Image Enhancement

Christian Leube, Martin Gorges, Thomas Bretzke

Gliederung

- Übersicht und Motivation
- Textvorstellung
- Zusammenfassung
- Referenzen

Übersicht und Motivation

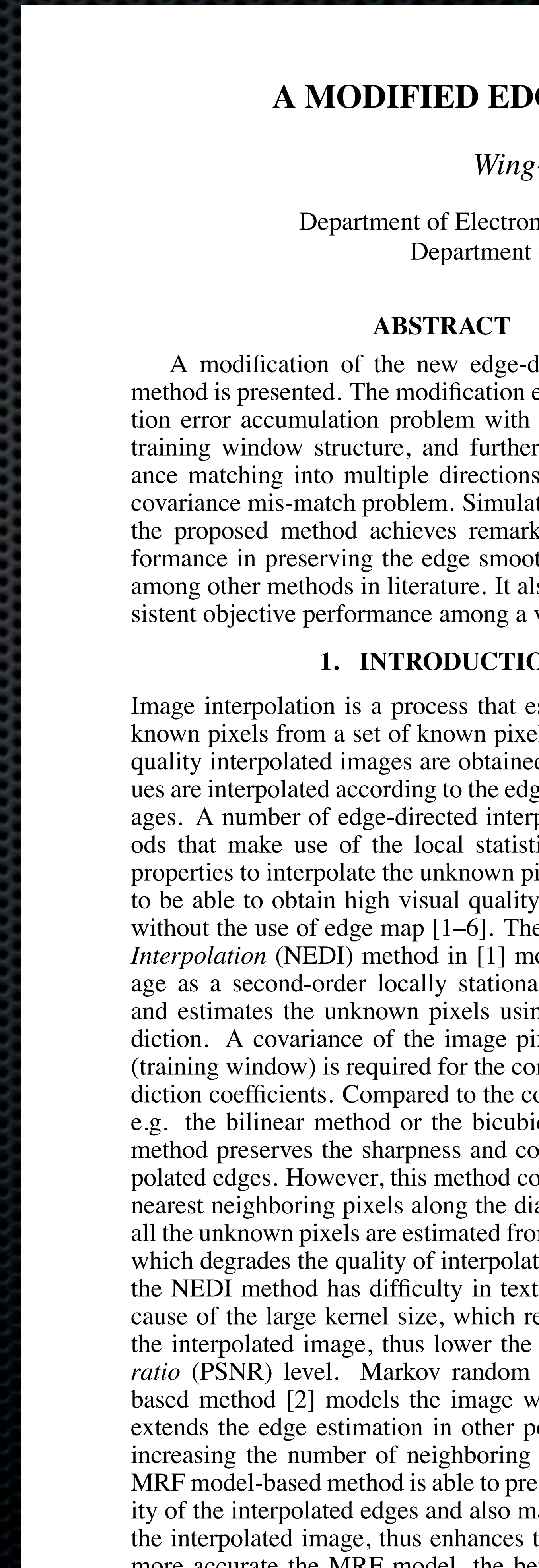
- Image Enhancement?
  - Bilder „verbessern“
  - bessere Erkennbarkeit
  - besserer „Input“

Übersicht und Motivation

- Zwei grundsätzliche Methoden:
  - Bildbereich (Pixel)
  - Frequenzbereich
- Hier: Beispiele aus beiden

Textvorstellung

- **„A Modified Edge Directed Interpolation For Images“**
  - Wing-Shan Tam, Chi-Wah Kok, Wan-Chi Siu
  - Department of Electronic and Information Engineering, Hong Kong Polytechnic University
  - Department of Electronic Engineering, City University of Hong Kong



A MODIFIED ED

Wing-

Department of Electron
Department

ABSTRACT

A modification of the new edge-d
method is presented. The modification e
tion error accumulation problem with
training window structure, and further
ance matching into multiple directions
covariance mis-match problem. Simulat
the proposed method achieves remark
formance in preserving the edge smoot
among other methods in literature. It als
sistent objective performance among a v

1. INTRODUCTIO

Image interpolation is a process that e
known pixels from a set of known pixe
quality interpolated images are obtained
ues are interpolated according to the edg
ages. A number of edge-directed interp
ods that make use of the local statisti
properties to interpolate the unknown pi
to be able to obtain high visual quality
without the use of edge map [1–6]. The
Interpolation (NEDI) method in [1] mo
age as a second-order locally stationa
and estimates the unknown pixels usin
diction. A covariance of the image pi
(training window) is required for the co
diction coefficients. Compared to the c
e.g. the bilinear method or the bicubi
method preserves the sharpness and co
polated edges. However, this method co
nearest neighboring pixels along the dia
all the unknown pixels are estimated fro
which degrades the quality of interpolat
the NEDI method has difficulty in text
cause of the large kernel size, which re
the interpolated image, thus lower the
ratio (PSNR) level. Markov random
based method [2] models the image w
extends the edge estimation in other p
increasing the number of neighboring
MRF model-based method is able to pre
ity of the interpolated edges and also m
the interpolated image, thus enhances t

