COMP 116
Programming Assignment #3:
Applications of Linear Equations
Due Date: Sunday, October 3, 2010

This assignment is composed of two parts. Your code/solutions for each part should be placed in one script and published as a single report. The script should be divided into cells for different sections of the assignment, but organization of the report is your decision.

1 Trusses

For this portion of the assignment, you will be solving a problem from your textbook (Gilat). Just in case anyone has "misplaced" their textbook, or perhaps "completely forgot" to buy it in the first place (it happens), we've provided a scan of the relevant page online.

You'll be solving **Problem 11** on page 117. Please include the code you use to solve the problem as well as the result, that is, the answer. Don't worry too much about "displaying the results in a table"; just make sure we can easily understand your answer in the published report.

2 Fitting Shapes onto Points

For this part of the assignment you'll be attempting to fit various shapes overlaid on a picture of a person's face. In the "Assignment3Resources" folder on Sakai, you'll find two pictures: `clark.jpg` and `stevens.jpg`. You're only required to use **one** of these images for the assignment; but we've considerately provided two images so you can choose the one you fancy, since you'll spend a good amount of time staring at the face you select during the course of your assignment.

Your MATLAB script should do the following:

1. Display the image you've chosen to use (as you did in Assignment #1).
2. Using the command `[x,y] = ginput(10);`, allow a user to click 10 points on the image that trace the pictured person's face.
3. Plot those 10 points clicked as yellow points (with no connecting line). Make sure that these points do not erase the image.
4. Find the circle, oval, and ellipse that best fit those 10 points clicked by the user. This is essentially the same as finding the proper coefficients (B, C, D, F) of the following equations:

$$\text{Circle: } (x^2 + y^2) + Dx + Fy + G = 0$$

$$\text{Oval: } x^2 + Cy^2 + Dx + Fy + G = 0$$

$$\text{Ellipse: } x^2 + Bxy + Cy^2 + Dx + Fy + G = 0$$

5. Plot the solutions you found for the circle, oval, and ellipse onto the image. Make the circle cyan, the oval red, and the ellipse magenta. To do this we've provided for you the function `draw_ellipse(1,B,C,D,F,G,eColor)`. You simply plug the coefficients that you found in the previous step into the function and a string representing what color to use ('r', 'b', etc.). For example, if I found my coefficients for the circle and they are called `d`, `f`, and `g`, I would call

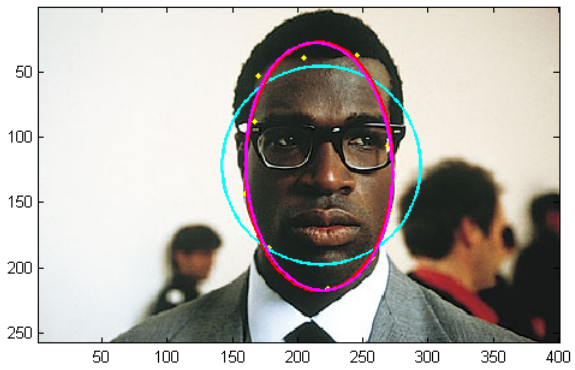
   ```
   draw_ellipse(1,0,1,d,f,g,'c');
   ```

   to draw a cyan circle defined by those coefficients. To use this function, you must be sure to have **both** of the .m files we included in the Assignment3Resources folder (`ellipse.m` and `draw_ellipse.m`) located in the MATLAB directory that you are working in when you are running your MATLAB code. Again, make sure that the plotted shapes you draw do not erase the image you've made from the previous steps.

6. Determine the squared residual for each shape. This is done by taking your `[x,y]` values you took from the user clicking the image, plugging those values into each of the three shape equations, and summing the squares of the results. This effectively describes how closely the shape fits those 10 points. As this value approaches zero, the closer the shape is to exactly fitting the points.

The meat of this assignment is finding those coefficients of the best fitting shapes for the points you take from the user. Consider this problem in terms of linear equations; your unknowns are B, C, D, F, and G(or a subset of those 5). Your equations are given by the shape equations above, substituted with each of the 10 $[x, y]$ values. 10 equations, 5 unknowns. In class, we talked about a system like this as being *overdetermined*.

Here's a sample output so you can get a better idea of what yours should look like:



3 Required Components [100 points]

1. Solve Problem 11 on page 117 of the Gilat textbook. Show MATLAB code used to solve it. [20 points]
2. Display one of the two images provided. [5 points]
3. Allow user to click 10 points around the person's face. [5 points]
4. Plot those 10 points as yellow unconnected points onto the image [10 points]
5. Find the coefficients for the best fitting circle, oval, and ellipse [25 points]
6. Plot the circle in cyan, the oval in red, and the ellipse in magenta. [10 points]
7. Determine the squared residual for each shape. [15 points]
8. Publish the script including your introduction, your code, the results, and your conclusions. [5 points]
9. Give us your ideas on how to improve or extend this assignment. [5 points]