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Coding for the Degraded Broadcast Channel with Random Parameters, with Causal and Non-Causal Side Information

Yossef Steinberg

Department of Electrical Engineering
Technion - Israel Institute of Technology
Haifa 32000, Israel
ysteinbe@ee.technion.ac.il

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Abstract

In this work coding for the degrarded broadcast channel controlled by random parameters is studied. Two main paradigms are considered: where side information on the random parameters is provided to the transmitter in a noncausal manner (termed here *non-causal coding*), and where side information is provided in a causal manner (termed *causal coding*). Inner and outer bounds are derived on the capacity region with non-causal coding. For the special case where the non-degrarded user is informed about the channel parameters, we show that the inner bound is tight, thus deriving the capacity region for that case. For causal coding, a single-letter characterization of the capacity region is derived. This characterization is expressed via auxiliary random variables, and can also be interpreted by means of *Shannon strategies*, as the formula for the capacity of the single-user channel with causal coding derived by Shannon. The capacity region of a class of binary broadcast channels with causal coding is computed, as an example. Applications to watermarking are suggested. In particular, our results on non-causal coding can be used to derive the capacity region of a watermarking system where the channel (attacker) is fixed, and the encoder is required to encode watermarks for both, private and public users.

Index terms — Broadcast channel, causal coding, degraded broadcast channel, information hiding, non-causal coding, side information, Shannon strategies, watermarking.

1 Introduction

Channels that depend on random parameters have been extensively studied, due to the wide range of applications in which such models appear. In many cases, it is reasonable to assume that the random parameters controlling the channel are known either to the receiver or to the transmitter. When such knowledge is present at the receiver, the known parameters can be regarded as part of the channel output, and hence, at least from theoretical point of view, this model does not differ