A Modified Edge Directed Interpolation For Images

- Interpolation von Bildern
  - Von niedriger in hohe Auflösung!
  - Unbekannte Pixel durch Analyse bekannter Pixel schätzen

A Modified Edge Directed Interpolation For Images

- Interpolation über Kantenerkennung:
  - Gängige Methode
  - Autoren schlagen Verbesserung vor

A Modified Edge Directed Interpolation For Images

- Beispiel: New Edge-Directed Interpolation (NEDI)
  - Lineare Vorhersage, ein „Training Window“
    - Ergebnis:
      - Scharfe, durchgängige Kanten
      - Diagonalen: Nur 4 benachbarte Pixel
        - senkt Qualität

A Modified Edge Directed Interpolation For Images

- Beispiel: Improved New Edge-Directed Interpolation (iNEDI)
    - Modifikation NEDI
    - Lernfenstergröße entspr. Kantengröße variiert
        - Bessere Qualität!

A Modified Edge Directed Interpolation For Images

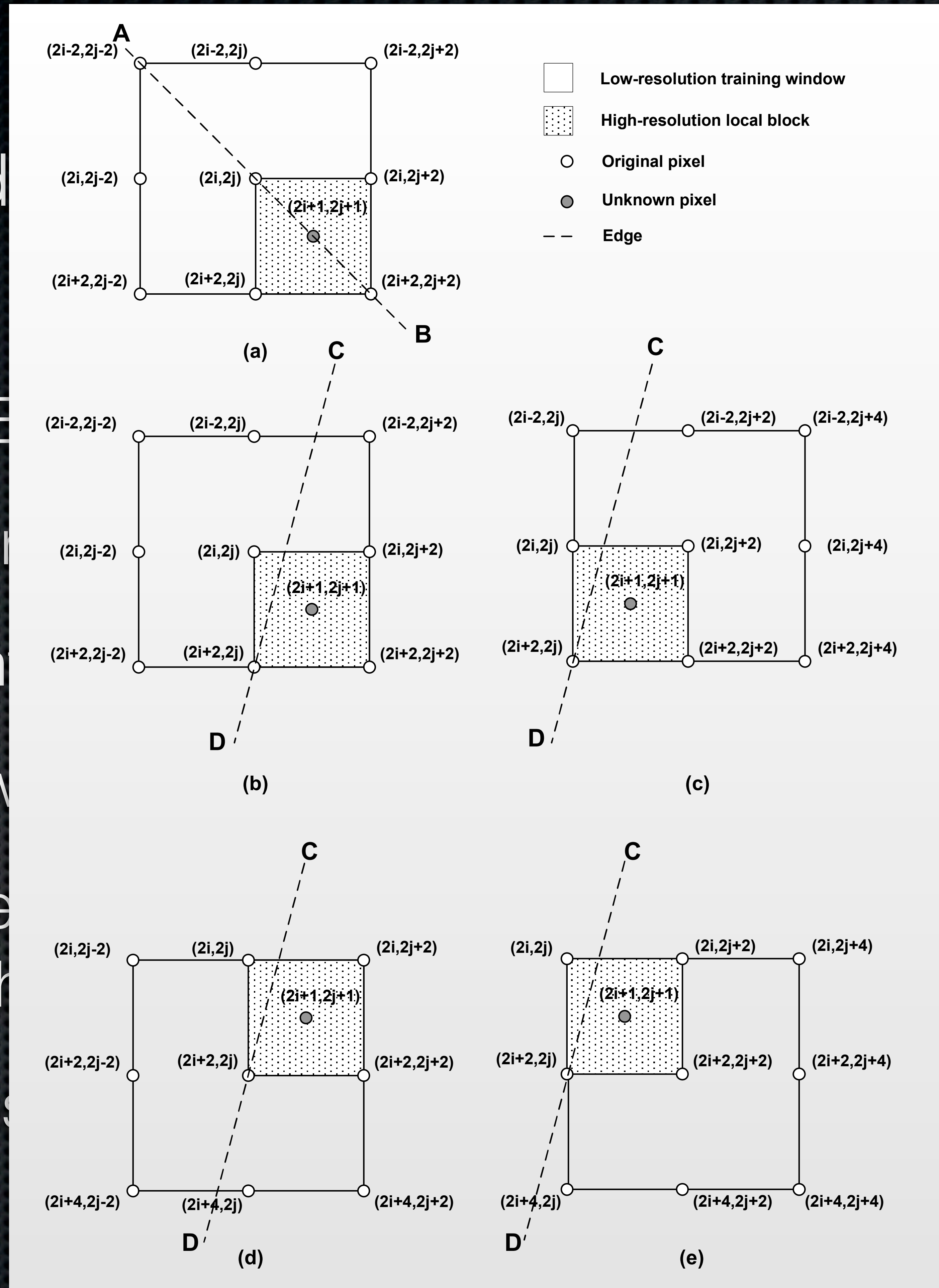
- NEDI und iNEDI
  - Ein Lernfenster
  - Gewichtung durch Kovarianz
    - Häufig fehlerhaft, weil eingeschränkt!

