FACULTY OF
COMPUTER SCIENCE AND AUTOMATION

COMPUTER SCIENCE MEETS AUTOMATION

VOLUME II

Session 6 - Environmental Systems: Management and Optimisation
Session 7 - New Methods and Technologies for Medicine and Biology
Session 8 - Embedded System Design and Application
Session 9 - Image Processing, Image Analysis and Computer Vision
Session 10 - Mobile Communications
Session 11 - Education in Computer Science and Automation
Preface

Dear Participants,

Confronted with the ever-increasing complexity of technical processes and the growing demands on their efficiency, security and flexibility, the scientific world needs to establish new methods of engineering design and new methods of systems operation. The factors likely to affect the design of the smart systems of the future will doubtless include the following:

- As computational costs decrease, it will be possible to apply more complex algorithms, even in real time. These algorithms will take into account system nonlinearities or provide online optimisation of the system’s performance.

- New fields of application will be addressed. Interest is now being expressed, beyond that in “classical” technical systems and processes, in environmental systems or medical and bioengineering applications.

- The boundaries between software and hardware design are being eroded. New design methods will include co-design of software and hardware and even of sensor and actuator components.

- Automation will not only replace human operators but will assist, support and supervise humans so that their work is safe and even more effective.

- Networked systems or swarms will be crucial, requiring improvement of the communication within them and study of how their behaviour can be made globally consistent.

- The issues of security and safety, not only during the operation of systems but also in the course of their design, will continue to increase in importance.

The title “Computer Science meets Automation”, borne by the 52nd International Scientific Colloquium (IWK) at the Technische Universität Ilmenau, Germany, expresses the desire of scientists and engineers to rise to these challenges, cooperating closely on innovative methods in the two disciplines of computer science and automation.

The IWK has a long tradition going back as far as 1953. In the years before 1989, a major function of the colloquium was to bring together scientists from both sides of the Iron Curtain. Naturally, bonds were also deepened between the countries from the East. Today, the objective of the colloquium is still to bring researchers together. They come from the eastern and western member states of the European Union, and, indeed, from all over the world. All who wish to share their ideas on the points where “Computer Science meets Automation” are addressed by this colloquium at the Technische Universität Ilmenau.

All the University’s Faculties have joined forces to ensure that nothing is left out. Control engineering, information science, cybernetics, communication technology and systems engineering – for all of these and their applications (ranging from biological systems to heavy engineering), the issues are being covered.

Together with all the organizers I should like to thank you for your contributions to the conference, ensuring, as they do, a most interesting colloquium programme of an interdisciplinary nature. I am looking forward to an inspiring colloquium. It promises to be a fine platform for you to present your research, to address new concepts and to meet colleagues in Ilmenau.

Professor Peter Scharff
Rector, TU Ilmenau

Professor Christoph Ament
Head of Organisation
## Contents

6 Environmental Systems: Management and Optimisation

| T. Bernard, H. Linke, O. Krol | 3 |
| A Concept for the long term Optimization of regional Water Supply Systems as a Module of a Decision Support System |

| S. Röll, S. Hopfgarten, P. Li | 11 |
| A groundwater model for the area Darkhan in Kharaa river Th. Bernard, H. Linke, O. Krol basin |

| A. Khatanbaatar Altantuul | 17 |
| The need designing integrated urban water management in cities of Mongolia |

| T. Rauschenbach, T. Pfützenreuter, Z. Tong | 23 |
| Model based water allocation decision support system for Beijing |

| T. Pfützenreuter, T. Rauschenbach | 29 |
| Surface Water Modelling with the Simulation Library ILM-River |

| D. Karimanzira, M. Jacobi | 35 |
| Modelling yearly residential water demand using neural networks |

| Th. Westerhoff, B. Scharaw | 41 |
| Model based management of the drinking water supply system of city Darkhan in Mongolia |

| N. Buyankhishig, N. Batsukh | 47 |
| Pumping well optimiation in the Shivee-Ovoo coal mine Mongolia |

| S. Holzmüller-Laue, B. Göde, K. Rimane, N. Stoll | 51 |
| Data Management for Automated Life Science Applications |

| N. B. Chang, A. Gonzalez | 57 |
| A Decision Support System for Sensor Deployment in Water Distribution Systems for Improving the Infrastructure Safety |

| P. Hamolka, I. Vrubblevsky, V. Parkoun, V. Sokol | 63 |
| New Film Temperature And Moisture Microsensors for Environmental Control Systems |

| N. Buyankhishig, M. Masumoto, M. Aley | 67 |
| Parameter estimation of an unconfined aquifer of the Tuul River basin Mongolia |
7 New Methods and Technologies for Medicine and Biology

