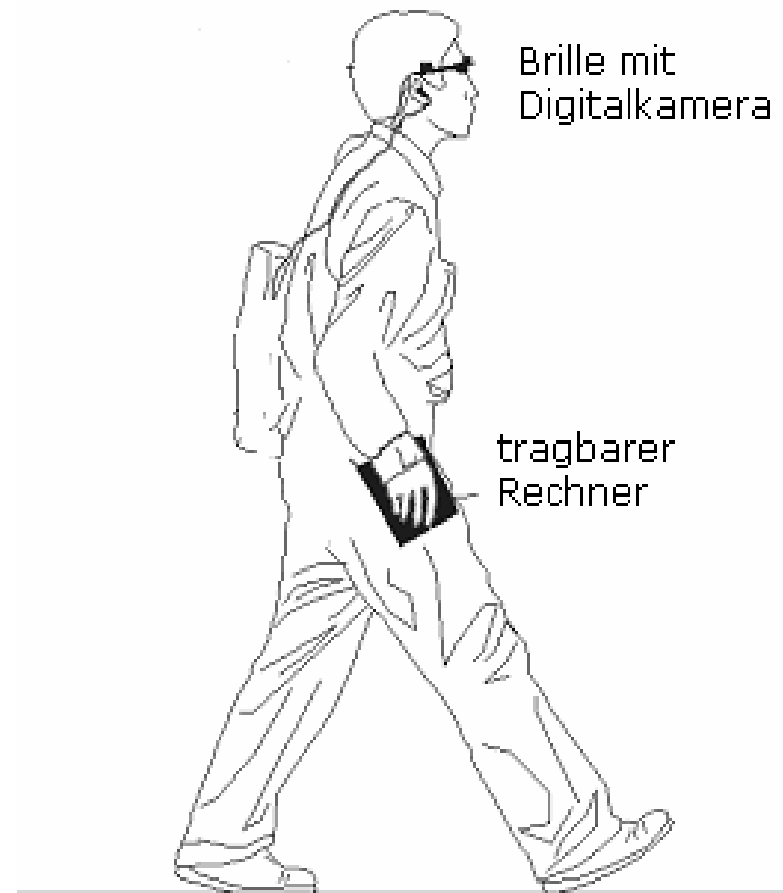


# Projekt „Lesebrille“ : Mobiles Vorlesegerät für Blinde



# Texterkennung

- Vorverarbeitung
  - Rauschen
  - Kontrasterhöhung, Schärfung
- Binarisierung
- Layouterkennung
  - Dokumentgrenzen
  - Textblöcke, Textspalten
  - Ausrichtung des Dokuments
  - Überschriften
  - Vorlesereihenfolge

# Texterkennung(2)

- Textzeilenextraktion
- Entzerrung des Dokuments anhand der Textzeilen, -blöcken
- OCR
  - (Skelettierung der Textzeilen)
  - Zeichenerkennung
- Zusammensetzung der Sätze aus einzelnen Buchstabenhypothesen
- Ausgabe

# Scanner vs. Kamera

on & offline GmbH – Gonsenheimer Str. 56a – 55126 Mainz

Michael van Laar  
Geschäftsführung/Herr Michael van Laar  
Johannisstraße 128  
D-90419 Nürnberg

Mainz, 14.10.2009

## 370.000 Kontakte / Community zur Erweiterung Ihres Kundenstammes

Sehr geehrter Herr van Laar,

wir sind Betreiber einer der größten national aufgestellten Communities im Internet mit aktuell rund 370.000 registrierten aktiven Benutzern im Alter zwischen 16 und 35 Jahren mit Schwerpunkt Kommunikation und Konsum in diversen Segmenten.

Zum Ausbau Ihres Netzwerkes möchten wir Ihnen unsere Userdaten oder andere Beteiligungs- / Kooperationsmöglichkeiten anbieten.


Die Datensätze beinhalten Vor-, Nachname, Geschlecht, Beziehungsstatus, Emailadresse, Geburtsdatum, Postadresse, Handynummer und Affinitäten (Hobbies, Sportarten etc.).

Unsere Mitglieder haben bei der Anmeldung der Weitervermarktung ihrer Daten zugestimmt.



Gerne stehen wir Ihnen persönlich zur Verfügung, um Ihre Interessen und mögliche Kooperationen im Detail zu besprechen.

