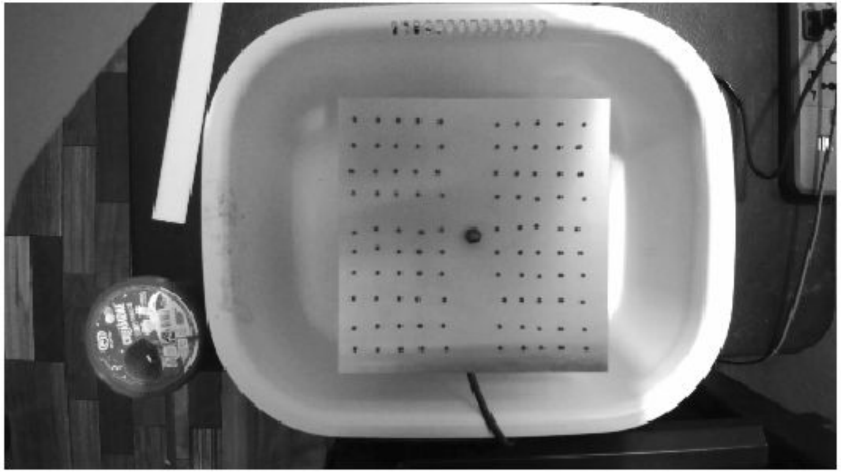
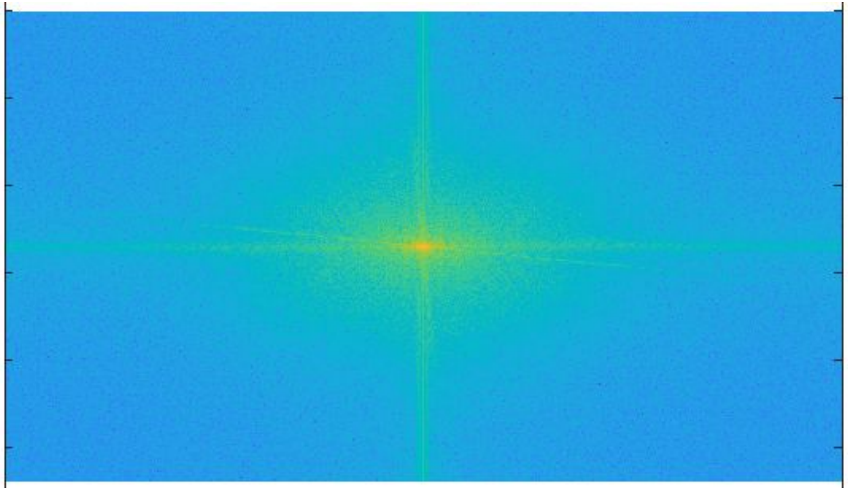
Compressive Sensing of an Image

Physics 305

The Fourier Transform of an Image is often sparse.





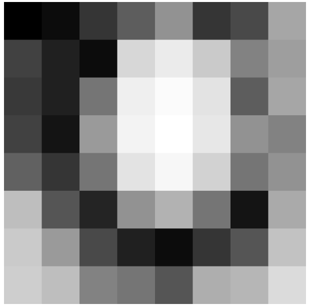
Can an image be compressively sensed?

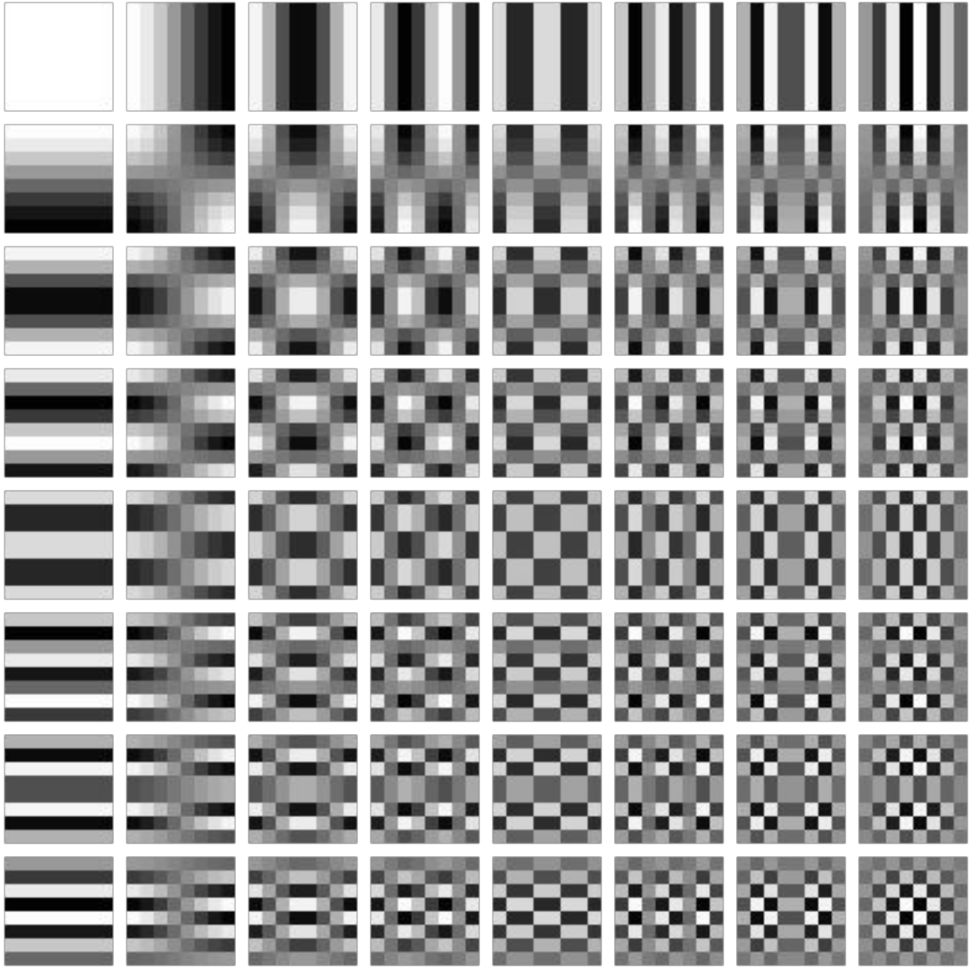
Yes, but not outright. Creating a Fourier Basis space as large as the image is computationally heavy.

