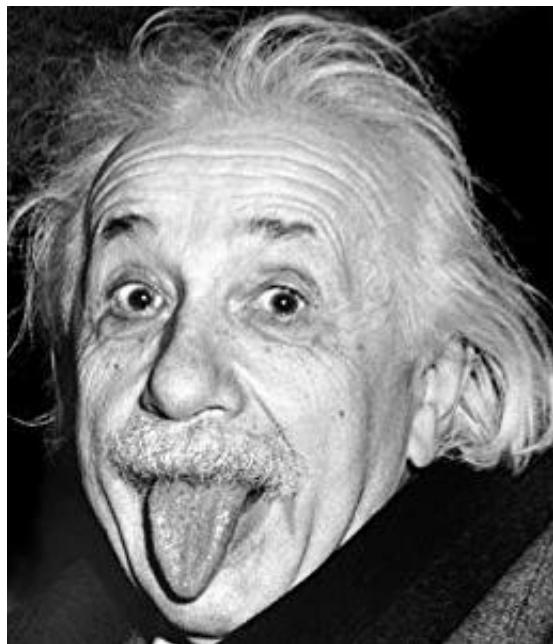


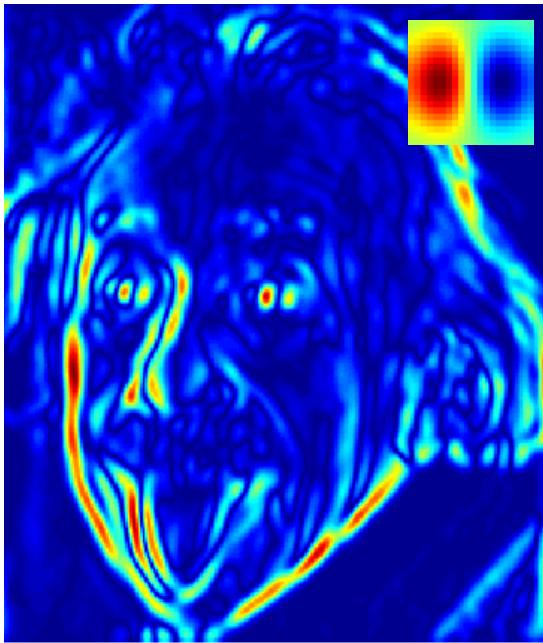
IMAGE GRADIENT

HYUN Soo PARK

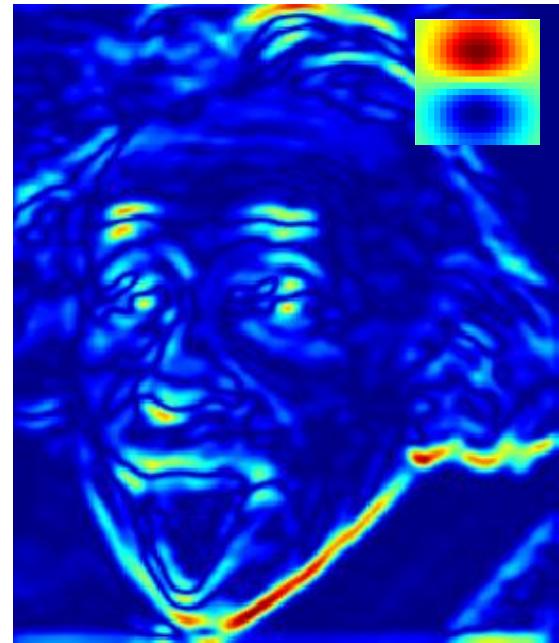
IMAGE PARTIAL DIFFERENTIAL



I

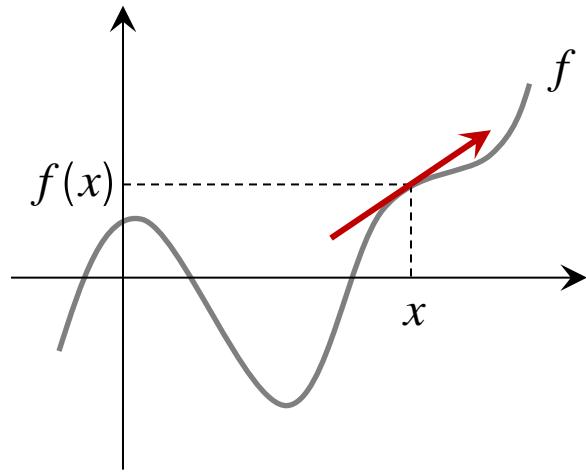


$$\frac{\partial I}{\partial u}$$



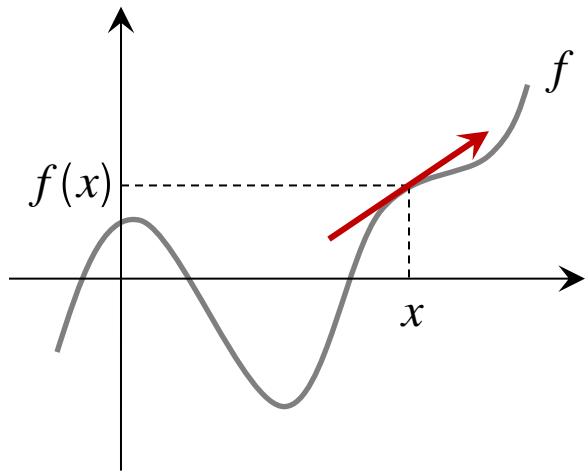
$$\frac{\partial I}{\partial v}$$

IMAGE GRADIENT

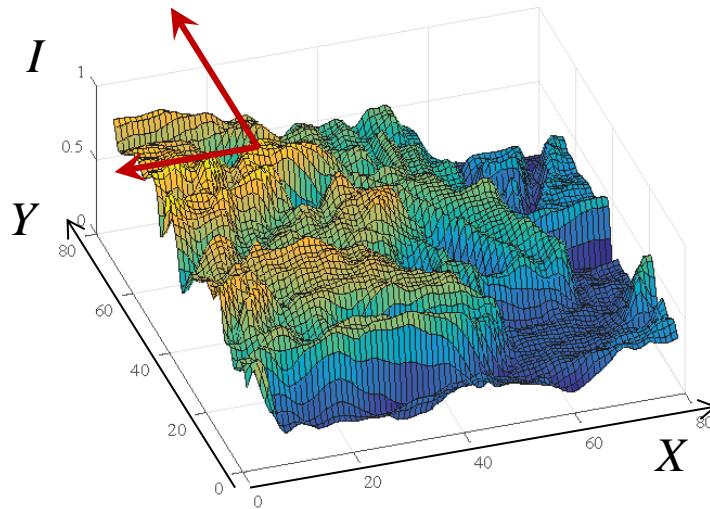


$$\frac{df(x)}{dx}$$

IMAGE GRADIENT



$$\frac{df(x)}{dx}$$



$$\nabla I = \frac{\partial I(x, y)}{\partial x} \mathbf{i} + \frac{\partial I(x, y)}{\partial y} \mathbf{j}$$

Gradient

def) a multivariate generalization of the derivative.

IMAGE GRADIENT

$$\nabla I = \frac{\partial I(x, y)}{\partial x} \mathbf{i} + \frac{\partial I(x, y)}{\partial y} \mathbf{j}$$

