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Colour and gray-scale image representations using lossless coding scheme for facsimile

ITU-T Recommendation T.43

(Previously CCITT Recommendation)

ITU-T T-SERIES RECOMMENDATIONS

TERMINALS FOR TELEMATIC SERVICES

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ITU-T RECOMMENDATION T.43

COLOUR AND GRAY-SCALE IMAGE REPRESENTATIONS USING LOSSLESS CODING SCHEME FOR FACSIMILE

Summary

This Recommendation defines a colour data representation method in order to make it possible to interchange colour and gray-scale image data using Recommendation T.82 coding scheme over facsimile communication services such as Group 3 and Group 4 facsimile. In this Recommendation, three types of images are treated. The first one is one bit per colour CMY(K) or RGB image. The second one is palettized colour image in which palette tables are specified with CIELAB colour space defined in Recommendation T.42. The last one is continuous-tone colour and gray-scale image specified with CIELAB colour space defined in Recommendation T.42.

Source

ITU-T Recommendation T.43 was prepared by ITU-T Study Group 8 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 2nd of July 1997.

FOREWORD

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The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, the ITU had/had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

COLOUR AND GRAY-SCALE IMAGE REPRESENTATIONS USING LOSSLESS CODING SCHEME FOR FACSIMILE

(Geneva, 1997)

1 Scope

This Recommendation defines colour and gray-scale image representation and their coding schemes in order to make it possible to interchange colour and gray-scale image data such as one bit per colour CMY(K) or RGB image, palettized colour image, and/or continuous-tone colour and gray-scale image, using lossless coding scheme over a facsimile communication service such as Group 3 or Group 4 facsimile.

Its purpose is to specify representation and lossless coding schemes for three types of colour and gray-scale images. The first one is one bit per colour CMY(K) or RGB image. The second one is palettized colour image. The last one is continuous-tone colour and gray-scale image.

This Recommendation, together with documents such as parts of Recommendations T.4 and T.30, or T.563, T.503 and T.521, will define a colour image data format that may be used by colour facsimile service and by other telematic services.

In this Recommendation, the coding scheme specified in Recommendation T.82 (JBIG) is used for lossless encoding of these three types of colour and gray-scale images. Application of other coding schemes are for further study.

2 Field of application

This Recommendation defines a colour data representation and coding scheme which mainly enables a receiver to reproduce colour image data as specified by the sender.

It is assumed that when a service is performed using this Recommendation, all non-basic features are subject to negotiation.

3 References

The following ITU-T Recommendations and other references contain provisions which, througth reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

– ITU-T Recommendation T.42 (1996), *Continuous-tone colour representation method for facsimile*.

– ITU-T Recommendation T.82 (1993) | ISO/IEC 11544:1993, *Information technology – Coded representation of picture and audio information – Progressive bi-level image compression*. (Commonly referred to as JBIG standard)

4 Definitions

The definitions in Recommendations T.42 and T.82 apply to this Recommendation unless explicitly amended.

4.1 JBIG: Joint Bi-level Image Experts Group, and also shorthand for the encoding method, described in Recommendation T.82, which was defined by this group.

5 Conventions

The conventions in Recommendations T.42 and T.82 apply to this Recommendation.

6 Image representation method

6.1 Overview

In this Recommendation, the representation methods for three types of colour and gray-scale images that require lossless coding scheme are defined. The first one is one bit per colour CMY(K) or RGB image. The second one is palettized colour image. The last one is continuous-tone colour and gray-scale image. Some of these images are electronically created under the soft-copy environment. Others may be obtained using scanner and image processing techniques such as the dither method.

As the palettized colour image mode may require accurate reproduction in some cases, this mode has to have accurate colour reproduction possibility. Therefore, the colour palette table data of this mode are specified by the device-independent interchange colour space defined in Recommendation T.42. On the other hand, one bit per colour image mode is specified mainly to reproduce colour image using primary colours.

The following represents an example for the use of one bit per colour CMY(K) or RGB mode:

– A sender creates or generates an original colour image with three or four colour components and one bit per colour component using scanner and image processing techniques such as dither. Each bit-plane indicates the on/off of one of the primary colours. The sender encodes this image using lossless encoding method such as Recommendation T.82 (JBIG). The sender then sends the encoded data with the indication of this mode. The receiver receives the data and represents the image on the CRT (soft-copy) or printer (hard-copy) using their own primary colours. Although the sender adds the information about sender's primary colours and the receiver has high reproduction ability, the receiver may not reproduce the accurate colour image, because the tone reproduction property of the printer depends not only on primaries but also on pel recording size.

