

CS 754

ADVANCED IMAGE PROCESSING

Inferring Basis Mismatch in in Signal Representations

Project Report

Team

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Effect of Basis Mismatch

Our basis were sinusoids defined in the region $[0,1]$, with frequencies going from 1 to 100 in step sizes of 1 Hz.

We considered two signals, of which signal1 has a sparse representation in our Basis.

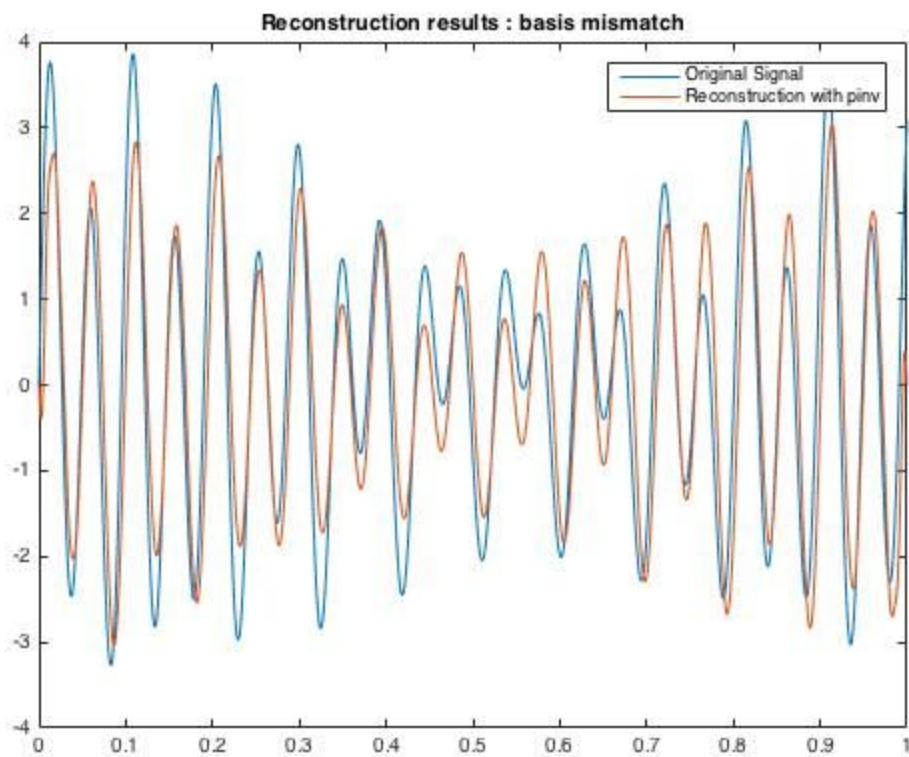
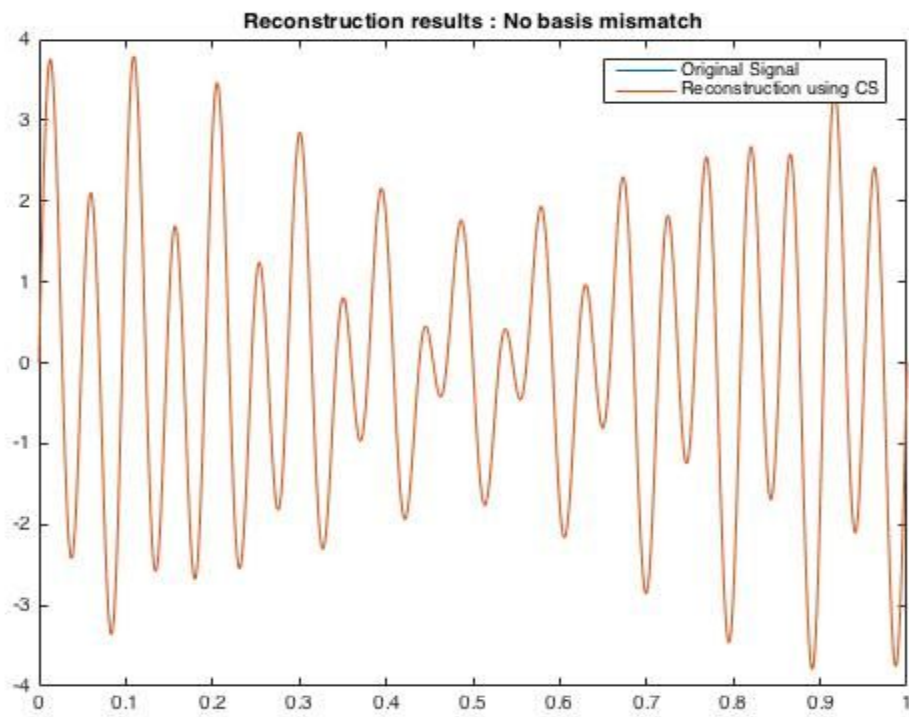
We perturbed the frequency values in signal1 to get signal2.