J. Meier, R. Bock, L. G. Nyúl, G. Michelson
Eye Fundus Image Processing System for Automated Glaucoma Classification

L. Hellrung, M. Tross
Automatic focus depending on an image processing algorithm for a non mydriatic fundus camera

M. Hamsch, C. H. Igney, M. Vauhkonen
A Magnetic Induction Tomography System for Stroke Classification and Diagnosis

T. Neumuth, A. Pretschner, O. Burgert
Surgical Workflow Monitoring with Generic Data Interfaces

Gene Expression Based Classification of Rheumatoid Arthritis and Osteoarthritis Patients using Fuzzy Cluster and Rule Based Method

S. Toepfer, S. Zellmer, D. Driesch, D. Woetzel, R. Guthke, R. Gebhardt, M. Pfaff
A 2-Compartment Model of Glutamine and Ammonia Metabolism in Liver Tissue

J. C. Ferreira, A. A. Fernandes, A. D. Santos
Modelling and Rapid Prototyping an Innovative Ankle-Foot Orthosis to Correct Children Gait Pathology

H. T. Shandiz, E. Zahedi
Noninvasive Method in Diabetic Detection by Analyzing PPG Signals

S. V. Drobot, I. S. Asayenok, E. N. Zacepin, T. F. Sergiyenko, A. I. Svirnovskiy
Effects of Mm-Wave Electromagnetic Radiation on Sensitivity of Human Lymphocytes to Ionizing Radiation and Chemical Agents in Vitro

8 Embedded System Design and Application

B. Dâne
Modeling and Realization of DMA Based Serial Communication for a Multi Processor System
M. Müller, A. Pacholik, W. Fengler
Tool Support for Formal System Verification

A. Pretschner, J. Alder, Ch. Meissner
A Contribution to the Design of Embedded Control Systems

R. Ubar, G. Jervan, J. Raik, M. Jenikhin, P. Ellervee
Dependability Evaluation in Fault Tolerant Systems with High-Level Decision Diagrams

A. Jutmann
On LFSR Polynomial Calculation for Test Time Reduction

M. Rosenberger, M. J. Schaub, S. C. N. Töpfer, G. Linß
Investigation of Efficient Strain Measurement at Smallest Areas Applying the Time to Digital (TDC) Principle

9 Image Processing, Image Analysis and Computer Vision

J. Meyer, R. Espiritu, J. Earthman
Virtual Bone Density Measurement for Dental Implants

F. Erfurth, W.-D. Schmidt, B. Nyuyki, A. Scheibe, P. Saluz, D. Faßler
Spectral Imaging Technology for Microarray Scanners

T. Langner, D. Kollhoff
Farbbasierte Druckbildinspektion an Rundkörpern

C. Lucht, F. Gaßmann, R. Jahn
Inline-Fehlerdetektion auf freigeformten, texturierten Oberflächen im Produktionsprozess

H.-W. Lahmann, M. Stöckmann
Optical Inspection of Cutting Tools by means of 2D- and 3D-Imaging Processing

A. Melitzki, G. Stanke, F. Weekend
Bestimmung von Raumpositionen durch Kombination von 2D-Bildverarbeitung und Mehrfachlinienlasertriangulation - am Beispiel von PKW-Stabilisatoren

F. Boochs, Ch. Raab, R. Schütze, J. Traiser, H. Wirth
3D contour detection by means of a multi camera system
M. Brandner
Vision-Based Surface Inspection of Aeronautic Parts using Active Stereo

H. Lettenbauer, D. Weiss
X-ray image acquisition, processing and evaluation for CT-based dimensional metrology

K. Sickel, V. Daum, J. Hornegger
Shortest Path Search with Constraints on Surface Models of In-the-ear Hearing Aids

S. Husung, G. Höhne, C. Weber
Efficient Use of Stereoscopic Projection for the Interactive Visualisation of Technical Products and Processes