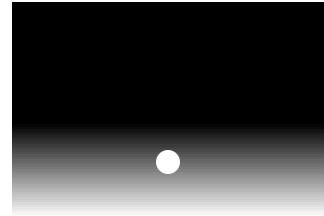
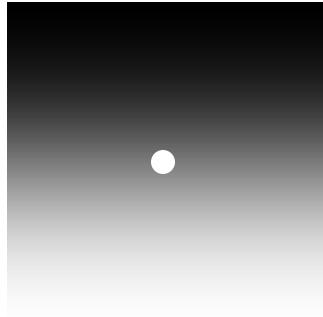
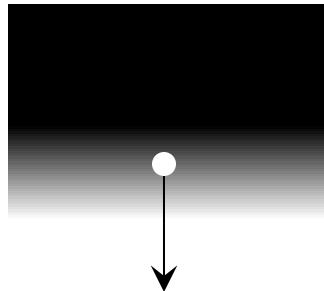
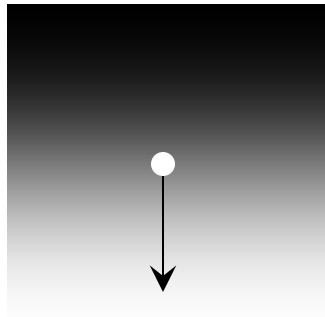


IMAGE GRADIENT

$$\nabla I = \frac{\partial I(x, y)}{\partial x} \mathbf{i} + \frac{\partial I(x, y)}{\partial y} \mathbf{j}$$



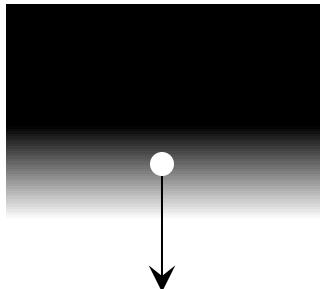
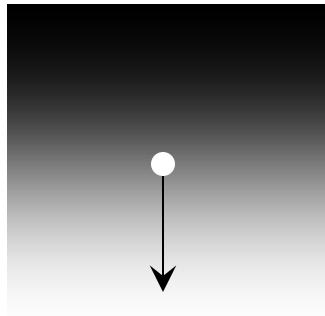
$$\frac{\partial I}{\partial u} = 0 \quad \frac{\partial I}{\partial v} = c_1$$

$$\frac{\partial I}{\partial u} = 0 \quad \frac{\partial I}{\partial v} = c_2$$

IMAGE GRADIENT

$$\nabla I = \frac{\partial I(x, y)}{\partial x} \mathbf{i} + \frac{\partial I(x, y)}{\partial y} \mathbf{j}$$

