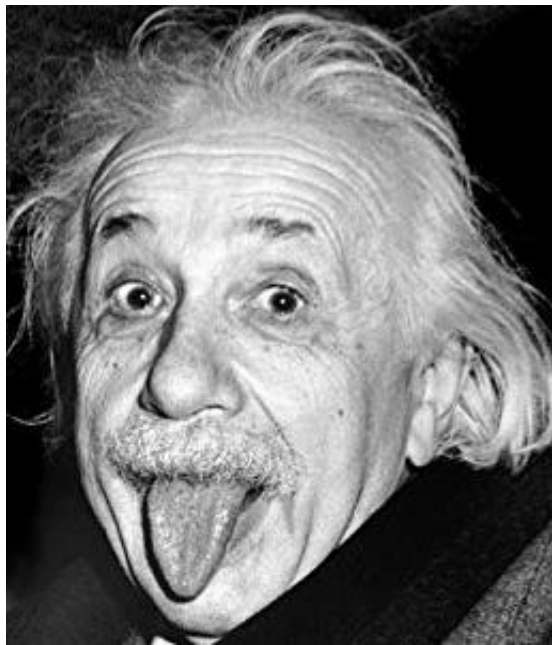


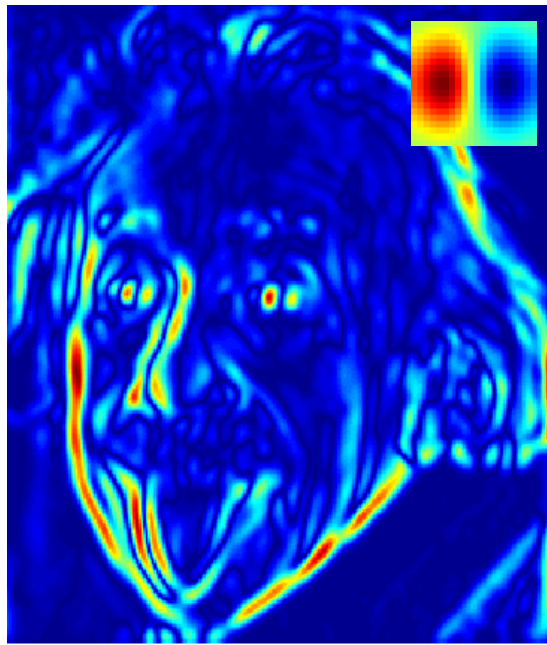
IMAGE GRADIENT

HYUN SOO PARK

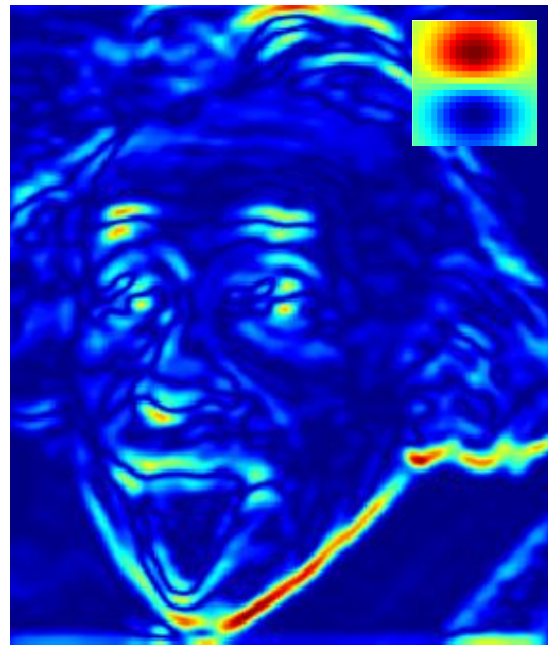
IMAGE PARTIAL DIFFERENTIAL



I

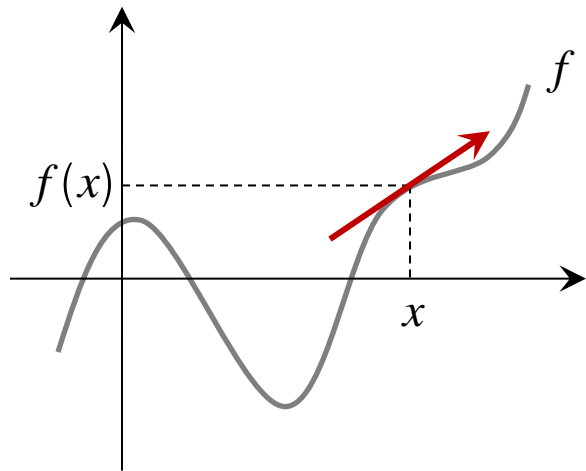


$\frac{\partial I}{\partial u}$



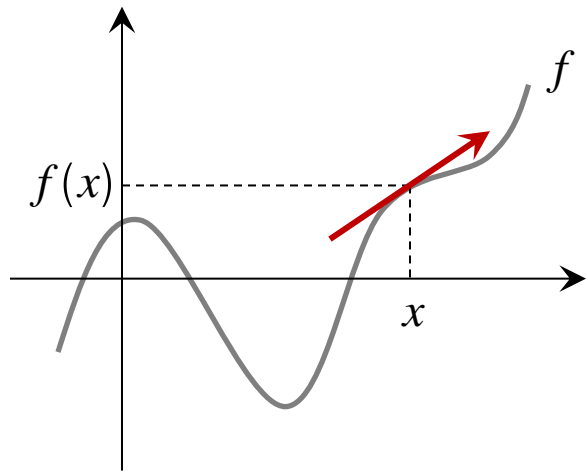
$\frac{\partial I}{\partial v}$

IMAGE GRADIENT

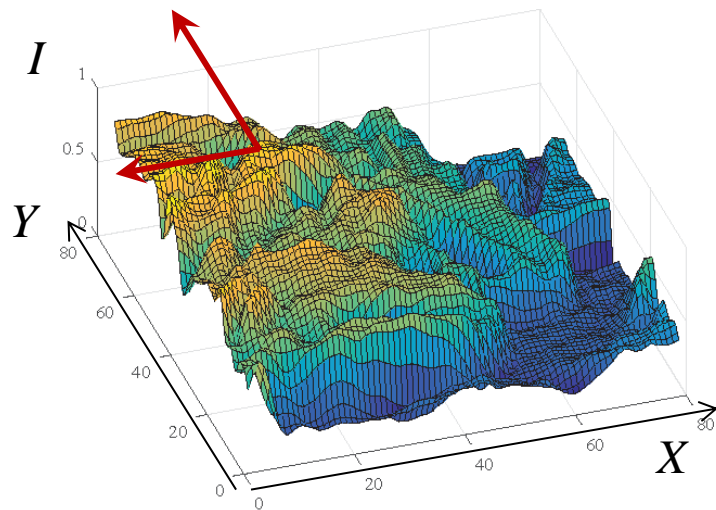


$$\frac{df(x)}{dx}$$

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

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

