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Improving the reconstruction efficiency of sparsity adaptive matching pursuit based on the Wilkinson matrix

Keywords: Block compressive sensing; Sparsity adaptive matching pursuit; Greedy algorithm; Wilkinson matrix

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Main idea

Traditional compression techniques

Acquisition → Transformation → Quantization → Entropy coding → Transmit

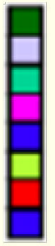
Compressive sensing (CS)

$N=r^{*}c$

Measurements (M)
M<<N → Entropy coding → Transmit

y

M X 1
measurements



Motivation

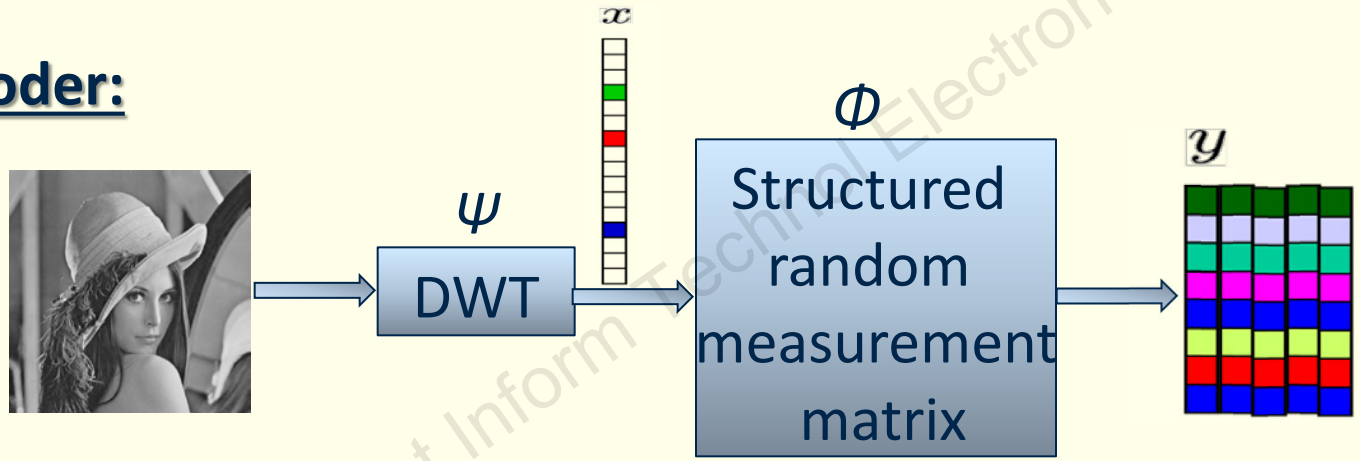
The most common limitations of compressive sensing (CS) techniques are:

1. lack of the reconstruction quality of reconstructed images;
2. requiring large no of measurements to reconstruct image with acceptable quality;
3. computational complexity is high at decoding side.

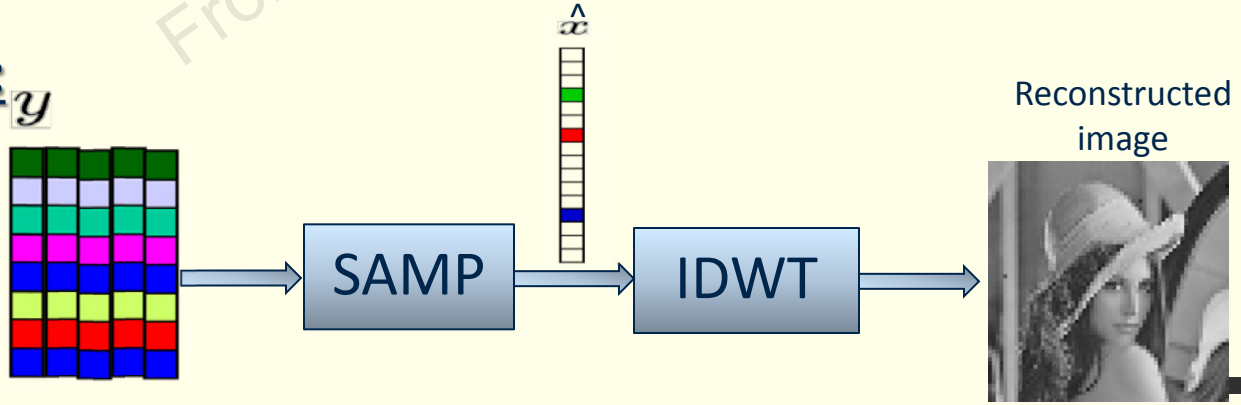
In this paper, limitations of the sparsity adaptive matching pursuit CS technique will be addressed to improve its reconstruction efficiency.