Magnitude of the gradient is proportional to contrast change rate



$$c_1 < c_2$$

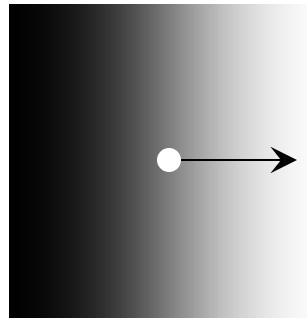
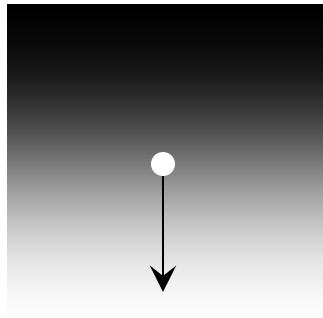
$$\frac{\partial I}{\partial u} = 0 \quad \frac{\partial I}{\partial v} = c_1$$

$$\frac{\partial I}{\partial u} = 0 \quad \frac{\partial I}{\partial v} = c_2$$

IMAGE GRADIENT

$$\nabla I = \frac{\partial I(x, y)}{\partial x} \mathbf{i} + \frac{\partial I(x, y)}{\partial y} \mathbf{j}$$

Direction of the gradient is greatest rate of increase .



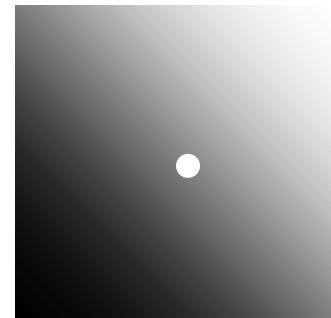
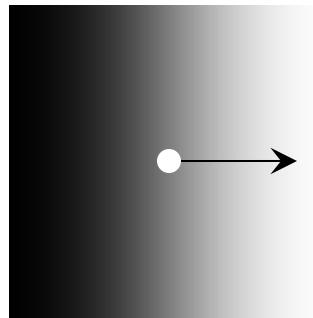
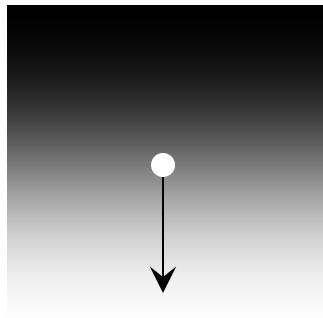
$$\frac{\partial I}{\partial u} = 0 \quad \frac{\partial I}{\partial v} = c_1$$

$$\frac{\partial I}{\partial u} = c_2 \quad \frac{\partial I}{\partial v} = 0$$

IMAGE GRADIENT

$$\nabla I = \frac{\partial I(x, y)}{\partial x} \mathbf{i} + \frac{\partial I(x, y)}{\partial y} \mathbf{j}$$

Direction of the gradient is greatest rate of increase .



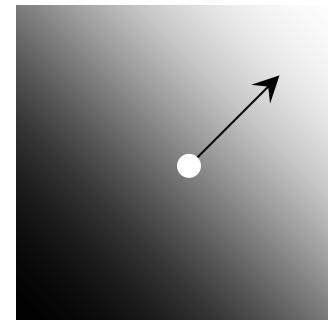
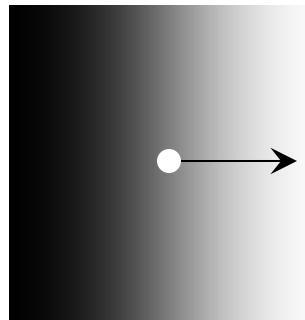
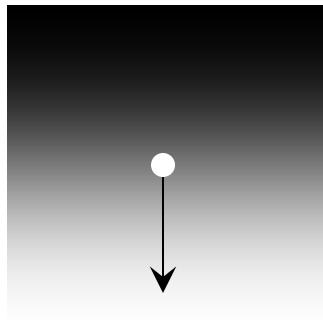
$$\frac{\partial I}{\partial u} = 0 \quad \frac{\partial I}{\partial v} = c_1$$

$$\frac{\partial I}{\partial u} = c_2 \quad \frac{\partial I}{\partial v} = 0$$

IMAGE GRADIENT

$$\nabla I = \frac{\partial I(x, y)}{\partial x} \mathbf{i} + \frac{\partial I(x, y)}{\partial y} \mathbf{j}$$

Direction of the gradient is greatest rate of increase .