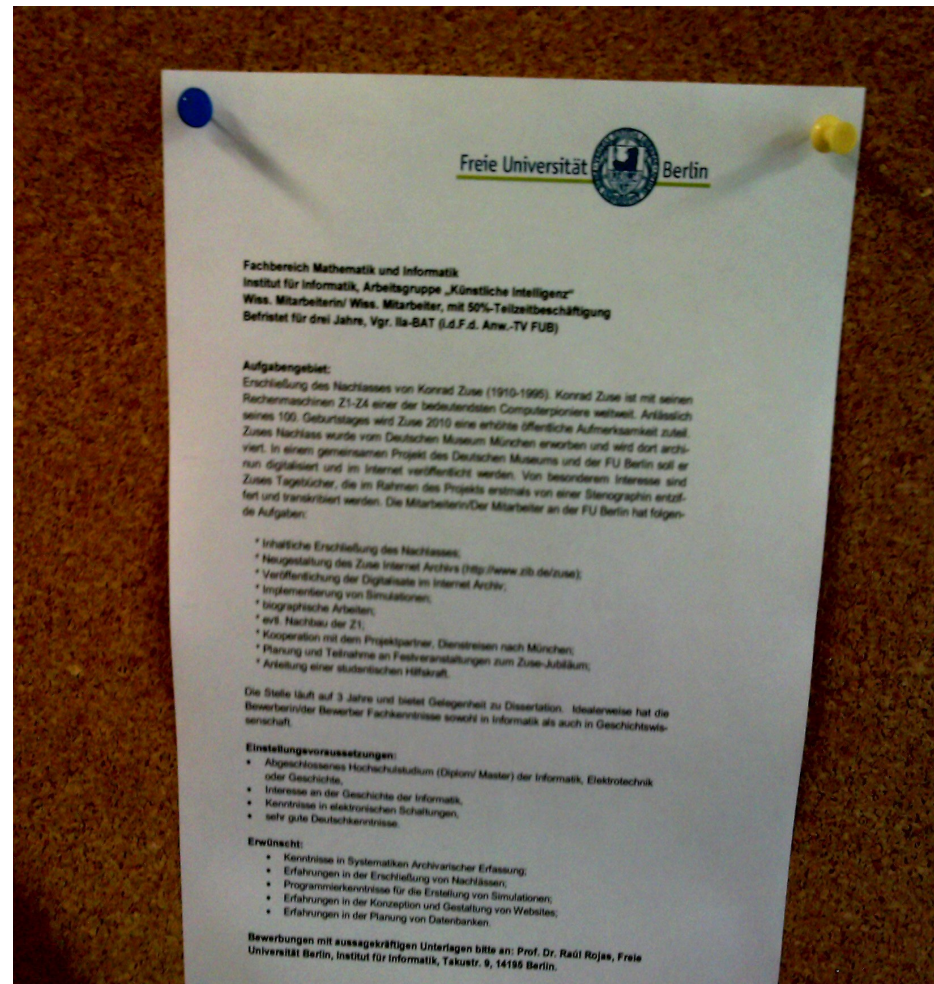
Kontaktieren Sie uns per email unter @on-und-offline.de oder per Telefon unter 

Mit freundlichen Grüßen,

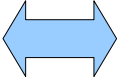
  
Daniel Langenbach  
- Geschäftsführer -

on & offline GmbH  
Gonsenheimer Str. 56a  
D-55126 Mainz

  
- Geschäftsführer -  
fon office: +49 (0) 6131 / 60 25 38 - 0  
fax office: +49 (0) 6131 / 60 25 38 -   
E-Mail: info@on-und-offline.de



# Erweiterte Vorverarbeitung

- Inhomogene, nicht optimale Beleuchtung
  - Position des Dokumentes nicht klar
  - Fokussierung nicht gegeben
  - Bewegungsartefakte
  - (vor allem perspektivische) Verzerrungen
- 
- HDR, Kontrasterhöhung
  - Dokumenterkennungsalgorithmen
  - Multifokus, Super-resolution, Stereo-Vision
  - Bildstabilisierung
  - Spezielle, mächtigere Entzerrungsalgorithmen

## Scanner vs. Kamera(2)

- Mobilität
- Kontaktlosigkeit
- Aufnahme-geschwindigkeit

# Textlokalisierung: Textmerkmale

- Textmerkmale:
  - Hoher Kontrast zwischen Buchstaben und dem Hintergrund
  - Räumlicher Zusammenhang
  - Text enthält spezifische Frequenz- und Orientierungsinformation
- Wavelet-Transformation bietet sich an

# Textlokalisierung: Gabor Filter

Fourier-Transformation mit Gaußglocke als Fensterfunktion: trade off zwischen der Frequenz- und Ortsauflösung

$$h(x, y, \sigma_x, \sigma_y, w, \theta) = \frac{1}{2\pi\sigma_x\sigma_y} e^{-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2}\right) + jw(x\cos\theta + y\sin\theta)}$$

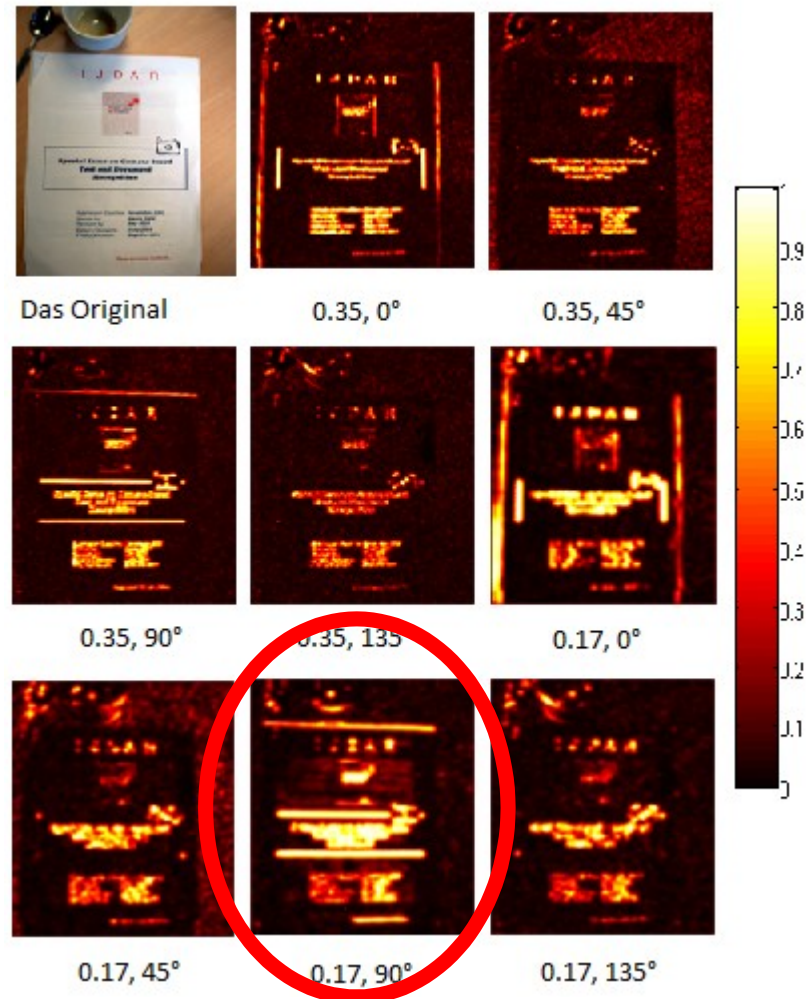
Gaußanteil                      Harmonische Funktion  
(Fourieranteil)

