2 2014



Collaboration Room 7 (5F), School of Information Science,
Japan Advanced Institute of Science and Technology (JAIST)
Ishikawa, 24–25 March 2014

Outage Analysis of Decode-and-Forward Relaying System Allowing Intra-link Errors

Presenter: *Xiaobo Zhou*

School of Information Science,
Japan Advanced Institute of Science and Technology (JAIST), Japan

In this talk, we investigate the outage probability of decode-and forward (DF) relaying system allowing intra-link (source-relay link) errors, where all the links between the source, relay and destination nodes suffer from independent block Rayleigh fading. In the system, we assume, even if errors are detected in the information sequence after decoding, the relay node still re-encodes and forwards the data sequence containing errors to the destination. The theoretical backbone of this system concept is that the data sequences sent from the source and relay nodes are highly correlated with each other because they are transmitted from the same source, and the correlation knowledge can be well exploited by the joint decoding at the destination node. We derive the outage probability expression for this system, based on Shannon's lossy source-channel separation and Slepian-Wolf's correlated source coding theorems. Moreover, with this system assumption, it is found that the optimal position of the relay is the midpoint between the source and destination nodes. Results of the simulations are provided to verify the accuracy of the analytical results.

Comments:

- Why the source should be silent in the second state. It may produce some other benefits.
- SW versus time diversity by using capacity achieving code for S-R link.

Sum-Power Minimization in OFDMA Networks with User Rate Constraints

Mirza Golam Kibria and Hidekazu Murata

Kyoto University, Kyoto, Japan

We consider the sum-power minimization problem in orthogonal frequency division multiple access networks under users rate constraints. The resource allocation optimization problem has a nonconvexity structure, therefore, it is numerically very difficult to solve, and the optimal solution imposes a prohibitive computational load on the system. We devise two efficient suboptimal solutions. The first solution is based on Lagrange dual decomposition (LDD), and employs iterative subgradient method. When the number of subcarriers is large, it is found that the solution obtained from LDD is optimal. However, the optimality is not guaranteed because the original optimization problem is nonconvex. The second solution is based on disjointing the power and subcarrier allocation. The subcarrier allocation is performed based on proportional

data rate requirements, and then optimal power allocation is performed with given subcarrier allocation. The achieved objective values for both of the solutions are very close to the optimal solution, and the solutions have less computational complexities.

Comments:

- Novelty comparison with other resource allocation techniques.
- convergence speed is highly interest.

A Study on Optimizations of Quantization Threshold for Decode-Quantize-Forward Relaying

Shinsuke Ibi

Osaka University, Osaka, Japan

This paper investigates optimizations of threshold values involved in quantization of log likelihood ratio (LLR), which is derived at relay node in decode-quantize-and-forward (DQF) relaying. In order to carry out exact decoding for LLR compress encoder of DQF relaying, we explicitly define an equivalent LLR transfer signal model. Under the definition, we propose an efficient approximation, which drastically reduces computational efforts for decoding. After carefully inspecting impacts of the quantization threshold, decode-adaptive quantize-and-forward (DAQF) that adaptively selects optimal threshold according to channel states is proposed. Finally, we validate the proposed system by computer simulations.

Comments:

- What is the benefit of using consistency condition rather than simply tresholding with respect to the conditional mean.
- Error floor caused either simply because of shortage in the quantization level or any related things, e.g., backhaul link capacity.
- How can we apply adaptive tresholding to the OFDM suffering from frequency selectivity.

Reliability-Aware Iterative Detection Scheme (RAID) for Distributed IDM Space-Time Codes in Relay System

Dirk Wübben

University of Bremen, Germany

In this talk we address the application of distributed Interleave-Division Multiplexing Space-Time Codes (dIDM-STCs) for multi-user two-hop Decode-and-Forward (DF) relay networks. In case of decoding errors at the relays which propagate to the destination, severe performance

degradations can occur as the original detection scheme for common IDM-STCs does not take any reliability information about the first hop into account. Here, a novel Reliability-Aware Iterative Detection Scheme (RAID) for dIDM-STCs is proposed. This new detection scheme takes the decoding reliability of the relays for each user into account for the detection at the destination. Performance evaluations show, that the proposed RAID scheme clearly outperforms the original detection scheme and that in certain scenarios even a better performance than for adaptive relaying schemes can be achieved.

Comments:

- Good technique
- CEO and STAR-CODE can utilize the technique presented in this results.