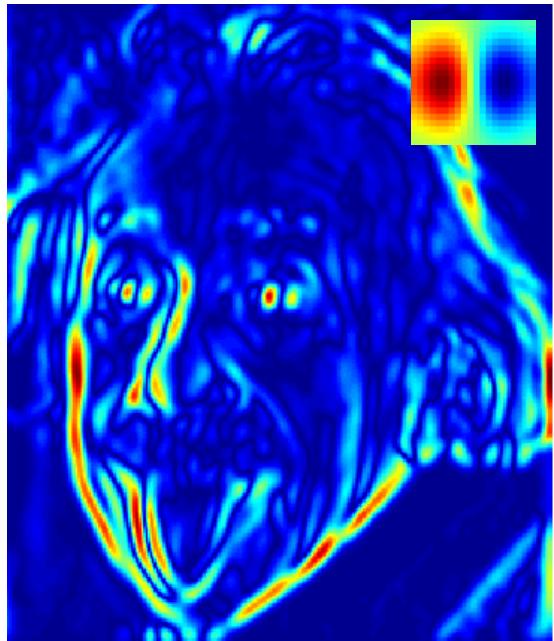


$$\frac{\partial I}{\partial u} = 0 \quad \frac{\partial I}{\partial v} = c_1$$

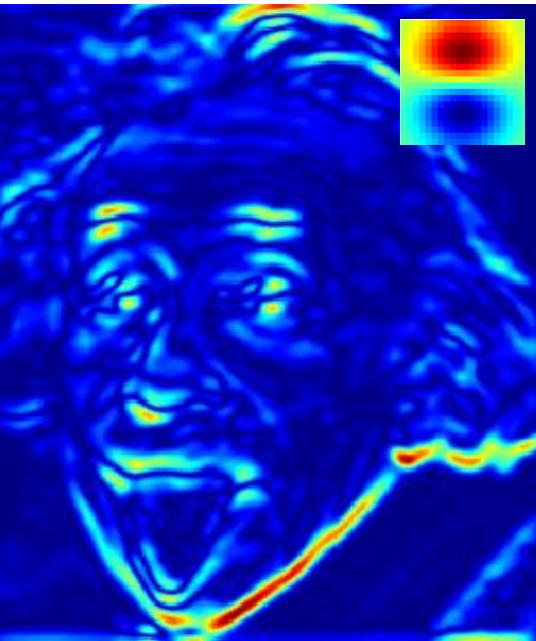
$$\frac{\partial I}{\partial u} = c_2 \quad \frac{\partial I}{\partial v} = 0$$

$$\frac{\partial I}{\partial u} = c_3 \quad \frac{\partial I}{\partial v} = c_3$$

