

**Ain Shams University
Faculty of Engineering**

**Digital Image Processing of
Monochrome Television Pictures**

By

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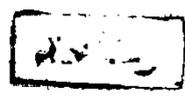
A THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science
in Electrical Engineering

32-38811
H.S.



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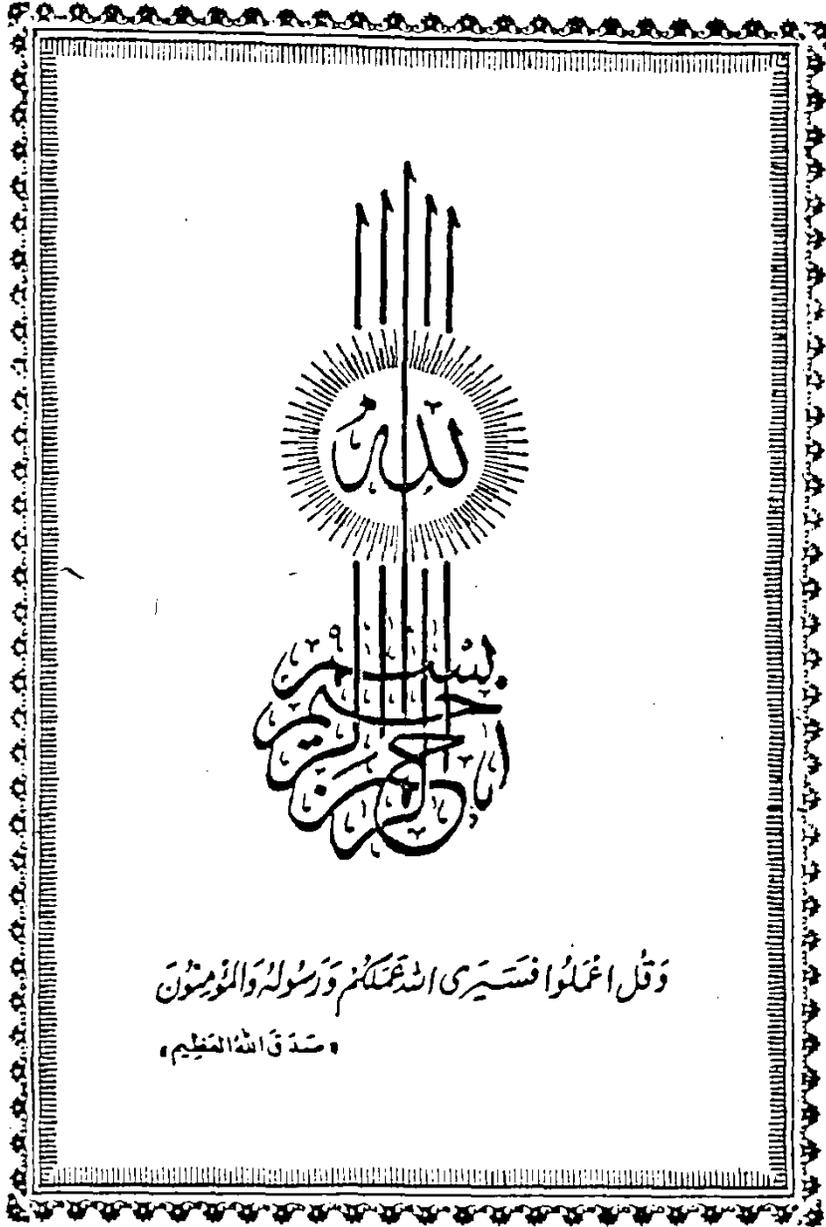
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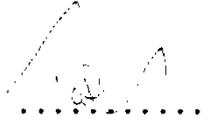
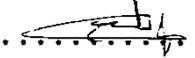
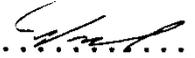
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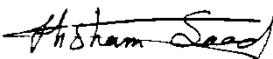
STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering.

The work included in this thesis was carried out by the author in the Department of Electronics and Computer Engineering, Ain Shams University, from 3 November 1986 to 30 April 1990.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institution.

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To My Parents . . .

With Love and Respect

ACKNOWLEDGEMENT

I wish to express my sincere gratitude, deepest thanks and appreciation to Professor Dr. Safwat Mahrous Mahmoud (Ain Shams University) and Maj. Gen. Professor Dr. Ahmed Dawood Hegazy (Military Technical College) for their faithful supervision, continuous encouragement, helpful discussions and valuable advise and care during the course of this accomplishment.

Finally, I wish to extend my very warm gratitude to my parents and family for their understanding, support and patience that made this work possible.