A Modified Edge Directed Interpolation For Images

- Modified Edge-directed Interpolation (MEDI)
- MEDI: Vier Lernfenster
  - Gesuchter Pixel jeweils im Zentrum
  - Vier Gewichtungen - Vergleich
  - Je höher Energie des Lernfensters, desto wahrscheinlicher existiert eine Kante
  - Lernfenster mit höchster Energie: Lineare Vorhersage

A Modified … or Images

- Modified E…
- MEDI: Vier…
  - Gesucht…
  - Vier Gev…
  - Je höhe… wahrsch…
  - Lernfens… Vorhersage



A Modified Edge Directed Interpolation For Images

- Versuche
  - Bild auf 50% verkleinert
  - Dann Skalierung auf Originalgröße

A Modified Edge Directed Interpolation For Images

- Ergebnisse
  - PSNR-Wert (peak signal to noise - Verhältnis maximale Signalstärke zu Störsignal)
  - SSIM-Wert (structural similarity index - Ähnlichkeit zweier Bilder)

A Modified Edge Directed Interpolation For Images

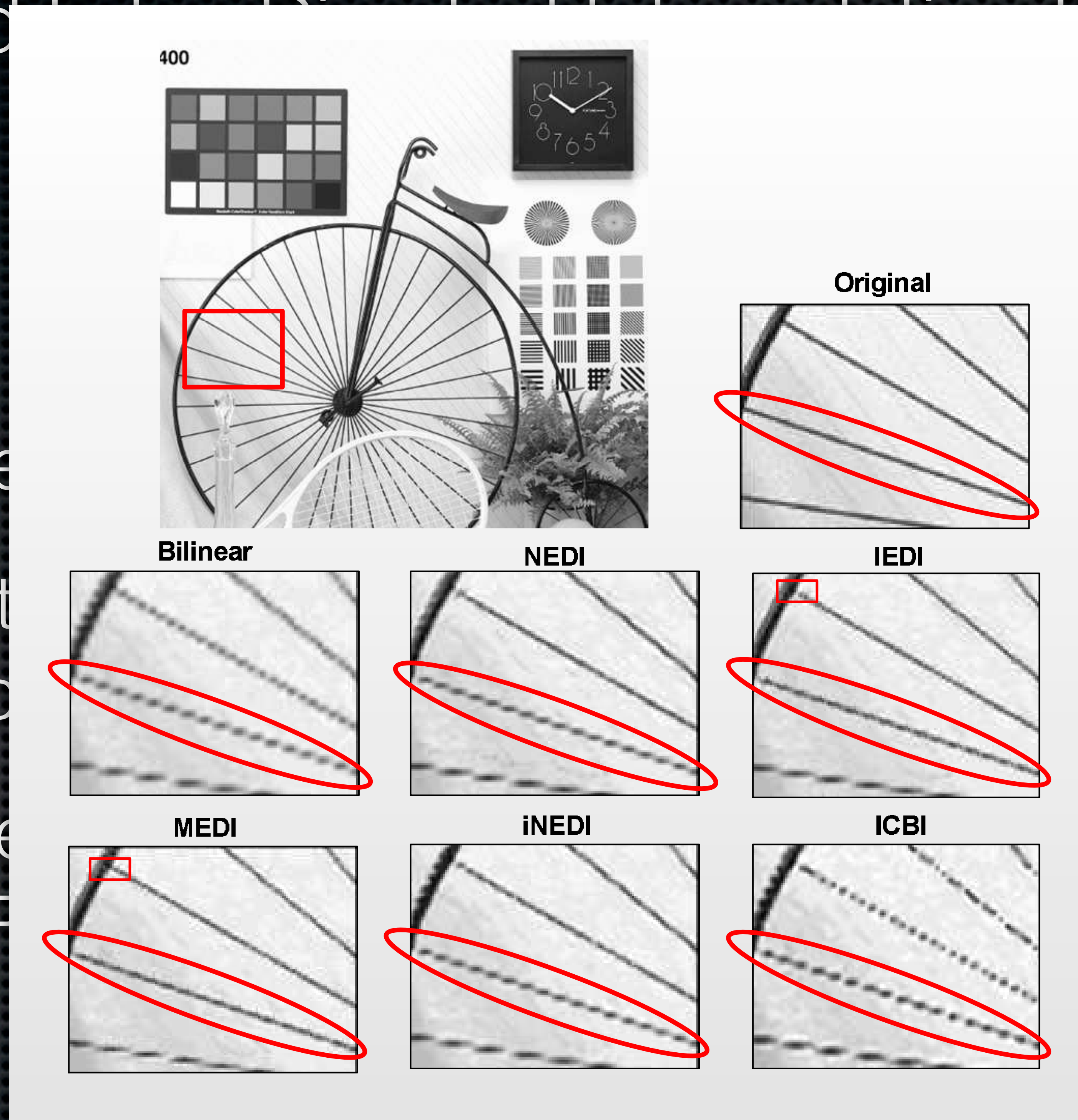
- Synthetische Bilder
  - MEDI mit höchsten PSNR- und SSIM-Werten
- Natürliche Bilder
  - Ergebnisse bildabhängig
  - Kein klarer Sieger zwischen vorn liegenden (NEDI, MEDI)