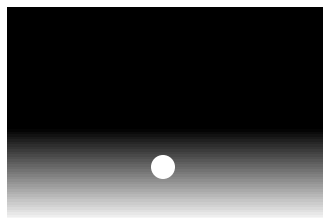
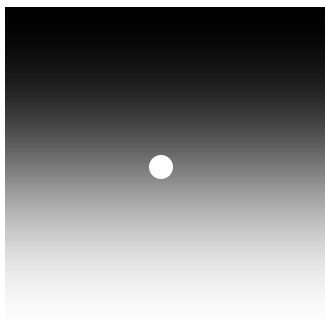
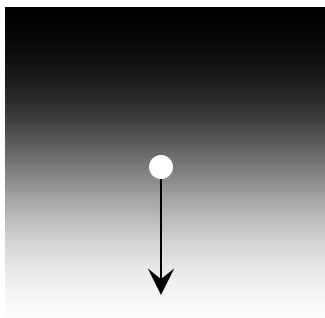
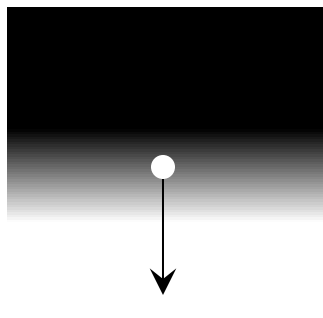


IMAGE GRADIENT

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



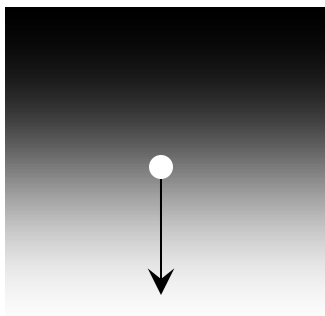
$$\frac{\partial I}{\partial u} = 0 \quad \frac{\partial I}{\partial v} = c_1$$



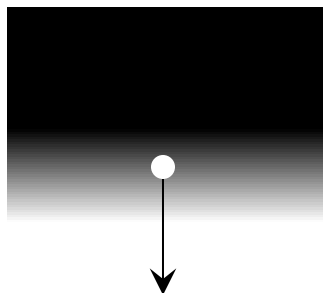
$$\frac{\partial I}{\partial u} = 0 \quad \frac{\partial I}{\partial v} = c_2$$