N. Schuster
Measurement with subpixel-accuracy: Requirements and reality

P. Brückner, S. C. N. Töpfer, M. Correns, J. Schnee
Position- and colour-accurate probing of edges in colour images with subpixel resolution

E. Sparrer, T. Machleidt, R. Nestler, K.-H. Franke, M. Niebelschütz
Deconvolution of atomic force microscopy data in a special measurement mode – methods and practice

T. Machleidt, D. Kapusi, T. Langner, K.-H. Franke
Application of nonlinear equalization for characterizing AFM tip shape

D. Kapusi, T. Machleidt, R. Jahn, K.-H. Franke
Measuring large areas by white light interferometry at the nanopositioning and nanomeasuring machine (NPMM)

R. Burdick, T. Lorenz, K. Bobey
Characteristics of High Power LEDs and one example application in with-light-interferometry

T. Koch, K.-H. Franke
Aspekte der strukturbasierten Fusion multimodaler Satellitendaten und der Segmentierung fusionierter Bilder

T. Riedel, C. Thiel, C. Schmullius
A reliable and transferable classification approach towards operational land cover mapping combining optical and SAR data

B. Waske, V. Heinzel, M. Braun, G. Menz
Classification of SAR and Multispectral Imagery using Support Vector Machines
V. Heinzel, J. Franke, G. Menz
Assessment of differences in multisensoral remote sensing imageries caused by discrepancies in the relative spectral response functions 287

I. Aksit, K. Bünger, A. Fassbender, D. Frekers, Chr. Götze, J. Kemenas
An ultra-fast on-line microscopic optical quality assurance concept for small structures in an environment of man production 293

D. Hofmann, G. Linss
Application of Innovative Image Sensors for Quality Control 297

A. Jablonski, K. Kohrt, M. Böhm
Automatic quality grading of raw leather hides 303

M. Rosenberger, M. Schellhorn, P. Brückner, G. Linß
Uncompressed digital image data transfer for measurement techniques using a two wire signal line 309

R. Blaschek, B. Meffert
Feature point matching for stereo image processing using nonlinear filters 315

A. Mitsiukhin, V. Pachynin, E. Petrovskaya
Hartley Discrete Transform Image Coding 321

S. Hellbach, B. Lau, J. P. Eggert, E. Körner, H.-M. Groß
Multi-Cue Motion Segmentation 327

R. R. Alavi, K. Brieß
Image Processing Algorithms for Using a Moon Camera as Secondary Sensor for a Satellite Attitude Control System 333

S. Bauer, T. Döring, F. Meysel, R. Reulke
Traffic Surveillance using Video Image Detection Systems 341

M. A-Megeed Salem, B. Meffert
Wavelet-based Image Segmentation for Traffic Monitoring Systems 347

E. Einhorn, C. Schröter, H.-J. Böhme, H.-M. Groß
A Hybrid Kalman Filter Based Algorithm for Real-time Visual Obstacle Detection 353

U. Knauer, R. Stein, B. Meffert
Detection of opened honeybee brood cells at an early stage 359
# Mobile Communications

K. Ghanem, N. Zamin-Khan, M. A. A. Kalil, A. Mitschele-Thiel  
Dynamic Reconfiguration for Distributing the Traffic Load in the Mobile Networks  

N. Z.-Khan, M. A. A. Kalil, K. Ghanem, A. Mitschele-Thiel  
Generic Autonomic Architecture for Self-Management in Future Heterogeneous Networks  

N. Z.-Khan, K. Ghanem, St. Leistritz, F. Liers, M. A. A. Kalil, H. Kärst, R. Böringer  
Network Management of Future Access Networks  

St. Schmidt, H. Kärst, A. Mitschele-Thiel  
Towards cost-effective Area-wide Wi-Fi Provisioning  

A. Yousef, M. A. A. Kalil  
A New Algorithm for an Efficient Stateful Address Autoconfiguration Protocol in Ad hoc Networks  

M. A. A. Kalil, N. Zamin-Khan, H. Al-Mahdi, A. Mitschele-Thiel  
Evaluation and Improvement of Queueing Management Schemes in Multihop Ad hoc Networks  