Network Coding-Based Turbo HARQ

Presenter: *Ade Irawan*

School of Information Science,
Japan Advanced Institute of Science and Technology (JAIST), Japan

I propose an efficient hybrid automatic repeat request (HARQ) protocol with serially concatenated coding and network coding principle. Network coding enables reduction in the total number of retransmissions from a system perspective and hence leverage the throughput. Furthermore, with the new strategy of HARQ protocol based on turbo principle, it is made possible to combine and decode all (re)transmitted packets in an iterative way to increase the reliability of the system. The decoding strategy comprises horizontal iteration (HI) and vertical iteration (VI). HI, performed for decoding of the serially concatenated codes, is followed by VI with the help of box plus operator to exchange extrinsic log-likelihood ratio (LLR) of the uncoded (systematic) bits. The HI/VI chain is then repeated. Excellent performance of the technique for unicast transmission is verified through packet-error-rate (PER) and throughput simulations. The ARQ scheme has equivalent topology of relay network when the intra-link is error free. Based on this observation, results of simulation conducted to evaluate the throughput of the relay network systems are presented.

Comments:

- Terminology "DTC" should not be used because transmitter is only one.
- Check the Dirk paper
- Do not use terminology "network coding" because it is point-to-point or it is like 2-D turbo coding.

On Linear Physical Layer Network Coding

Alister Burr

University of York, UK

We introduce a very general model of a multi-layer relay network employing linear physical layer network coding at the relays. We derive conditions on the coefficients of the linear network code mapping functions employed at the relays in order to ensure unambiguous decodability at the destination. We consider functions based on rings, rather than fields, and show that this can still allow unambiguous decoding, but increases the flexibility of the network and hence its robustness to channel fading. We discuss functions based on the ring of binary matrices, and evaluate outage probability for the two simple network topologies: the two way relay channel and a single layer, two source, two relay network.

Comments:

- Using ring has benefit rather than the conventional one because we have more degree of freedom for choosing the size of alphabet.
- It has no direct relationship with STAR-CODE because it focuses more on complex network. STAR-CODE can be seen as an example of network.

Outage probability bound for Erroneous estimates-exploiting Multi-Access relaying system

Presenter: *Penshun Lu*^{1,2}

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Japan Advanced Institute of Science and Technology (JAIST), Japan

² Centre for Wireless Communications, University of Oulu, Finland

An outage probability bound that is independent of signaling schemes is theoretically derived for an orthogonal multiple-access relay channel (MARC) system, where the estimates of the information sequences sent from source nodes, regardless of whether or not they are correctly decoded at the relay, are exclusive-OR network-coded and forwarded by the relay to the destination. The MARC system described above is referred to as estimates-exploiting MARC (e-MARC) for convenience. Following to the bound derivation of e-MARC, we further numerically calculate the outage probability for a special case of e-MARC where differential detection is utilized at the relay. It is found that the probability is roughly 3.5 – 4.5 dB away from the bound; this performance loss is in exchange for the computational complexity. Moreover, the impact of the source correlation on the outage probability bound of the e-MARC system is also investigated.

Comments:

- What is the similarity between Xiaobo
- Get graduate as soon as possible.

Theoretical Analysis of a Binary Data Gathering WSN from the Viewpoint of CEO Problem

Presenter: *Xin He*

School of Information Science,
Japan Advanced Institute of Science and Technology (JAIST), Japan

In this talk, we investigate the transmission techniques for a binary data gathering wireless sensor network (WSN). We propose a practical coding/decoding scheme for the binary data gathering WSN, where the correlation knowledge among sensors data is well exploited at the fusion center (FC). We model this WSN by the binary chief executive officer (CEO) problem in the category of network information theory. The theoretical limit is then analyzed based on the Berger-Tung inner bound. The simulation results show that the bit-error-rate (BER) performances of our proposed technique is very close to theoretical limits supported by the Berger-Tung inner bound. The error floor of BER performances is further predicted by using the Poisson binomial process.

Comments:

- Per-link SNR should be clearly defined.
- The gap between hard decision majority logic combining and soft... should be clarified.

