Compressed Sampling of Image Using Householder Transform

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Abstract- Conventional approaches to sampling signals or images follow Shannon's theorem. Compressed Sampling theory asserts that one can recover certain signals and images from far fewer samples or measurements than traditional methods use. In this paper a new compressed sampling method for image is presented. The method uses a householder transform for the sampling purpose. The tridiagonalization provides proper compression to the image. The experimental result shows that the proposed method provides high PSNR and compression ratio.

1. INTRODUCTION

1.1 IMAGE SAMPLING

The images are considered as 2-D signals processed by human visual system. The signals representing images are analog in nature. For image processing applications, these analog signals are converted into it's corresponding digital forms. A digital image is a numeric representation (normally binary) of a two-dimensional image. Sampling process converts analog signal into digital.

Image sampling is the process of extracting partial information from an image. or simply we can say that the process

of taking inner product between an image and a mask function. Depending upon the mask used for sampling ,it is broadly classified into adaptive and non adaptive image sampling techniques.

1.2 COMPRESSED SAMPLING

Compressed sensing is a novel research area, which was introduced in 2006, and since then has already become a key concept in various areas of applied mathematics, computer science, and electrical engineering.

Conventional approaches to sampling signals or images follow Shannon's celebrated theorem: the sampling rate must be at least twice the maximum frequency present in the signal (the so-called Nyquist rate). CS theory asserts that one can recover certain signals and images from far fewer samples or measurements than traditional methods use. CS relies on two principles: Sparsity and Incoherence.

Sparsity expresses the idea that the "information rate" of a continuous time signal may be much smaller than suggested by its bandwidth, or that a discrete-time signal depends on a number of degrees of freedom which is comparably much smaller than its (finite) length. More precisely, CS exploits the fact that many natural signals are sparse or compressible in the sense that they have concise representations when expressed in the proper basis.

Incoherence extends the duality between time and frequency and expresses the idea that objects having a sparse representation in a proper domain must be spread out in the domain in which they are acquired.ie, It represents the sensing modality of the signal.

1.3 CS ENCODING

Below figure shows the matrix representation of the CS encoding

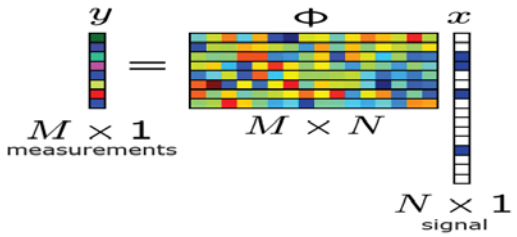

Fig 1: CS encoding

Where Y is measurement matrix, Φ is CS matrix and Mostly zeros in Φ matrix.

1.4 HOUSEHOLDER TRANSFORM

It is one type of orthogonal transform. Used for QR factorization.

Defenision:- $Let\ v \in R^n$ be nonzero

Then

$$P = I - \frac{2}{v^T v} v v^T \quad (1)$$

is called **Householder matrix** (Reflection, Transformation) and v is called householder matrix. The properties of the householder matrices are

1. H is symmetric
2. H is orthogonal
3. They are rank one modification of identity

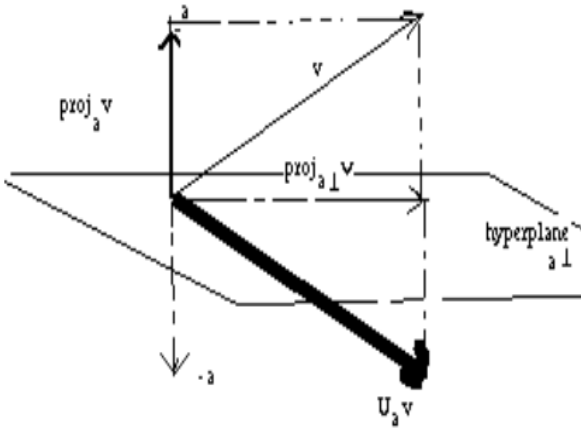

Fig 2:- the diagram for householder transformation

2. PROPOSED METHOD

The concept of householder transform can be used for compressed sampling. The diagonalization matrix behaves as a compressed sampling mask and the correlation between the diagonalization matrix and covariance matrix produces the sampled image.this method is similar to QR factorization technique.

The proposed method consist of three steps. they are

1. Tridiagonalization
2. Covariance calculation
3. Projecting covariance vector to HHT

In tridiagonalization step a diagonalized matrix is calculated from the image using the householder equation. the matrix act as the adaptive sampling mask for the image matrix. In second step the covariance matrix for the original image is calculated(It is achieved by taking the correlation between the pixels). In final stage the covariance matrix to householder domain produces the sampled image.(ie , Mapping the upper triangular matrix with the covariance matrix of image produces the compressed sampled image). the block diagram representation for the proposed method is shown below.