M. Ritzmann  
Scientific visualisation on mobile devices with limited resources  

R. Brecht, A. Kraus, H. Krömker  
Entwicklung von Produktionsrichtlinien von Sport-Live-Berichterstattung für Mobile TV Übertragungen  

N. A. Tam  
RCS-M: A Rate Control Scheme to Transport Multimedia Traffic over Satellite Links  

Ch. Kellner, A. Mitschele-Thiel, A. Diab  
Performance Evaluation of MIFA, HMIP and HAWAII  

A. Diab, A. Mitschele-Thiel  
MIFAv6: A Fast and Smooth Mobility Protocol for IPv6  

A. Diab, A. Mitschele-Thiel  
CAMP: A New Tool to Analyse Mobility Management Protocols
11 Education in Computer Science and Automation

S. Bräunig, H.-U. Seidel
Learning Signal and Pattern Recognition with Virtual Instruments

St. Lambeck
Use of Rapid-Control-Prototyping Methods for the control of a nonlinear MIMO-System

R. Pittschellis
Automatisierungstechnische Ausbildung an Gymnasien

A. Diab, H.-D. Wuttke, K. Henke, A. Mitschele-Thiel, M. Ruhwedel
MAeLE: A Metadata-Driven Adaptive e-Learning Environment

V. Zöppig, O. Radler, M. Beier, T. Ströhla
Modular smart systems for motion control teaching

N. Pranke, K. Froitzheim
The Media Internet Streaming Toolbox

A. Fleischer, R. Andreev, Y. Pavlov, V. Terzieva
An Approach to Personalized Learning: A Technique of Estimation of Learners Preferences

N. Tsyrelchuk, E. Ruchaevskaia
Innovational pedagogical technologies and the Information educational medium in the training of the specialists

Ch. Noack, S. Schwintek, Ch. Ament
Design of a modular mechanical demonstration system for control engineering lectures
Hartley Discrete Transform Image Coding

IMAGE PROCESSING, IMAGE ANALYSIS AND COMPUTER VISION

The prevailing development vector in modern radio-electronic information-measuring systems (complexes) is the introduction of digital methods and processing, transformations and signaling. However the use of digital methods leads to an increase in a frequency bandwidth, reduction of the processing rate and the volume of transferred data. Traditional problems for digital systems are their speed and utilized algorithms. In part these problems can be resolved by the development of effective digital coding methods (compression) of information.

Information compression methods eliminate the redundancy of digital representation of the information. They represent a procedure of linear digital signal coding on the basis of discrete unitary transforms (discrete Fourier (DFT), Walsh-Hadamard (WHT), Haar, cosine (DCT), etc.).

This paper addresses the compression of video information (images) that is to be transmitted using two-dimensional digital signals, using the Hartley discrete orthogonal transform (DHT). The compression efficiency is estimated and compared with the presently used DCT and WHT.

In general the transformation coding is realized in two operations. The first operation is the linear transformation of the original data. The second operation reduces (selects) the transformation factors (transformants). The number of these transformants can be reduced by fixing some threshold level of values or by allocating the most informative zones in a floor of spatial frequencies of digital images. Below we describe the procedures of zone selection (filtration) of transformation factors with the use of DHT. The procedure of an efficient coding of two-dimensional digital signals is as follows:

1. A direct two-dimensional DHT of the original N x N image fragment is calculated. It can be represented the matrix form as
where \([g(n_1, n_2)]\) is the readout matrix of the image of size NxN; \([G(k_1, k_2)]\) - the NxN matrix of DHT factors; \([v(k, n)]\) - an NxN kernel of the DHT transform;

\[
[v(k, n)] = \left[ \cos \frac{2\pi kn}{N}, \sin \frac{2\pi kn}{N} \right], \quad k, n \in \{0, 1, \ldots, N-1\}
\]

The 2D reverse Hartley transform has the form of

\[
[g(n_1, n_2)] = \frac{1}{N} [v(k, n)]^T [G(k_1, k_2)] [v(k, n)].
\]

Transformation matrices of the direct and reverse DHT are identical, as \([v(k, n)] = [v(k, n)]^T\).

