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Information technology — JPEG DNA Media storage based on DNA —

Part 1: Core coding system

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at https://www.iso.org/members.html and https://www.iec.ch/national-committees.

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Introduction

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document may involve the use of patents.

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Information technology — JPEG DNA Media storage based on DNA —

Part 1:
Core coding system

1 Scope

This document defines the syntax and an accompanying decompression process that is capable of representing bi-level, continuous-tone grey-scale, continuous-tone colour, or multichannel digital samples in a format representing nucleotide sequences for supporting DNA storage.

This document:

— specifies decoding processes for converting nucleotide sequences to reconstructed image data;

— provides guidance on encoding processes for converting source image data to the format representing nucleotide sequences.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 18181-1, *Information technology — JPEG XL image coding system — Part 1: Core coding system*

ITU-T Recommendation T.801, | *ISO/IEC 15444-2, Information technology — JPEG 2000 image coding system — Part 2: Extensions*

IETF RFC 5053:2007, *Raptor Forward Error Correction Scheme for Object Delivery*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org

3.1.1
bit
binary choice encoded as either 0 or 1

3.1.2
byte
group of 8 bits

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3.1.3
codestream
compressed image data representation that includes all necessary data to allow a (full or approximate) reconstruction of the sample values of a digital image

3.1.4
compression
process of reducing the number of bits used to represent source image data

3.1.5
continuous-tone image
image whose components have more than one bit per sample

3.1.6
decoder
embodiment of a decoding process

3.1.7
decoding process
process which takes as its input an image file and outputs a continuous-tone image

3.1.8
encoder
embodiment of an encoding process

3.1.9
encoding process
process which outputs compressed image data in the form of a codestream

3.1.10
encoding symbol
symbol included in a data packet

3.1.11
entropy decoder
embodiment of an entropy decoding procedure

3.1.12
entropy decoding
lossless procedure which recovers the sequence of symbols from the sequence of bits produced by the entropy encoder

3.1.13
entropy encoder
embodiment of an entropy encoding procedure

3.1.14
entropy encoding
lossless procedure which converts a sequence of input symbols into a sequence of bits such that the average number of bits per symbol approaches the entropy of the input symbols

3.1.15
error correcting codes
techniques used to detect and correct errors that can occur during DNA synthesis, storage, or sequencing

3.1.16
grayscale image
continuous-tone image that has only one component

3.1.17
header section
portion of the encoded DNA containing the information required for the correct decoding of the main section

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3.1.18
image file
binary data that contains pixel values of an image that can include corresponding meta-data

3.1.19
lossless
descriptive term for encoding and decoding processes and procedures in which the output of the decoding procedure(s) is identical to the input to the encoding procedure(s)

3.1.20
lossless coding
mode of operation which refers to any one of the coding processes defined in this document in which all of the procedures are lossless

3.1.21
lossy
descriptive term for encoding and decoding processes which are not lossless

3.1.22
main section
portion of the encoded DNA containing the larger bulk of data representing the compressed input image

3.1.23
nucleotide
basic structural unit of DNA. Nucleotides are the building blocks of DNA molecules, and their sequence forms the basis for encoding genetic and digital information

3.1.24
oligo
short, synthetic DNA or RNA molecules (typically a few hundred of nucleotides in length) that can be chemically synthesized with a specific sequence

3.1.25
packet
segment of the codestream containing entropy coded information on a single precinct, line and a subset of the bands within this precinct and line

3.1.26
procedure
set of steps which accomplishes one of the tasks which comprise an encoding or decoding process

3.1.27
redundancy
intentional inclusion of extra copies of data or error correction information in a DNA data storage system to improve data reliability and facilitate error correction

3.1.28
repair symbol
encoding symbols sent for a source block that are not the source symbols

3.1.29
sample
one element in the two-dimensional image array which comprises a component

3.1.30
sequencing
process of determining the precise order of nucleotides (A, C, T and G) in a DNA molecule

3.1.31
source block
block of source symbols that are considered together for Raptor encoding purposes

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3.1.32
source symbol
smallest unit of data used during the encoding process

3.1.33
symbol
unit of data

3.1.34
symbol size
size, in bytes, of a symbol

3.2 Abbreviated terms

BDI	binary error-correcting decoder indicator
DNA	deoxyribonucleic acid
ESI	encoding symbol ID
IDI	image decoder indicator
JPEG	The informal name of the committee which created this document, the “joint” comes from the ITU-T and ISO/IEC collaboration
JPEG DNA	informal name of this standard
NDI	nucleotide decoder indicator
nt	nucleotide
SBN	source block number

3.3 Symbols

F	Image file length in bytes
K	Number of source symbols per block
T	Symbol size in bytes

4 Conventions

4.1 Conformance language

This document consists of normative and informative text.

Normative text is that text which expresses mandatory requirements. The word “shall” is used to express mandatory requirements strictly to be followed in order to conform to this document and from which no deviation is permitted. A conforming implementation is one that fulfils all mandatory requirements.

Informative text is text that is potentially helpful to the user, but not indispensable and can be removed, changed or added editorially without affecting interoperability. All text in this document is normative, with the following exceptions: the Introduction, any parts of the text that are explicitly labelled as “informative”, and statements appearing with the preamble “NOTE” and behaviour described using the word “should”. The word “should” is used to describe behaviour that is encouraged but is not required for conformance to this document.

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