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Amendment 2
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SERIES T: TERMINALS FOR TELEMATIC SERVICES

Information technology – Lossy/lossless coding of bi-level images

Amendment 2: Extension of adaptive templates for halftone coding

ITU-T Recommendation T.88 (2000) – Amendment 2

INTERNATIONAL STANDARD ISO/IEC 14492
ITU-T RECOMMENDATION T.88

Information technology – Lossy/lossless coding of bi-level images

Amendment 2

Extension of adaptive templates for halftone coding

Summary

The objective of this amendment is to further improve JBIG2's compression of periodic bi-level images, like the halftones used in printing. In particular, it improves compression for the clustered-dot halftones often used in very high resolution commercial printing. When applying the appropriate 16-pixel JBIG2 'template' for such applications, this amendment facilitates more compression by increasing the number of moveable (Adaptive Template, 'AT') pixels from 4 to 12. For periodic halftones at resolutions of over 2400 dpi, effectively exploiting these 12 AT pixels yields approximately 20% better compression than the best obtainable with the current 16-pixel JBIG2 template (by optimizing its maximum of 4 AT pixels). To signal the presence of this amendment's datastreams, new flag bits have been defined for both the overall JBIG2 File header and for relevant image Segment headers. The flag bits permit early detection of this amendment's datastreams, making it possible to quickly prevent current JBIG2 decoders from attempting to decode these new datastreams.

Source

Amendment 2 to ITU-T Recommendation T.88 (2000) was prepared by ITU-T Study Group 16 (2001-2004) and approved on 29 June 2003. An identical text is also published as ISO/IEC 14492, Amendment 2.

FOREWORD

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As of the date of approval of this Recommendation, ITU had 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.

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1) Subclause 4.2

a) Eight symbols for additional adaptive template pixels (from A_5 to A_{12}) are added after A_4 as follows (with the additions underlined):

A_1, A_2, A_3, A_4, $\underline{A_5}$, $\underline{A_6}$, $\underline{A_7}$, $\underline{A_8}$, $\underline{A_9}$, $\underline{A_{10}}$, $\underline{A_{11}}$, $\underline{A_{12}}$

Adaptive template pixels in the generic region decoding procedure

b) A new symbol "EXTTEMPLATE" is inserted after the symbol "EXRUNLENGTH" as follows (with the additions underlined):

EXRUNLENGTH The length of a run of identical export flag values

EXTTEMPLATE A parameter indicating whether extended reference template is used in a generic region decoding procedure

c) New 16 symbols "$GBATX_i$" and "$GBATY_i$" (i={5,...,12}) are inserted after "$GBATY_4$" as follows (with the additions underlined):

$GBATY_4$ The Y location of adaptive template pixel 4 in a generic region decoding procedure

$\underline{GBATX_5}$ The X location of adaptive template pixel 5 in a generic region decoding procedure

$\underline{GBATY_5}$ The Y location of adaptive template pixel 5 in a generic region decoding procedure

$\underline{GBATX_6}$ The X location of adaptive template pixel 6 in a generic region decoding procedure

$\underline{GBATY_6}$ The Y location of adaptive template pixel 6 in a generic region decoding procedure

$\underline{GBATX_7}$ The X location of adaptive template pixel 7 in a generic region decoding procedure

$\underline{GBATY_7}$ The Y location of adaptive template pixel 7 in a generic region decoding procedure

$\underline{GBATX_8}$ The X location of adaptive template pixel 8 in a generic region decoding procedure

$\underline{GBATY_8}$ The Y location of adaptive template pixel 8 in a generic region decoding procedure

$\underline{GBATX_9}$ The X location of adaptive template pixel 9 in a generic region decoding procedure

$\underline{GBATY_9}$ The Y location of adaptive template pixel 9 in a generic region decoding procedure

$\underline{GBATX_{10}}$ The X location of adaptive template pixel 10 in a generic region decoding procedure

$\underline{GBATY_{10}}$ The Y location of adaptive template pixel 10 in a generic region decoding procedure

$\underline{GBATX_{11}}$ The X location of adaptive template pixel 11 in a generic region decoding procedure

$\underline{GBATY_{11}}$ The Y location of adaptive template pixel 11 in a generic region decoding procedure

$\underline{GBATX_{12}}$ The X location of adaptive template pixel 12 in a generic region decoding procedure

$\underline{GBATY_{12}}$ The Y location of adaptive template pixel 12 in a generic region decoding procedure

2) Subclause 6.2.2

In Table 2, new symbols "EXTTEMPLATE", "GBATX$_i$" and "GBATY$_i$" (i={5,...,12}) are inserted, and the notes of the table are revised as follows (with the additions and revisions underlined):