2. Zone filtration of transformant is being performed, which requires prior knowledge of the distribution function for a two-dimensional dispersion of transformation factors

\[
\text{diag}[\sigma^2] = \text{diag}[\tilde{K}_C] \otimes \text{diag}[\tilde{K}_R],
\]

where \(\otimes\) is the Kronecker product of matrices; \(\text{diag}[\tilde{K}_C] \otimes \text{diag}[\tilde{K}_R]\) - diagonal covariances matrices of transformation factors columns and rows respectively. Covariance matrices \(K_C\) and \(K_R\) in the field of originals and in the area of images are connected by transformation of similarity. Then \([\tilde{K}_C]\) and \([\tilde{K}_R]\) are defined from expressions

\[
[\tilde{K}_C] = [v(k, n)] [K_C] [v(k, n)]^T,
\]

\[
[\tilde{K}_R] = [v(k, n)] [K_R] [v(k, n)]^T.
\]

After lexicographic transformation of a matrix \(\text{diag}[\sigma^2]\) the matrix \([L]\), is formed, which defines the zone of transformant selection. Recovery of the original image fragments is performed by the reverse spectral transformation according to the dispersive criterion, where the kept transformants possess the greatest dispersions chosen by the filtration zone. The following example shows the estimation of quality of 8x8 fragment compression for the three transformations: DCT, DWAT, and investigated DHT.

**Example.** An input image fragment has the size of 8x8. The image is described by the Toeplitza distribution. The correlation factor \(p\) for adjacent readouts is set to 0.9. The covariance matrix for the fragment’s columns and rows and the DHT kernel (2) is as follows:
The covariance matrix in the area of images for columns and rows (5), (6) is equal to:

\[
K_C = K_R = \begin{pmatrix}
1 & 0.9 & 0.81 & 0.729 & 0.656 & 0.59 & 0.531 & 0.478 \\
0.9 & 1 & 0.9 & 0.81 & 0.729 & 0.656 & 0.59 & 0.531 \\
0.81 & 0.9 & 1 & 0.9 & 0.81 & 0.729 & 0.656 & 0.59 \\
0.729 & 0.81 & 0.9 & 1 & 0.9 & 0.81 & 0.729 & 0.656 \\
0.656 & 0.729 & 0.81 & 0.9 & 1 & 0.9 & 0.81 & 0.729 \\
0.59 & 0.656 & 0.729 & 0.81 & 0.9 & 1 & 0.9 & 0.81 \\
0.531 & 0.59 & 0.656 & 0.729 & 0.81 & 0.9 & 1 & 0.9 \\
0.478 & 0.531 & 0.59 & 0.656 & 0.729 & 0.81 & 0.9 & 1
\end{pmatrix}
\]

\[
\nu(k, n) := \begin{pmatrix}
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
1 & 1.414 & 1 & 0 & -1 & -1.414 & -1 & 0 \\
1 & 1 & -1 & -1 & 1 & 1 & -1 & -1 \\
1 & 0 & -1 & 1.414 & -1 & 0 & 1 & -1.414 \\
1 & -1 & 1 & -1 & 1 & 1 & -1 & -1 \\
1 & -1.414 & 1 & 0 & -1 & 1.414 & -1 & 0 \\
1 & -1 & -1 & 1 & 1 & -1 & 1 & -1 \\
1 & 0 & -1 & -1.414 & -1 & 0 & 1 & 1.414
\end{pmatrix}
\]

The covariance matrix in the area of images for columns and rows (5), (6) is equal to:

\[
\tilde{K}_C = \tilde{K}_R = \begin{pmatrix}
49.478 & -0.956 & 0 & 0.069 & 0 & -0.166 & -0.566 & -2.307 \\
-0.956 & 6.03 & 1.907 & 1.351 & 0.956 & 0.558 & -4.414 \times 10^{-3} & -1.351 \\
0 & 1.907 & 1.97 & 0.8 & 0.566 & 0.331 & 0 & -0.79 \\
0.069 & 1.351 & 0.8 & 1.06 & 0.402 & 0.235 & 6.56 \times 10^{-4} & -0.558 \\
0 & 0.956 & 0.566 & 0.402 & 0.706 & 0.166 & 0 & -0.396 \\
-0.166 & 0.558 & 0.331 & 0.235 & 0.166 & 0.589 & -1.586 \times 10^{-3} & -0.235 \\
-0.566 & -4.414 \times 10^{-3} & 0 & 6.56 \times 10^{-4} & 0 & -1.586 \times 10^{-3} & 0.838 & -0.011 \\
-2.307 & -1.351 & -0.79 & -0.558 & -0.396 & -0.235 & -0.011 & 3.328
\end{pmatrix}
\]