Joint Turbo Equalization and BICM-ID-based IDMA over Frequency Selective Fading Channels: Measurement Data Verification

Presenter: *Wu Kun*

School of Information Science,
Japan Advanced Institute of Science and Technology (JAIST), Japan

This talk proposes a joint turbo equalization and bit interleaved coded modulation with iterative detection-based interleave division multiple access (BICM-ID-based IDMA) technique over frequency selective fading channels. A frequency domain soft-interference cancellation minimum mean-square error (FD-SC-MMSE) turbo equalization is used for IDMA signal detection. It is shown that the proposed technique can eliminate the influences of intersymbol interference (ISI) and multiple access interference (MAI), due to, respectively, the fading frequency selectivity and the channel sharing with other simultaneous users, and achieve the frame error rate (FER) very close to theoretical outage probability bound. Furthermore, we also propose a detection ordering technique which determines the detection order of users to improve the efficiency of MUD. Meanwhile, the measurement data has been also applied into the system to investigate the performance of the proposed system in the realistic channel.

Comments:

- Sensitivity to channel estimation and variance estimation should be investigated.

- Asynchronization at the frame level should be most important, when topology change is dominating factor.
- fractionally spaced path versus integer separated path, they should be compared when using measurement data.

Gain of STAR-CODE Network: Uncoded Case

Presenter: *Mohammad Nur Hasan*

School of Information Science,
Japan Advanced Institute of Science and Technology (JAIST), Japan

We consider star-structured relaying for global wireless data exchange (STAR-CODE) network with three users and one relay where direct links are unavailable for some users. We design a transmission scheduling scenario to optimize the efficiency of the network. Inspired by *protograph* of low density parity check (LDPC) codes, we propose a transmission scheduling where in the first time slot, two users send message information to the relay simultaneously; in the next time slot, relay broadcasts the received messages to all three users. To decode all messages, we assume side information from neighboring users is available via direct links. With the proposed STAR-CODE network, we found that the network throughput can be improved two times better than the conventional relaying network.

Comments:

- See Anwar's part.
- Gain is not from the network, but from geographical gain.

Outage Based Power Allocation: Slepian-Wolf Relaying Viewpoint

Presenter: *Meng Cheng*

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Japan Advanced Institute of Science and Technology (JAIST), Japan

This work presents optimal power allocation schemes for a simple Slepian-Wolf relay system over block Rayleigh fading channels. It is well known that the exploitation of the correlation knowledge between the sequences from the source and relay nodes at the destination achieves significant performance improvement, according to the Slepian-Wolf theorem. In this research, we obtain an approximated closed-form outage probability expression, based on our previous work for the outage analysis. The power allocation issue for the proposed Slepian-Wolf relay

system is formulated as a convex optimization problem. Specifically, we aim to minimize the outage probability while keeping the total power fixed, and to minimize the total power under an given outage threshold. It is shown that the system performance with optimal power allocation outperforms that with equal power allocation.

Comments:

- Closed form expression using inverse $R(D)$ function representing S-R link to be published.
- Use alternating cvx by replacing the exponential part of outage expression, eventhough the results might be suboptimal.

Error Performance Analysis of Asymmetric Slepian-Wolf Coding for Ordered Random Variables

Kana Deguchi and Motohiko Isaka

Kwansei University, Japan

We analyze the error performance of source coding with side information at the decoder, or the asymmetric Slepian-Wolf coding. The source output we consider is the ordered random variables in the sense that they are deliberately extracted from a pair of input and output of the Gaussian channel. Such a scenario is indeed found in protocols for certain physical layer security. A tight upper bound on the error probability is derived and the effect of the signal extraction on the performance is quantified.

Comments:

- Bob is usually a boy
- Union bound is usually worse at low SNR
- Tire trap channel in the presence of noise
- Relay-eavesdropper is the common problem of everybdy in this room

Some Improvements of the Forced-convergence Decoding of LDPC Codes

Yuichi Kaji

Graduate School of Information Science,
Nara Institute of Science and Technology (NAIST), Nara, Japan

Comments:

- EXIT and trajectory analysis
- Doing something more quantitatively
- Deactivating the node might be cause of the correlation
- How to measure the complexity (in term of complexity per iteration and overall iteration) not in relative sense but in absolute sense. The purpose is to identify the application
- Identify or analyze the information theoretic background.
- Create some tools or technique to analyse the tradeoff between iteration and performance, like EBSA.

Abstract

WOMAMAC: Write-Once Memory Codes for the Asymmetric MAC Channel

Brian M. Kurkoski

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Japan Advanced Institute of Science and Technology (JAIST), Ishikawa, Japan

Codes for write-once memories, or WOM codes, are a technique to extend the lifetime of flash memories, and have been receiving substantial attention from the coding theory community. On the other hand, in the asymmetric multiple-access channel (AMAC channel) for two users, User 2 knows User 1's message (but not visa verse). The capacity regions are known, even when the sources are correlated. The AMAC model has applications to the MAC phase of the relay channel.