TABLE OF CONTENTS

ABSTRACT	VII
LIST OF SYMBOLS	VIII
LIST OF ABBREVIATIONS	X

CHAPTER 1 : INTRODUCTION	1
CHAPTER 2 : IMAGE CHARACTERIZATION	10
2.1 Continuous Image Representation	10
2.1.1 Two Dimensional Fourier Transform	11
2.1.2 Continuous Images As Random Fields	13
2.1.3 Statistical Characterization Of Continuous Images.	15
2.1.4 Homogeneous Random Fields.	16
2.2 Discrete Image Characterization.	17
2.2.1 Spatial Domain Image Sampling.	17
2.2.2 Digitizing Image Samples.	20
2.2.3 Vector Representation Of Discrete Images.	24
2.2.4 Statistical Characterization Of Discrete Images.	25
2.2.5 Image Structure And Modeling.	29
2.2.6 Discrete Image Processing, Compre- ssion And Reconstruction.	30
2.2.7 Image Subdivision For Transform coding.	33

CHAPTER 3 : TWO DIMENSIONAL DISCRETE TRANSFORMS.	37
3.1 Introduction.	37
3.2 Discrete Image Expansion Using Orthonormal Basis Images.	38
3.3 Unitary And Nonunitary Transforms.	40
3.4 Matrix Formulation Of 2D Transforms.	42
3.5 Two Dimensional Discrete Transforms.	45
3.5.1 The Fourier Transform.	46
3.5.2 The Cosine Transform.	48
3.5.3 The Sine Transform.	50
3.5.4 The Haar Transform.	50
3.5.5 The Slant Transform.	52
3.5.6 The Karhunen-Loeve Transform.	53
3.6 The Walsh-Hadamard Transform.	56
3.6.1 Definition Of The Walsh Functions	56
3.6.1.1 The Sequency Or Walsh Ordering.	59
3.6.1.2 The Dyadic Or Paley Ordering	61
3.6.1.3 The Hadamard Or Natural Ordering.	63
3.6.1.4 Walsh Spectral Analysis considerations.	65
3.6.2 Discrete Walsh-Hadamard Transforms	66
3.6.2.1 The Sequency Ordered WHT	67
3.6.2.2 The Paley Ordered WHT.	69
3.6.2.3 The Hadamard Ordered WHT.	69
3.6.2.4 Relations Between Different Transform Types.	70

3.6.3	Fast WHT Algorithms.	73
3.6.3.1	Fast Fourier-Hadamard Transform.	74
3.6.3.2	Fast SO-WHT Algorithms	77
3.6.4	Design, Computation, And Realization Of The SO-WHT	82
3.7	Statistical Characterization Of Image Transforms.	87
3.7.1	A Variance Model For The SO-WHT.	91
3.7.2	Probability Density Models For Image Transforms.	93
CHAPTER 4 : IMAGE QUANTIZATION AND CODING.		97
4.1	Introduction	97
4.2	Scalar Quantization.	98
4.2.1	Coding Of The Quantizer Outputs.	100
4.2.1.1	Types Of Equal Length codes.	100
4.2.1.2	Unequal Length Coding (Entropy Coding)	103
4.2.2	Calculation Of Quantization Error.	104
4.2.2.1	Computation Using Normalized Inputs.	107
4.2.3	PDF Optimized Uniform Quantizers.	109
4.2.4	PDF Optimized Nonuniform Quantizers.	111
4.3	Transmission Error Effects.	117
4.3.1	Total Reconstruction Error.	118
4.3.2	Quantizer Reoptimization For Noisy Channels.	119
4.4	Block Quantization And Bit Allocation.	120
4.4.1	Optimum Bit Allocation	124
4.4.1.1	Minimal Error Algorithm.	126

4.4.2 Suboptimum Bit Allocation.	128
4.4.2.1 Zonal Sampling.	128
4.4.2.2 Threshold Sampling.	129
4.5 Design Considerations For The SO-WHT Coding.	131
CHAPTER 5 : Design And Implementation Of The Imaging system	132
5.1 Introduction.	132
5.2 Hardware Organization Of The Imaging System.	132
5.2.1 The Digitizer-Coder-Transmitter Card	133
5.2.1.1 The Analog To Digital Conversion Stage.	136
5.2.1.2 Image Store-Process Memory Organization and addressing	136
5.2.1.3 The Program Memory Organization And Addressing.	138
5.2.1.4 Serial Output Stage.	138
5.2.2 The Receiver-Decoder-Display Card.	143
5.2.2.1 The Serial Output Stage.	143
5.2.2.2 The Program Memory Organization And Addressing.	144
5.2.2.3 Image Display-Process Memory Organization and Addressing.	144
5.2.2.4 The Digital To Analog Conversion And Display Stage.	146
5.2.3 The Program Development Interface Circuit.	150
5.2.4 Fabrication, Testing And Debugging.	154
5.3 Software Organization Of The Imaging System	155