The diagonal covariance matrix for columns and rows is

\[
\text{diag}[\tilde{K}_C] = \text{diag}[\tilde{K}_R] = \begin{pmatrix}
49.478 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 6.03 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1.97 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1.06 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0.706 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0.589 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0.838 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 3.328
\end{pmatrix}
\]

From formula (4), a matrix of values can be obtained:
After the lexicographic transform of the matrix \( \text{diag}(\sigma^2) \) the matrix \([L]\) is formed as:

\[
\begin{pmatrix}
38.254 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 4.663 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1.522 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0.816 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0.544 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0.458 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0.649 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 2.573 & 0 & 0 \\
* & * & * & * & * & * & * & * & * & * \\
* & * & * & * & * & * & * & * & * & * \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.031 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.044 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.173
\end{pmatrix}.
\]

From the matrix \([L]\) it is possible to define the zone of the transformant filtration. For example, for the compression factor of 1.3 the zone has the following shape (the highlighted part of a matrix):

\[
\begin{pmatrix}
2448 & 298.352 & 97.472 & 52.447 & 34.931 & 29.143 & 41.463 & 164.663 \\
52.447 & 6.392 & 2.088 & 1.124 & 0.748 & 0.624 & 0.888 & 3.528 \\
34.931 & 4.257 & 1.391 & 0.748 & 0.498 & 0.416 & 0.592 & 2.35 \\
29.143 & 3.552 & 1.16 & 0.624 & 0.416 & 0.347 & 0.494 & 1.96 \\
41.463 & 5.053 & 1.651 & 0.888 & 0.592 & 0.494 & 0.702 & 2.789 \\
164.663 & 20.068 & 6.556 & 3.528 & 2.35 & 1.96 & 2.789 & 11.076
\end{pmatrix}.
\]

Distortions, resulting from the compression procedure, can be estimated by the mean-square error (MSE) of one signal readout, defined using the formula:
\[ \sigma^2 = \frac{1}{64} \left[ \sum_{i=0}^{7} \sum_{j=0}^{7} \sigma_{i,j} \right] \]

where \( i, j \) belong to the chosen zone of filtration. The coding efficiency estimate using a dispersive criterion is illustrated in Figure 1 and 2.

Table 1. Mean-square error of DCT, DHT and DWAT transforms

<table>
<thead>
<tr>
<th>( k )</th>
<th>1.1</th>
<th>1.3</th>
<th>1.63</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCT</td>
<td>0.0003422</td>
<td>0.001208</td>
<td>0.003208</td>
<td>0.005973</td>
<td>0.035</td>
</tr>
<tr>
<td>DHT</td>
<td>0.0006529</td>
<td>0.002231</td>
<td>0.006028</td>
<td>0.011</td>
<td>0.043</td>
</tr>
<tr>
<td>DWAT</td>
<td>0.0008346</td>
<td>0.002354</td>
<td>0.006042</td>
<td>0.009432</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Fig. 1: MSE as a function of compression factors with the correlation factor \( p = 0.9 \), image size of fragments is 8x8.

Fig. 2: MSE as a function of compression coefficient for a real fragment of the size of 8x8

Conclusion: Computing complexity of the fast DHT algorithm is lower than that of the fast DCT algorithm. Therefore, DHT compression might prove to be valuable for practical purposes.

References:


Authors:

Dr.-Ing. A. Mitsiukin
Dean,Ph.D. V. Pachynin
Dipl.-Ing. (FH) E. Petrovskaya
Company, street, P.O.B. Belarusian State University of Informatics & Radioelectronics, Brovka Str. 6
Zip code, city BY-220013, Minsk
Phone: 00375+172+938991
Fax: 00375+172+913908
E-mail:mityuhin @bsuir. by