IMAGE GRADIENT

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



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



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

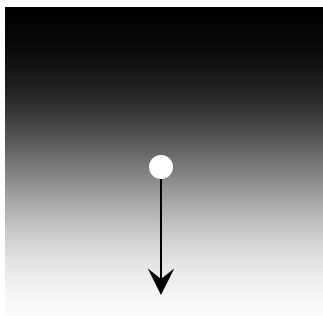
Magnitude of the gradient is
proportional to contrast change rate

$$c_1 < c_2$$

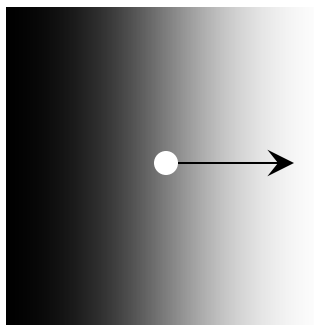
IMAGE GRADIENT

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

Direction of the gradient is
greatest rate of increase .



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

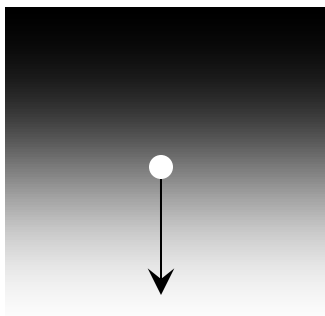


$$\frac{\partial I}{\partial u} = c_2 \quad \frac{\partial I}{\partial v} = 0$$

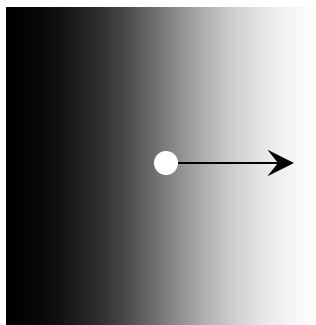
IMAGE GRADIENT

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

Direction of the gradient is
greatest rate of increase .



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



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

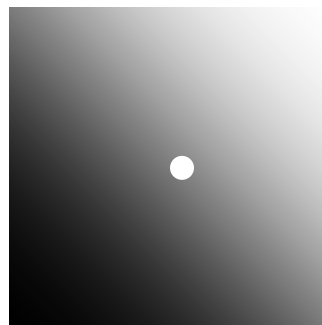
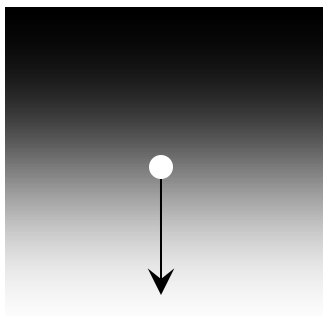


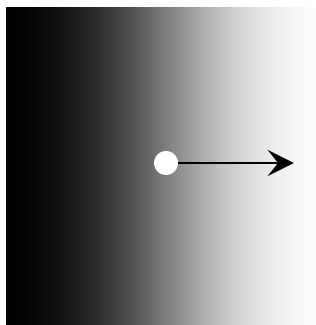
IMAGE GRADIENT

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

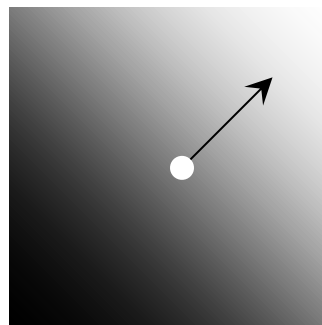
Direction of the gradient is greatest rate of increase .



