CS 615

D

$$\begin{bmatrix} x \\ y \end{bmatrix} = \underbrace{\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}}_{A} \begin{bmatrix} x' \\ y' \end{bmatrix}$$

$|A| = 1$

$$x' = \begin{vmatrix} x & -\sin\theta \\ y & \cos\theta \end{vmatrix}$$

$$x' = \cos\theta\, x - \sin\theta\, y$$

$$y' = \begin{vmatrix} \cos\theta & x \\ \sin\theta & y \end{vmatrix}$$

$$y' = -\sin\theta\, x + \cos\theta\, y$$

$$\frac{\partial}{\partial x} = \frac{\partial x'}{\partial x}\frac{\partial}{\partial x'} + \frac{\partial y'}{\partial x}\frac{\partial}{\partial y'} = \cos\theta \frac{\partial}{\partial x'} - \sin\theta \frac{\partial}{\partial y'}$$

$$\frac{\partial}{\partial y} = \frac{\partial x'}{\partial y}\frac{\partial}{\partial x'} + \frac{\partial y'}{\partial y}\frac{\partial}{\partial y'} = -\sin\theta \frac{\partial}{\partial x'} + \cos\theta \frac{\partial}{\partial y'}$$

$$\frac{\partial^2}{\partial x^2} = \left(\cos\theta \frac{\partial}{\partial x'} - \sin\theta \frac{\partial}{\partial y'}\right)\left(\cos\theta \frac{\partial}{\partial x'} - \sin\theta \frac{\partial}{\partial y'}\right)$$

$$\frac{\partial^2}{\partial x^2} = \cos^2\theta \frac{\partial^2}{\partial x'^2} - 2\cos\theta\sin\theta \frac{\partial^2}{\partial x' \partial y'} + \sin^2\theta \frac{\partial^2}{\partial x' \partial y'}$$

$$\frac{\partial^2}{\partial y^2} = \sin^2\theta \frac{\partial^2}{\partial x'^2} + 2\sin\theta\cos\theta \frac{\partial^2}{\partial x' \partial y'} + \cos^2\theta \frac{\partial^2}{\partial x' \partial y'}$$

$$\nabla^2 f = f_{xx} + f_{yy}$$

$$= \cos^2\theta\, f_{x'x'} - 2\cos\theta\sin\theta\, f_{x'y'} + \sin^2\theta\, f_{y'y'} + \sin^2\theta\, f_{x'x'} + 2\cos\theta\sin\theta\, f_{x'y'} + \cos^2\theta\, f_{y'y'}$$

$$\nabla^2 f = f_{x'x'} + f_{y'y'} = f_{xx} + f_{yy}$$

Table of Contents


```
clear
clc
```

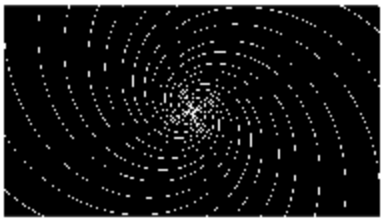
Exercise 1: On Paper

Exercise 2

```
moon = imread('./Moon.jpg');
lap = ones(3, 3);
lap(2, 2) = -8;

g = moon - imfilter(moon, lap);

figure;
subplot(1, 2, 1)
imshow(moon, [])

subplot(1, 2, 2)
imshow(g, [])
```

Exercise 3

```
spiral = imread('./spiral.jpg');
spiralGray = rgb2gray(spiral);
spiralBW = imbinarize(spiralGray, graythresh(spiralGray));

figure;
subplot(1, 2, 1)
imshow(spiralBW, [])

subplot(1, 2, 2)
imshow(spiralBW - imerode(spiralBW, strel('disk', 2)), [])
```



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