We show how to use WOM codes on the AMAC channel. In one case, WOM codes can achieve the AMAC capacity. Furthermore, an elegant property of the WOM code allows for efficient decoding. Since a separability theorem holds for correlated sources transmitted over the AMAC channel, this work has applications to relaying of correlated data sources.

Comments:

- The case $1 \rightarrow 0$ is prohibited is the case of OR channel. We can see it as "Kasami Code".
- What happen if intra-link error happens
- 2/4 at what page, calculation of $p(x_1, \dots)$ should be affected by Markovinity
- Relationship to DPC should be clarified
- Asymmetric region is indeed achievable for discrete alphabet case.

Hierarchical Successive Compute & Forward Decoding with Hierarchical Interference Cancellation

Jan Sykora

Czech Technical University in Prague,
Faculty of Electrical Engineering, Czech Republic

Abstract

State Sstimation over Fading Channels: Outage and Diversity Effects

Kimmo Kansanen

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Norwegian University of Science and Technology (NTNU), Norway

Uncoded (analog) transmission of a scalar first-order Gauss-Markov process over fading channels is considered. This model is applicable in real-time applications and for settings such as wireless sensor networks with processing at the fusion center due to its simplicity and zero-delay property. The optimal MMSE estimator at the receiver is the Kalman filter with random instantaneous estimation error variance, assuming perfect channel estimation. We select the estimation error outage probability as a means of characterizing the estimation quality. This criterion depicts probabilistically how often the value of the instantaneous estimation error variance crosses a certain threshold. We first consider the SISO case and find an integral equation that characterizes the probability distribution function of the instantaneous estimation error variance for general fading channels. We then use the pdf to obtain the outage probability and find tight upper and lower bounds for Rayleigh fading channels and in the high SNR regime. Thereafter, we extend our study to the SIMO case and assuming d independent Rayleigh fading channels to transmit the signal, we find the pdf and outage probability for instantaneous estimation error variance. Finally, we prove that in the high SNR regime, the outage probability decreases with d -th power of SNR, analogous to the notion of diversity in the digital communications over fading channels.

Theoretical Impact Analysis of Fading First Order Statistics of Channel Variation on Outage Probability of Cooperative Wireless Networks

Presenter: *Shen Qian*

School of Information Science,
Japan Advanced Institute of Science and Technology (JAIST), Ishikawa, Japan

Outage probability of Slepian-Wolf relaying system is derived, by considering that the information of source and relay are transmitted via Rayleigh and Rician, as well as via Rayleigh and Nakagami-m fading channels. Optimal power allocations for minimizing the outage probability are investigated with the condition that the total transmit power is kept constant. Rician fading model can well be approximated by the Nakagami-m fading model by adjusting the factor K in Rician fading model and the factor m in Nakagami-m fading model. Therefore, the impact difference of Rician and Nakagami-m fading variation on outage performance are evaluated based on the investigation on Kullback-Leibler distance (KLD) between Rician and Nakagami-m distributions. The numerical results of a series of simulations based on practical coding and decoding algorithm verified the accuracy of theoretical analysis results. Moreover, by replacing the bit-flipping model with rate distortion function to represent the source-relay correlation, the outage probability of the Slepian-Wolf relaying system is derived in more practical way. The optimal relay locations for minimizing the outage probability of the Slepian-Wolf relaying system are then investigated, where the channels have different statistical properties.

Comments:

- What is the difference between SW rate region and Source Coding with helper rate region.
- Investigate all possible combinations for the links.

STAR-CODE Networks with Side Information

Khoirul Anwar

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We consider a three-way relaying network as an example of STAR-CODE networks with three users. To exchange information between each user within only two phases over the same frequency band, we used an iterative spatial demapping (ISM) technique to completely separate the information from each user. Since the idea of spatially coupled codes is utilized, a side information is assumed to be available for some users. We found that without careful consideration on either ISM or decoding, the side information availability is useless. In this talk, we report the possible solution to fully exploit the side information in STAR-CODE networks.

Comments:

- Does side information has to be fully decoded?
- All users have to be synchronized with spatial mapping
- Map the problem more general, not neceserally three-way relay, amplify and forward.
- This project does not need to strictly follow Spatially Coupled LDPC, make it by yourself if possible.