A Modified Edge Directed Interpolation For Images

- Subjektive Betrachtung
  - Synthetische Bilder mit klaren Kanten: Nahezu identisch mit Originalen
  - MEDI liefert teilweise hervorragende Ergebnisse, löst einige Probleme anderer EDI-Verfahren

A Modified … For Images

- Subjektive
  - Synthet … hezu identisc
  - MEDI lie … onisse, löst einige F



Textvorstellung

- **„Image Denoising Using Over-complete Wavelet Representations“**
  - Slaven Marusic, Guang Deng, David B. H. Tay
  - School of Electrical Engineering and Telecommunications, The University of New South Wales Sydney
  - Department of Electronic Engineering, La Trobe University Victoria

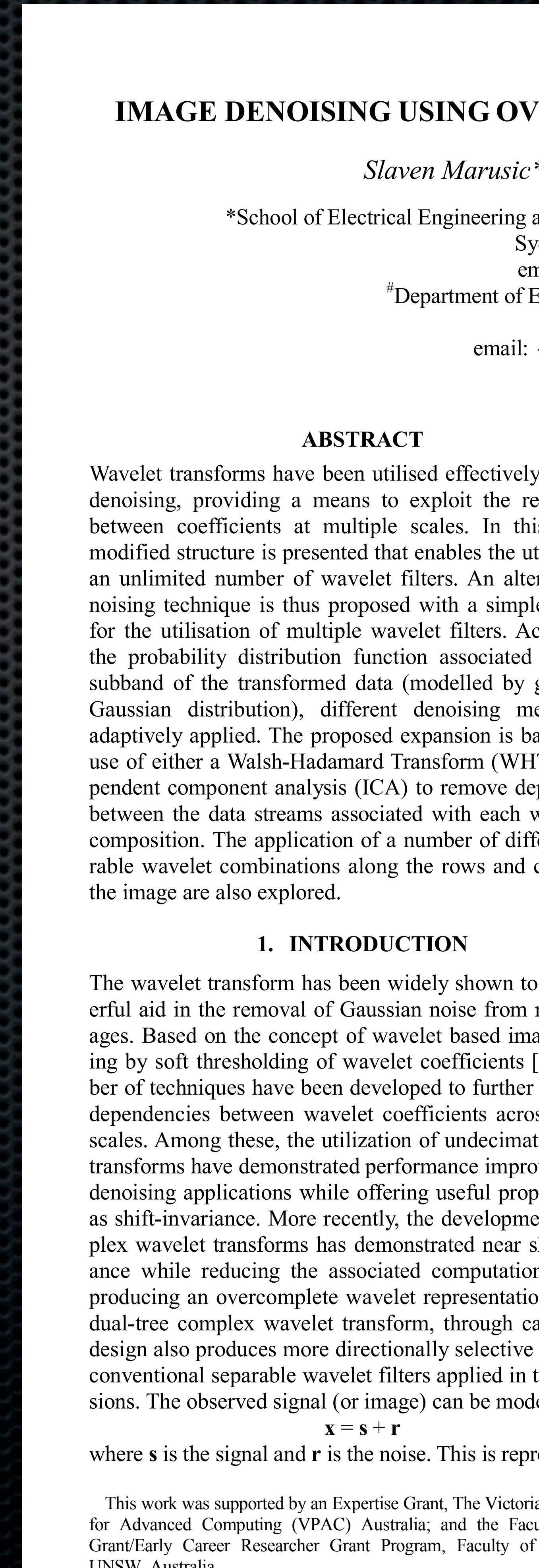


IMAGE DENOISING USING OV

Slaven Marusic

*School of Electrical Engineering a
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#Department of E

email:

ABSTRACT

Wavelet transforms have been utilised effectively
denoising, providing a means to exploit the re
between coefficients at multiple scales. In thi
modified structure is presented that enables the ut
an unlimited number of wavelet filters. An alter
noising technique is thus proposed with a simpl
for the utilisation of multiple wavelet filters. Ac
the probability distribution function associated
subband of the transformed data (modelled by g
Gaussian distribution), different denoising me
adaptively applied. The proposed expansion is ba
use of either a Walsh-Hadamard Transform (WH
pendent component analysis (ICA) to remove dep
between the data streams associated with each w
composition. The application of a number of diffe
rable wavelet combinations along the rows and c
the image are also explored.

1. INTRODUCTION

The wavelet transform has been widely shown to
erful aid in the removal of Gaussian noise from i
ages. Based on the concept of wavelet based ima
ing by soft thresholding of wavelet coefficients [
ber of techniques have been developed to further
dependencies between wavelet coefficients acros
scales. Among these, the utilization of undecimat
transforms have demonstrated performance impro
denoising applications while offering useful prop
as shift-invariance. More recently, the developme
plex wavelet transforms has demonstrated near s
ance while reducing the associated computation
producing an overcomplete wavelet representatio
dual-tree complex wavelet transform, through ca
design also produces more directionally selective
conventional separable wavelet filters applied in t
sions. The observed signal (or image) can be mode

$$\mathbf{x} = \mathbf{s} + \mathbf{r}$$

where **s** is the signal and **r** is the noise. This is repr

This work was supported by an Expertise Grant, The Victoria
for Advanced Computing (VPAC) Australia; and the Facu
Grant/Early Career Researcher Grant Program, Faculty of
UNSW, Australia.