The following represents an example for the use of palettized colour image mode:

– A sender creates an original colour image using a colour palette in which table data are specified by a specific device-dependent colour space. This colour space may depend on the primaries, white point and gamma of the sender's CRT. The sender converts the device-dependent colour palette to the palette interchange colour space in which table data are specified by the device-independent colour space defined in Recommendation T.42. The sender then sends the interchange colour palette and the image data encoded with a lossless encoding method such as Recommendation T.82 (JBIG). The receiver receives the interchange colour palette and the encoded image data. The interchange colour palette is converted to the receiver-specific colour palette, which is specified by the receiver's device-dependent hard-copy or soft-copy colour space.

The following represents an example for the use of lossless encoded continuous-tone colour image mode:

– A sender creates or generates an original continuous-tone colour or gray-scale image in the colour space defined in Recommendation T.42. In some high-end applications, they need lossless transmission of these images. This Recommendation supports lossless encoding of these images using, such as Recommendation T.82 (JBIG). In order to obtain high data compression ratio using the lossless encoding methods, Gray code conversion technique is introduced.

6.2 Colour representation

Colour representation defines colour image specification method. In this subclause, three types of colour representation methods are defined.

6.2.1 One bit per colour CMY(K) or RGB image representation

In this mode, the colour image is treated as one bit per colour component type image using CMY(K) or RGB primaries. In one bit per colour type image in three colour primaries (CMY or RGB) or in four colour primaries (CMYK), each bit-plane expresses the following colour primaries as shown in Tables 1 to 3.

Table 1/T.43 – Colour table for one bit per colour "CMYK" image

Bit-plane	Colour primaries
MSB	Cyan
LSB+2	Magenta
LSB+1	Yellow
LSB	Black

Table 2/T.43 – Colour table for one bit per colour "CMY" image

Bit-plane	Colour primaries
MSB	Cyan
LSB+1	Magenta
LSB	Yellow

Table 3/T.43 – Colour table for one bit per colour "RGB" image

Bit-plane	Colour primaries
MSB	Red
LSB+1	Green
LSB	Blue

6.2.2 Palettized colour image representation

Palettized colour images are expressed by indices of 12 bits or less or optionally 13 to 16 bits. The corresponding colour information of each index is given by the colour palette table, in which each entry consists of three component colour coordinates in CIELAB colour space. Each component of the colour coordinate is represented by 8 bits or 12 bits value specified by Recommendation T.42. A colour palette example that has 236 entries and each component is represented by 8 bits precision is shown in Table 4. A colour palette example that has 128 entries and each component is represented by 12 bits precision is shown in Table 5.

6.2.3 Continuous-tone colour and gray-scale image representation

In this mode, the colour image is represented by CIELAB colour space specified in Recommendation T.42 and the gray-scale image is represented by L* component of CIELAB colour space specified in Recommendation T.42. Each component has 8 bits or less or optionally 9 to 12 bits precision. The data structure for this mode is defined for lossless encoding method. In order to obtain high encoding data efficiency, Gray code conversion is used. Currently sub-sampling is not supported in this Recommendation.

Table 4/T.43 – Colour palette table example for 236 entries and 8 bit accuracy

Index	Component values (8 bits)		
	L^*	a^*	b^*
0	255	128	96
1	0	128	96
2	128	128	96
–	–	–	–
–	–	–	–
–	–	–	–
235	220	128	220

Table 5/T.43 – Colour palette table example for 128 entries and 12 bit accuracy

Index	Component values (12 bits)		
	L^*	a^*	b^*
0	4095	2048	1536
1	0	2048	1536
2	2048	2048	1536
–	–	–	–
–	–	–	–
127	3520	2048	3520

7 Data structure specification

7.1 Overview

Lossless encoding method such as JBIG can be used as a coding scheme for colour and gray-scale images. In this encoding, an image is resolved into a set of bit-planes, and each bit-plane is coded by lossless encoding method. In resolving an image into bit-planes, Gray code conversion is only used for continuous-tone image. This data structure is defined as BCIE (Bit-plane Colour Image Entity) consisting of BCIH (Bit-plane Colour Image Header), BCID (Bit-plane Colour Image Data) and ending marker (X'FFA9') as shown in Figure 1.