mit  $\theta = \tan^{-1}(w_y/w_x)$  ,  $w = \sqrt{w_x^2 + w_y^2}$

Ein Satz von Gabor Filtern mit verschiedenen ( $w$ -Frequenzen,  $\theta$ -Orientierungen) bildet eine approximative Basis für Wavelet-Transformation mit der Gabor-Funktion als Wavelet



# Textlokalisierung: Gabor-Filter



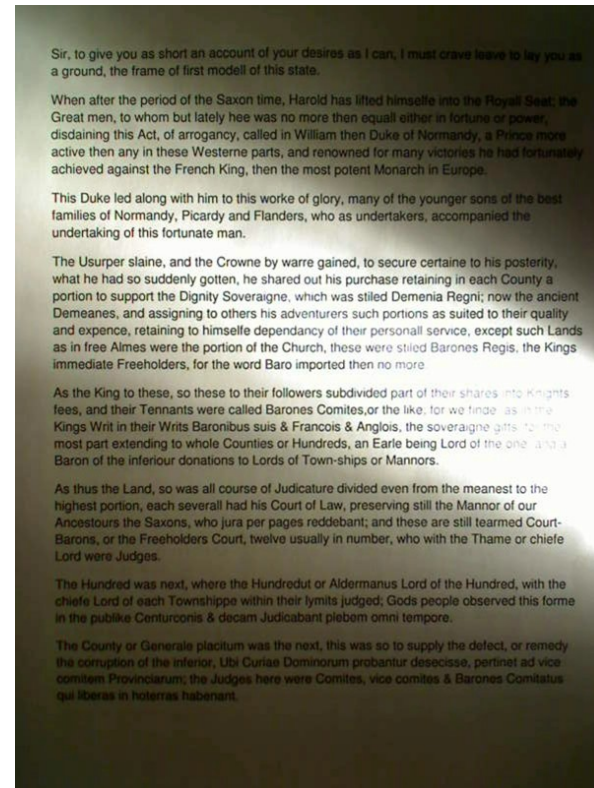
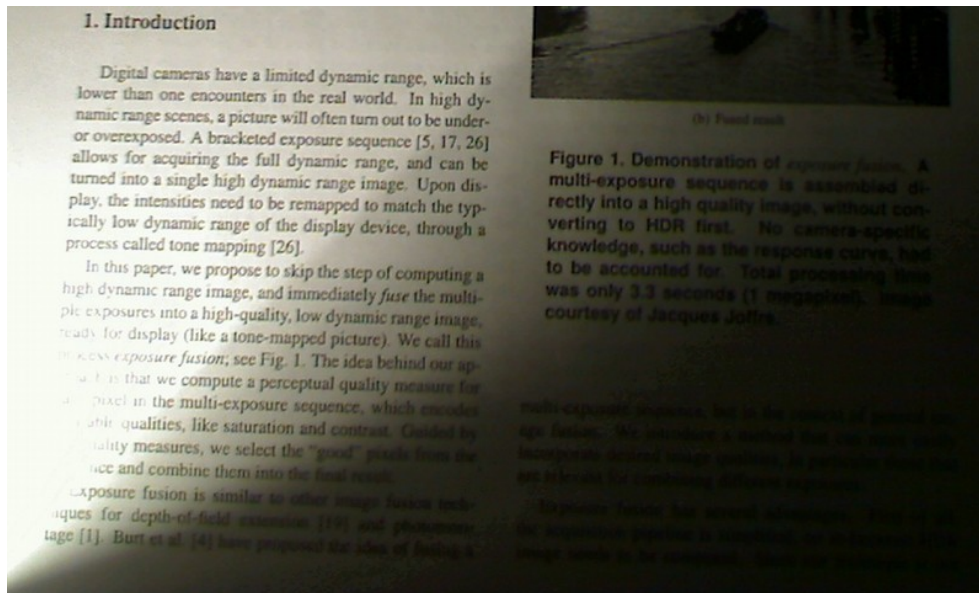
# Textlokalisierung: Gabor Filter

- Das Bild mit der stärksten Filterantwort wird ausgewählt.
- Binarisierung
- Klassifizierung der Pixel mit einem UNION-FIND Algorithmus
- Berechnung der Konvexe Hülle der Pixel einer Klasse → Textblockgrenzen