Conventional CS-SAMP technique

Encoder:



Decoder:



Conventional CS-SAMP technique

Advantage

- Reconstructs signals without prior information of sparsity
- Robust to noise compared to the other greedy algorithms
- faster than linear programming methods

Disadvantage

- Still suffer from the lack of reconstruction quality

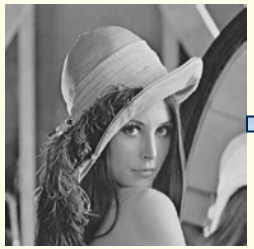
WHY?

Because of choosing an improper measurement matrix

Method

Proposed BCS-SAMP Technique

Encoder:



Block Division

DCT

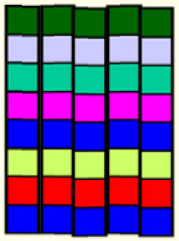
$\hat{x}\hat{x}\hat{x}\hat{x}\hat{x}$

Wilkinson measurement matrix

y

Decoder:

y



SAMP

$\hat{x}\hat{x}\hat{x}\hat{x}\hat{x}$

IDCT

Reconstructed image

Wilkinson Matrix

8x8 Wilkinson matrix

$\frac{n-1}{2}$	1	0	0	0	0	0	0	0
1	$\frac{n-2}{2}$	1	0	0	0	0	0	0
0	1	$\frac{n-3}{2}$	1	0	0	0	0	0
0	0	⋱	⋱	⋱	⋱	⋱	⋱	0
⋮	⋱	⋱	⋱	⋱	⋱	⋱	⋱	⋮
0	0	0	⋱	⋱	⋱	⋱	⋱	0
0	0	0	0	0	1	$\frac{n-3}{2}$	1	0
0	0	0	0	0	0	1	$\frac{n-2}{2}$	1
0	0	0	0	0	0	0	1	$\frac{n-1}{2}$

Re-orthogonal of 3x8 Wilkinson matrix

-0.78	0.58	-0.21	-0.05	0	0	0	0
-0.57	0.53	0.57	0.25	0	0	0	0
-0.23	0.54	-0.44	-0.68	0	0	0	0

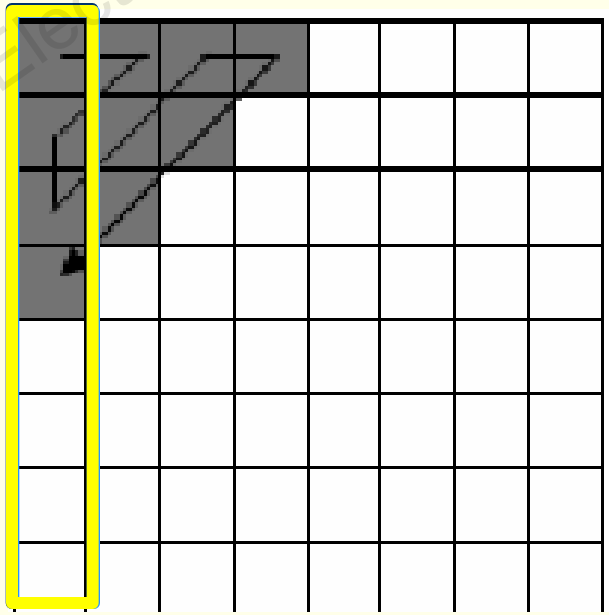
Re-orthogonal M measurements

Re-orthogonal of 3x8 Wilkinson matrix

−0.78	0.58	−0.21	−0.05	0	0	0	0
−0.57	0.53	0.57	0.25	0	0	0	0
−0.23	0.54	−0.44	−0.68	0	0	0	0