Image Denoising Using Over-complete Wavelet Representations

- Entrauschen von Bildern
  - Bildsignal und Rauschsignal trennen!
- Gängig: Nutzung von „Wavelet-Transformationen“
  - unwichtige, irrelevante Bilddetails aus Bilddaten entfernen

Image Denoising Using Over-complete Wavelet Representations

- Bisher:
  - Ein Wavelet auf beide Dimensionen
  - Zwei Filterpaare

Image Denoising Using Over-complete Wavelet Representations

- Bisher:
  - Ein Wavelet auf beide Dimensionen
  - Zwei Filterpaare

- Autoren:
- Unterschiedliche Wavelets auf Zeilen und Spalten
- Beliebig viele Filterpaare und Einzelfilter

Image Denoising Using Over-complete Wavelet Representations

- Multiple Wavelet Denoising (MWD)
  - Beliebige Anzahl von Filtern → Mehr Charakteristika und unerwünschtes Rauschen
  - Voneinander trennbare Filter → gleichzeitig alle Kombinationen eines Filterpaares auf Dimensionen anwendbar

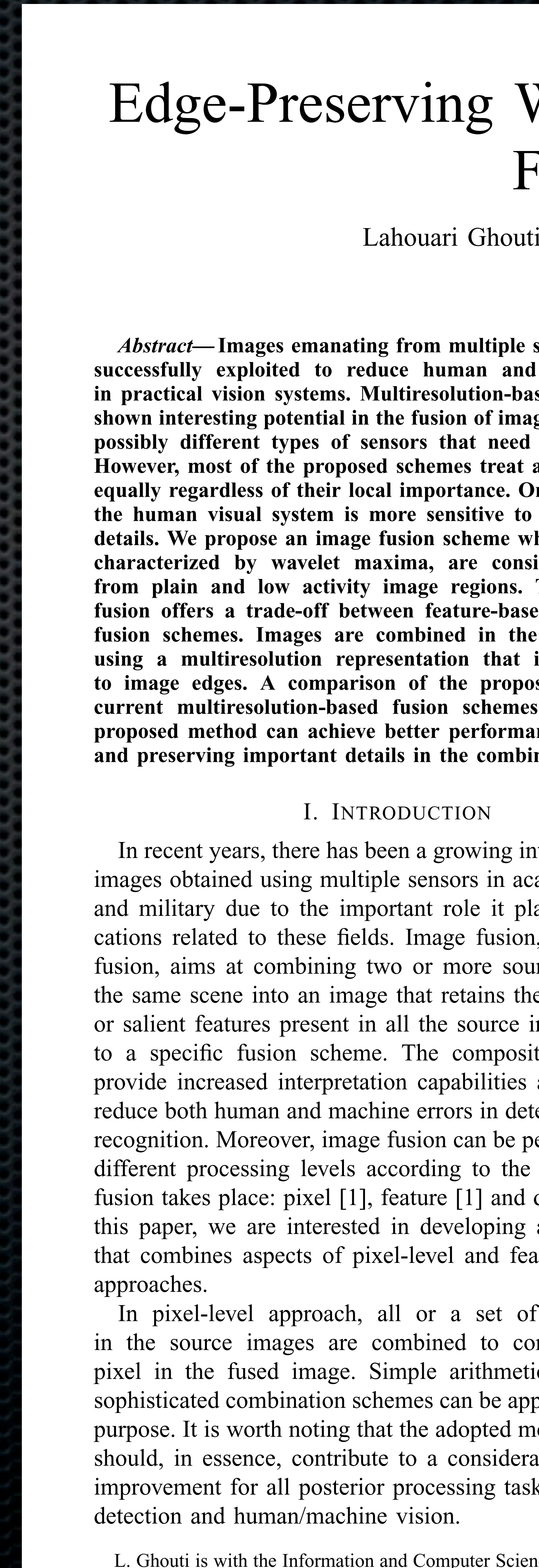
Image Denoising Using Over-complete Wavelet Representations

- Neues Verfahren führte im Test zu ähnlichen Ergebnissen wie bisherige
- ist aber wesentlich flexibler!

Bearbeitung: Christian Leube

Textvorstellung

- **„Edge-Preserving Wavelet-Based Multisensor Image Fusion Approach“**
  - Lahouari Ghouti, Ahmed Bouridane and Mohammad K. Ibrahim


Edge-Preserving W
F
Lahouari Ghouti

Abstract—Images emanating from multiple s
successfully exploited to reduce human and
in practical vision systems. Multiresolution-bas
shown interesting potential in the fusion of imag
possibly different types of sensors that need
However, most of the proposed schemes treat a
equally regardless of their local importance. O
the human visual system is more sensitive to
details. We propose an image fusion scheme wh
characterized by wavelet maxima, are consi
from plain and low activity image regions.
fusion offers a trade-off between feature-base
fusion schemes. Images are combined in the
using a multiresolution representation that
to image edges. A comparison of the propos
current multiresolution-based fusion schemes
proposed method can achieve better performa
and preserving important details in the combi

I. INTRODUCTION

In recent years, there has been a growing in
images obtained using multiple sensors in aca
and military due to the important role it pla
cations related to these fields. Image fusion
fusion, aims at combining two or more sou
the same scene into an image that retains the
or salient features present in all the source i
to a specific fusion scheme. The composit
provide increased interpretation capabilities
reduce both human and machine errors in det
recognition. Moreover, image fusion can be pe
different processing levels according to the
fusion takes place: pixel [1], feature [1] and
this paper, we are interested in developing
that combines aspects of pixel-level and fea
approaches.

