



**Silesian University
of Technology**

**FACULTY OF AUTOMATIC CONTROL, ELECTRONICS
AND COMPUTER SCIENCE**

**PROGRAMME: CONTROL, ELECTRONIC
AND INFORMATION ENGINEERING**

Master Thesis

**Improving the efficiency of lossless image compression
using extensions of Part 2 of the JPEG 2000 standard**

Author: Szymon Zosgórnik, BEng

Supervisor: Roman Starosolski, DSc PhD

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O Ś W I A D C Z E N I E

Wyrażam zgodę/nie wyrażam* zgody na udostępnienie mojej pracy dyplomowej/rozprawy doktorskiej*

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Abstract

Lorem ipsum...

Keywords: loseless image compression, image processing, JPEG 2000, discrete wavelet transform, entropy estimation, multithreading, modern c++

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Chapter 1. Introduction

1.1 Preface

The usage of digital images is constantly growing across whole world. There are multiple types of application where memory usage matters to the users. Image compression is a possible solution to this problem in some of these fields. For example it is mission critical component in medical and picture archiving and communication systems (PACSs). [13] There are two major types of such compression. The one is lossy variant and the other one is lossless. Applying lossy methods to the image can result in the occurrence of compression artifacts. However, there are applications where such disadvantage is negligible, e.g. natural images and photographs processing in Internet day-to-day usage. [3] On the other hand lossless image compression does not produce such artefacts, sacrificing some performance and bitrates optimizations. It is employed in mentioned before medical systems. Images used for the sake of diagnostics can be taken as an example. In some countries there are regulations that forbid applying lossy compression to such images. [13] Moreover, the usage of lossless variant is more desired when there exists some uncertainty whether information contained in the image can be discarded. In these scenarios not using any variant of compression can be the only substitute of lossless one. [13]

Taking into account mentioned before reasons, some compression algorithms have been introduced as ISO standards. [13] Some notable examples of such papers are PNG, JPEG and JPEG 2000 (often written as JP2). The latter was originally developed from 1997 to 2000 with the desire of expanding JPEG capabilities. The main feature of this standard is usage of discrete wavelet transform (DWT) instead of discrete cosine transform (DCT) which was introduced in the predecessor. [4] The other feature of JPEG 2000 are support for lossy and lossless compression. As can be described before, such compression is needed to be performed in mission critical systems such as medicine. Therefore, the JPEG 2000 standard is utilized in PACSs and Digital Imaging and Communications in Medicine DICOM standard. [13] This standard consist of 16 ISO parts which contain wide set of features. Some notable ones are core system coding and its extensions, motion images, testing and reference software. [4]

The successor of JPEG standard improved several aspects over its predecessor. With the usage of its algorithms, e.g. DWT, it was possible to improve compression performance over JPEG. Moreover, there are other improved areas with even greater importance. The few examples of such features are scalability and editability. [4] The JPEG 2000 standard supports both very low and very high rates of the compression. It comes crucial in applications that require such flexibility. Another main advantage of this standard is the ability of effective handling large range of bit rates. It allows to reduce number of steps taken in processing certain images in comparison to JPEG. As an example, reducing the number of bits in some image below certain amount using JPEG standard compliant solution requires reducing the resolution of the input at first. Only after this procedure encoding of the image can be applied. The JPEG 2000 standard supplies adequate feature named multiresolution decomposition structure which makes such transformation transparent and one step only. [4]

1.2 Objective of the project

- objective of the thesis

1.3 Scope of the thesis

- scope of the thesis

1.4 Thesis outline

- short description of chapters
- clear description of contribution of the thesis's author

Chapter 2. Problem analysis

2.1 Problem statement

- problem analysis, problem statement

2.2 Known solutions

- state of the art, literature research (all sources in the thesis have to be referenced)
- description of known solutions, algorithms

2.3 Thesis in scientific domain

- location of the thesis in scientific domain
- The title of this chapter is similar to the title of the thesis.

Chapter 3. Subject of the thesis

3.1 Solution to the problem

- solution to the problem proposed by the author of the thesis
- theoretical analysis of proposed solutions

3.2 Rationale of applied algorithms

- rationale of applied methods, algorithms, and tools

Chapter 4. Experiments

This chapter presents the experiments. It is a crucial part of the thesis and has to dominate in the thesis. The experiments and their analysis should be done in the way commonly accepted in the scientific community (eg. benchmark datasets, cross validation of elaborated results, reproducibility and replicability of tests etc).

4.1 Methodology

- description of methodology of experiments
- description of experimental framework (description of user interface of research applications – move to an appendix)

4.2 Data sets

- description of data sets

4.3 Results

- presentation of results, analysis and wide discussion of elaborated results, conclusions

Table 4.1: A caption of a table is **above** it.

ζ	method						
	alg. 1	alg. 2	alg. 3			alg. 4, $\gamma = 2$	
			$\alpha = 1.5$	$\alpha = 2$	$\alpha = 3$	$\beta = 0.1$	$\beta = -0.1$
0	8.3250	1.45305	7.5791	14.8517	20.0028	1.16396	1.1365
5	0.6111	2.27126	6.9952	13.8560	18.6064	1.18659	1.1630
10	11.6126	2.69218	6.2520	12.5202	16.8278	1.23180	1.2045
15	0.5665	2.95046	5.7753	11.4588	15.4837	1.25131	1.2614
20	15.8728	3.07225	5.3071	10.3935	13.8738	1.25307	1.2217
25	0.9791	3.19034	5.4575	9.9533	13.0721	1.27104	1.2640
30	2.0228	3.27474	5.7461	9.7164	12.2637	1.33404	1.3209
35	13.4210	3.36086	6.6735	10.0442	12.0270	1.35385	1.3059
40	13.2226	3.36420	7.7248	10.4495	12.0379	1.34919	1.2768
45	12.8445	3.47436	8.5539	10.8552	12.2773	1.42303	1.4362
50	12.9245	3.58228	9.2702	11.2183	12.3990	1.40922	1.3724

Chapter 5. Summary

5.1 Results

- synthetic description of performed work

5.2 Conclusions

- conclusions
- Has the objective been reached?

5.3 Future development

- Future development, potential future research

Appendices

Technical documentation

List of abbreviations and symbols

JPEG Joint Photographic Experts Group

PNG Portable Network Graphics

PACSs Picture Archiving and Communication Systems

DICOM Digital Imaging and Communications in Medicine

ISO International Organization for Standardization

DCT Discrete Cosine Transform

DWT Discrete Wavelet Transform

N cardinality of data set

μ membership function of a fuzzy set

\mathbb{E} set of edges of a graph

\mathcal{L} Laplace transformation

Contents of attached CD

The thesis is accompanied by a CD containing:

- thesis (pdf file),
- source code of applications,
- data sets used in experiments.

List of Figures

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List of Tables

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