On Compressive Sensing in Coding Problems:

A Rigorous Approach

Wasim Huleihel, Neri Merhav, Shlomo Shamai (Shitz)

Department of Electrical Engineering

Technion - Israel Institute of Technology

Haifa 32000, ISRAEL

E-mail: {wh@tx, merhav@ee, sshlomo@ee}.technion.ac.il

Abstract

We take an information theoretic perspective on a classical sparse-sampling noisy linear model and present an analytical expression for the mutual information, which plays central role in a variety of communications/processing problems. Such an expression was addressed previously either by bounds, by simulations and by the (non-rigorous) replica method. The expression of the mutual information is based on techniques used in [1], addressing the minimum mean square error (MMSE) analysis. Using these expressions, we study specifically a variety of sparse linear communications models which include coding in different settings, accounting also for multiple access channels and different wiretap problems. For those, we provide single-letter expressions and derive achievable rates, capturing the communications/processing features of these timely models.

Index Terms

Channel coding, state dependent channels channel, wiretap channel, multiple access channel (MAC), replica method, random matrix theory.

I. Introduction

Compressed sensing [2, 3] is a collection of signal processing techniques that compress sparse analog vectors by means of linear transformations. Using some prior knowledge on the signal *sparsity*, and by