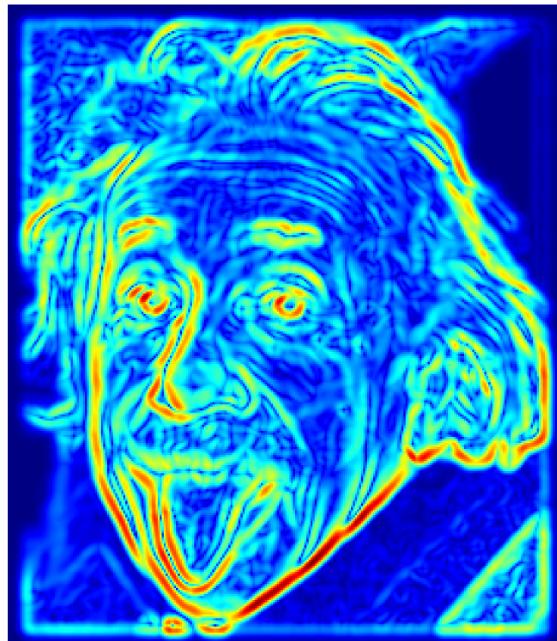
IMAGE GRADIENT MAGNITUDE



$$\frac{\partial I}{\partial u}$$

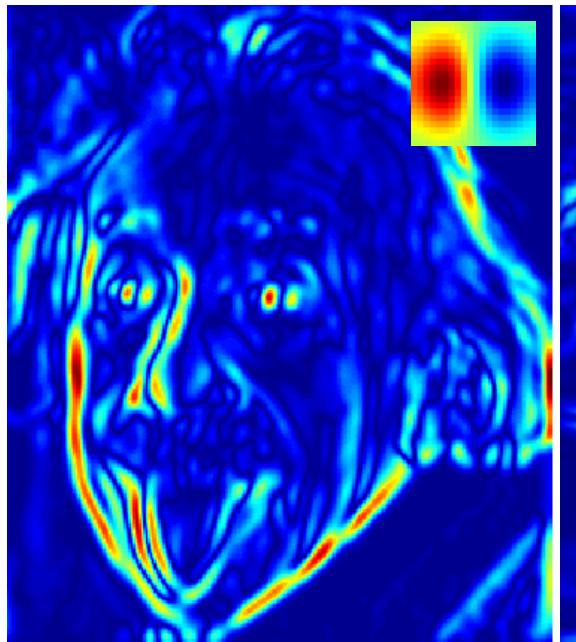


$$\frac{\partial I}{\partial v}$$

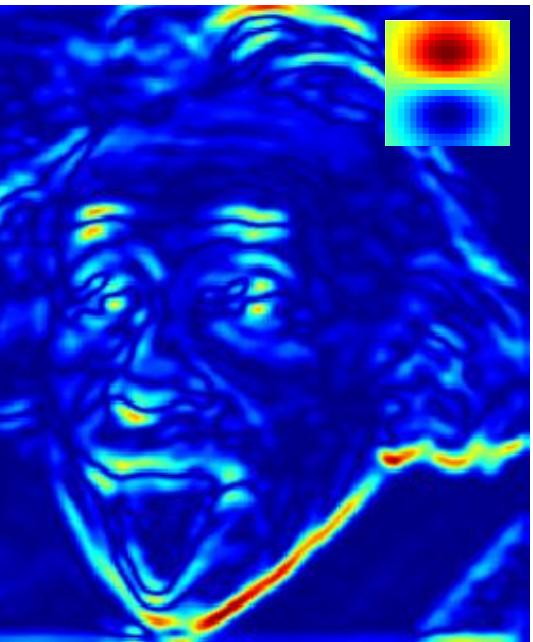


$$\|\nabla I\| = \sqrt{\left(\frac{\partial I}{\partial u}\right)^2 + \left(\frac{\partial I}{\partial v}\right)^2}$$

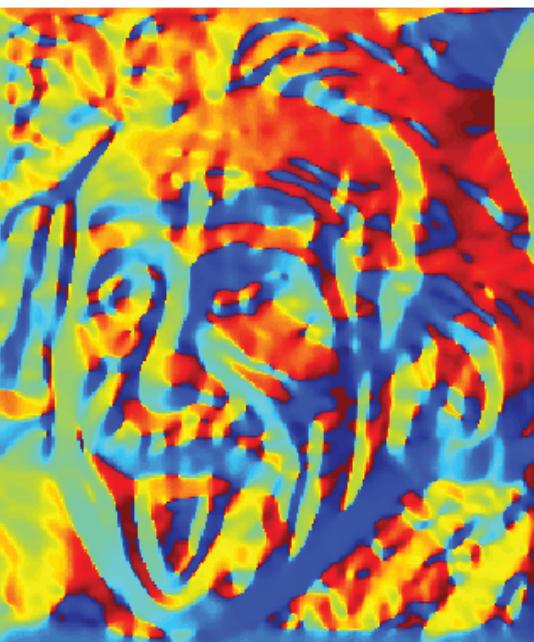
IMAGE GRADIENT DIRECTION



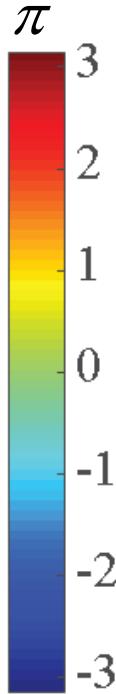
$$\frac{\partial I}{\partial u}$$



$$\frac{\partial I}{\partial v}$$



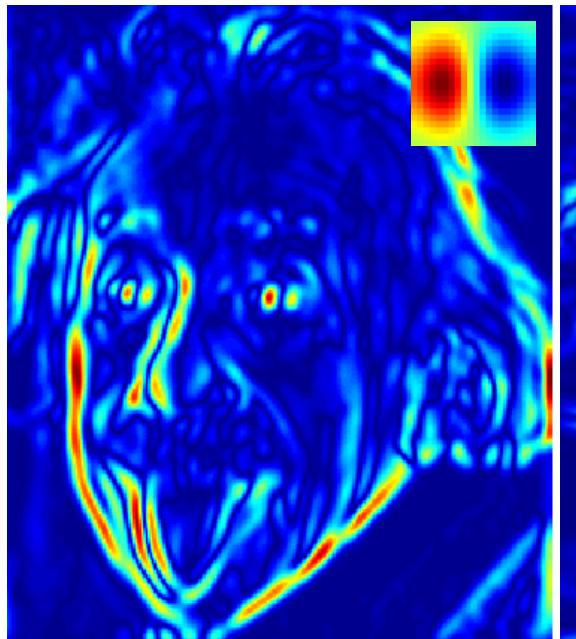
$$\angle \nabla I = \tan^{-1} \left(\frac{\frac{\partial I}{\partial v}}{\frac{\partial I}{\partial u}} \right)$$



