

Image
Detection
Task

**Leonhard
Applis**

What
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an Edge?
Problems
Definition

Convolution
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Gaussian
Blur
Derivative
Operator

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2D
Approach
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Edge Detection

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TH Nürnberg

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Figure: Felix

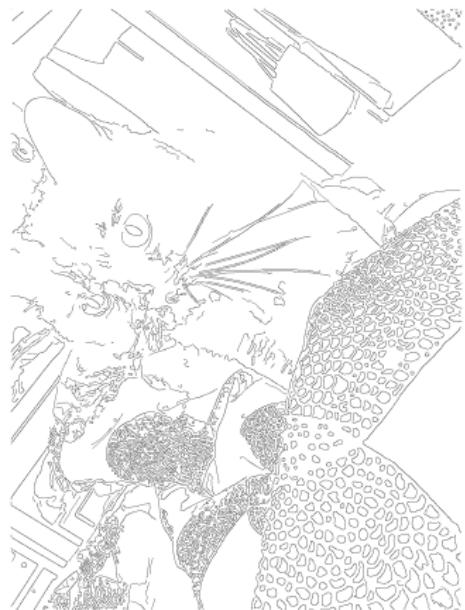


Figure: Felix's Edges

Problem I: Contrast

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Figure: High Contrast Felix



Figure: Low Contrast Felix

Problem II: Smoothness



Figure: Smooth Felix

Problem III: Noise



Figure: Salted Felix

Definition

In Image Processing, an edge can be defined as a set of contiguous pixel positions where an abrupt change of intensity, gray- or color-values occur. Edges represent boundaries between objects and background. Sometimes, the edge-pixel-sequence may be broken due to insufficient intensity difference.(Malay K. Pakhira)

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Requirements

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- ❶ color values known (for example only grayscale)
- ❷ picture scale known
- ❸ loaded as pixelmatrix

One dimensional approach

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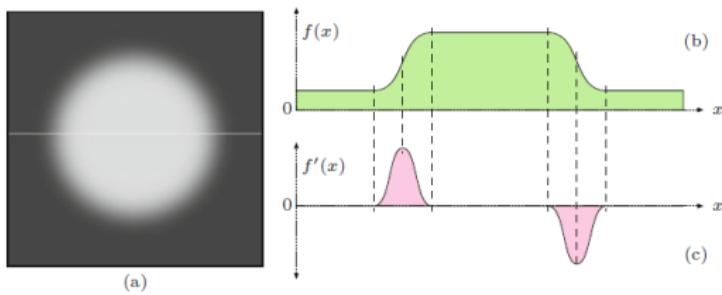


Figure: One dimensional image function and derivation

Only applicable with known, steady functions

Approximating discrete derivation

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Problem: the image function is discrete, therefore we need to approximate the derivation

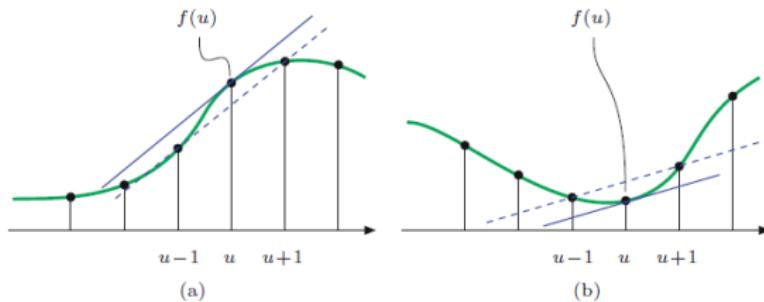


Figure: Approximation of the derivation for discrete imagefunctions

$$\frac{df}{dx}(u) \approx \frac{f(u+1) - f(u-1)}{(u+1) - (u-1)} = \frac{f(u+1) - f(u-1)}{2}$$

Two dimensional approach

If working with full images, we got two dimensions and therefore two partial derivations:

$$I_x = \frac{\partial I}{\partial x}(u, v), I_y = \frac{\partial I}{\partial y}(u, v)$$

the **gradient** at the point (u, v) is

$$\nabla I(u, v) = \begin{pmatrix} I_x(u, v) \\ I_y(u, v) \end{pmatrix}$$

And the **magnitude** is

$$|\nabla I| = \sqrt{I_x^2 + I_y^2}$$

Example

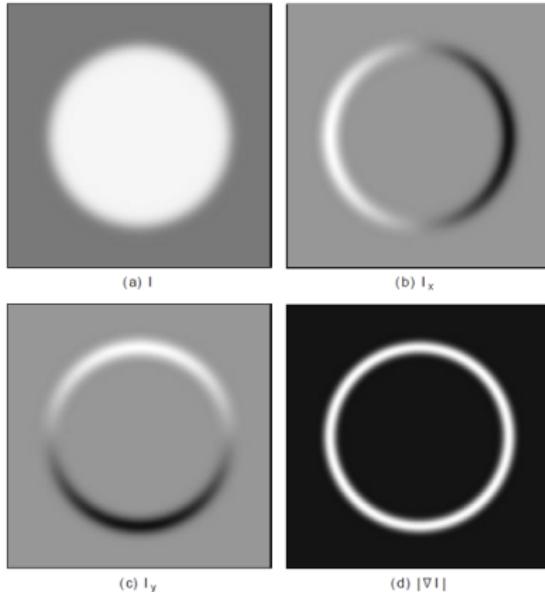


Figure: Visualisation of simple gradient-based edgedetection

Example to Felix

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Figure: Raw Felix



Figure: Felix' X-Edges



Figure: Felix' Y-Edges



Figure: Felix' Edges

Note: All images have a 50% increased brightness

Implementation with filters

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Expressing the gradient as a *linear filter* is simple:

$$I_x = [-0.5 \quad 0 \quad 0.5] \qquad I_y = \begin{bmatrix} -0.5 \\ 0 \\ 0.5 \end{bmatrix}$$

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