$$\text{signal1} = \sin(2\pi(11x)) + \sin(2\pi(20x)) + 2 * \sin(2\pi(21x))$$

$$\text{signal2} = \sin(2\pi(11.3x)) + \sin(2\pi(20.2x)) + 2 * \sin(2\pi(21.1x))$$

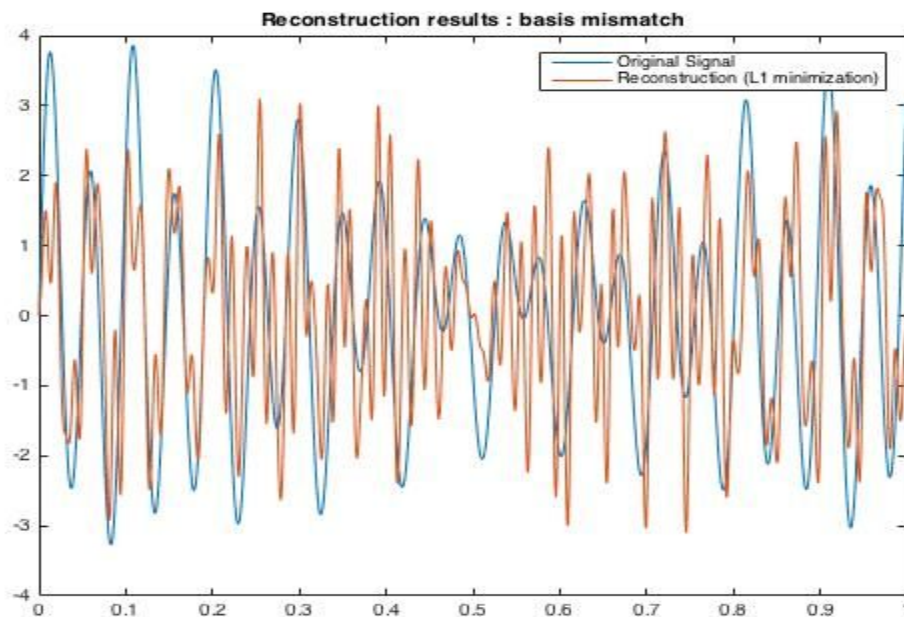
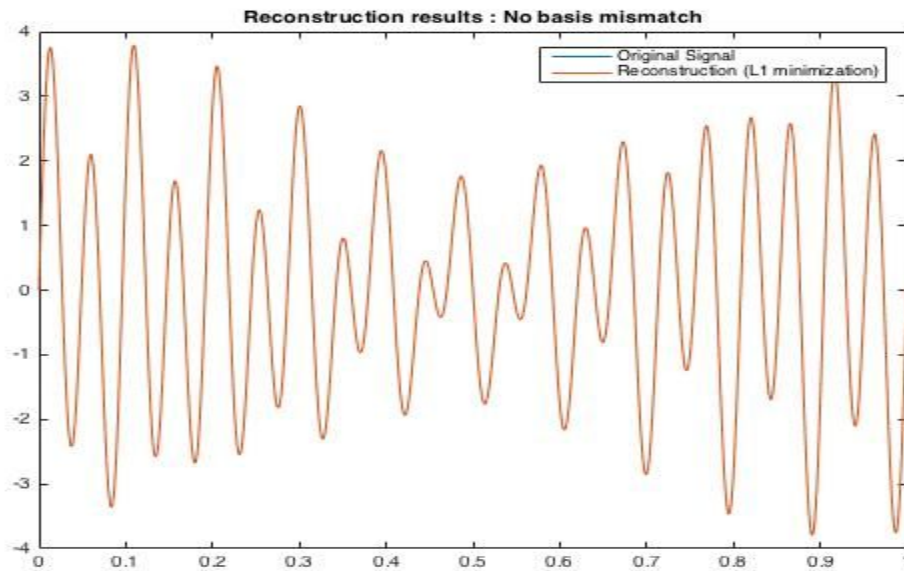
Reconstruction with pseudoinverse

We tried using the pseudoinverse to find the coefficients of the signal in our basis. We took no compressive measurements in this part. Pseudoinverse gives exact recovery for signal1, while it fails for signal2. The reconstruction results are as follows:-



Reconstruction using L1 minimization

Our measurement matrix ϕ consisted of random draws from $\{ \frac{-1}{\sqrt{m}}, \frac{1}{\sqrt{m}} \}$ with equal probability. Following are the reconstruction results for the two signals.