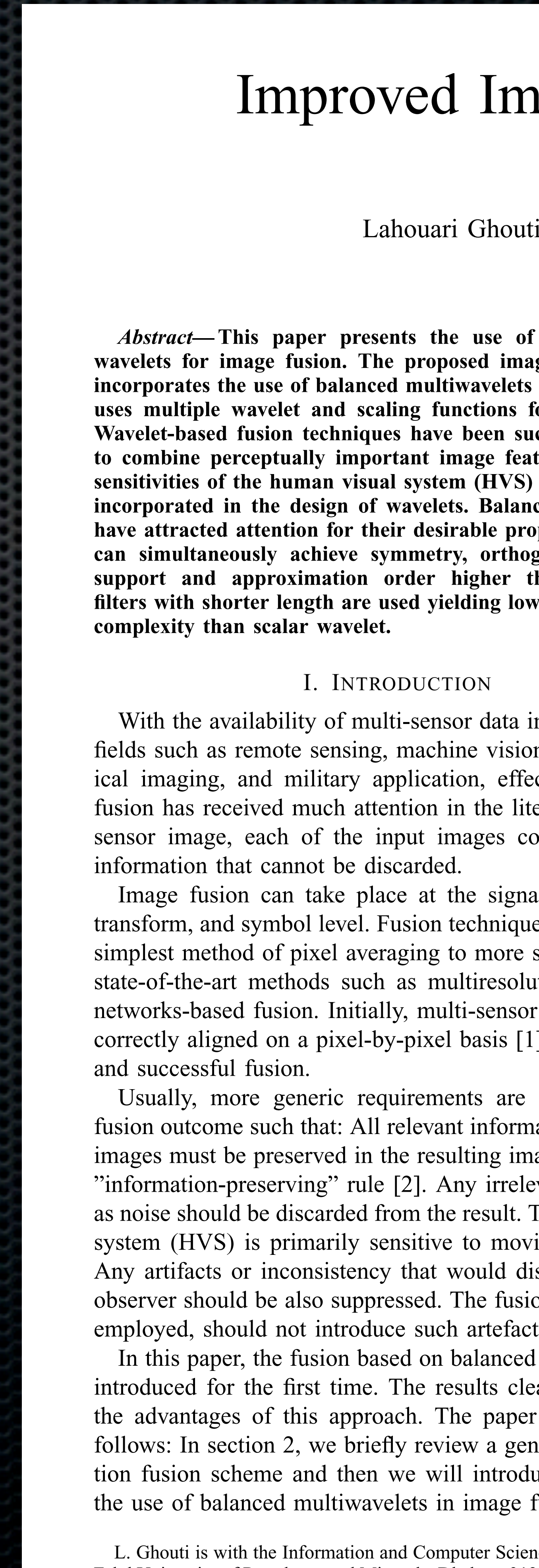
In pixel-level approach, all or a set of
in the source images are combined to co
pixel in the fused image. Simple arithmeti
sophisticated combination schemes can be app
purpose. It is worth noting that the adopted m
should, in essence, contribute to a considera
improvement for all posterior processing task
detection and human/machine vision.

L. Ghouti is with the Information and Computer Scien

Bearbeitung: Christian Leube

Textvorstellung

- **„Improved Image Fusion Using Balanced Multiwavelets“**
  - Lahouari Ghouti, Ahmed Bouridane and Mohammad K. Ibrahim


Improved Im

Lahouari Ghouti

Abstract—This paper presents the use of
wavelets for image fusion. The proposed imag
incorporates the use of balanced multiwavelets
uses multiple wavelet and scaling functions fo
Wavelet-based fusion techniques have been suc
to combine perceptually important image feat
sensitivities of the human visual system (HVS)
incorporated in the design of wavelets. Balanc
have attracted attention for their desirable prop
can simultaneously achieve symmetry, orthog
support and approximation order higher th
filters with shorter length are used yielding low
complexity than scalar wavelet.

I. INTRODUCTION

With the availability of multi-sensor data in
fields such as remote sensing, machine vision
ical imaging, and military application, effec
fusion has received much attention in the lite
sensor image, each of the input images co
information that cannot be discarded.

Image fusion can take place at the signa
transform, and symbol level. Fusion technique
simplest method of pixel averaging to more s
state-of-the-art methods such as multiresolu
networks-based fusion. Initially, multi-sensor
correctly aligned on a pixel-by-pixel basis [1]
and successful fusion.

