Performance Evaluation of L1, L2 and SL0 on Compressive Sensing based on Stochastic Estimation Technique

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Abstract- **In this paper, we proposed 2 algorithms based on L1 and L2 norm estimator to recover the signal by using just few components. Moreover we comprehensively present the recovery algorithm based on L1, L2 and SL0 for digital signal or image under some several noise models from their incomplete observation. The proposed algorithm is used with a matrix that the number of row is much fewer than the column. The algorithm states that if signal or image is sufficient sparse, we can recover it from small number of linear measurement by solving convex program of observation vector. Base on the very important properties of the image which most of the signal information tends to be concentrated in few low frequency components of the DCT. Finally experiments results are presented on both synthesis and real image under various kind of noise (AWGN, Salt & Pepper Noise and Speckle Noise) with different noise power. The effects of different noise models will be compared in order to show the improvement of L1 norm over SL0 and L2 norm under heavy noise or some noise that doesn't have Gaussian form.**

Keyword: Compressive Sensing, SL0 norm, L1 norm, L2 norm, Image Reconstruction.

I. INTRODUCTION

For many years Shannon/Nyquist sampling theory underlies most sensing, signal acquisition and analog to digital conversion protocol in use today. But as our modern technology-driven civilization acquires and exploits ever-increasing amounts of data, everyone now knows that most of the data we acquire can be thrown away with almost no perceptual loss. There are a lot of example that can prove this state for sound, images and specialized technical data. Base on this phenomenon, someone may ask: why we have to effort that much of bandwidth to acquire all the data when most of the data can be thrown away? Can we just collect directly the part that is really necessary needed? So over the last few years, an alternative sampling/sensing theory known as "Compressive sampling" or "Compressive Sensing" (CS) has been developed to fulfill our desire: is it possible to directly acquire just the important information about the signal/images-in effect, not acquiring that part of the data that would eventually just be thrown away by lossy compression.

The core of new approach is based on two crucial observations:

a. The first is that the Shannon/Nyquist signal representation exploits only minimal prior knowledge about the signal being sampled, namely its bandwidth. However, most object we are interested in acquiring are structured and depend upon a smaller number of degrees of freedom than the bandwidth suggests. In other words, most objects of interest are sparse or compressible in sense that they can be encoded with just few numbers without much numerical or perceptual loss.

b. The second observation is that useful information content can be captured via sampling or sensing protocol that condense the signal into small amount of data. These protocols actually linearly correlate the signal with a fixed set of signal independence waveforms. These waveforms are then incoherent with the family of waveforms in which signal is compressible. What is most remarkable about these sampling protocols is that they allow a sensor to very efficiently capture the information in a sparse signal without trying to comprehend that signal. Further, there is a way to use numerical optimization to reconstruct the full length signal form small amount of collected data.

So the main ideal of CS is to combine "low rate sampling" with computation power for efficient and accurate signal acquisition. It makes CS bypass the current technique by overcoming the disadvantage of acquisition process. Massive amount of data are collected and after that large part are discard by subsequent compression stage. CS data acquisition system directly translates analog data into a compressed digital form so that the recovery stage is done by only few measurements.

The classical solution to such problem would be L2 Norm that minimizing the amount of energy in the system. This is usually simple mathematically by involving only a matrix multiplication by the pseudo-inverse of the basis sampled. However, this leads to poor result for most practical applications, as the not sampled coefficients seldom have zero energy (this may lead to the case where the solution is inverse). Another disadvantage of L2 Norm is that: it is very sensitive with the heavy noise if the noise is not Gaussian form.

Thus L1 Norm or the sum of the absolute values was introduced by Tao to improve the efficiency. Finding the candidate with the smallest L1 Norm can be expressed relatively easily as a linear program, for which efficient solution methods already exist. L1 Norm has attracted attention as an effective technique for solving undetermined system of linear equations. In many applications, L1 Norm is