# HDR (High Dynamic Range)

Schlechte Lichtverhältnisse, unter- und überbelichtete Regionen

Keine perfekte Aufnahme möglich



# Dynamikbereich

| Lichtverhältnisse                           | Leuchtdichte ( $cd/m^2$ )       |
|---|---------------------------------|
| Sternenlicht                                | $10^{-3}$                       |
| Mondlicht                                   | $10^{-1}$                       |
| Innenraum                                   | $10^2$                          |
| LED-Außenbildschirm                         | $5 \times 10^3$                 |
| 60-Watt Glühbirne                           | $120 \times 10^3$               |
| Sonne am Morgen/Abend                       | $6 \times 10^6$                 |
| Sonne am Mittag                             | $1,6 \times 10^9$               |
| Helligkeit von konventionellen Bildschirmen | $2 \times 10^2 - 5 \times 10^2$ |

Konventionelle 8-Bit-Videokamera  
 $10^{2,4}$

Menschliches Auge  
eine Szene  $10^5$

Menschliches Auge  $10^{10}$



# Exposure Fusion: Ausrichtung

When extracting low-level features, a number of parameters, most adjustment of these parameters is to a particular class of images. The elimination of these parameters

When

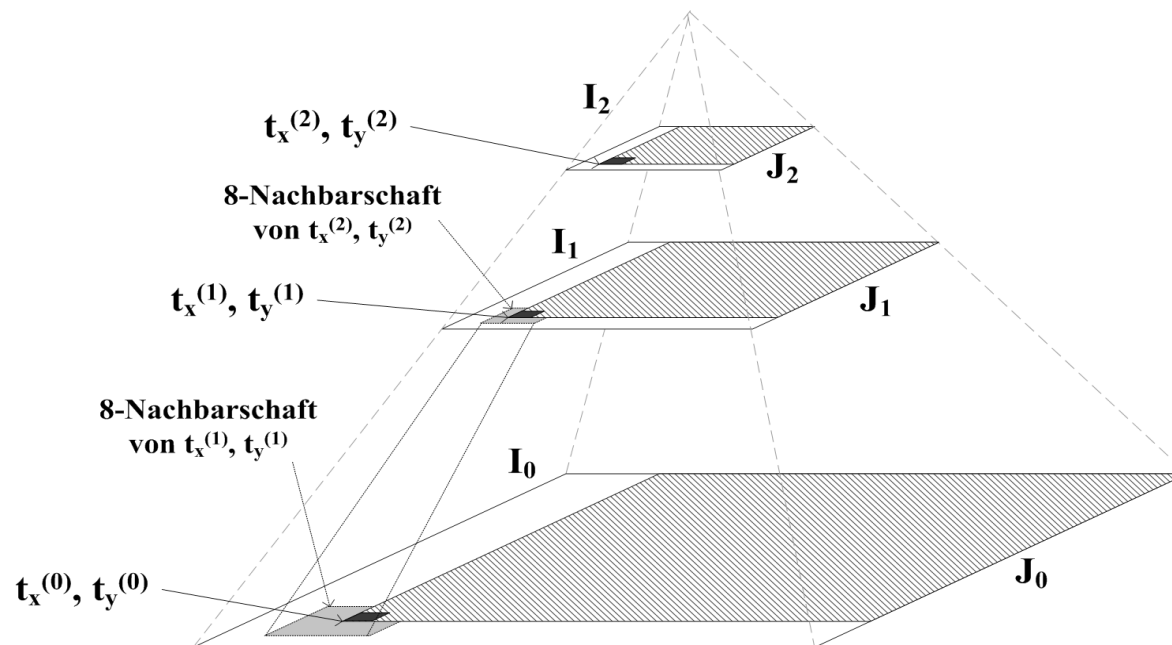
# Ausrichtungsalgorithmen

| <u>Laufzeit</u>                                       | <u>Robustheit</u>   |
|---|---------------------|
| Global  | Lokal               |
| Merkmalsbasiert                                       | Pixelbasiert        |
| Nur 2d-Transformationen<br>(Translation,<br>Rotation) | 3d-Transformationen |

# Alignmentkorrektur. Beschleunigung

## Grob-zu-fein Strategie

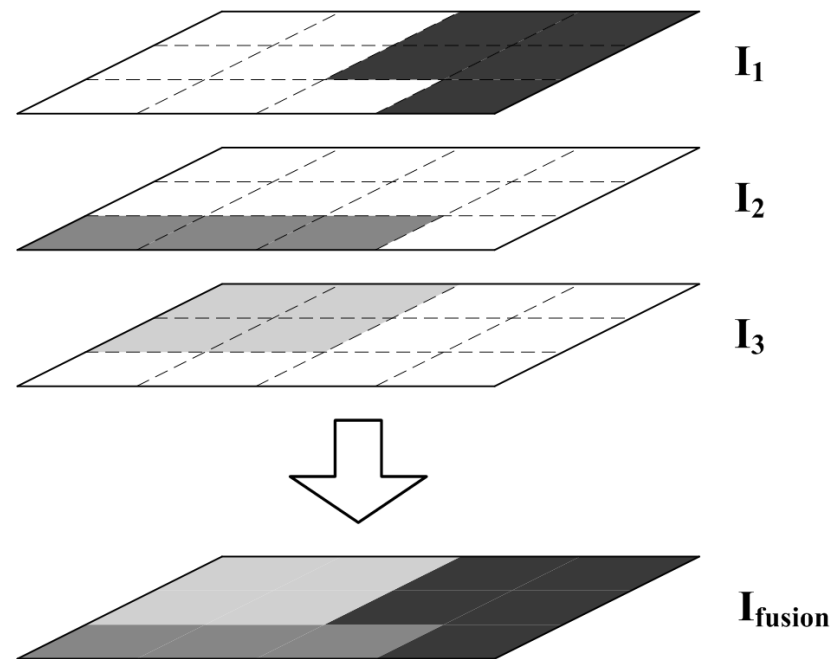
- Gauß-Pyramide für jedes Bild
- Komplette Suche für die höchste Pyramidenebene
- Nur die 8-Nachbarschaft für nächst größere Ebene