5.3.1	Communication Protocol And Data Flow Control.	155
5.3.2	Software Organization Of The Transmitter.	158
5.3.2.1	The Memory Mapping And Main Program Flow	158
5.3.2.2	The Basic PCM Mode	162
5.3.2.3	The SO-WHT Transparent Mode	162
5.3.2.4	The Block Coding Mode	163
5.3.3	Software Organization Of The Receiver.	168
5.3.3.1	The Memory Mapping And Main Program Flow	169
5.3.3.2	The Receiver Self Test	173
5.3.3.3	The Basic PCM Mode	175
5.3.3.4	The SO-WHT Transparent Mode	175
5.3.3.5	The Block Coding Mode	175
CHAPTER 6 : ANALYSIS AND PERFORMANCE OF THE IMAGING SYSTEM		181
6.1	Introduction.	181
6.2	The Image Random Field	181
6.3	Block Coding Using The Minimal Error Algorithm.	189
6.4	Practical Block Coding Considerations	190
6.4.1	A Triangular PDF Model For The DC Coefficient Quantization	192
6.4.2	Gaussian Quantizer Design Considerations.	196
6.4.3	Image Quality Enhancement And Subjective Bit Modification.	197

6.5 The Block Coding Results.	199
6.6 A Comparison Between The PCM And Block Coded Images.	204
6.7 The System Performance Under The Presence Of Channel Noise.	208
6.4.1 Noise In The PCM Images.	209
6.4.2 Noise In The Block Coded Images.	209
6.8 Variance Modeling In The SO-WHT Domain	212
6.9 Conclusion.	215
CHAPTER 7 : CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK	216
APPENDIX I	220
APPENDIX II	221
APPENDIX III	230
APPENDIX IV	236
REFERENCES	237
ARABIC SUMMARY	240

ABSTRACT

This research deals with the theoretical and practical aspects for the transform compression of monochrome images.

The theory of digital image representation, transformation and processing has been introduced. A comparison between the different transforms has shown that the sequency ordered Walsh-Hadamard transform (SO-WHT) provides the best compromise between the computation complexity and the mean square coding error.

A study of different software algorithms of SO-WHT has shown that the Fast Fourier-Hadamard Transform (FFHT) with Gray coding and bit reversal provides the utmost speed efficiency. A study of the transform domain quantization and coding has shown that block coding using nonuniform Max quantizer gives the best image reconstruction compared to other compression strategies.

A practical microprocessor based digital communication system has been designed and implemented for the digitization, processing, transmission, reception and reconstruction of composite video still images digitized with 7 bits per pixel. It consists of two main boards fabricated using PCB technology with CAD design in addition to a digital RS 232 serial channel. It can be connected to the RS 232 port of any computer for image storage or retrieval. It operates in three modes: the basic PCM mode, the SO-WHT transparent mode and the compressed block coding mode. A block quantizer has been designed and optimized for the system based on the statistical measurements of 5 natural images. A triangular probability model has been suggested for the quantization of the first coefficient and a Gaussian model has been used for the other coefficients. Quantization was performed using a binary search algorithm. A packing algorithm was designed to adapt variable word length block codes to the RS 232 channel.

The reconstructed images have been compared to the original analog images and PCM images at 3 different bit rates: 1.7, 2 and 2.25 bits per pixel. It has been shown that 2 bits per pixel provides the best compromise between the image degradation and the compression factor in addition to a good picture quality. The effect of noise on both PCM and compressed images has been tested using a supplementary noise simulator. A sample of noisy images were shown under different signal to noise ratios and different noise effects.

The variance modeling in the transform domain has been carried out based on practical data. An exponential n-power law variance model with independent row and column weighting parameters has been suggested. It has been shown that a 0.3 law offers the best modeling formula and that the process exhibits more vertical correlation, which agrees with the mostly applicable conventions.

LIST OF SYMBOLS

$f(x, y)$	Continuous image function of the spatial variables
$F(\omega_x, \omega_y)$	Fourier transform of the spatial frequencies
$f(j, k)$	Digital image function of the spatial indices
p	One dimensional, row scanned spatial index.
\vec{r}	Image vector in the spatial domain
N	Number of pixels per total image row or column
b	Number of gray scale bits
G_{\max}	Total number of gray scale levels
N_b	Number of pixels per image block row or column
$c_f(\tau_j, \tau_k)$	Covariance function in the spatial domain
$\sigma_f^2(j, k)$	Variance function of the spatial indices
$\mu_f(j, k)$	Mean value of the spatial indices
$F(u, v)$	Image transform function of the transform indices
q	One dimensional, row scanned transform index
$\phi^{(u,v)}(j,k)$	Basis image of the transform indices (u, v)
$A_c(u, j)$	Column transform kernel
$A_R(v, k)$	Row transform kernel
$A(u,v; j,k)$	Two dimensional transform kernel
$R_m(t)$	Rademacher function of index "m"
$W(u, t)$	Continuous Walsh function
$Cal(u, t)$	Continuous Cosine-Walsh function
$Sal(u, t)$	Continuous Sine-Walsh function
$F_h(u, v)$	Hadamard ordered Walsh-Hadamard transform
$F_p(u, v)$	Paley ordered Walsh-Hadamard transform
$F_w(u, v)$	Sequency ordered Walsh-Hadamard transform