Usually, more generic requirements are
fusion outcome such that: All relevant informa
images must be preserved in the resulting ima
"information-preserving" rule [2]. Any irrelev
as noise should be discarded from the result. T
system (HVS) is primarily sensitive to movi
Any artifacts or inconsistency that would dis
observer should be also suppressed. The fusio
employed, should not introduce such artefact

In this paper, the fusion based on balanced
introduced for the first time. The results clea
the advantages of this approach. The paper
follows: In section 2, we briefly review a gen
tion fusion scheme and then we will introdu
the use of balanced multiwavelets in image f

L. Ghouti is with the Information and Computer Scien

Edge-Preserving Wavelet-based Multisensor Image Fusion Approach / Improved Image Fusion Using Multiwavelets

- Multisensor-Bilder
  - Aus mehreren Einzelbildern zusammengesetzt
  - unterschiedliche visuelle Sensoren, selbes Motiv
- Paper: Verschiedene Ansätze zur Generierung und Qualitätsverbesserung

Edge-Preserving Wavelet-based Multisensor Image Fusion Approach

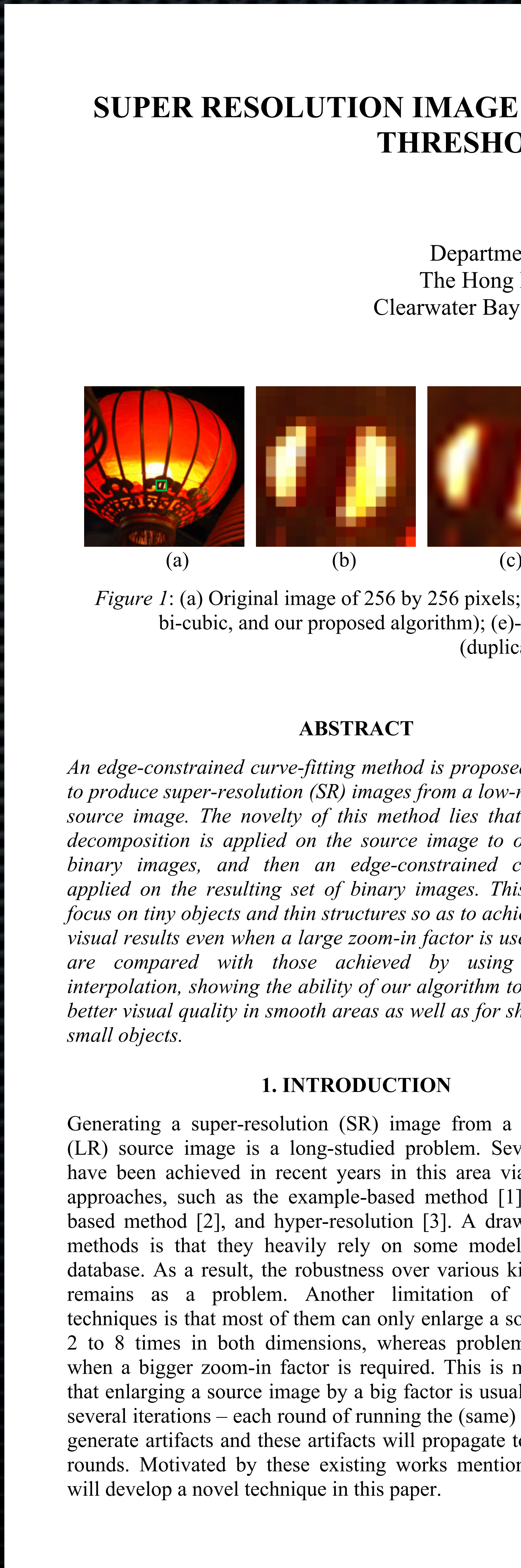
- Paper 1:
  - Verwendung symmetrischer MultiWavelets zur Erzeugung von Multisensor-Bildern
  - Wichtige Bestandteile sollen erhalten bleiben, Besonderheiten verstärkt werden

Improved Image Fusion Using Multiwavelets

- Paper 2:
  - Fusion zweier Multisensor-Bilder
  - Wichtigste Bildinformationen werden in einem fusionierten Bild zusammengefasst

Textvorstellung

- **„Super Resolution Image By Edge-Constrained Curve Fitting In The Threshold Decomposition Domain“**
  - Tsz Chun Ho, Bing Zeng
  - Department of Electronic and Computer Engineering, The Hong Kong University of Science and Technology



SUPER RESOLUTION IMAGE
THRESHO

Departme
The Hong
Clearwater Bay

(a) (b) (c)

Figure 1: (a) Original image of 256 by 256 pixels;
bi-cubic, and our proposed algorithm); (e)-
(duplica

ABSTRACT

An edge-constrained curve-fitting method is propose
to produce super-resolution (SR) images from a low-r
source image. The novelty of this method lies that
decomposition is applied on the source image to o
binary images, and then an edge-constrained c
applied on the resulting set of binary images. Thi
focus on tiny objects and thin structures so as to achi
visual results even when a large zoom-in factor is use
are compared with those achieved by using
interpolation, showing the ability of our algorithm to
better visual quality in smooth areas as well as for sh
small objects.