BCIH	BCID	Ending marker

Figure 1/T.43 – Data structure of BCIE

7.2 BCIH structure and entry classification

7.2.1 BCIH structure

The structure of BCIH (Bit-plane Colour Image Header) is specified in Figure 2. BCIH consists of Magic Number X'FFA8' and two or more entries. G3FAX0/G4FAX0 entry and ECIH (End of Colour Image Header) entries are mandatory. Each entry consists of Entry Marker X'FFE1' or X'FFE3', entry length, FAX identifier *n* and entry data. Format of each entry is specified in the subsequent subclauses.

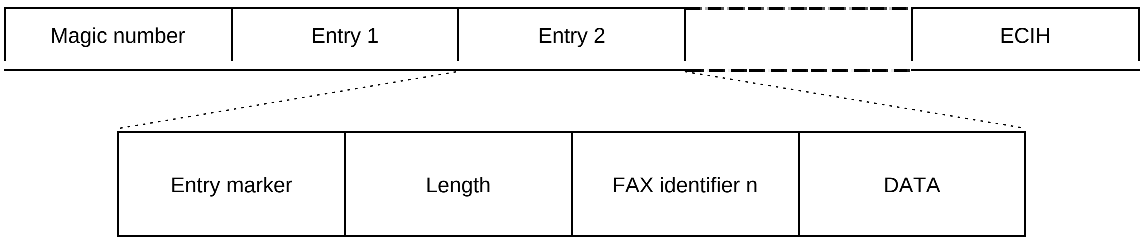

Figure 2/T.43 – Data structure of BCIH

7.2.2 Definition of entries

7.2.2.1 Entry marker

The entry marker X'FFE1' or X'FFE3' will initiate identification of the entry. Marker X'FFE1' is the same code used in JPEG colour fax as 'APP1' and used when length indication is two octet space. Marker X'FFE3' is used when length indication requires four octet space. Each entry is identified by the FAX identifier N. The FAX identifier N is 6 octets value X'47', X'3m', X'46', X'41', X'58', X'n', where m equals 3 or 4 and n equals 0 to maximum X'FF' (255).

7.2.2.2 G3FAX0/G4FAX0 entry

The magic number of the BCIH and this entry uniquely identifies the image data encoded by lossless coding scheme for colour and gray-scale image FAX application. It defines the version, image size, spatial resolution, encoding method, image type, interleave and number of bits. This entry is mandatory. The data format is as follows:

X'FFE1'(Entry marker), length, FAX-identifier 0, version, image size, spatial resolution, coding method, image type, interleave, number of bits.

The above terms are defined as follows:

Length: (2 octets) Total G3FAX0/G4FAX0 entry field octet count including the octet count itself, but excluding the entry marker.

FAX-identifier 0: (6 octets) X'47', X'3m', X'46', X'41', X'58', X'00' (m = 3 or 4). This identifier specifies G3FAX0/G4FAX0 entry.

Version: (2 octets) X'07CD'. This string specifies the year of approval of the standard, for identification in the case of future revision (for example, 1997).

Spatial resolution: (2 octets) Pixel density in pels/25.4 mm. The basic value is 200. Allowed values are 200, 300 and 400.

Coding method: (1 octet) The value of this parameter specifies the type of lossless coding method.

0: JBIG (see 7.3.2.1.1)

In this Recommendation, only "0: JBIG" is allowed. Other numbers are for further study.

Image type: (1 octet) The value of this parameter specifies the image type:

- 0: 1 bit/colour image (using RGB primaries);
- 1: 1 bit/colour image (using CMY primaries);
- 2: 1 bit/colour image (using CMYK primaries);
- 16: Palettized colour image (using CIELAB 8 bits/component precision table);
- 17: Palettized colour image (using CIELAB 12 bits/component precision table);
- 32: Gray-scale image (using L*);
- 48: Continuous-tone colour image (using CIELAB).

Number of bits: (4 octets) The value of this parameter specifies the number of bit-planes. For 1 bit/colour image, palettized image and gray-scale images, the first octet of this parameter specifies the total bit-planes. For continuous-tone colour image, the first octet specifies the number of bit-planes of the first colour component, the second, third and fourth octets specify the second, third and fourth colour components respectively. For example, 1 bit/colour (CMYK) case will be defined as X'04', X'00', X'00', X'00'. The 9 bits entries palette colour case will be defined as X'09', X'00', X'00', X'00'. And the colour continuous-tone using 7 bits for L*, 4 bits for a* and 4 bits for b* case will be defined as X'07', X'04', X'04',X'00'.