This will help SAMP to find the right column easily

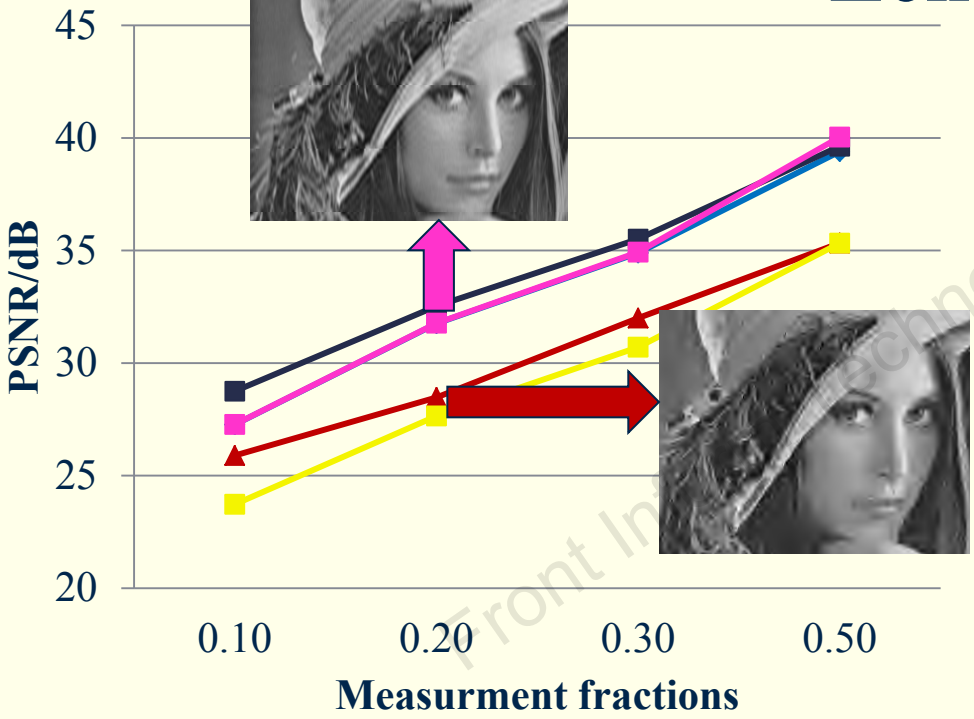
DCT coefficients of image

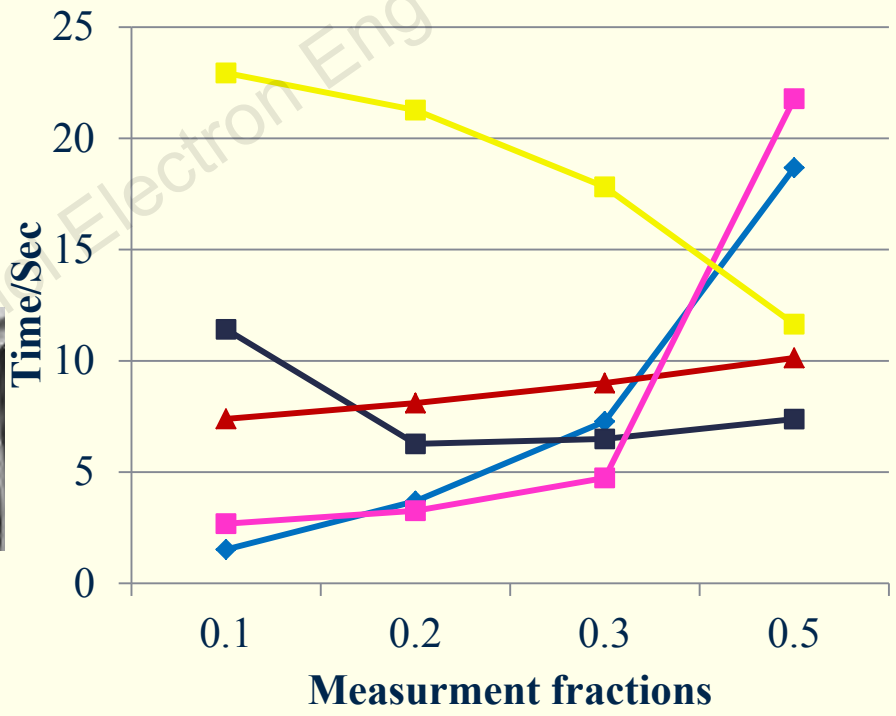


High coefficient=VIP

Low coefficient=approximately zero

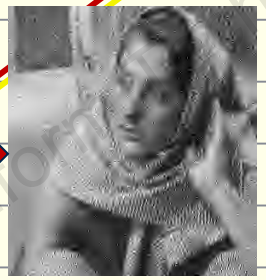
Results

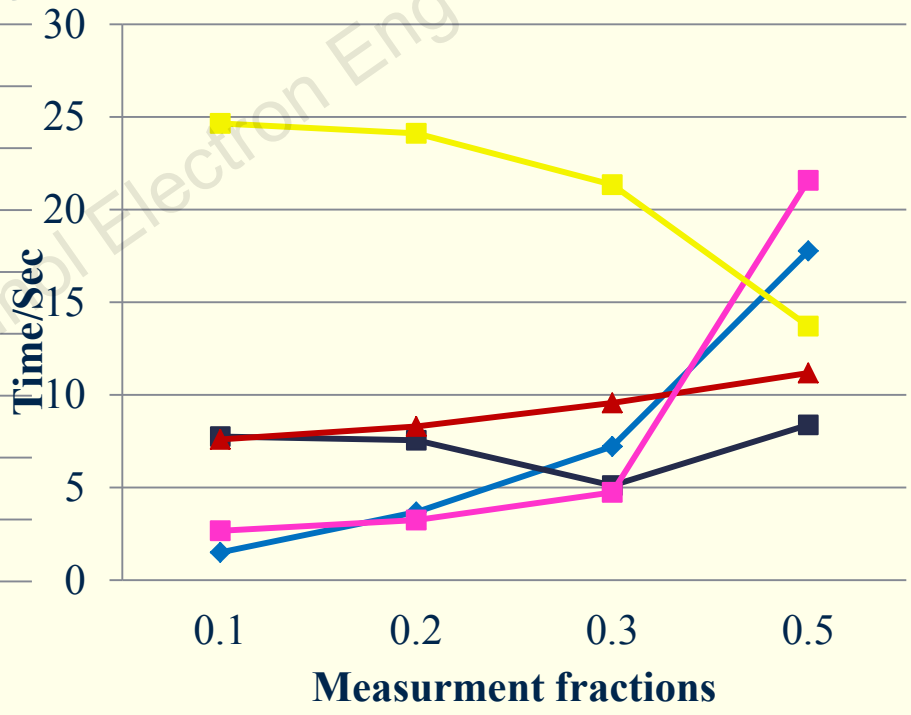




BCS-OMP
BCS-SPL
SAMP
Proposed 3 BCS-SAMP
GPSR

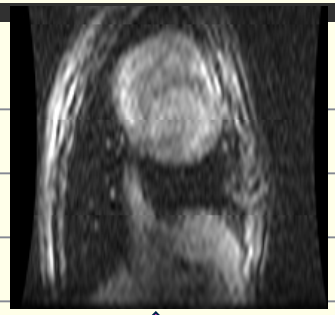
Barbara

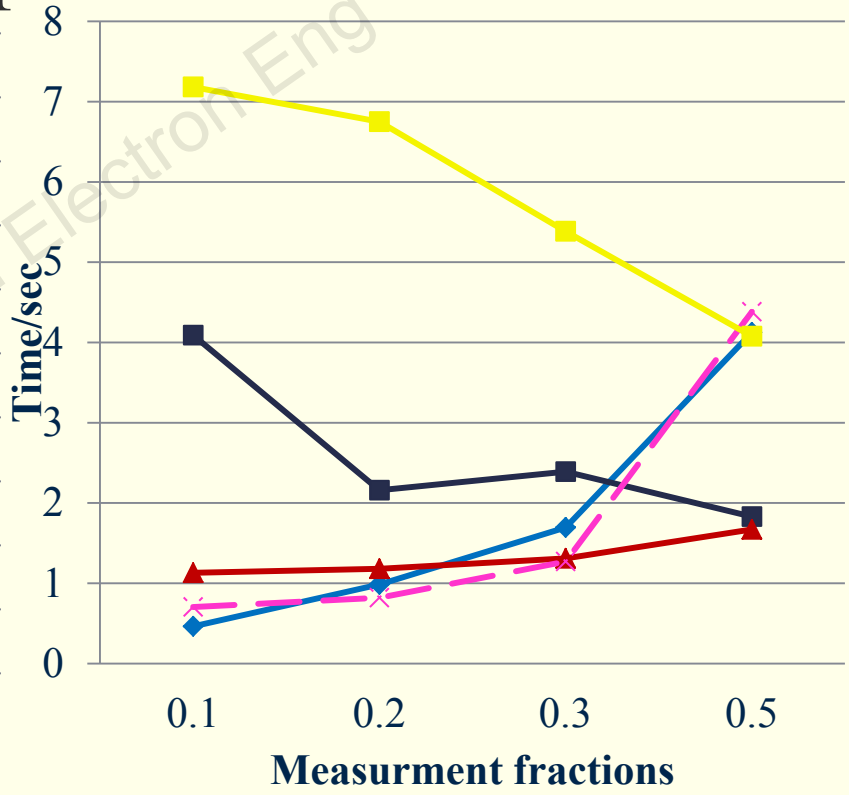




BCS-OMP
BCS-SPL
SAMP
Proposed 3 BCS-SAMP
GPSR

MRI





BCS-OMP

BCS-SPL

SAMP

Proposed 3 BCS-SAMP

GPSR

Conclusion

It can be concluded from our work that

1. The good choice of measurement matrix play a vital role in the performance of the BCS-SAMP techniques.

2. The use of Wilkinson measurement matrix improve reconstruction quality, increased the compression ratio and reduced the computational time of these greedy algorithm.

3. The performance of the greedy algorithms as BCS-SAMP become comparable to the performance of the iterative techniques as BCS-SPL in terms of quality with less computational time.