Improved Rate-Compatible Joint Network-Channel Code for the Two-Way Relay Channel

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In [1] a rate-compatible joint network-channel code (JNCC) for the two-way relay channel was proposed which can be applied for the cooperative uplink and downlink in a mobile communication system with the help of a relay. We assume the system model of [1] and present an improved JNCC which is based on the decode-and-forward scheme of [2]. In [2] a coding scheme was proposed which does not consider that the base station can also listen to the transmission of the mobile station and vice versa. We extend this scheme to a distributed coding scheme with hybrid automatic repeat request/forward error correction (H-ARQ/FEC) such that the transmission between mobile and base station can be also exploited. Due to the wireless broadcast nature, this transmission is for free.

Fig. 1 depicts the channel encoder which is used at mobile and base station. It contains the same parallel concatenated convolutional code (PCCC) as in [1] with information bit block length $K = 1500$ and a H-ARQ/FEC functionality. The $N = 4512$ code bits are arranged according to the order described in [1]. Packets of $M = 600$ code bits are (re)transmitted from the mobile/base station until the relay or the base/mobile station can decode without error. If the relay has decoded the data of the mobile and base station correctly and one of the two stations requires still more retransmissions, the relay network encodes the estimates $\hat{\mathbf{u}}_{\mathrm{MR}}$ and $\hat{\mathbf{u}}_{\mathrm{BR}}$ and broadcasts the network code bits $\mathbf{x}_{\mathrm{R}}$ to mobile and base station. The network encoder is depicted in Fig. 2 (a). It differs from the one in [1]. The H-ARQ/FEC functionality chooses the bits according to the same order as the channel encoder. However, it starts from the position where the channel encoders stopped to send. Fig. 2 (b) depicts the joint network-channel decoder at the base station. The decoder can use the transmission from the mobile station ($\bar{\mathbf{y}}_{\mathrm{MB}}$) and from the relay ($\bar{\mathbf{y}}_{\mathrm{RB}}$) by taking into account the own information $\mathbf{u}_{\mathrm{B}}$.

Fig. 3 compares the throughput performance of the improved JNCC scheme and of the JNCC scheme (multiple turbo network code) from [1]. Moreover, we depict the performance of a system which uses separate network-channel coding (SNCC). This system does not consider the direct transmission between mobile and base station. The network encoder is a modulo 2 addition of $\hat{\mathbf{u}}_{\mathrm{MR}}$ and $\hat{\mathbf{u}}_{\mathrm{BR}}$. The communication links are protected with the PCCC. Fig. 3 depicts also the performance of a point-to-point communication system without relay with the PCCC. The dashed line is the information theoretic benchmark for the two-way relay channel which was obtained in [1]. We gain around 1 dB with the improved JNCC scheme compared to the one from [1]. For small SNRs $E_s/N_0 < -3$ dB the gain of JNCC compared to SNCC is less than 1 dB. For larger SNRs JNCC provides a significant gain compared to SNCC and the system withou relay.

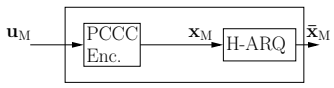

Fig. 1. Channel encoder at the mobile station.

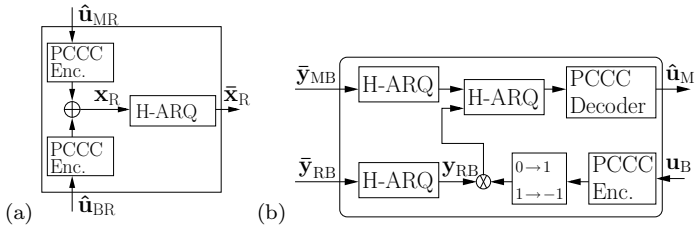

Fig. 2. (**a**): Network encoder at the relay. (**b**): Joint network-channel decoder at the base station.

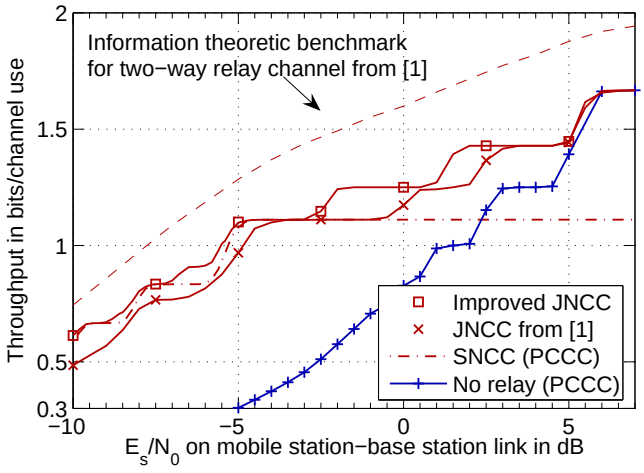

Fig. 3. Throughput comparison with reference systems.

References

[1] C. Hausl and J. Hagenauer, "Iterative Network and Channel Decoding for the Two-Way Relay Channel", *accepted for IEEE ICC 2006*

[2] B. Rankov and A. Wittneben, "Spectral Efficient Signaling for Half-Duplex Relay Channels", *Asilomar Conference on Signals, Systems, and Computers*, Nov. 2005