Table 2 – Parameters for the generic region decoding procedure

Name	Type	Size (bits)	Signed?	Description and restrictions
... (Leave untouched) ...				
TPGDON	Integer	1	N	Whether typical prediction is used. [a)]
EXTTEMPLATE	Integer	1	N	Whether extended reference template is used. [e)]
... (Leave untouched) ...				
GBATY$_4$	Integer	8	Y	The Y location of the adaptive template pixel A_4. [b)]
GBATX$_5$	Integer	8	Y	The X location of the adaptive template pixel A_5. [d)]
GBATY$_5$	Integer	8	Y	The Y location of the adaptive template pixel A_5. [d)]
GBATX$_6$	Integer	8	Y	The X location of the adaptive template pixel A_6. [d)]
GBATY$_6$	Integer	8	Y	The Y location of the adaptive template pixel A_6. [d)]
GBATX$_7$	Integer	8	Y	The X location of the adaptive template pixel A_7. [d)]
GBATY$_7$	Integer	8	Y	The Y location of the adaptive template pixel A_7. [d)]
GBATX$_8$	Integer	8	Y	The X location of the adaptive template pixel A_8. [d)]
GBATY$_8$	Integer	8	Y	The Y location of the adaptive template pixel A_8. [d)]
GBATX$_9$	Integer	8	Y	The X location of the adaptive template pixel A_9. [d)]
GBATY$_9$	Integer	8	Y	The Y location of the adaptive template pixel A_9. [d)]
GBATX$_{10}$	Integer	8	Y	The X location of the adaptive template pixel A_{10}. [d)]
GBATY$_{10}$	Integer	8	Y	The Y location of the adaptive template pixel A_{10}. [d)]
GBATX$_{11}$	Integer	8	Y	The X location of the adaptive template pixel A_{11}. [d)]
GBATY$_{11}$	Integer	8	Y	The Y location of the adaptive template pixel A_{11}. [d)]
GBATX$_{12}$	Integer	8	Y	The X location of the adaptive template pixel A_{12}. [d)]
GBATY$_{12}$	Integer	8	Y	The Y location of the adaptive template pixel A_{12}. [d)]

a) Unused if **MMR = 1**
b) Unused if **MMR = 1** or **GBTEMPLATE ≠ 0**
c) Unused if **USESKIP = 0** or **MMR = 1**
d) Used only if MMR = **0** and **GBTEMPLATE = 0** and **EXTTEMPLATE = 1**
e) Used only if **MMR = 0** and **GBTEMPLATE = 0**

3) Subclause 6.2.5.3

a) The identification number of Figure 3 is changed to "Figure 3(a)", and its caption is revised (with the additions and revisions underlined):

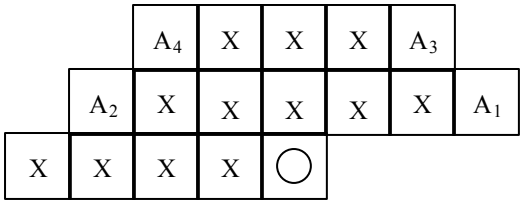

Figure 3(a) – Template when GBTEMPLATE = 0 and EXTTEMPLATE = 0, showing the AT pixels at their nominal locations

b) New Figure 3(b) is inserted as follows:

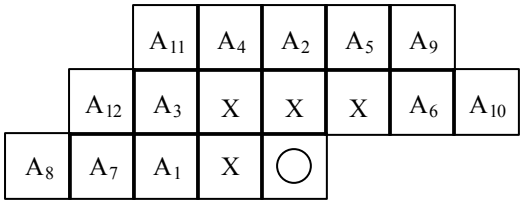

Figure 3(b) – Template when GBTEMPLATE = 0 and EXTTEMPLATE = 1, showing the AT pixels at their nominal locations

c) The second paragraph in subclause 6.2.5.3 is revised as follows (with the additions and revisions underlined):

Figure 3(a) shows the template which shall be used when **GBTEMPLATE** is 0 and **EXTTEMPLATE** is 0. Figure 3(b) shows the template which shall be used when **GBTEMPLATE** is 0 and **EXTTEMPLATE** is 1. Figure 4 shows the template which shall be used when **GBTEMPLATE** is 1. Figure 5 shows the template which shall be used when **GBTEMPLATE** is 2. Figure 6 shows the template which shall be used when **GBTEMPLATE** is 3. In each of these figures, the pixel denoted by a circle corresponds to the pixel to be coded and is not part of the template. The pixels denoted by 'X' correspond to ordinary pixels in the template. The pixels denoted A_1-A_{12} are special pixels in the template. They are denoted "adaptive" or AT pixels. These pixels are special in that their locations are not fixed, but can be placed at different locations. See 6.2.5.4 for a description of AT pixels. The legends A_1-A_{12} indicate the AT pixels 1 to 12. The pixels' actual locations are specified as parameters to this decoding procedure; Figures 3-6 show the nominal locations of these AT pixels for each template.