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

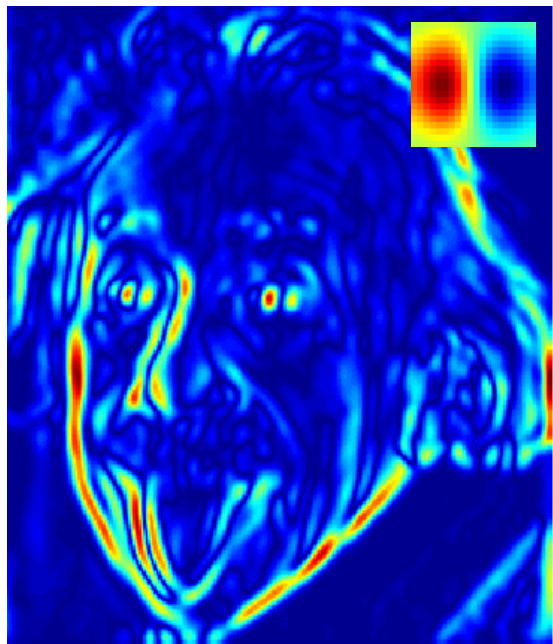


$$\frac{\partial I}{\partial u} = c_2 \quad \frac{\partial I}{\partial v} = 0$$

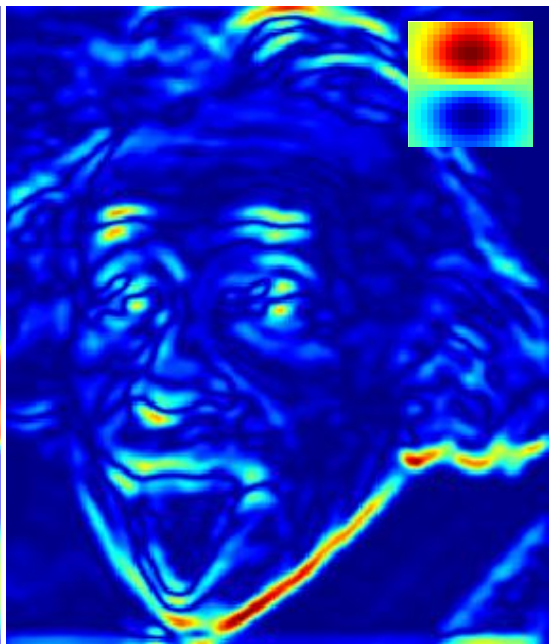


$$\frac{\partial I}{\partial u} = c_3 \quad \frac{\partial I}{\partial v} = c_3$$