We thus observe that using normal compressed sensing recovery algorithms on signals with basis mismatch can give poor results.

Reducing Basis Mismatch using Alternative convex search

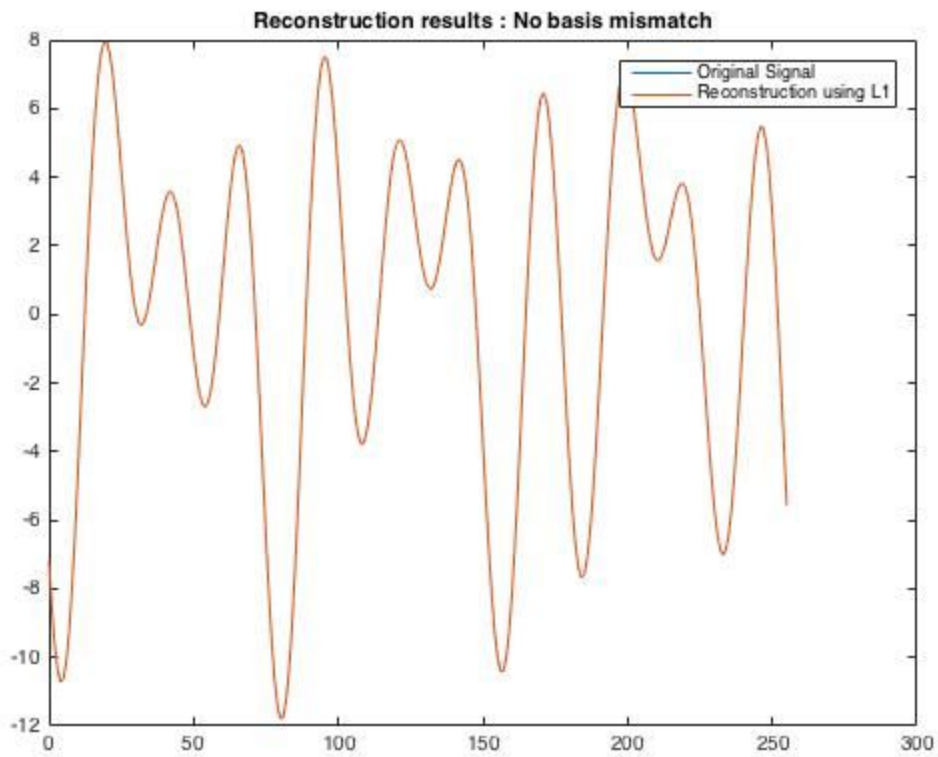
For this part, we have used the basis as defined in the paper.

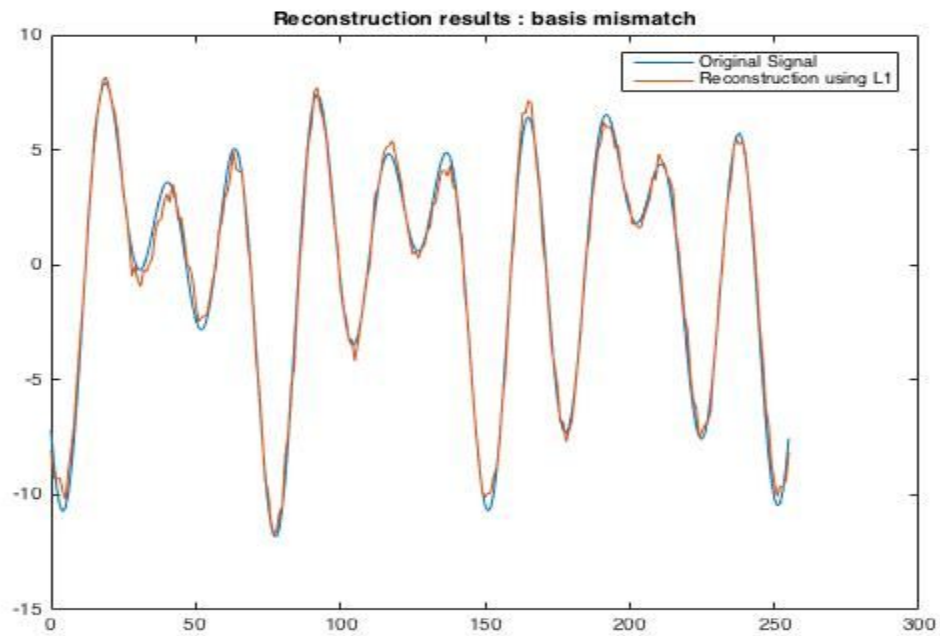
The signals used were as follows:-

$$\text{Signal1} = 3\cos(2\pi(\frac{3x}{QN}) + 3.7) + 4\cos(2\pi(\frac{7x}{QN}) + 2.1) + 5\cos(2\pi(\frac{10x}{QN}) + 2.123)$$