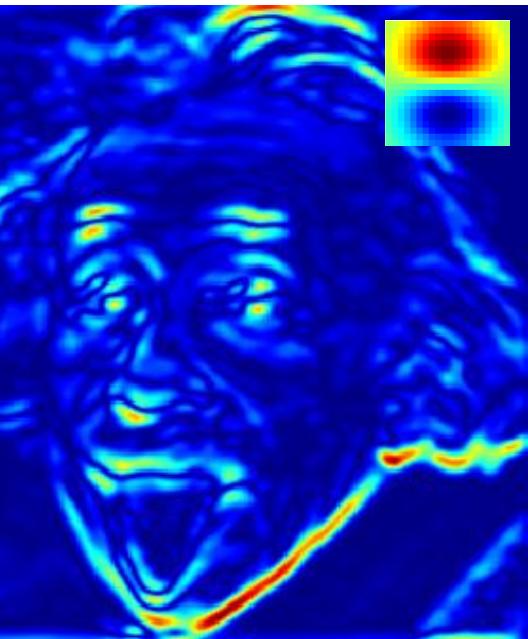
π

- π

IMAGE GRADIENT DIRECTION



$$\frac{\partial I}{\partial u}$$

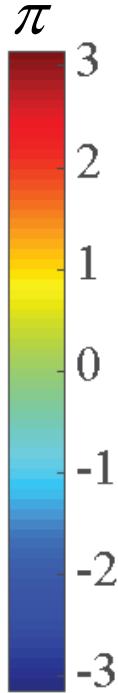


$$\frac{\partial I}{\partial v}$$



$$\angle \nabla I = \text{atan2}\left(\frac{\partial I}{\partial v}, \frac{\partial I}{\partial u}\right)$$

MATLAB



π

2

1

0

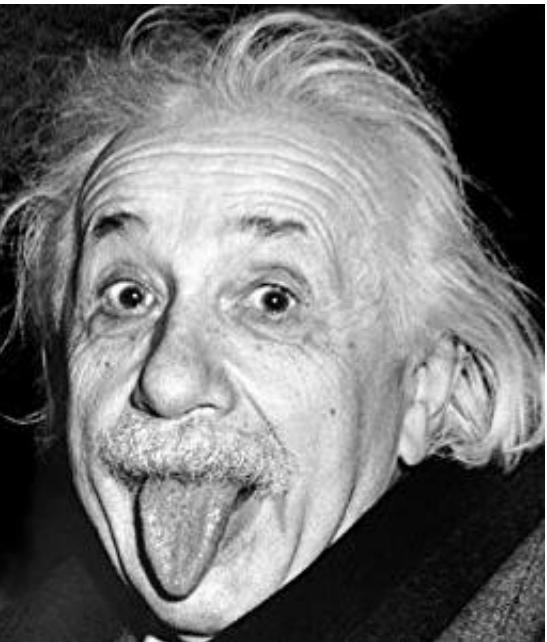
-1

-2

-3

$-\pi$

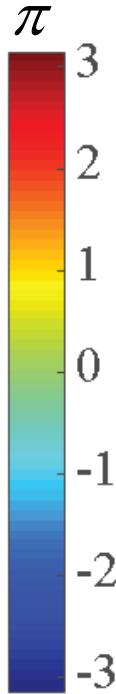
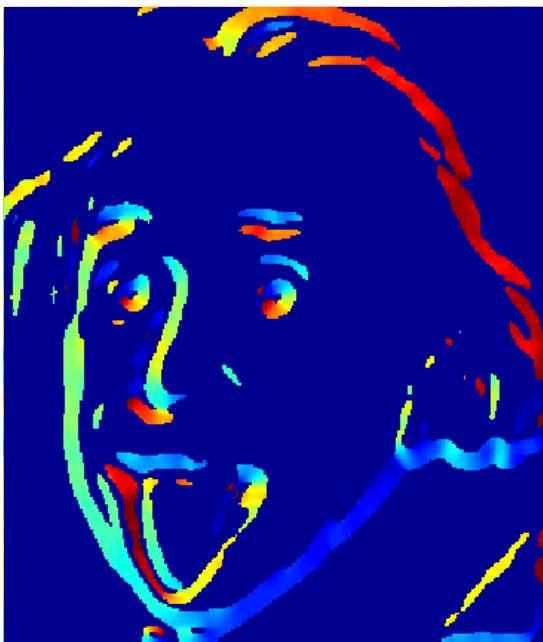
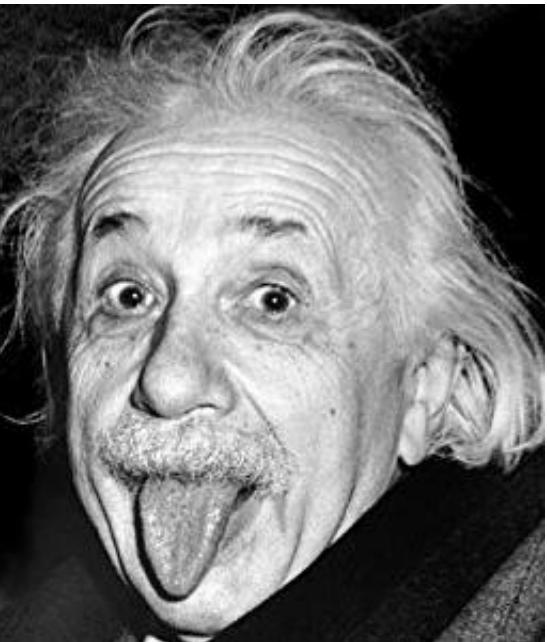
IMAGE GRADIENT DIRECTION