Following is an example of the string including the Magic Number and Entry Marker for JBIG coded 1997 G4FAX application at 200 pels/25.4 mm, gray-scale, 12 bits/pel:

Example Code String:

X'FFA8'	X'FFE1'	X'0012'	X'47', X'34', X'46', X'41', X'58', X'00'	X'07CD'
Magic Number	Entry Marker	length	FAX identifier 0 " G4FAX '0' "	version

X'00C8'	X'00'	X'20'	X'0C' X'00' X'00' X'00'
res. 200	JBIG	gray	12 bit-planes

7.2.2.3 ECIH entry

A special entry, the ECIH entry, is used to signal the end of the bit-plane colour image header. No additional entries may follow the ECIH entry. The identifier is followed immediately by the compressed image data. This entry is mandatory. The data format is as follows:

X'FFE1'(Entry Marker), length, FAX identifier 255.

Length: (2 octets) Total ECIH entry field octet count, X'08', including the octet count itself, but excluding the Entry Marker**.**

FAX identifier 255: (6 octets) X'47', X'3m', X'46', X'41', X'58', X'FF' (m = 3 or 4). This identifier specifies ECIH entry.

7.2.2.4 G3FAX/G4FAX option entries

G3FAX/G4FAX option identifiers defined as G3FAX1/G4FAX1 for gamut range and G3FAX2/G4FAX2 for illuminant data defined in B.8.3.1/T.503 and in B.8.3.2/T.503 or in E.6.6/T.4 and in E.6.7/T.4 are also applicable to this Recommendation. G3FAX3/G4FAX3 optional identifier is defined for colour palette table. From G3FAX4/G4FAX4 to G3FAX254/G4FAX254 are reserved for future use.

7.2.2.4.1 G3FAX3/G4FAX3 entry for colour palette table

Colour palette table is specified using the Entry Marker X'FFE3' as follows:

X'FFE3'(Entry Marker), length (4 octets), FAX identifier 3, table ID, $t_{entries}$, colour table data.

Length: (4 octets) Total G3FAX3/G4FAX3 entry field octet count including the octet count itself, but excluding the Entry Marker.

FAX identifier 3: (6 octets) X'47', X'3m', X'46', X'41', X'58', X'03' (m = 3 or 4) This identifier specifies G3FAX3/G4FAX3 entry.

Table ID: (2 octets) This specifies the type of colour palette table.

0: table specified in CIELAB space (8 bits/comp. precision)

4: table specified in CIELAB space (12 bits/comp. precision).

$T_{entries}$: (4 octets) It specifies the number of the colour palette table entries. This value should have the following relations:

N: Number of bits specified in G3FAX0/G4FAX0.

mb: octets/component in the table:

1: 8 bits precision

2: 12 bits precision

$2^{**}(N - 1) < t_{entries} \leq 2^{**}N$

length = $16 + (3 * t_{entries} * mb)$.

Colour table data: $((3 * t_{entries} * mb)$ octets) This data consists of $t_{entries}$ colour palette table entries. Each table entry which consists of 3 components, is in sequential order from index = 0 to index = $t_{entries} - 1$. Each component consists of one or two octets value. Its length is specified by the table ID. Each component value is represented by CIELAB space defined in Recommendation T.42. The representation method is specified in 6.2.2.

Following is an example of the string for the colour palette table for Table 4. It assumes that the table is specified in CIELAB space (8 bit/comp. precision), $t_{entries} = 236$:

Example Code String:

X'FFE3' Entry Marker	X'000002D4' length	X'47', X'33', X'46', X'41', X'58', X'03' FAX-identifier " G3FAX '3' "	X'0000' table ID = 0	X'000000EC' $t_{entries} = 236$
X'FF', X'80', X'60' index = 0 (255,128,96)	X'00', X'80', X'60' index = 1 (0,128,96)	X'80', X'80', X'60' index = 2 (128,128,96)	... ...	X'DC', X'80', X'DC' index = 235 (220,128,220)

Following is an example of the string for the colour palette table for Table 5. It assumes that the table is specified in CIELAB space (12 bit/comp. precision), $t_{entries} = 128$:

Example Code String:

X'FFE3' Entry Marker	X'00000310' length	X'47', X'34', X'46', X'41', X'58', X'03' FAX-identifier " G4FAX '3' "	X'0004' table ID = 4	X'00000080' $t_{entries} = 128$
X'0FFF', X'0800', X'0600' index = 0 (4095,2048,1536)	X'0000', X'0800', X'0600' index = 1 (0,2048,1536)	X'0800', X'0800', X'0600' index = 2 (2048,2048,1536)	... ...	X'0DC0', X'0800', X'0DC0' index = 127 (3520,2048,3520)

7.3 BCID structure and application rule for encoding scheme

BCID (Bit-plane Colour Image Data) field contains only coded image data. For JBIG coding method, it contains BIE (Bi-level Image Entity) that consists of BIH (Bi-level Image Header) and BID (Bi-level Image Data).

