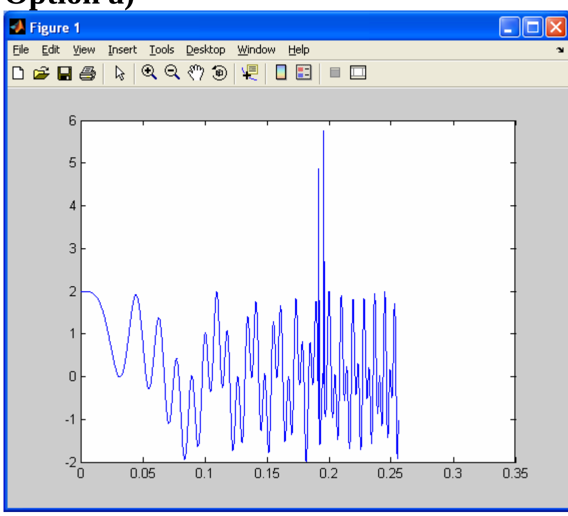
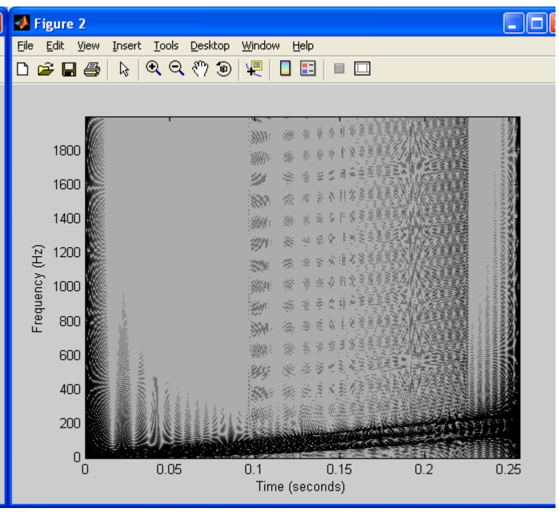
Physics 640
October 30, 2008

Project 5
Week 6 & 7: Time-Frequency Analysis and Fractals
Project 5: Pick one option below for this project

a) Develop a Matlab code that allows you to recognize a vowel from a recording (wav file) using the Wigner transform.
b) Write a Matlab code to demonstrate the advantage of using wavelet transform versus Fourier transform in signal recovery
   Matlab code to calculate the <u>Wigner function</u>; and <u>wavelet</u> subroutines will be available
c) Work on the Mandelbrot Fractal Fortran Code, then visualize using Matlab, make a movies to show the "self-similarity" zooming in effects of fractals

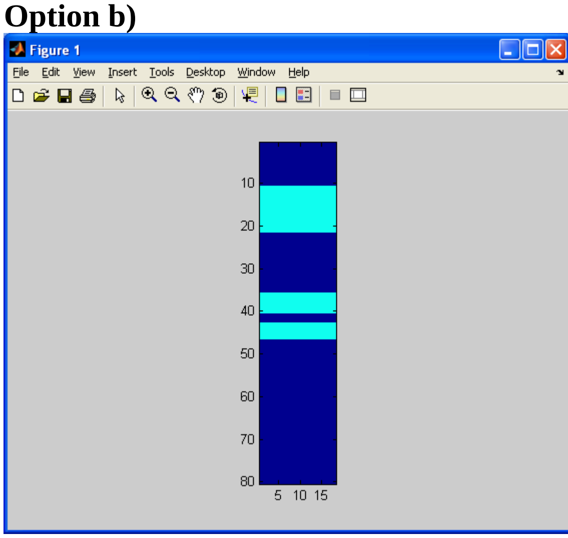
Option a)