4) Subclause 6.2.5.4

a) The second paragraph is revised as follows (with the additions and revisions underlined):

The pixels that are allowed to change are called AT pixels. Their nominal locations are indicated by 'A_1', 'A_2', 'A_3', 'A_4', 'A_5', 'A_6', 'A_7', 'A_8', 'A_9', 'A_{10}', 'A_{11}', and 'A_{12}' in Figures 3(a), 3(b), 4, 5 and 6. Note that some templates have fewer than sixteen AT pixels. In general, an AT pixel can be located anywhere in the field shown in Figure 7, not including the current pixel. Hence, there is the possibility to use an effective template size of 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, or 4 pixels by having the moved location of the AT pixel overlap a regular template pixel. The actual locations of the AT pixels for any invocation of this decoding procedure are specified as parameters to the decoding procedure. The location of the pixel A_1 is given by (**GBATX$_1$**, **GBATY$_1$**). If **GBTEMPLATE** is 0, then:

- the location of the pixel A_2 is given by (**GBATX$_2$**, **GBATY$_2$**);
- the location of the pixel A_3 is given by (**GBATX$_3$**, **GBATY$_3$**);
- and the location of the pixel A_4 is given by (**GBATX$_4$**, **GBATY$_4$**).

Additionally, if **GBTEMPLATE** is 0 and **EXTTEMPLATE** is 1, then:

- the location of the pixel A_5 is given by (**GBATX$_5$**, **GBATY$_5$**);
- the location of the pixel A_6 is given by (**GBATX$_6$**, **GBATY$_6$**);
- the location of the pixel A_7 is given by (**GBATX$_7$**, **GBATY$_7$**);
- the location of the pixel A_8 is given by (**GBATX$_8$**, **GBATY$_8$**);
- the location of the pixel A_9 is given by (**GBATX$_9$**, **GBATY$_9$**);
- the location of the pixel A_{10} is given by (**GBATX$_{10}$**, **GBATY$_{10}$**);
- the location of the pixel A_{11} is given by (**GBATX$_{11}$**, **GBATY$_{11}$**);
- the location of the pixel A_{12} is given by (**GBATX$_{12}$**, **GBATY$_{12}$**).

b) Note 2 is revised as follows (with the additions and revisions underlined):

NOTE 2 – The indices of the AT pixels in Figures 3(a) and 3(b) correspond to the expected goodness. If moving only one AT pixel from the nominal location shown in Figure 3(a), it is advisable to move A_4. The next pixel to move is A_3 and so on.

c) Table 5 is revised as follows (with the additions and revisions underlined):

Table 5 – The nominal values of the AT pixel locations

GBTEMPLATE		0		0		1		2		3	
EXTTEMPLATE		1		0		0		0		0	
$GBATX_1$	**$GBATY_1$**	–2	0	3	–1	3	–1	2	–1	2	–1
$GBATX_2$	**$GBATY_2$**	0	–2	–3	–1	NA	NA	NA	NA	NA	NA
$GBATX_3$	**$GBATY_3$**	–2	–1	2	–2	NA	NA	NA	NA	NA	NA
$GBATX_4$	**$GBATY_4$**	–1	–2	–2	–2	NA	NA	NA	NA	NA	NA
$GBATX_5$	**$GBATY_5$**	1	–2	NA	NA	NA	NA	NA	NA	NA	NA
$GBATX_6$	**$GBATY_6$**	2	–1	NA	NA	NA	NA	NA	NA	NA	NA
$GBATX_7$	**$GBATY_7$**	–3	0	NA	NA	NA	NA	NA	NA	NA	NA
$GBATX_8$	**$GBATY_8$**	–4	0	NA	NA	NA	NA	NA	NA	NA	NA
$GBATX_9$	**$GBATY_9$**	2	–2	NA	NA	NA	NA	NA	NA	NA	NA
$GBATX_{10}$	**$GBATY_{10}$**	3	–1	NA	NA	NA	NA	NA	NA	NA	NA
$GBATX_{11}$	**$GBATY_{11}$**	–2	–2	NA	NA	NA	NA	NA	NA	NA	NA
$GBATX_{12}$	**$GBATY_{12}$**	–3	–1	NA	NA	NA	NA	NA	NA	NA	NA
NOTE – NA means that the parameter has no nominal value.											