# Bildfusion

1. Teile die Aufnahmen in rechteckige Regionen
2. Wähle ein entsprechendes **Qualitätsmaß** und berechne es für jede Region
3. Führe **Blending** von Regionen aus



# Qualitätsmaße

- **Entropie** (Informationsinhalt):  $E = - \sum_{i=0}^{255} p_i \log_2 p_i$ ,  $p_i = \frac{\text{\#Pixel mit Wert } i}{\text{\#Pixel im Bild}}$
- **Varianz**:  $Var = \frac{1}{MN} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} (I(m,n) - \mu)^2$ ,  $\mu = \frac{1}{MN} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} I(m,n)$
- **Energy of Laplacian**:  $EOL = \sum_{x=1}^{N-1} \sum_{y=1}^{M-1} (\Delta f(x,y))^2$ ,  $\Delta f(x,y) = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$

# Bildfusion

**Problem** – sichtbare Kanten nach dem Zusammenstellen der Regionen

4. Generation of keypoint descriptors.

## 2.1.2 Scale-space extrema detection

The first step in using the SIFT algorithm lies in extracting interest points. In order to find *interest points*, one has to search all over the scales and locations. This is implemented by building a multi-scale pyramid of Difference-of-Gaussian (DoG) images.

**Ausweg** – Blending, Verschmelzen der Regionen

# Bildfusion. Blending der Regionen

## Blending nach Goshtasby

Neuer Pixelwert ( $I'_{jk}$  ist das Bild, in dem Block  $jk$  das höchste Qualitätsmaß hat):

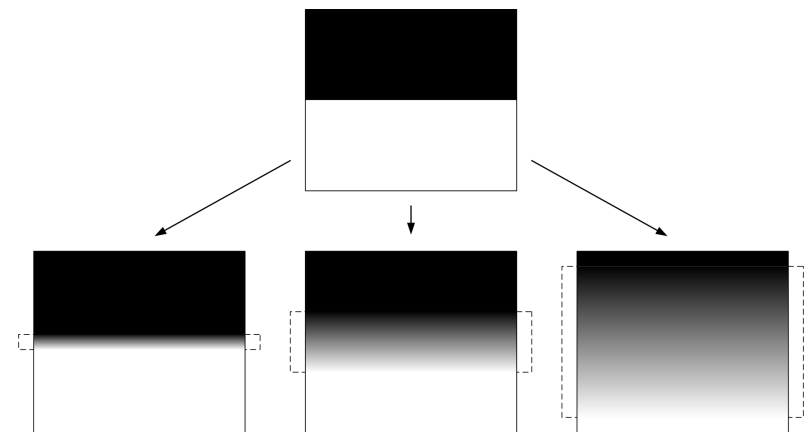
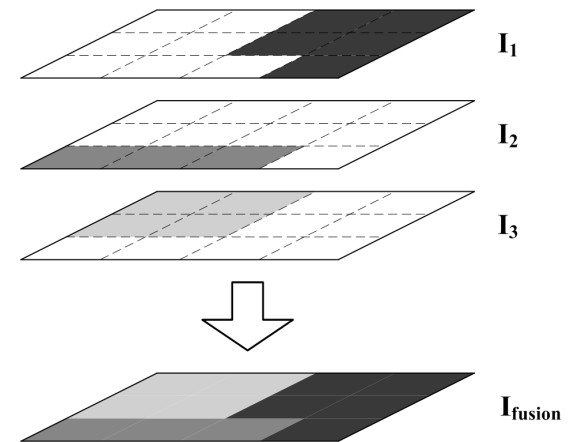
$$O(x, y) = \sum_{j=1}^{N_{rows}} \sum_{k=1}^{N_{cols}} W_{jk}(x, y) I'_{jk}(x, y)$$

Gewichte:

$$W_{jk}(x, y) = \frac{G_{jk}(x, y)}{\sum_{m=1}^{N_{rows}} \sum_{n=1}^{N_{cols}} G_{mn}(x, y)}$$

Gauß-Verteilung.  $(x_{jk}, y_{jk})$  – Zentrum des Blocks  $jk$

$$G_{jk}(x, y) = e^{-\frac{1}{2} \frac{(x - x_{jk})^2 + (y - y_{jk})^2}{\sigma^2}}$$



Verschiedene  $\sigma$  - Breiten der Blending-Funktion

# Resultat

## Pixelbasierte Bildfusion. Methode der *Kantenintensitäten*

Sir, to give you as short an account of your desires as I can, I must crave leave to lay you as a ground, the frame of first modell of this state.