$$\angle \nabla I = \text{atan2}\left(\frac{\partial I}{\partial v}, \frac{\partial I}{\partial u}\right)$$

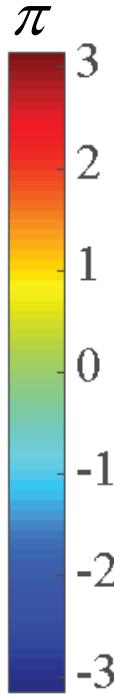
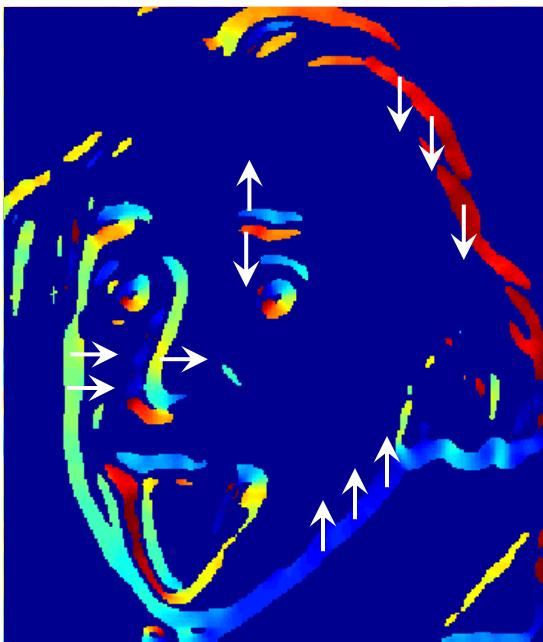
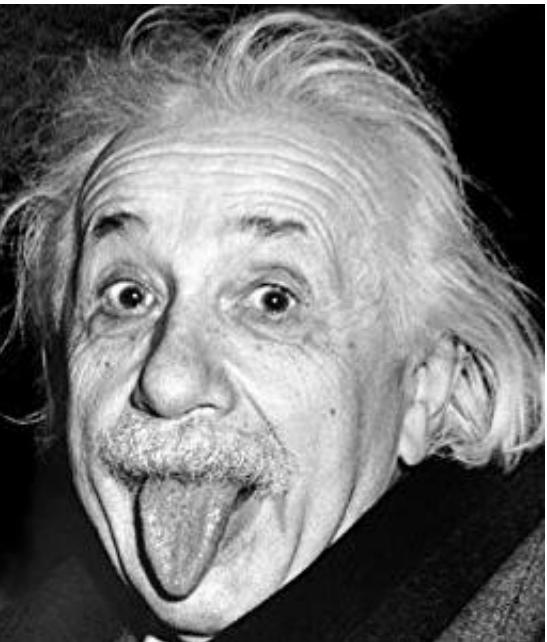
MATLAB

IMAGE GRADIENT DIRECTION



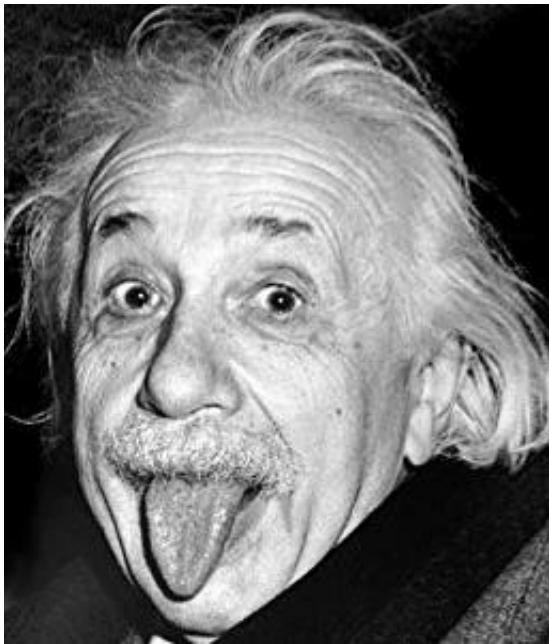
Angle with gradient magnitude
thresholding