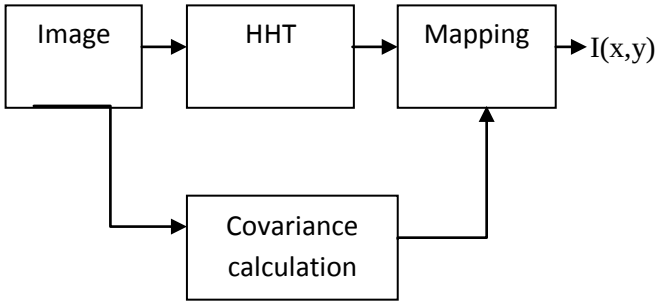

Fig 3: block diagram for proposed method

I(x,y)is the sampled image.

At reconstruction stage the inverse process is performed, produces reconstructed image.Ie, the sampled image is multiplied with the inverse of upper triangular matrix and an orthogonal matrix ,produces reconstructed image.

3 .EXPERIMENTAL RESULTS

Proposed method provides a good compression ratio with high PSNR. As no. of coefficients retained increases compression ratio decreases and PSNR increase. It have a very good PSNR than previous method.

Fig 4: original image

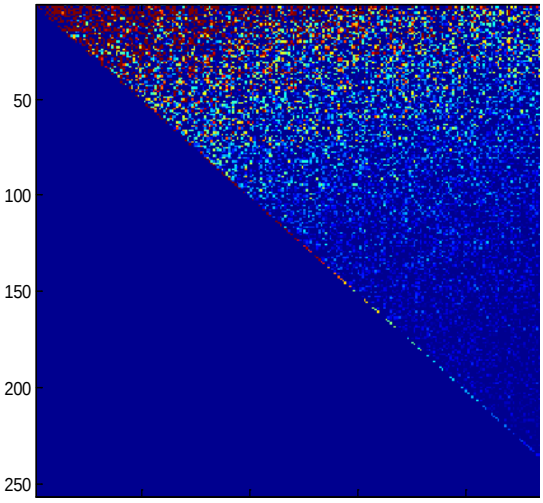

Fig 5: upper triangular matrix for image

Figure 6: compressed image

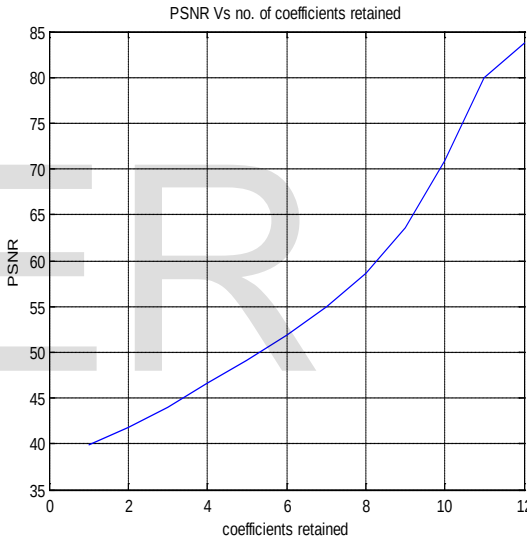

Fig 7: PSNR Vs level of compression

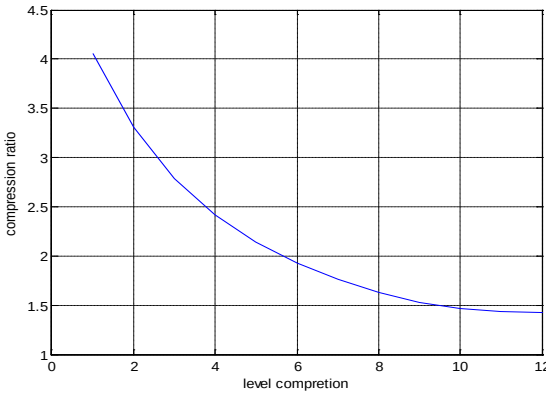

Fig 8: compression ratio Vs level of compression

TABLE I

PSNR and compression ratio for different level of compression

No. of coefficient retained	PSNR	Compression ratio
65	39.87377	4.0587
80	41.8112	3.3029
95	44.0580	2.7862
110	46.6220	2.4171
125	49.1562	2.140
140	51.9531	1.9278
155	54.9046	1.7589
170	58.5497	1.6280
185	63.6333	1.5287
200	70.8923	1.4827
215	79.9609	1.4322
230	83.7429	1.4251

4. CONCLUSION

In this paper a new compressed sampling for images is explained. It uses householder transformation as compressed sampling part, and is applicable to any types of images. Experimental result shows that the method provides good compression with high PSNR and less MSE.

5. REFERENCES

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