AMATH 582 Winter Quarter 2012

Homework 4: PCA
DUE: Wednesday, Feb. 22, 2012

On the webpage are movie files created from three different cameras (videos are from 2011). The experiments are an attempt to illustrate various aspects of the PCA and its practical usefulness and the effects of noise on the PCA algorithms.

- **(test 1) Ideal case:** Consider a small displacement of the mass in the z direction and the ensuing oscillations. In this case, the entire motion is in the z directions with simple harmonic motion being observed.
- **(test 2) noisy case:** Repeat the ideal case experiment, but this time, introduce camera shake into the video recording. This should make it more difficult to extract the simple harmonic motion. But if the shake isn't too bad, the dynamics will still be extracted with the PCA algorithms.
- **(test 3) horizontal displacement:** In this case, the mass is released off-center so as to produce motion in the $x-y$ plane as well as the z direction. Thus there is both a pendulum motion and a simple harmonic oscillations. See what the PCA tells us about the system.
- **(test 4) horizontal displacement and rotation:** In this case, the mass is released off-center and rotates so as to produce motion in the $x-y$ plane, rotation as well as the z direction. Thus there is both a pendulum motion and a simple harmonic oscillations. See what the PCA tells us about the system.

In order to extract out the mass movement from the video frames, the following MATLAB code is needed. This code is a generic way to read in movie files to MATLAB for post-processing.

```
obj=mmreader('matlab_test.mov')

vidFrames = read(obj);
numFrames = get(obj,'numberOfFrames');

for k = 1 : numFrames
    mov(k).cdata = vidFrames(:,:,:,k);
    mov(k).colormap = [];
end

for j=1:numFrames
  X=frame2im(mov(j));
  imshow(X); drawnow
end
```

This command multi-media reader command **mmreader** simply characterizes the file type and its attributes. The bulk of time in this is the **read** command which actually uploads the movie frames into the MATLAB desktop for processing. Once the frames are extracted, they can again be converted to double precision numbers for mathematical processing. In this case, the position of the mass is to be determined from each frame. This basic shell of code is enough to begin the process of extracting the spring-mass system information.

Explore the PCA method on this problem and see what you find.