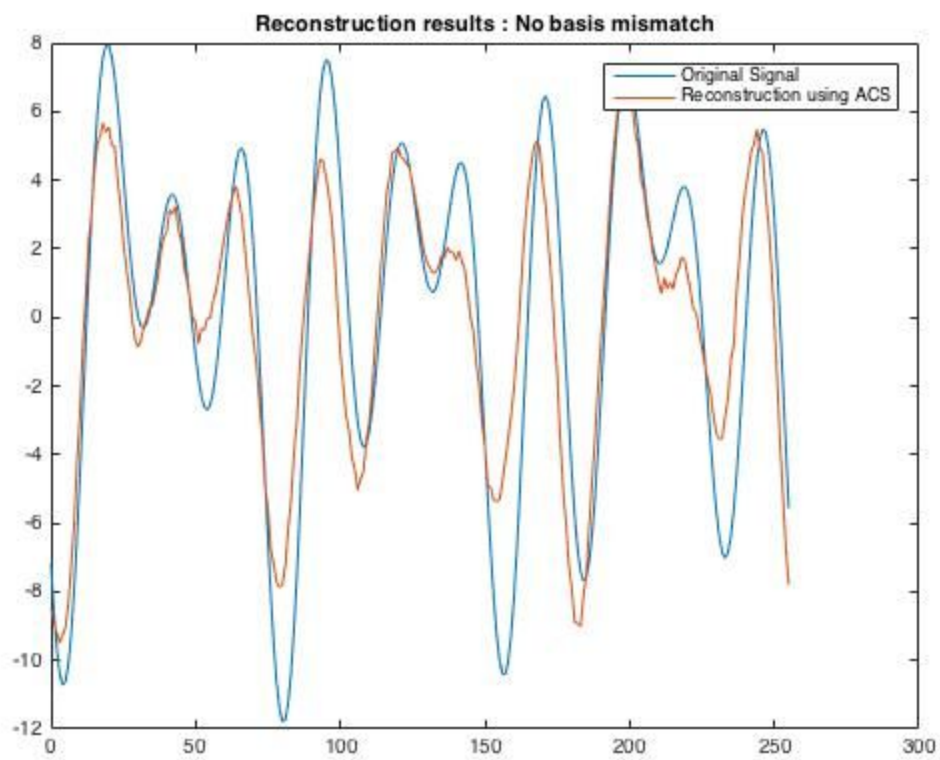
$$\text{Signal2} = 3\cos(2\pi(\frac{3.11x}{QN}) + 3.7) + 4\cos(2\pi(\frac{7.23x}{QN}) + 2.1) + 5\cos(2\pi(\frac{10.37x}{QN}) + 2.123)$$

