

**CEG4316 Digital Image Processing**  
**Lab Assignment #0**  
October 2013

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**Objective:** To generate an image with 128 lines and 256 columns consisting of a zone plate with local horizontal frequency varying from -64 to +64 c/ph and vertical frequency varying from 0 to +64 c/ph. To display this image and to save it as a TIFF file.

**Theory:** The amplitude scale has not been specified. I will make maximum use of the scale from 0 to 1. The  $x$  coordinate runs from 0 to 2 ph and the  $y$  coordinate from 0 to 1 ph. I will place the origin of the zoneplate at coordinate (1,0). Thus the mathematical expression for the zoneplate is

$$f(x, y) = 0.5 + 0.5 * \cos(\pi((x-1)^2 + y^2)/r^2)$$

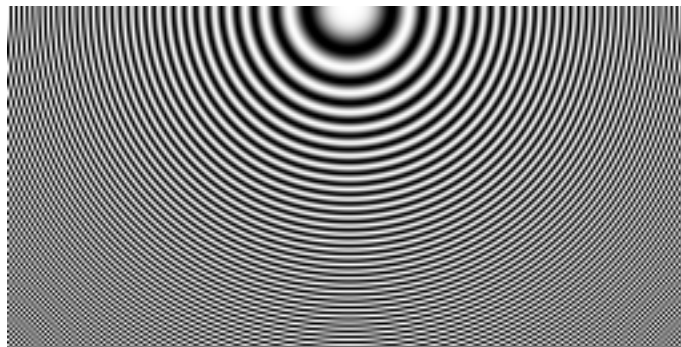
The maximum local vertical frequency will occur when  $y = 1$ , with value  $1/r^2$  which should be 64 c/ph. Thus  $r^2 = 1/64$ . It is clear that this gives the correct values for maximum local horizontal frequency when  $x = 0$  and  $x = 2$ . Thus the zoneplate to be generated is

$$f(x, y) = 0.5 + 0.5 * \cos(64\pi((x-1)^2 + y^2)), \quad 0 \leq x < 2, \quad 0 \leq y < 1$$

**Method:** I generated a 128 by 256 matrix in MATLAB containing the desired zone plate. I made use of the `meshgrid` function to generate the desired  $x$  and  $y$  values with spacing 1/128. The image was displayed using `imshow` and saved in TIFF format using `imwrite`. The MATLAB code I wrote to carry this out follows:

```
% MATLAB code for Computer experiment 0, CEG4316
% F. Gauss 2013-10-01
x = 0:1/128:2-1/128; % 256 x values from 0 to 2 in steps of 1/128
y = 0:1/128:1-1/128; % 128 y values from 0 to 1 in steps of 1/128
[X,Y] = meshgrid(x,y);
Z = .5 + .5*cos(64*pi*((X-1).^2 + Y.^2)); % generate the zoneplate
imshow(Z) % display the image
imwrite(Z,'zoneplate.tif') % save the image as a TIFF file
```

**Result:** The program ran correctly and generated the image shown below.



*(Note: In your report, you need not include all images that you generated. You can describe in words the resulting image in many cases, and include a few particularly interesting examples, perhaps marking certain features of note.)*

**Discussion:** The zoneplate image contains some interference patterns that I don't fully understand. The printed version of the zoneplate in my report looks different than the one on my screen due to limitations of my printer.

**Conclusion:** It is possible to generate this useful test pattern with only a few statements in MATLAB. The zoneplate is a useful test pattern to evaluate many imaging systems.