7.3.1 Gray code conversion

In encoding the images specified in this Recommendation by bi-level coding method such as JBIG, an image is resolved into a set of bit-planes, and each bit-plane is coded by this coder. In resolving an image into bit-planes, Gray code conversion is only used for continuous-tone images, specified as image type 32 or 48 in the G3FAX0/G4FAX0 entry.

7.3.1.1 Gray code and natural binary code

The conversion between natural binary code and Gray code is as follows: if the MSB in natural binary code is zero, the MSB in Gray code is zero. Similarly, if the MSB in natural binary code is one, the MSB in Gray code is one. Then, checking the pair bits with the lower bit starting from MSB in natural binary code, each transition (0-to-1, and 1-to-0) produces a "1", each non-transition produces a "0". For example, 13, expressed as (1011) in natural binary code, is expressed as (1110) in Gray code (1 ≥ 1, 1-to-0 ≥ 1, 0-to-1 ≥ 1, 1-to-1 ≥ 0). The following express the relation between two corresponding representations:

$(a_1, a_2, ..., a_i, ..., a_{n-1}, a_n)$ and in Gray code $(b_1, b_2, ..., b_i, ..., b_{n-1}, b_n)$ for n-bit integer N.

1) Conversion from natural binary code to Gray code:

$b_1 = a_1$

$b_i = a_i \text{ EXOR } a_{i-1} \quad i \geq 2$

2) Conversion from Gray code to natural binary code:

$a_1 = b_1$

$a_i = b_i \text{ EXOR } a_{i-1} \quad i \geq 2$ EXOR means exclusive OR.

7.3.1.2 Example of Gray code representation

The following table is the comparison of natural binary and Gray code representation for 4 bits integer.

Tableau 6/T.43 – The comparison of natural binary code and Gray code for 4 bits integer

Natural number (N)	Natural binary code	Gray code
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111
11	1011	1110
12	1100	1010
13	1101	1011
14	1110	1001
15	1111	1000

7.3.2 Usage of T.82 encoding scheme (JBIG)

The BCID (Bit-plane Colour Image Data) field contains only coded image data. For the JBIG coding method, it contains BIE (Bi-level Image Entity) that consists of BIH (Bi-level Image Header) and BID (Bi-level Image Data). Object identifier of this coding T.43 is specified as {0 0 20 43 0}. In order to simplify the colour facsimile standard, only single progression sequential mode is currently supported. Any other modes are left for further study. This subclause gives a description of the JBIG data structure.

7.3.2.1 BIH and marker classification

The rule of parameter setting in BIH for colour facsimile standard is specified in the following subclause. Marker classification is specified in Recommendation T.82.

7.3.2.1.1 Parameters in BIH

The BIH specifies encoded data structure and coding parameters. Parameters in BIH are precisely specified in Recommendation T.82. Table 7 shows the rule of parameter setting for colour facsimile standard.

Table 7/T.43 – Parameter setting rule for applying Recommendation T.82 to colour and gray-scale image

Parameter	Meaning	Value	Note
D_L	Initial layer to be transmitted	0 fixed	
D	Number of differential layers	0 fixed	
P	Number of binary-planes	1 to 36	(Note 1)
X_D	Horizontal image size at layer D	–	(Note 4)
Y_D	Vertical image size at layer D	full range of T.82	
L_0	Lines per stripe at the lowest resolution	BASIC: 128 OPTION: 1 to Y_D	(Note 6)
M_X	Maximum horizontal offset allowed for AT pixel	0 to 127	
M_Y	Maximum vertical offset allowed for AT pixel	0 fixed	
HITOLO	Transmission order of differential layers	0 fixed	(Note 2)
SEQ	Indication of progressive-compatible sequential coding	0 fixed	(Note 3)
ILEAVE	Interleaved transmission order of multiple bit-plane	1 fixed	(Note 3)
SMID	Transmission order of stripes	0/1	(Note 3)
LRLTWO	Model template type	0/1	0: 3-line template 1: 2-line template
VLENGTH	Indication of possible use of NEWLEN marker segment	0/1	0: NEWLEN is not used 1: NEWLEN may be used (Note 5)