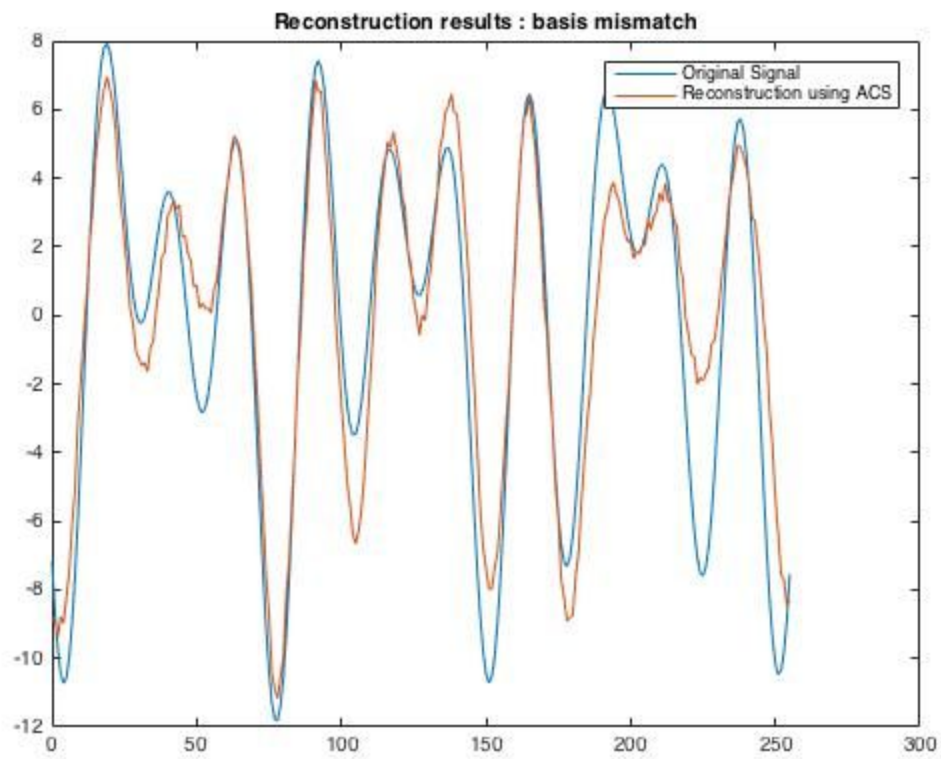
Reconstruction using L1 minimization:-



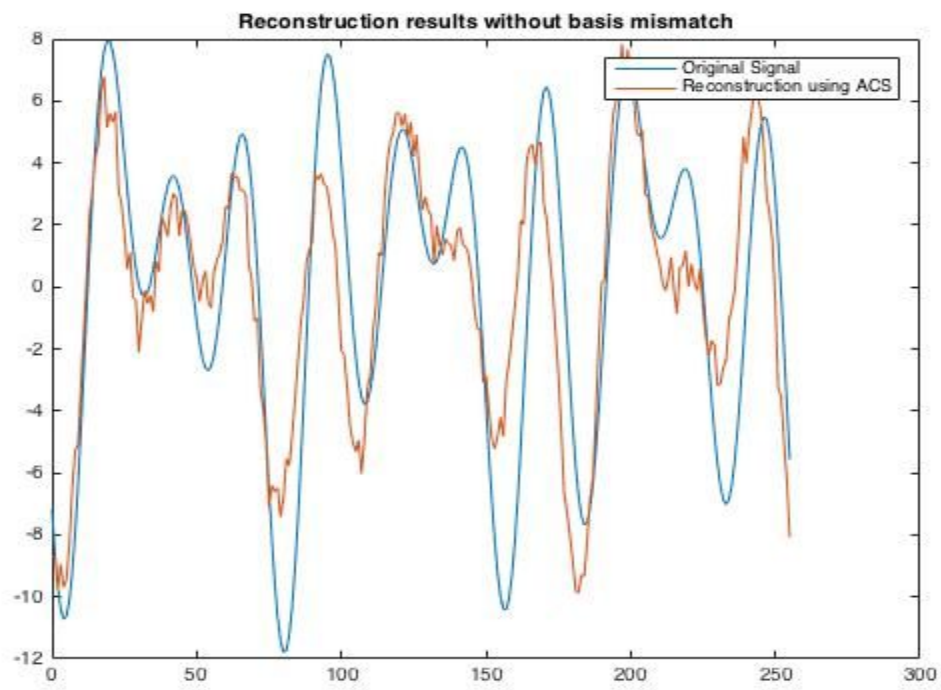


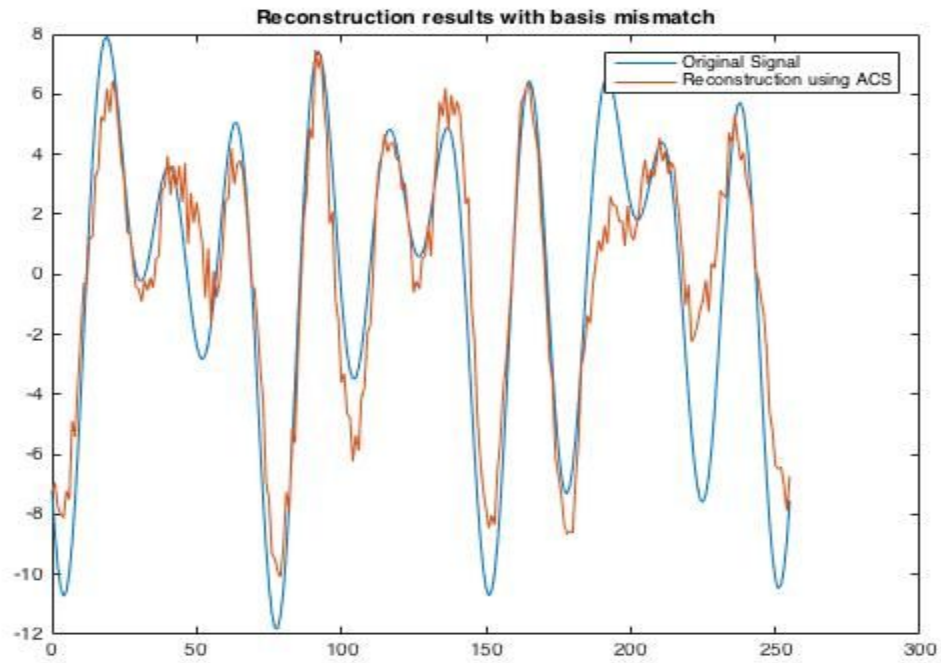
Reconstruction using ACS (no noise)