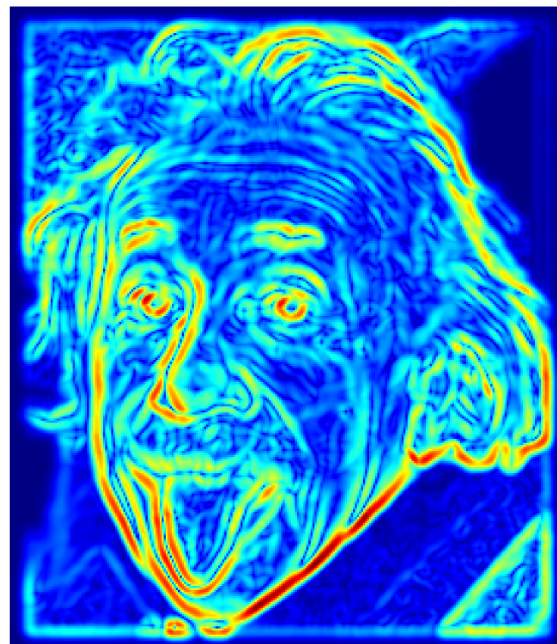
IMAGE GRADIENT MAGNITUDE



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

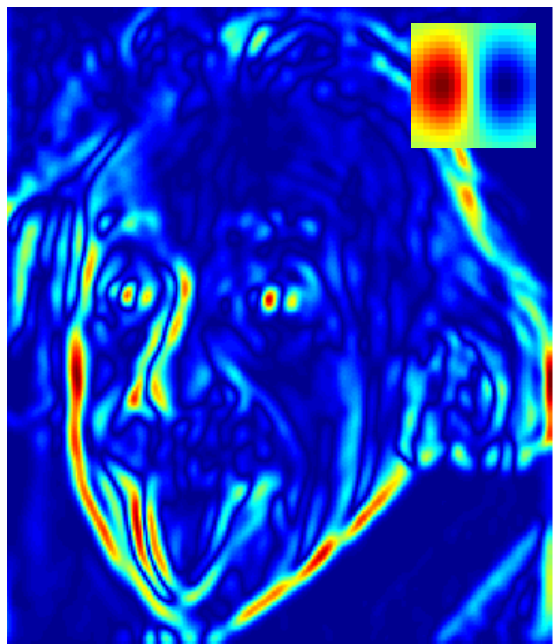


$$\frac{\partial I}{\partial v}$$

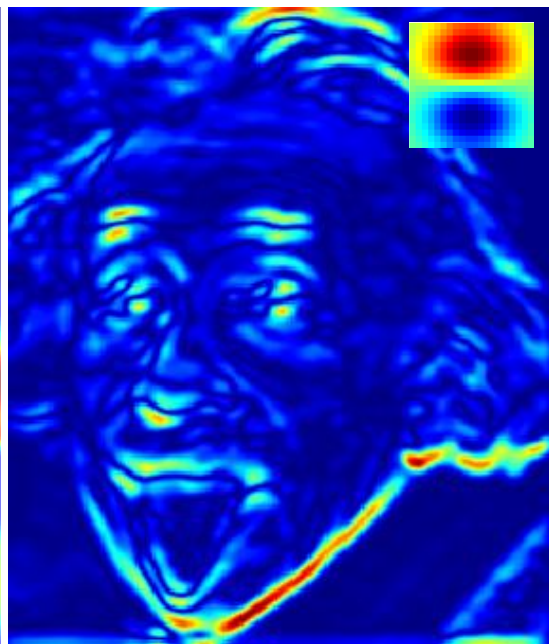


$$\|\nabla I\| = \sqrt{\left(\frac{\partial I}{\partial u}\right)^2 + \left(\frac{\partial I}{\partial v}\right)^2}$$

IMAGE GRADIENT DIRECTION



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

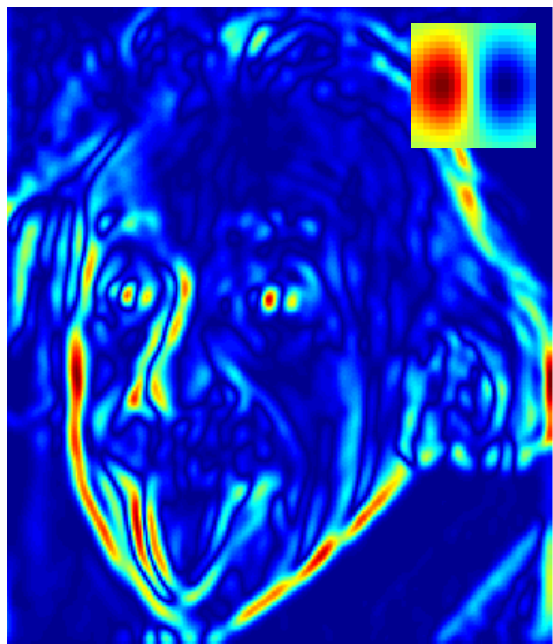


$$\frac{\partial I}{\partial v}$$

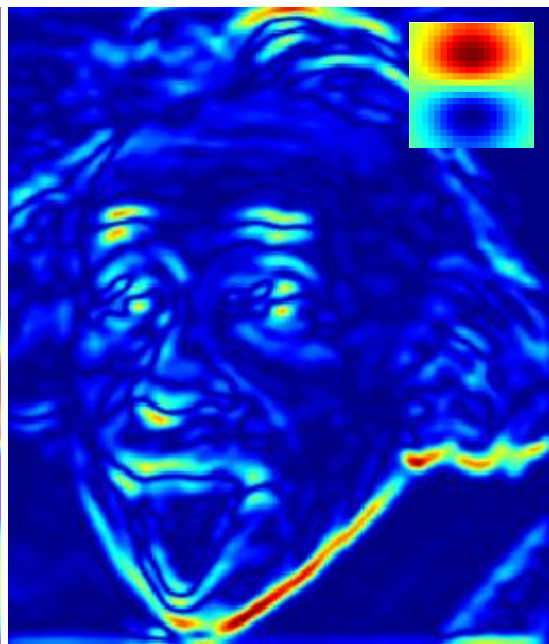


$$\angle \nabla I = \tan^{-1} \left(\frac{\frac{\partial I}{\partial v}}{\frac{\partial I}{\partial u}} \right) - \pi$$

