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Nonequivalent Cascaded Convolutional Codes Obtained from Equivalent Constituent Convolutional Encoders

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Abstract — Casced convolutional codes with conventional convolutional codes as constituent codes are powerful and attractive to use in communication systems where very low error probabilities are needed. This paper clearly demonstrates the dramatic effect the replacement of the inner convolutional encoder by an equivalent one could have on the cascaded convolutional code.

I. INTRODUCTION

The cascade of two convolutional encoders without an interleaver but with matched rates is a cascade of a rate $R_0 = b_0/c_0$, outer encoder of memory $m_0$ and a rate $R_i = b_i/c_i$ inner encoder of memory $m_i$, where $b_i = c_i$. The cascaded convolutional code $C_c$ is encoded by the rate $R_c = R_0R_i = b_0/c_0$ convolutional encoder of memory $m_c = m_0 + m_i$.

The paper will be illustrated by examples. We also notice that since $C_c \subset C_1$, catastrophicity of the generator matrix does not imply catastrophicity of the generator matrix for the cascade.

Can the inner generator matrix be chosen such that we obtain the same cascaded convolutional code, i.e., such that $G'(D)$ is equivalent to $G(D)$? Indeed it can, which will be illustrated by a simple example. If $G'(D)$ and $G(D)$ are equivalent generator matrices, then for some invertible $b_0 \times b_0$ matrix $S(D)$

$$G'(D) = G(D)T(D)G'(D) = S(D)G(D).$$

III. SYSTEMATIC CASCaded ENCODers FROM SYSTEMATIC CONSTITUENT ENCODers

From basic encoding matrices we can easily obtain equivalent rational systematic encoding matrices,

$$G_{sys}^c(D) = G_{sys}^c(D)G_{sys}^f(D).$$

REFERENCES