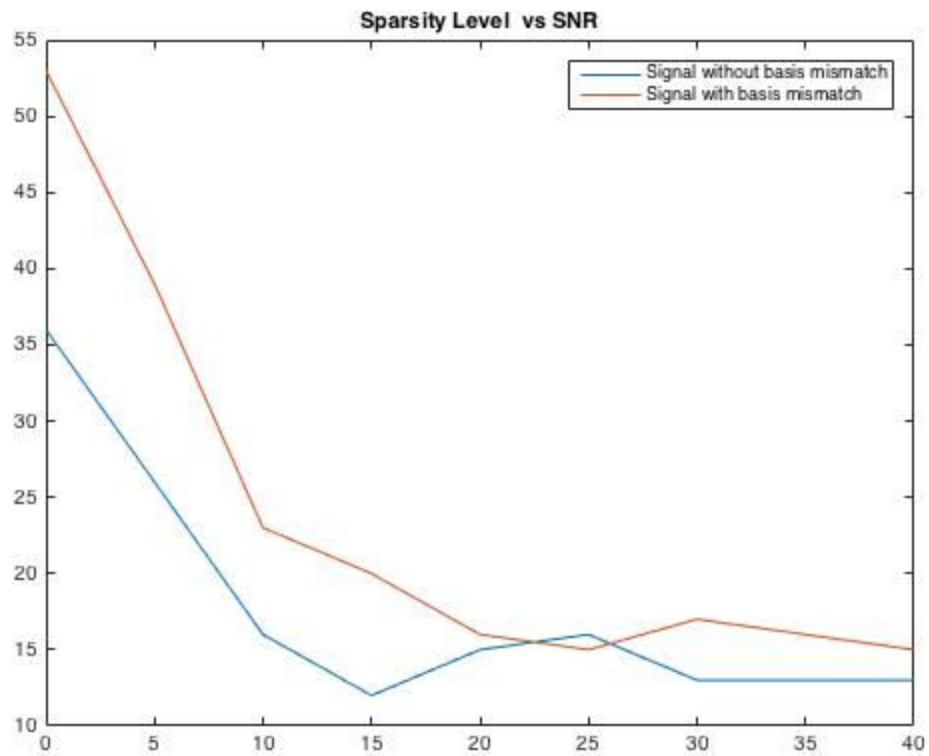


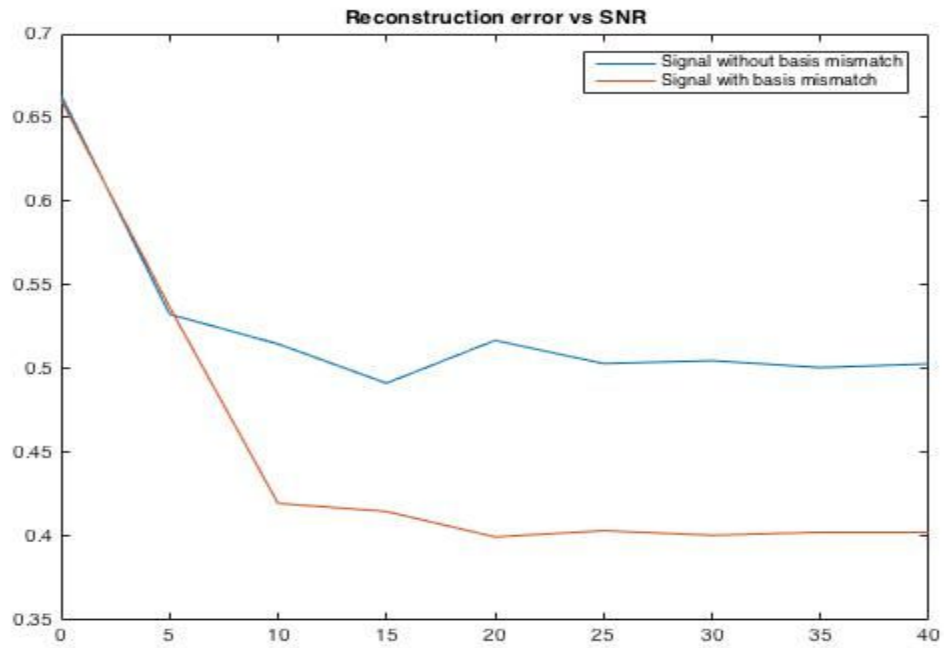
Reconstruction using ACS (noise with SNR = 10dB):-