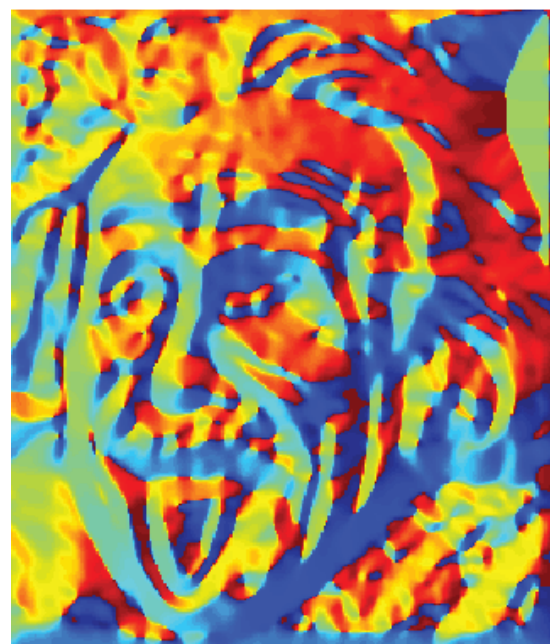
IMAGE GRADIENT DIRECTION



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



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



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

MATLAB

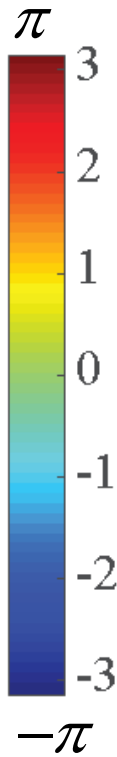
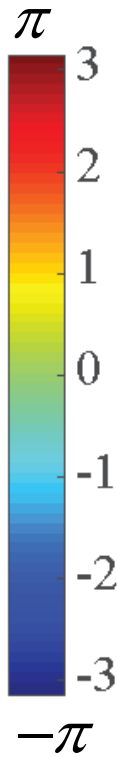
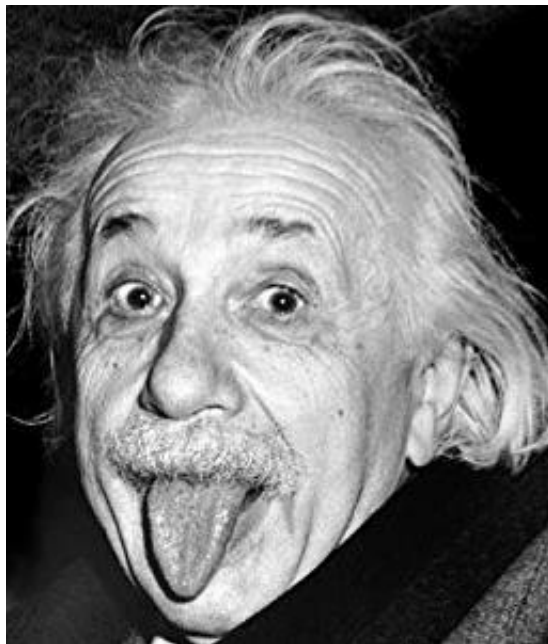


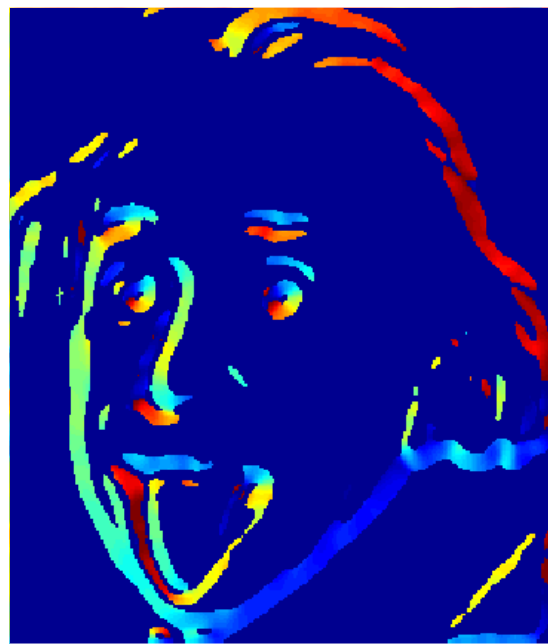
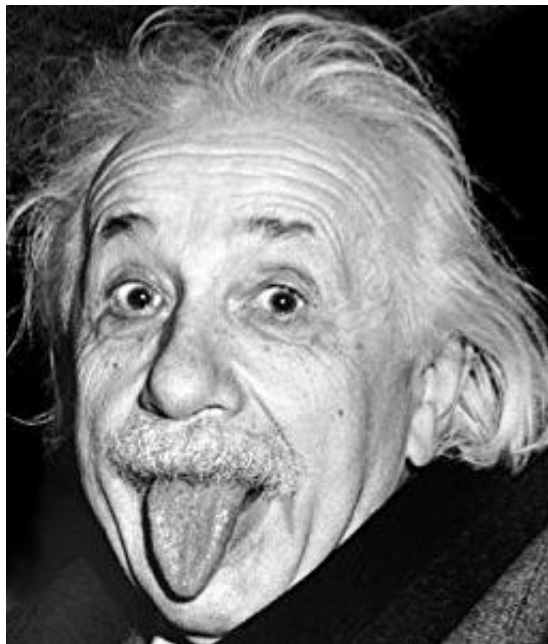
IMAGE GRADIENT DIRECTION