Instead, we can do it in blocks a la J-PEG Compression

a. Subdivide image into 8 x 8 blocks
b. For each pixel subtract $2^{(n-1)}$ eg. if grayscale resolution is 2^8 subtract 2^7 (128) from each pixel.
c. Compute Discrete Cosine Transform coefficients for each 8 x 8 block

J-PEG Compression

x = 

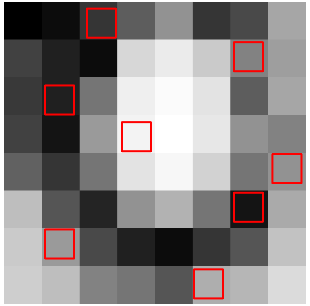
Ψ = 

s =

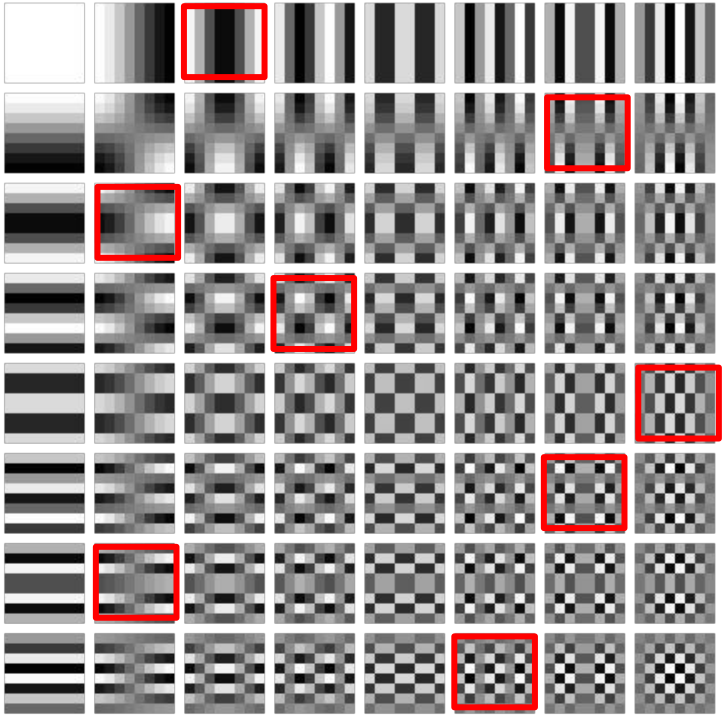
$$G = \overset{\longrightarrow}{\begin{bmatrix} -415.38 & -30.19 & -61.20 & 27.24 & 56.12 & -20.10 & -2.39 & 0.46 \\ 4.47 & -21.86 & -60.76 & 10.25 & 13.15 & -7.09 & -8.54 & 4.88 \\ -46.83 & 7.37 & 77.13 & -24.56 & -28.91 & 9.93 & 5.42 & -5.65 \\ -48.53 & 12.07 & 34.10 & -14.76 & -10.24 & 6.30 & 1.83 & 1.95 \\ 12.12 & -6.55 & -13.20 & -3.95 & -1.87 & 1.75 & -2.79 & 3.14 \\ -7.73 & 2.91 & 2.38 & -5.94 & -2.38 & 0.94 & 4.30 & 1.85 \\ -1.03 & 0.18 & 0.42 & -2.42 & -0.88 & -3.02 & 4.12 & -0.66 \\ -0.17 & 0.14 & -1.07 & -4.19 & -1.17 & -0.10 & 0.50 & 1.68 \end{bmatrix}} \Bigg\downarrow v.$$

So the 8x8 block is where you will get random samples.

y =



$\boldsymbol{\theta}$ =



Solve for **s.**

But that’s only for one 8x8 block.

Do it for all blocks and reassemble the image.

Activity 4 - Compressive Sensing of an Image

Procedure:

1. Open an image and convert it to grayscale.
2. Divide the image into non-overlappings blocks of 8x8 pixels.
3. For each block perform compressive sensing using the Discrete Cosine Transform as basis.
4. Recover the block image from the computed sparse vector s and the DCT.
5. Reassemble the blocks and measure the quality of the recovered image using Structural Similarity Index Measure (SSIM).