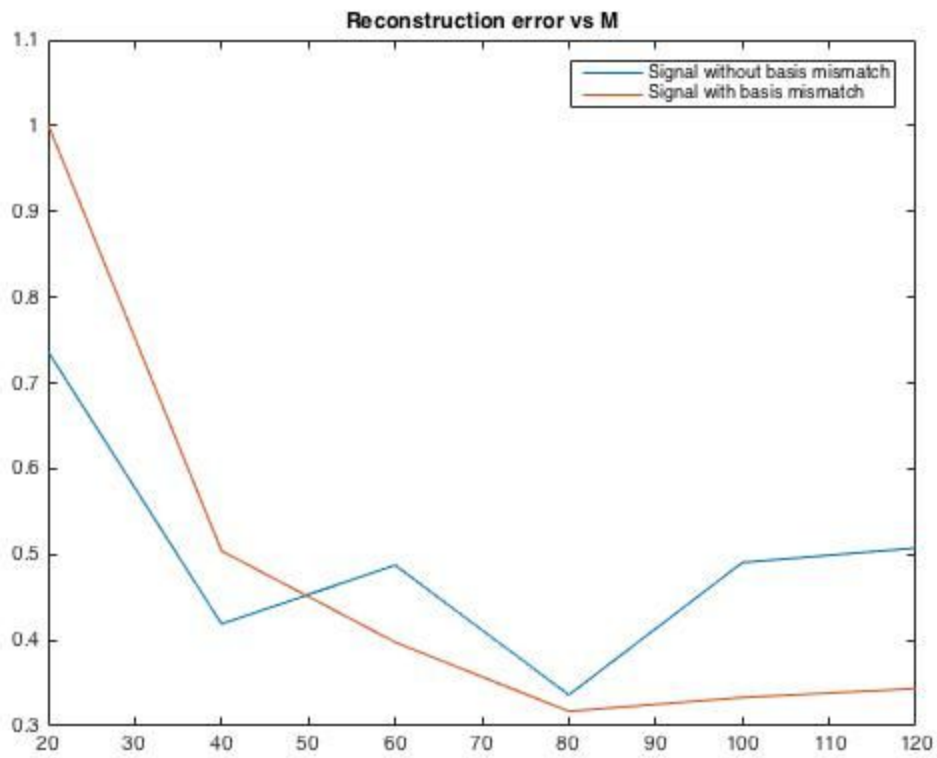


Variation with SNR:-

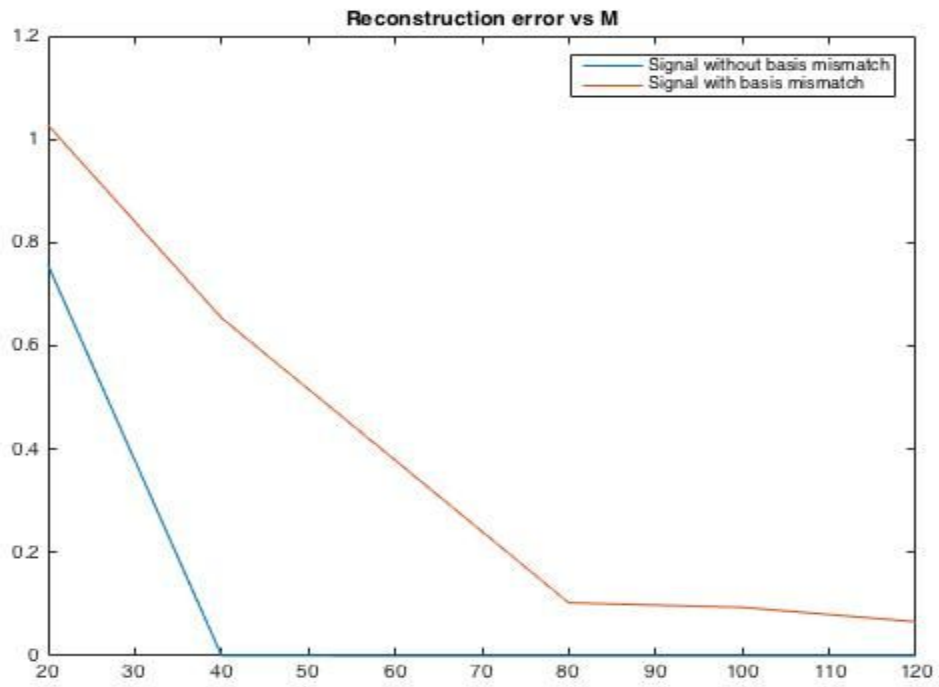




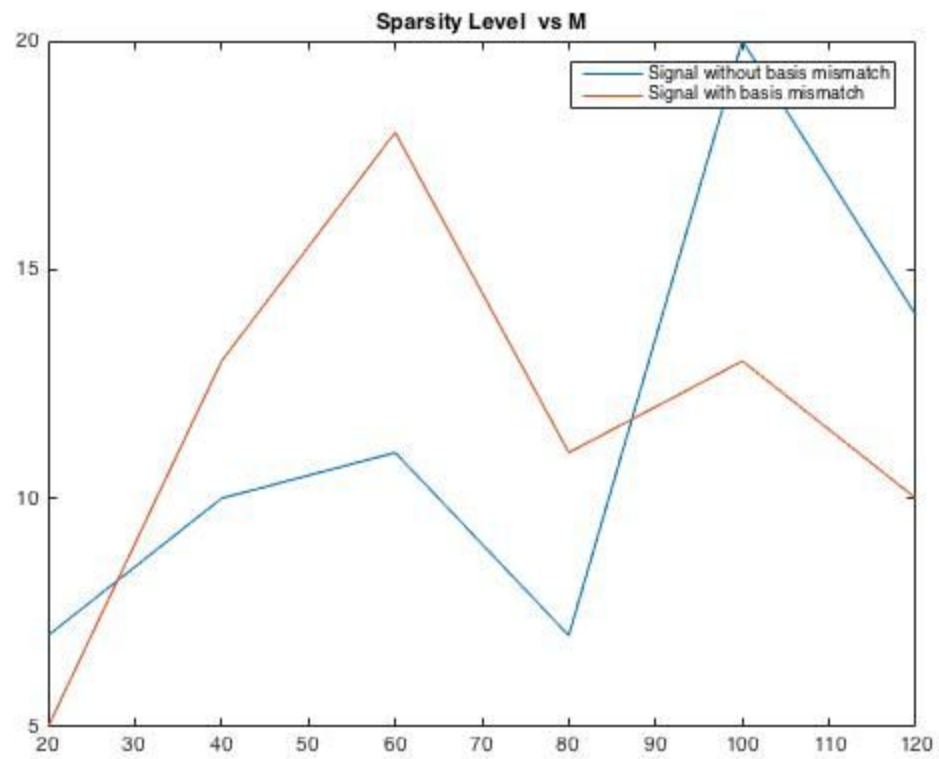
Variation with m