When after the period of the Saxon time, Harold had lifted himself into the Royal Seat; the Great men, to whom but lately hee was no more then equal either in fortune or power, disdainng this Act, of arrogancy, called in William then Duke of Normandy, a Prince more active then any in these Westerne parts, and renowned for many victories he had fortunately achieved against the French King, then the most potent Monarch in Europe.

This Duke led along with him to this worke of glory, many of the younger sons of the best families of Normandy, Picardy and Flanders, who as undertakers, accompanied the undertaking of this fortunate man.

The Usurper staine, and the Crowne by warre gained, to secure certaine to his posterity, what he had so suddenly gotten, he shared out his purchase retaining in each County a portion to support the Dignity Sovereigne, which was stiled Demenia Regni; now the ancient Demeanes, and assigning to others his adventurers such portions as suited to their quality and expence, relating to himselfe dependancy of their personal service, except such Lands as in free Aimes were the portion of the Church, these were stiled Barones Regis, the Kings immediate Freeholders, for the word Baro imported then no more.

As the King to these, so these to their followers subdivided part of their shares into Knights fees, and their Tennants were called Barones Comites, or the like; for we finde, as in the Kings Writ in their Writs Baronus surs & Francos & Anglos, the sovereigne gifts, for the most part extending to whole Counties or Hundreds, an Earle being Lord of the one, and a Baron of the inferior donations to Lords of Town-ships or Mannors.

As thus the Land, so was all course of Judicature divided even from the meanest to the highest portion, each severall had his Court of Law, preserving still the Mannor of our Ancestours the Saxons, who jura per pages reddabant; and these are still learned Court-Barons, or the Freeholders Court, twelve usually in number, who with the Thame or chiefe Lord were Judges.

The Hundred was next, where the Hundred or Alderman Lord of the Hundred, with the chiefe Lord of each Townshipp within their limits judged; Gods people observed this forme in the publicke Centurionis & decam Judicabant plebem omni tempore.

The County or Generale placitum was the next, this was so to supply the defect, or remedy the corruption of the inferior, Ubi Curiae Dominorum probantur desessio, perinet ad vice comitem Provinciarum; the Judges here were Comites, vice comites & Barones Comitatus qui liberas in hoteras habebant.

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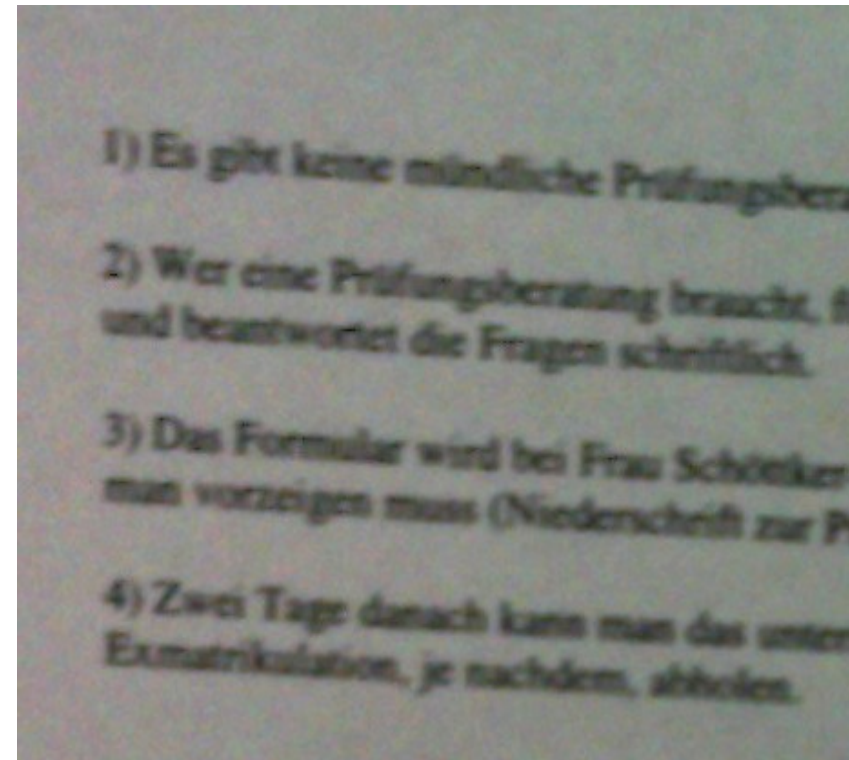
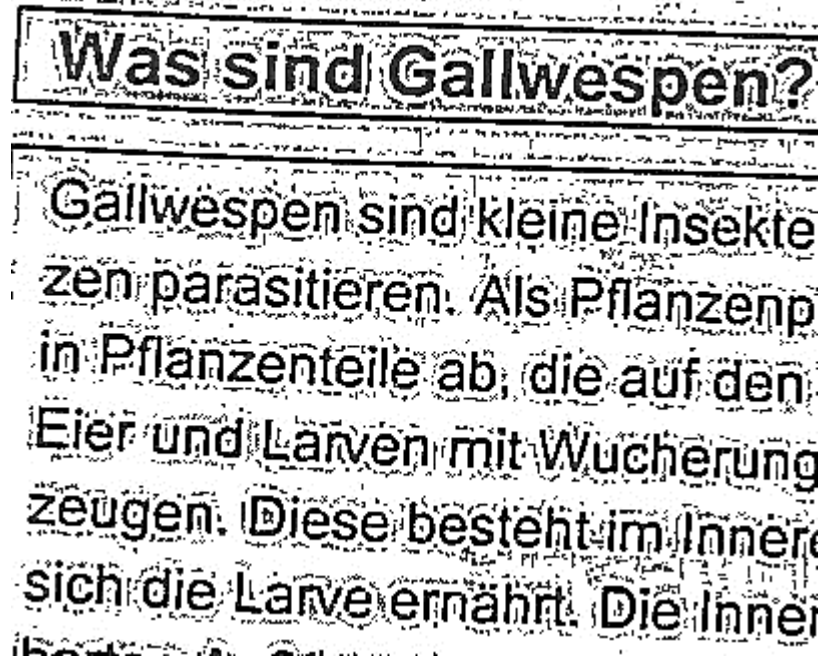
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# Unterdrückung des Rauschens