IMAGE GRADIENT DIRECTION

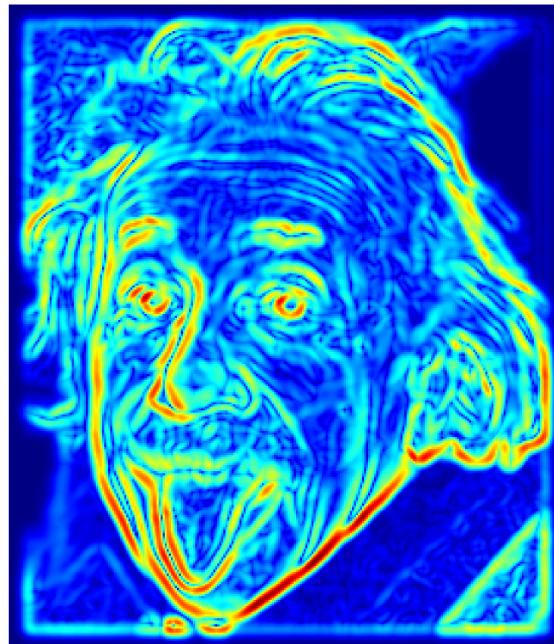


Angle with gradient magnitude
thresholding

IMAGE GRADIENT



I

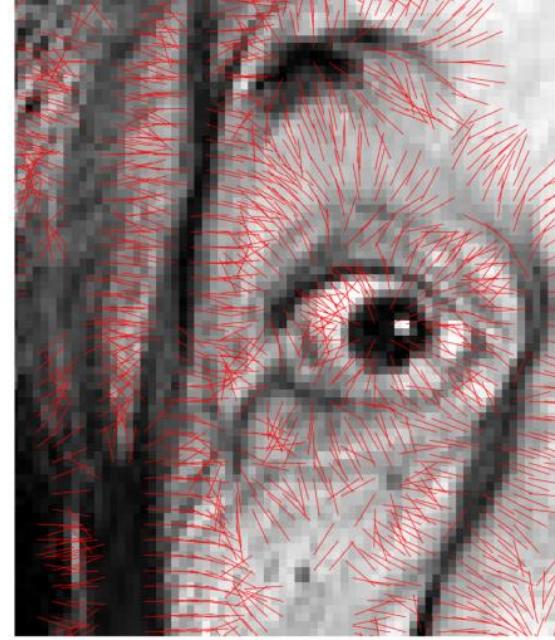
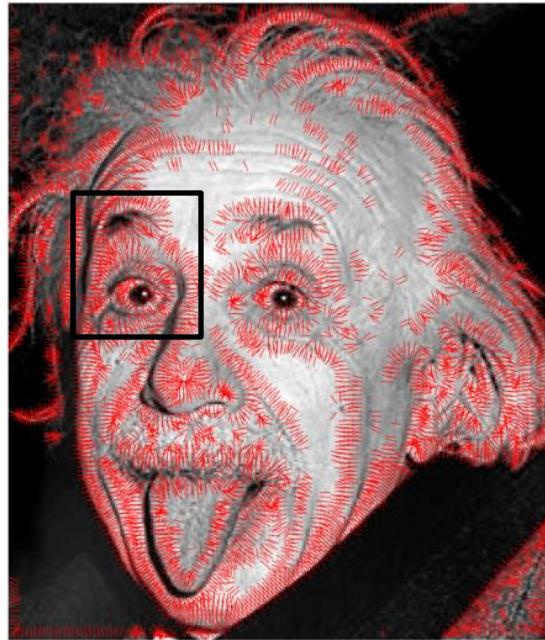
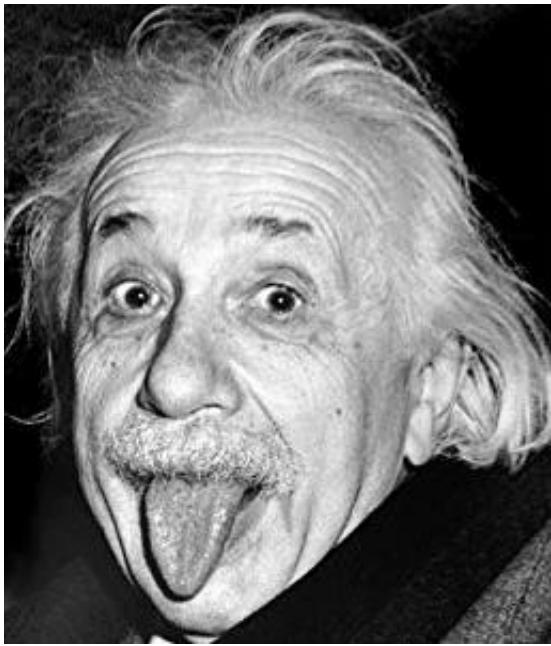


$$\|\nabla I\|$$



$$\angle \nabla I$$

IMAGE GRADIENT



ILLUMINATION INVARIANT GRADIENT