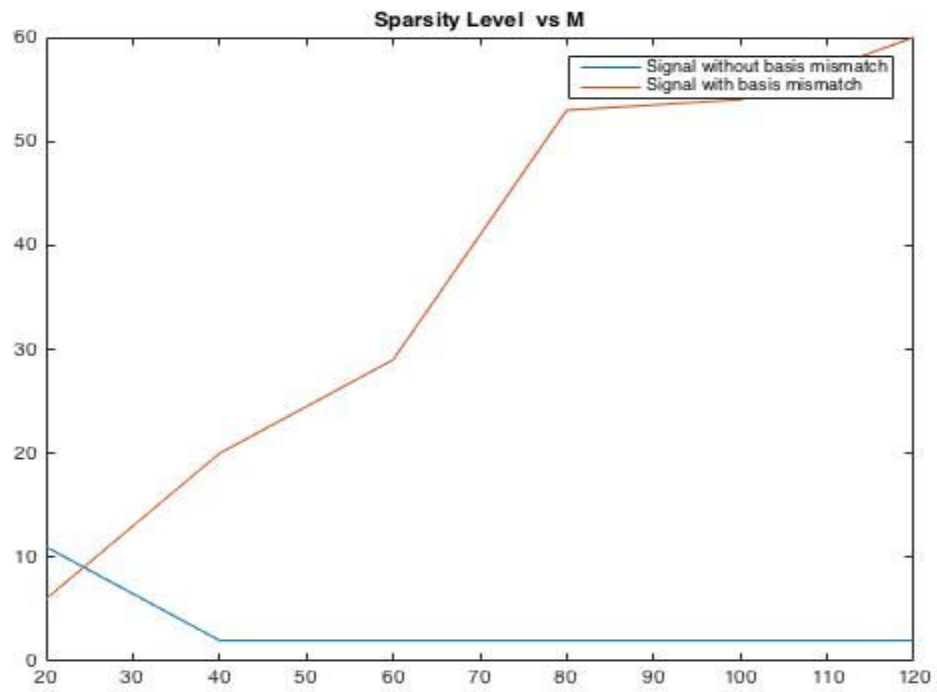
The above plot is for ACS algorithm.



The above plot is for L1 minimization.



The above graph is for ACS algorithm.



The above graph is for L1 minimization.