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

MATLAB

IMAGE GRADIENT DIRECTION



Angle with gradient magnitude
thresholding

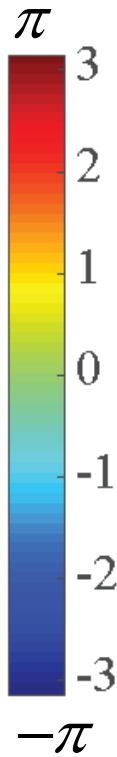
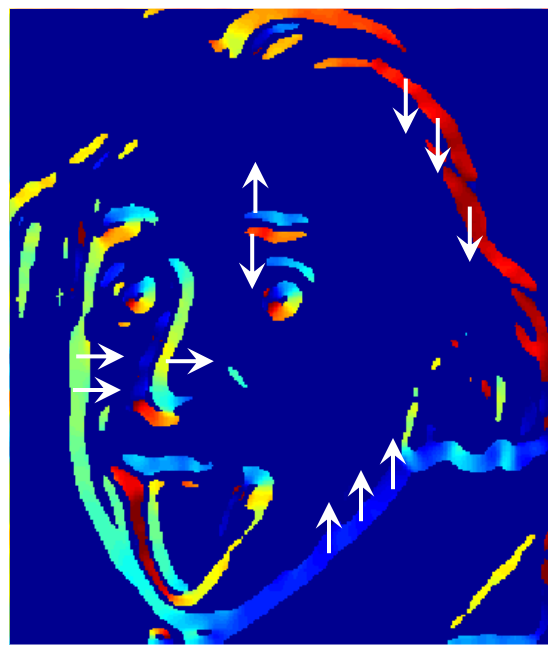
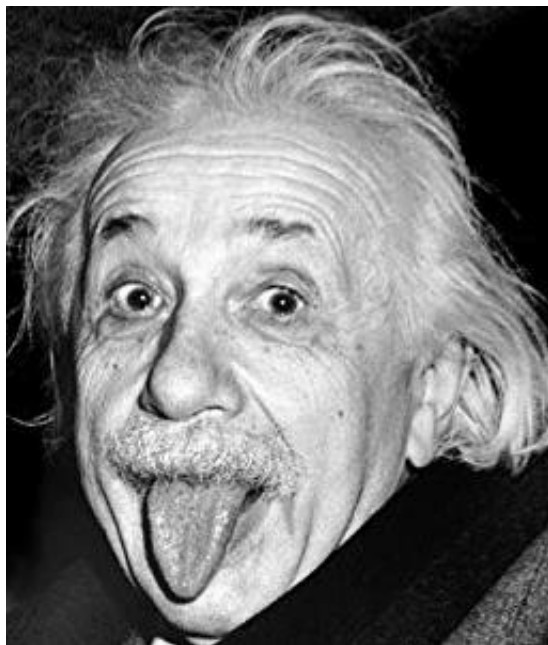


IMAGE GRADIENT DIRECTION



Angle with gradient magnitude thresholding

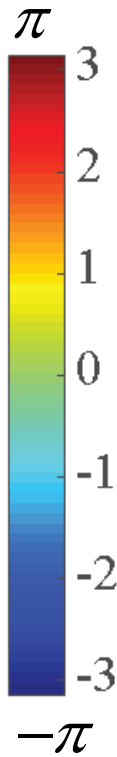
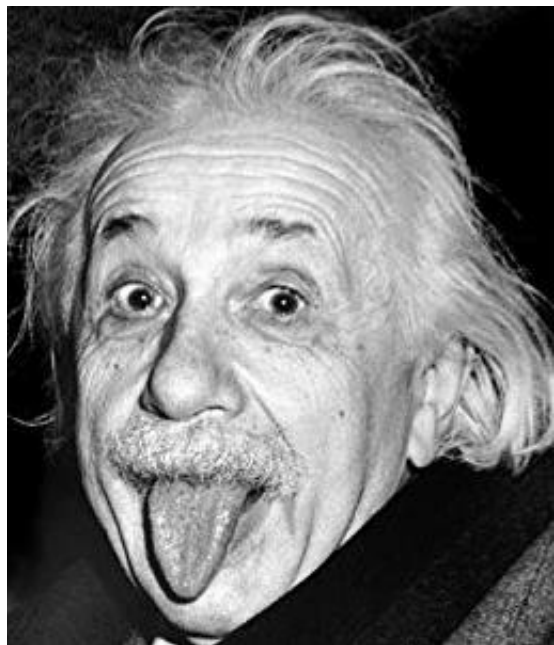
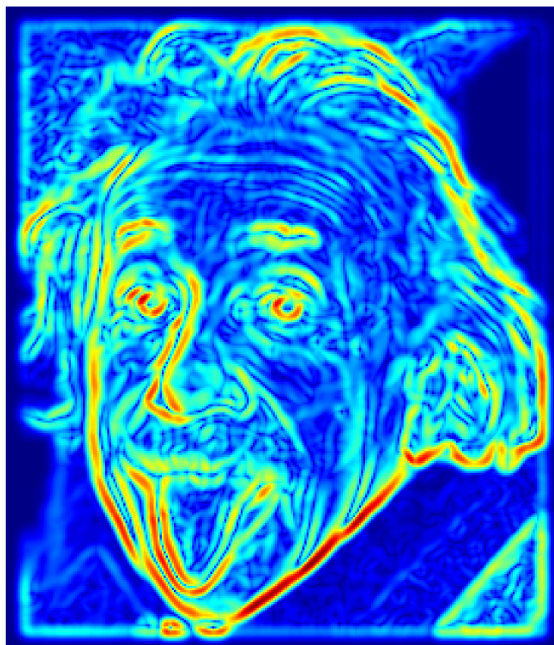