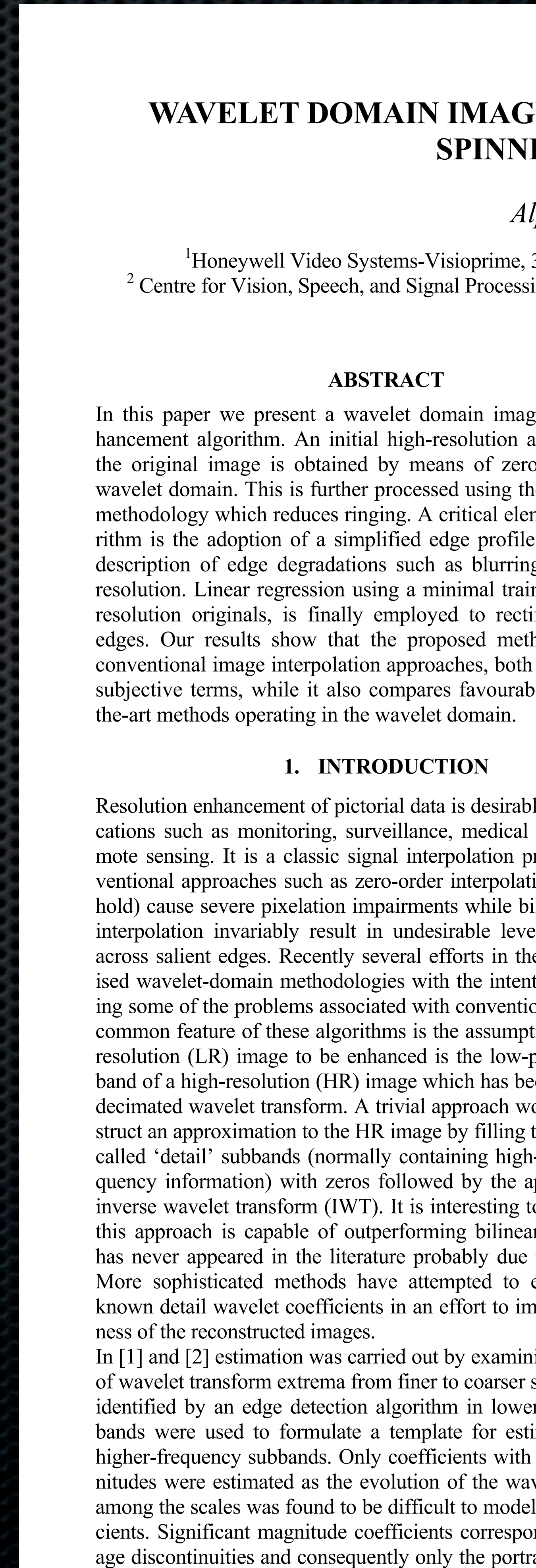
1. INTRODUCTION

Generating a super-resolution (SR) image from a
(LR) source image is a long-studied problem. Sev
have been achieved in recent years in this area via
approaches, such as the example-based method [1]
based method [2], and hyper-resolution [3]. A draw
methods is that they heavily rely on some model
database. As a result, the robustness over various ki
remains as a problem. Another limitation of
techniques is that most of them can only enlarge a so
2 to 8 times in both dimensions, whereas problem
when a bigger zoom-in factor is required. This is m
that enlarging a source image by a big factor is usual
several iterations – each round of running the (same)
generate artifacts and these artifacts will propagate t
rounds. Motivated by these existing works mention
will develop a novel technique in this paper.

Bearbeitung: Martin Gorges

Textvorstellung

- **„Wavelet Domain Image Resolution Enhancement Using Cycle Spinning And Edge Modelling“**
  - Alptekin Temizel, Theo Vlachos
  - Honeywell Video Systems-Visioprime (UK)
  - Centre for Vision, Speech, and Signal Processing (CVSSP), University of Surrey, Guildford (UK)



Super Resolution Image By Edge-Constrained Curve Fitting In The Threshold Decomposition Domain / Wavelet Domain Image Resolution Enhancement Using Cycle Spinning And Edge Modelling

- In beiden Papern:
  - Generierung eines hoch aufgelösten Bildes
  - aus einem niedrig aufgelösten

Super Resolution Image By Edge-Constrained Curve Fitting In The Threshold Decomposition Domain

- Paper 1:
  - analytische Herangehensweise
  - Kanten im niedrig aufgelösten Bild
  - übertragen in hochauflösendes
  - Füllung mit weiterem Algorithmus (im Paper nicht näher erläutert)
  - *Scharfe Kanten, aber unnatürlich wirkendes Bild*

Super Resolution Image By Edge-Constrained Curve Fitting In The Threshold Decomposition Domain

- Paper 2:
  - mathematische Herangehensweise
  - komplettes Bild wird vergrößert
  - Im Anschluss: Bereinigung des Bildes
  - *Kanten weniger scharf, Bild wirkt aber natürlich*

Zusammenfassung

- Unterschiedliche Methoden zur Bildverbesserung
- Aber alle im 2D-Raum
- Anwendung im 3D-Raum?
  - Durchaus vorstellbar
  - Unterschiedlich stark anzuwenden
  - Änderungen an den Algorithmen notwendig

Referenzen

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- TAN, Wing-Shan / KOK, Chi-Wah / SIU, Wan-Chi: „A Modified Edge Directed Interpolation For Images“. Paper EUSIPCO 2009.
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