Table 7/T.43 – Parameter setting rule for applying Recommendation T.82 to colour and gray-scale image *(concluded)*

Parameter	Meaning	Value	Note
TPDON	Use of typical prediction for differential layers	0 fixed	(Note 2)
TPBON	Use of typical prediction for lowest-resolution-layer	0/1	0: OFF 1: ON
DPON	Use of Deterministic Prediction	0 fixed	(Note 2)
DPPRIV	Use of private DP table	0 fixed	(Note 2)
DPLAST	Use of last DP table	0 fixed	(Note 2)

NOTE 1 – In Recommendation T.82, P specifies number of bit-planes. But in colour facsimile application, P specifies the number of binary-planes which means the total number of bit-planes in all colour planes. Since the maximum value of bit-planes per colour component is 12, and the maximum value of colour component is three, the maximum value of P is 36.

NOTE 2 – These parameters are not applied in single-progression sequential coding. Transmitter shall set "0" to these unused parameters. It is not necessary to recognize these parameters at receiver.

NOTE 3 – These parameters are used for interleaving in multiple-level coding.

NOTE 4 – Parameter X_D, horizontal image size, shall conform to the values defined in clause 2/T.4 for Group 3 facsimile and clause 3/T.563 for Group 4 facsimile.

NOTE 5 – For details, see 6.2.6.2/T.82.

NOTE 6 – When using this Recommendation, BASIC is 128. OPTIONS shall be negotiated by the appropriate facsimile protocols.

7.3.2.2 Interleave

In the JBIG coding, interleaving format is identified by the order of three loops: Stripe, Bit-plane, and Resolution. The order of loops is expressed with the combination of three binary JBIG header parameters: SEQ, ILEAVE, and SMID. In colour facsimile application, colour plane and bit-plane are merged into larger binary-plane loop, and the colour plane is put to the outer loop and bit-plane is put to the inner loop. The order of resolution is put to the outest loop considering the possible extension to future progressive mode.

Considering the above assumptions, possible interleaving schemes are restricted to the following:

1) Plane interleave: The order of loops from outer side is (Resolution, Plane, Stripe).

2) Stripe interleave: The order of loops from outer side is (Resolution, Stripe, Plane).

The corresponding JBIG Header parameters are (SEQ = 0, ILEAVE = 1, SMID = 0) for (1), and (SEQ = 0, ILEAVE = 1, SMID = 1) for (2).

Plane interleave may require full image size of memory at the transmitter, and require the same size of memory at the receiver for any printing systems as long as (L,a,b) colour space is used. (If CMY colour space will be specified in a future, colour plane memories can be saved at the receiver in thermal transfer or similar printing systems. It needs only one set of statistics memories for coding.)

Stripe interleave requires only stripe-size memory at the transmitter, and also requires same size memory at the receiver for the ink jet or similar printing systems. However, the number of set of statistics memories for coding will correspond to the number of binary-planes to be coded, as long as SDNORM termination is used.

The basic interleave scheme is stripe interleave and 128 line/stripe can be used without negotiation. Other stripe sizes, for example, 256, 512, 1024 lines in stripe interleave, are for further study. Plane interleave can be used with negotiation, and any stripe size can be used.

In the binary-plane loop, the order among colour components and bit-planes are as follows:

- One bit per colour mode:
  - One bit per colour "CMY(K)": C, M, Y, (K)
  - One bit per colour "RGB": R, G, B
- Palette colour mode: MSB to LSB
- Continuous-tone colour and gray-scale image: MSB to LSB of L*, (MSB to LSB of a*, MSB to LSB of b*).

7.3.2.3 The bit order of coded data transmission on communication line

The bit order of the coded data on the communication line is LSB first for each octet.

For example, if the coded data stream, which was shown as an example in Table 26/T.82, is obtained by encoder, it is transmitted following the bit order shown below on the communication line:

Coded data stream:

PSCD: 6989 995c 32ea faa0 ....,

```
                   MSB  LSB
(Bit expression)   01101001   10001001   10011001   01011100   00110010   11101010 .................,
                      69         89         99         5c         32         ea
```

Bit order on the communication line:

First

10010110 10010001 10011001 00111010 01001100 01010111......

7.3.3 Other encoding schemes

For further study.

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