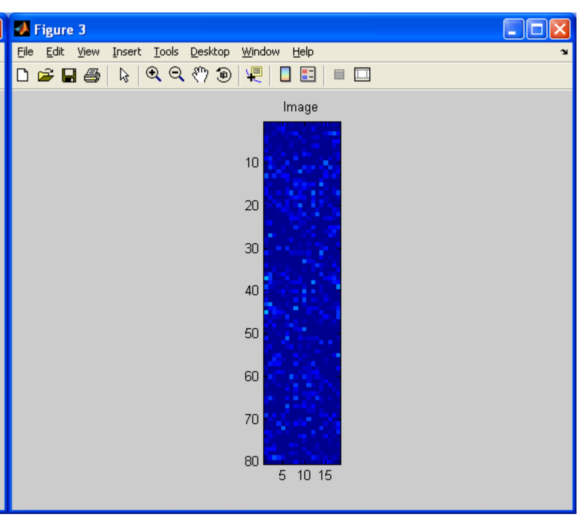




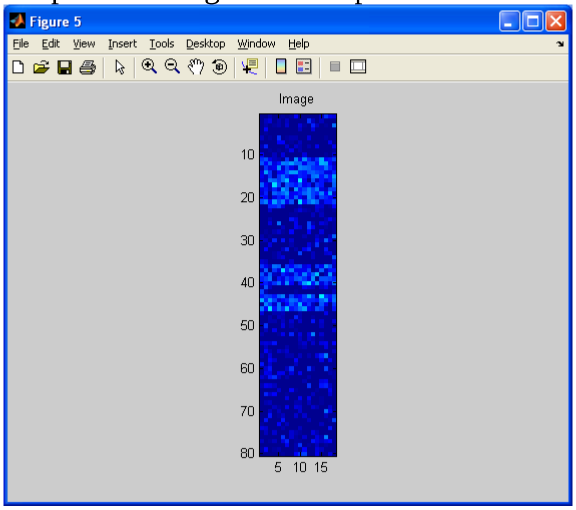
Chirp signal with two perturbations in time   Wigner transform showing linear dependence of frequency w.r.t. time
Start by recording one vowel to use as a gold standard. Should be able to determine if a given wav file contains that same vowel or not by doing correlation between the two Wigner function 2D plots ("corr2")
Human voice processing is very intensive, will need to use a very short piece of your recording.

Option b)





2D pattern or signal with a perturbation in the lower band   Masked by added noise