Problem: Rauschen im Bild verringert die Erkennungsrate dramatisch:



Lösung: Glättung

Problem: Unscharfe Kanten verringern die Erkennungsraten

Lösung: Schärfung. Führt aber zur Verstärkung des Rauschens

# Bilateralfilter

Bsp: Gauß-Filter für beide Komponenten:

$$BF[I]_{\mathbf{p}} = \frac{1}{W_{\mathbf{p}}} \sum_{\mathbf{q} \in \mathcal{S}} G_{\sigma_s}(\|\mathbf{p} - \mathbf{q}\|) G_{\sigma_r}(|I_{\mathbf{p}} - I_{\mathbf{q}}|) I_{\mathbf{q}}$$

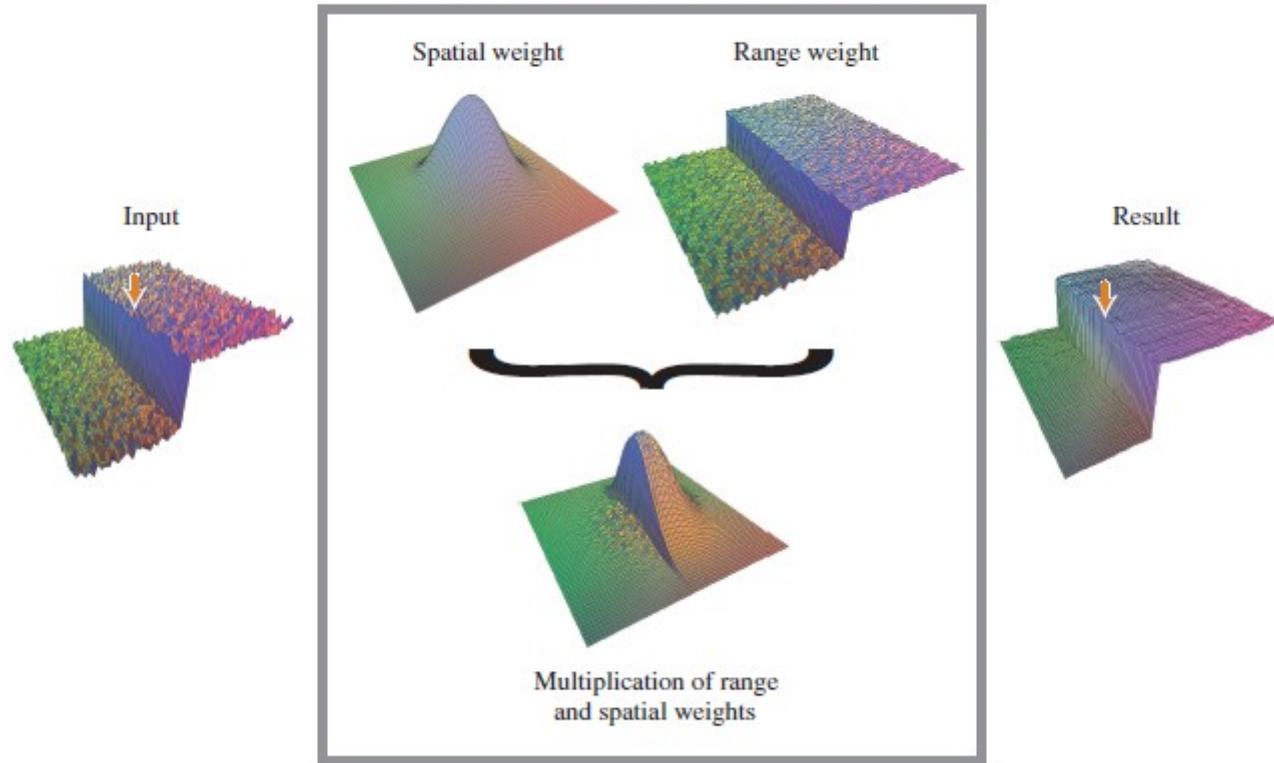
mit

$$W_{\mathbf{p}} = \sum_{\mathbf{q} \in \mathcal{S}} G_{\sigma_s}(\|\mathbf{p} - \mathbf{q}\|) G_{\sigma_r}(|I_{\mathbf{p}} - I_{\mathbf{q}}|).$$

als Normalisierungsfaktor

# Bilateral filter

Bilateral filter weights at the central pixel





# Binomialfilter

Gauß-Binomialfilter hat 2 Parameter:

- Standardabweichung der Abstandsfunktion:
  - legt die Größe der zu glättenden Merkmale fest
- Standardabweichung der Intensitätsfunktion
  - bestimmt wie gut die Kanten erhalten bleiben