IMAGE GRADIENT



I

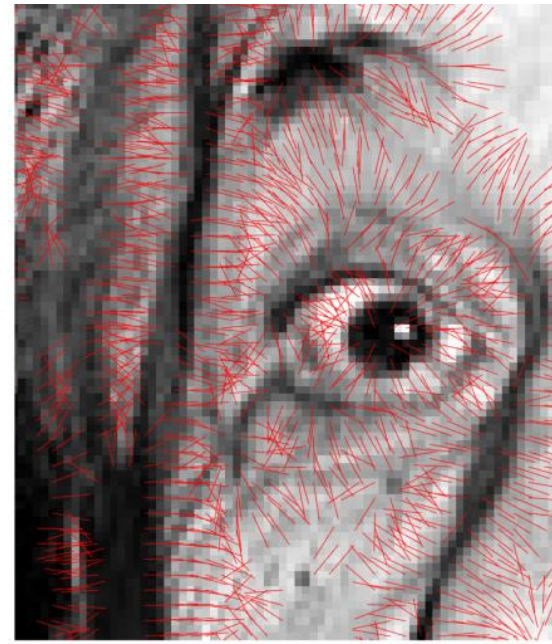
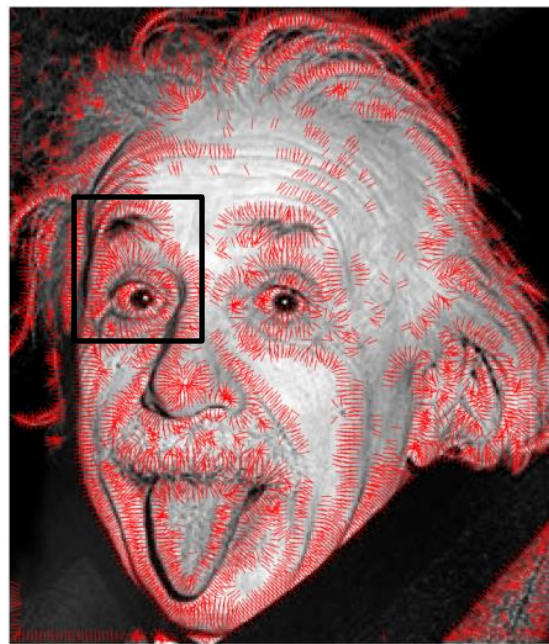
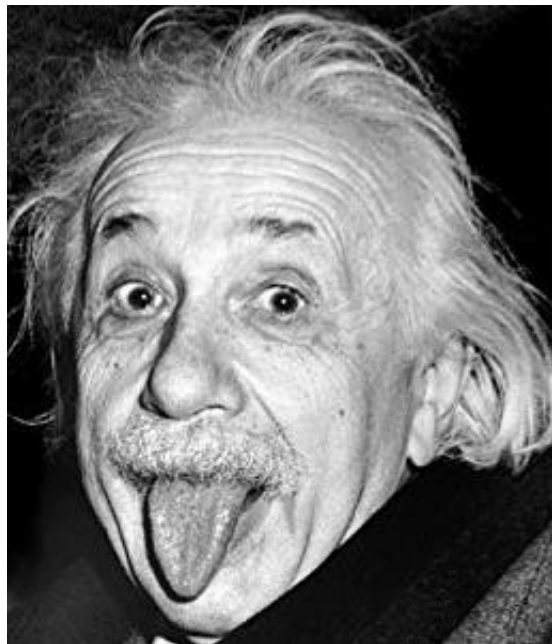


$\|\nabla I\|$



$\angle \nabla I$

IMAGE GRADIENT



ILLUMINATION INVARIANT GRADIENT

