Title	Iterative techniques for cooperative communications allowing intra-link errors- from the Slepian Wolf compression viewpoint (invited talk)
Author(s)	Matsumoto, Tad; Burr, Alister
Citation	The 18th European Wireless Conference (EW 2012): 1-2
Issue Date	2012-04-20
Type	Conference Paper
Text version	author
URL	http://hdl.handle.net/10119/10686
Rights	This is the author's version of the work. Copyright (C) 2012 VDE VERLAG GMBH. Tad Matsumoto and Alister Burr, The 18th European Wireless Conference (EW 2012), 2012, 1-2.
Description	European Wireless 2012, April 18-20, 2012, Poznan, Poland

Iterative Techniques for Cooperative Communications Allowing Intra-Link Errors--- from the Slepian Wolf Compression Viewpoint (Invited Talk)

Tad Matsumoto[+**]

[+]Japan Advanced Institute of Science and Technology
1-1 Asahidai, Nomi-Shi, Ishikawa, Japan
matumoto@jaist.ac.jp
** University of Oulu, Oulu, Finland
tadashi.matsumoto@ee.oulu.fi

Alister Burr*

* Department of Electronics, University of York, York, UK
agb1@ohm.york.ac.uk

A goal of this invited talk is to provide the audience with the knowledge about the relationship between the relay systems and the Slepian-Wolf theorem for coding of correlated sources. As shown in Fig. 1, According to the Slepian-Wolf theorem, the achievable rate region is constituted as an unbounded polygon. The source information can be recovered only when the compressed rate pair falls into this area. For instance, if b_1 is compressed at the rate $R1$ which equals to its entropy H(b_1), then b_2 can be compressed at the rate R_2 which is less than its entropy H(b_2), but must be greater than their conditional entropy H($b_2|b_1$), or vise verse. Specifically, the pair of compression rates R_1 and R_2 satisfies three equations [1]:

$$R_1 \geq H(b_1 \mid b_2), \qquad (1)$$

$$R_2 \geq H(b_2 \mid b_1), \qquad (2)$$

$$R_1 + R_2 \geq H(b_1, b_2). \qquad (3)$$

According to the Slepian-Wolf theorem, by exploiting the correlation knowledge of the data streams at the destination, the distributed source coding can achieve the same compression rare as the optimum single encoder which compresses the sources jointly.

This talk assumes that the correlation model of the sources can be expressed as the bit flipping model [2], as $b_2 = EOR(b_1, e)$ and $P(e = 1) = p_e$, where p_e is the bit flipping probability. Then, if the appearance probabilities of the source information is equi-probable, H(b_1) = H(b_2) = 1, H(b_1 | b_2) = H(b_2 | b_1) = H(p_e), H(b_1; b_2) = 1 + H(p_e) with H(p_e) = - p_e $\log_2(p_e)$ - (1- p_e) $\log_2(1- p_e)$.

Now, let us consider a one-way relaying system, where the relay does not aim to perfectly recover the original information transmitted by the source, but it only “extracts” the source information, even though the relay knows that extracted sequence may contain some errors. In this sense, the proposed technique is referred to as “Extract-and-Forward” (EF) system. As shown in Fig. 2, the extracted sequence representing an estimate of the original information sequence, which is then interleaved and transmitted to the common destination. Obviously, the original and extracted sequences are correlated, where in this talk it is assumed that the errors caused in the source-relay (SR) link can be expressed by the bit flipping model. This is reasonable if we assume block fading and no heavy decoding of the channel code is performed at the relay.

This talk is started by reviewing the Slepian-Wolf theorem, and then considers the relationship between the theorem and the relaying systems. This talk then focuses on a very simple coding technique for relay systems for single carrier signaling in frequency-flat block fading channels. In relay systems, the probability of error occurring in the source-relay link can be viewed as representing correlation between the source and the relay. This talk proposes a simple iterative decoding technique, accumulator-assisted distributed turbo coding (ACC-DTC) using 2-state (memory-1) convolutional codes, where the correlation knowledge between the source and the relay is estimated, and exploited at the destination via the *vertical* iterations, as shown in Fig. 2. The relay only extracts the un-coded source bits, interleaves, re-encodes, and forwards it to the destination. To adapt the correlation variation due to the link quality between the source and the relay, we add a D-ACC to assist the decoder's extrinsic information transfer (EXIT) curve to reach a point very close to the (1,1) mutual information (MI) and avoid error floor. The results obtained via a series of computer simulations conducted to evaluate convergence property and bit-error-rate (BER) performance show that the proposed ACC-DTC provides much better BER performances compared to the conventional distributed turbo code (DTC) and its advanced version, super turbo codes (SuTC).

Some theoretical basics supporting the techniques presented in this lecture, such as EXIT chart analysis, EXIT-based code design, and convergence property and mutual information will be provided prior to the key part of the lecture, but the timing at which this very basic part is provided depends on the reaction of the audience to the instructor's presentations. Also, the participants are asked some key questions to verify their correct understanding.

Keywords: Cooperative Communications, Relay Systems, Iterative Decoding, EXIT Chart, Distributed Turbo Code, Correlated Sources

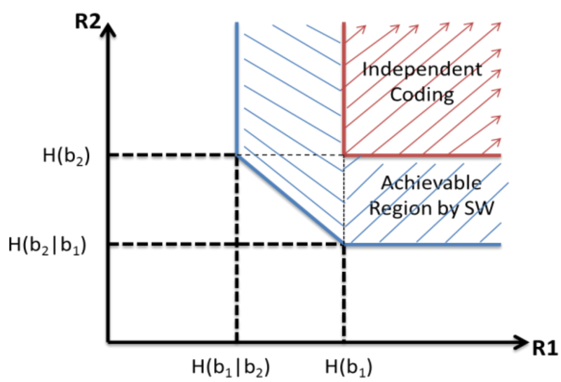

Fig. 1 Slepin-Wolf Rate Region

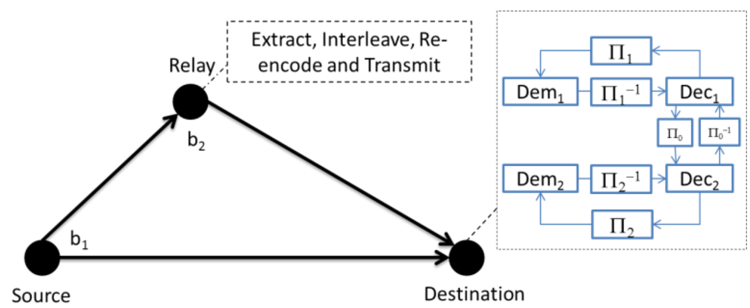

Fig. 2 Extract-and-Forward Relay System

References:

[1] D. Slepian and J. Wolf, "Noiseless coding of correlated information sources," Information Theory, IEEE Transactions on, vol. 19, no. 4, pp. 471-480, Jul. 1973.
[2] J. Garcia-Frias, "Compression of correlated binary sources using turbo odes," Communications Letters, IEEE, vol. 5, no. 10, pp. 417-419, Oct. 2001.