# Bilateralfilter: Ergebnis

## Was sind Gallwespen?

Gallwespen sind kleine Insekten, die auf Pflanzen parasitieren. Als Pflanzentiere ab, die auf den Eier und Larven mit Wucherung zeugen. Diese besteht im Inneren sich die Larve ernährt. Die Innen

## Was sind Gallwespen?

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# Binomialfilter

- Problem: Binomialfilter ist nicht linear und nicht separierbar
- Nur für kleine Filtergrößen anwendbar
- Einige approximative Lösungen vorhanden

# Superresolution

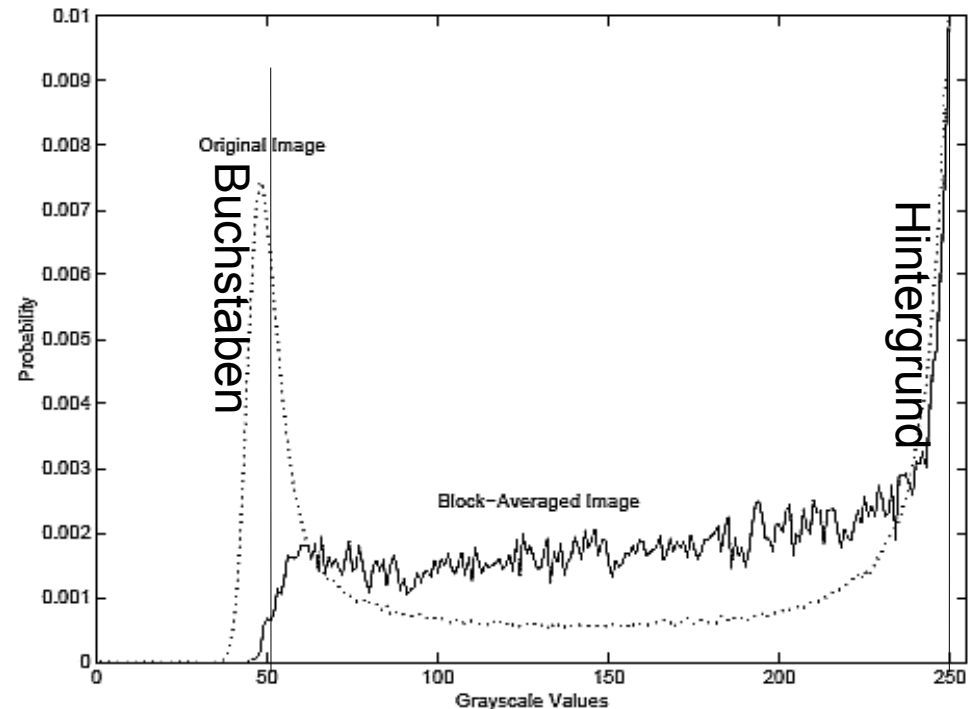
- Problem: Die Qualität der Aufnahme ist nicht optimal
  - Das Dokument ist zu weit weg
  - Schlechte Fokussierung
- Lösung: Superresolutionsverfahren
  - Einzel-Frame-Verfahren
  - Multi-Frame-Verfahren

# Superresolution

- Texteigenschaften:
  - Bimodalität der Pixelwerte
  - Hintergrund sowie Vordergrund(Buchstaben) sind glatt
  - Scharfe Kanten zwischen Vorder- und Hintergrund

# Superresolution: Bimodalität der Pixelwerte

**Bimodalitätsbewertung** gibt an wie weit Pixelwerte im Bild von den beiden Maxima des Histogramms entfernt sind. Das Ziel ist Polarisierung der Werte.



$$B(x) = \sum_{r,c} (x_{r,c} - \mu_{black})^2 (x_{r,c} - \mu_{white})^2$$

# Superresolution

**Glattheitbewertung:** bewertet die Glattheit der Flächen im Bild. Angestrebt wird die Glattheit entlang der Kanten.

$$S(x) = \sum_{r,c} [(x_{r-1,c} - x_{r,c})^2 + (x_{r,c-1} - x_{r,c})^2 + (x_{r,c+1} - x_{r,c})^2 + (x_{r+1,c} - x_{r,c})^2]$$

# Superresolution

**Mittelwert-Nebenbedingung:** der Mittelwert einer Gruppe von Pixel im interpolierten Bild sollte ungefähr gleich dem Mittelwert der korrespondierenden Gruppe im Originalbild bleiben.

$$A(\mathbf{x}) = \left[ \mu_i - \frac{1}{q^2} \sum_{r=1}^q \sum_{c=1}^q x_{r,c}^{(i)} \right]^2$$

wo  $q^2$  – Anzahl der Pixel in der Gruppe.



# Superresolution: Bewertungsfunktion

Das Minimum der Funktion

$$BSA(x) = \lambda_1 B(x) + \lambda_2 S(x) + \lambda_3 A(x)$$

bedeutet, dass das Bild optimal ist.

Die Berechnungsvorschrift für die iterative Aktualisierung:

$$\delta' = H'^{-1} \nabla BSA'(x)$$

wo  $H'$  – (diagonalisierte Hesse Matrix des entsprechenden Pixelblocks  $\nabla BSA$  der Gradient.

# Superresolution

solutions that conform

Original Image

solutions that conform

Lineare Interpolation

solutions that conform

Cubic Spline Interpolation

solutions that conform

BSA Interpolation