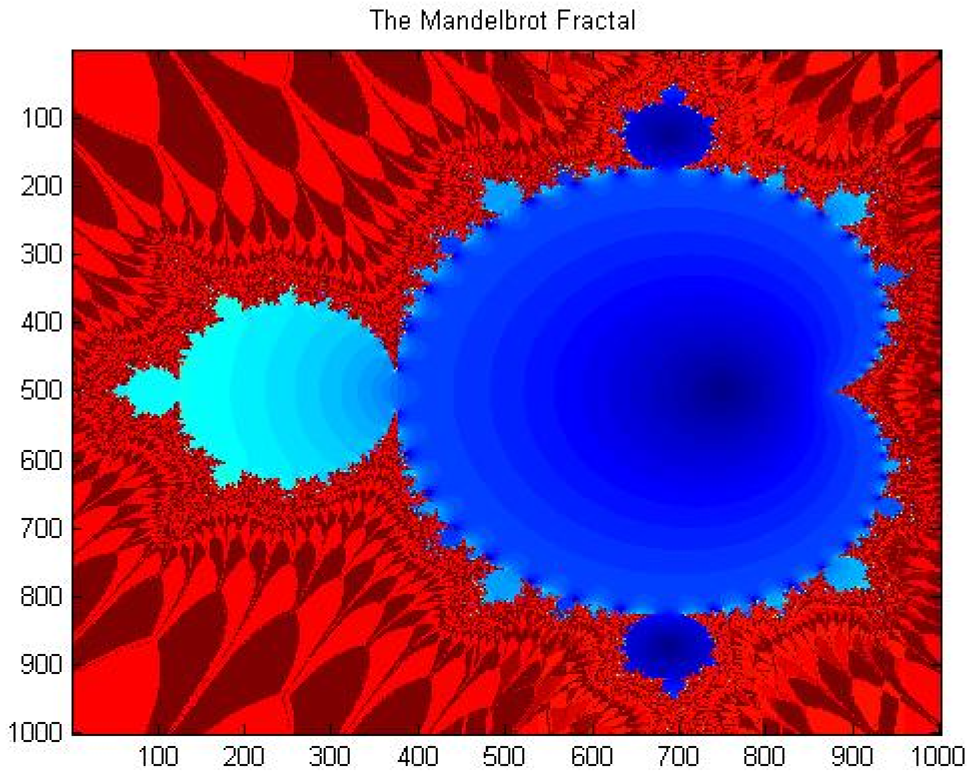


Recovered pattern using wavelet transform

The code provided, "perform_wavelet_transform.m", can perform direct and inverse 2D wavelet transforms. You would need to create your own 2D signal, add noise and do the analysis to recover the signal . Write your own Matlab code, when wavelet transform is needed, call in this subroutine.

```
y = perform_wavelet_transform(x, Jmin, dir, options);
%
%   'x' is either a 1D or a 2D array.
%   'Jmin' is the minimum scale (i.e. the coarse channel is of size 2^Jmin
%       in 1D).
%   'dir' is +1 for fwd transform and -1 for bwd.
%   'options.wavelet_vm' is the number of Vanishing moment (both for primal and
dual).
%   'options.wavelet_type' can be
%       'daubechies', 'symmlet', 'battle', 'biorthogonal'.
```

Option c)



Here is an example code to calculate the Mandelbrot fractal

```
      program mandel
C        FORTRAN77 code to generate a Mandelbrot fractal
      implicit none
      integer npts
C      Number of points in side of image
      parameter (npts=1000)
      real*8 zRe(npts,npts)
      real*8 zIm(npts,npts)
      real*8 kRe(npts,npts)
      real*8 kIm(npts,npts)
      real*8 qRe(npts,npts)
      real*8 qIm(npts,npts)
      integer i,j,k,niter
C        Number of iterations in the Mandelbrot fractal calculation
      niter=51
      do j=1,npts
       do i=1,npts
C        Generating z = 0 (real and imaginary part)
       zRe(i,j)=0.
       zIm(i,j)=0.
C        Generating the constant k (real and imaginary part)
         kRe(i,j)=dble(i)*2.0/(dble(npts)-1.)-1.5
         kIm(i,j)=dble(j)*2.0/(dble(npts)-1.)-1.
         enddo
      enddo

C        Iterating
```

```
      do k=1,niter
         do j=1,npts
          do i=1,npts
C        Calculating q = z*z + k in complex space
C        q is a temporary variable to store the result
      qRe(i,j)=zRe(i,j)*zRe(i,j)-zIm(i,j)*zIm(i,j)+kRe(i,j);
      qIm(i,j)=2.*zRe(i,j)*zIm(i,j)+kIm(i,j);
C        Assigning the q values to z constraining between
C         -5 and 5 to avoid numerical divergences
                    zRe(i,j)=qRe(i,j);
                    zIm(i,j)=qIm(i,j);
                    if (zRe(i,j) < -5.) zRe(i,j)=-5.;
                    if (zRe(i,j) > 5.) zRe(i,j)=5.;
                    if (zIm(i,j) < -5.) zIm(i,j)=-5.;
                    if (zIm(i,j) > 5.) zIm(i,j)=5.;
          enddo
         enddo
      enddo
C   You will need to output zRe and zIm to a file here

      end program mandel
```

November 2008

S	M	T	W	Th	F	Sat.
2	3	4 Midterm	5	6 Term Proj. Selection	7	8
9	10	11 Pr 5 due Term Proj. Selection	12	13 Term Proj. topic and report #1 due	14	15
16	17	18	19	20 Term Proj. topic and report #2 due	21	22
23	24	25	26	27 Term Proj. topic and report #3 due	28	29

December 2008

S	M	T	W	Th	F	Sat.
	1	2	3	4 Term Proj. topic and report #4 due	5	6
7	8	9 Term Proj. Pres.	10	11 Term Proj. Pres.	12 Last day of classes	13
14	15	16 Final report due	17	18	19	20