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Rateless Codes on Noisy Channels

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TR2004-038 April 2004

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To be published in the Proceedings of the International Symposium on Information Theory, 2004

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Rateless codes on noisy channels

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Abstract — **We study the performance of two classes of rateless codes (LT- and Raptor codes) on noisy channels such as the BSC and the AWGNC. We find that Raptor codes outperform LT codes, and have good performance on a wide variety of noisy channels.**

I. LT Codes

In a recent landmark paper, Luby [1] designed a class of "fountain" or "rateless" codes called Luby Transform (LT) codes. An LT-encoder transmits a stream of encoded bits, which are sparse random linear combinations of k data bits. The receiver picks up up noisy versions of the encoded bits and uses a belief propagation decoder to try to figure out the k data bits. The number of noisy encoded bits (n) required for successful decoding depends on the quality and type of the channel. Luby proved that LT codes designed using the "robust soliton degree distribution" can achieve capacity on *every* binary erasure channel (BEC). In other words, $R = k/n$ can be made arbitrarily close to $(1-p)$ for every erasure probability p [1]. However, he did not study the performance of LT codes on other channels.

We studied the performance of the robust solition LT codes, and other LT codes with degree distributions proposed by Shokrollahi [2], on the binary symmetric channel (BSC) and the additive white Gaussian noise channel (AWGNC). We found that while these codes had fairly good performance in the waterfall regime, they suffer from error floors.

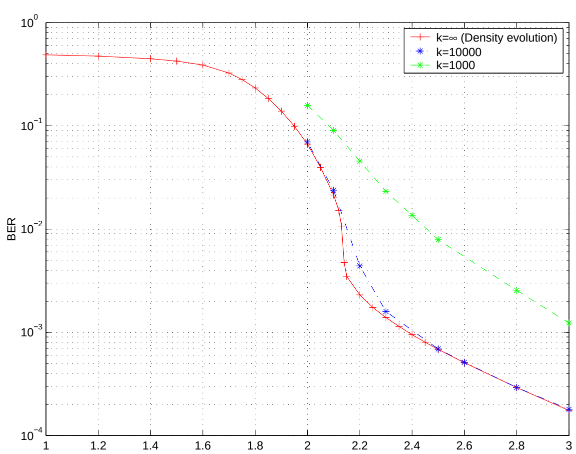

Figure 1: LT codes with degree distribution proposed by Shokrollahi on BSC with p=0.11

[1]This work was done while the author was an intern at Mitsubishi Electric Research Laboratories.

An error floor, such as the one seen in Figure 1, implies that the receiver may fail to decode even after receiving an extremely large number of bits i.e., even when $n \gg k/C$, where C is the capacity of the channel.

II. Raptor codes

The problem of error floors can be solved by using a high-rate outer block code. The combination of an outer high-rate LDPC code and an inner LT code is called a Raptor code [2]. We find that Raptor codes do not suffer from the severe error floors experienced by LT-codes, and that these codes, even those designed for the BEC [2], perform well on other channels as well, as seen in Figure 2. Similar performance curves are observed on other channels and at a variety of noise conditions [3].

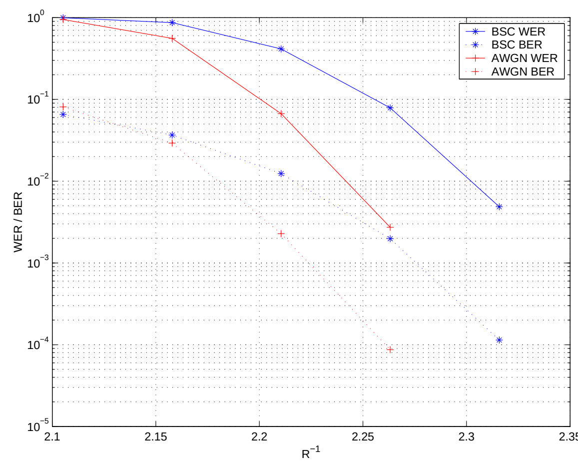

Figure 2: Performance of a Raptor code with k=9500 on a BSC with $p = 0.11$ and an AWGNC with $E_s/N_0 = -2.83dB$. Both channels have capacity 0.5.

After this work was completed, we received the paper [4] which reports similar results.

References

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[4] O. Etesami, M. Molkaraie and A. Shokrollahi, "Raptor codes on symmetric channels," preprint 2004.