5) Subclause 6.2.5.7

The step d) ii) is changed as follows (with the additions and revisions underlined):

d) If LTP = **0** then, from left to right, decode each pixel of the current row of GBREG. The procedure for each pixel is as follows:

i) If **USESKIP** is **1** and the pixel in the bitmap **SKIP** at the location corresponding to the current pixel is **1**, then set the current pixel to **0**.

ii) Otherwise:

- Place the template given by parameters **GBTEMPLATE**, **$GBATX_1$** through **$GBATX_{12}$** and **$GBATY_1$** through **$GBATY_{12}$** so that the current pixel is aligned with the location denoted by a circle in the figure describing the appearance of the template with identifier **GBTEMPLATE**.

6) Subclause 7.4.6.2

a) Figure 46 is replaced by the following figure:

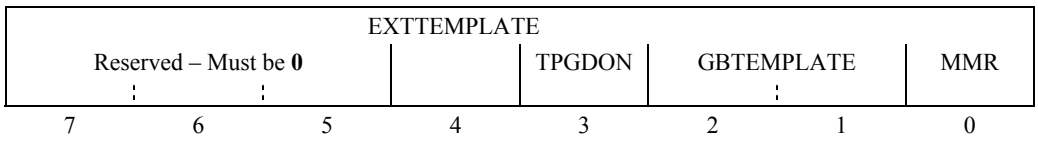

Figure 46 – Generic region segment flags field structure

7) Subclause 7.4.6.2

The notations of Bit 4 are added for EXTTEMPLATE, and reserved bits are changed to Bits 5-7 as follows (with the additions and revisions underlined):

Bit 4 **EXTTEMPLATE**

This field specifies whether extended reference template is used.

Bits 5-7 Reserved; must be zero.

8) Subclause 7.4.6.3

a) The first paragraph is changed as follows (with the additions and revisions underlined):

This field is only present if **MMR** is **0**. If **GBTEMPLATE** is **0** and **EXTTEMPLATE** is **0**, it is an eight-byte field, formatted as shown in Figure 47(a) and as described below.

b) The identification number of Figure 47 is changed to Figure 47(a) as follows (with the revision underlined):

GBATX$_1$	**GBATY$_1$**	**GBATX$_2$**	**GBATY$_2$**	**GBATX$_3$**	**GBATY$_3$**	**GBATX$_4$**	**GBATY$_4$**

Figure 47(a) – Generic region AT flags field structure when GBTEMPLATE is 0 and EXTTEMPLATE is 0

c) New Figure 47(b) is inserted immediately after as follows:

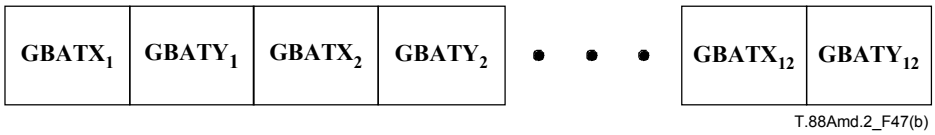

Figure 47(b) – Generic region AT flags field structure when GBTEMPLATE is 0 and EXTTEMPLATE is 1

d) The last paragraph is revised as follows (with the additions and revisions underlined):

If **GBTEMPLATE** is 0 and **EXTTEMPLATE** is 1, it is a 32-byte field, formatted as shown in Figure 47(b) and as described below.

Byte 0 **GBATX$_1$**

Byte 1 **GBATY$_1$**

Byte 2 **GBATX$_2$**

Byte 3 **GBATY$_2$**

Byte 4 **GBATX$_3$**

Byte 5 **GBATY$_3$**

Byte 6 **GBATX$_4$**

Byte 7 **GBATY$_4$**

Byte 8 **GBATX$_5$**

Byte 9 **GBATY$_5$**

Byte 10 **GBATX$_6$**

Byte 11 **GBATY$_6$**

Byte 12 **GBATX$_7$**

Byte 13 **GBATY$_7$**

Byte 14 **GBATX$_8$**

Byte 15 **GBATY$_8$**

Byte 16 **GBATX$_9$**

Byte 17 **GBATY$_9$**

Byte 18 **GBATX$_{10}$**

Byte 19 **GBATY$_{10}$**

Byte 20 **$GBATX_{11}$**

Byte 21 **$GBATY_{11}$**

Byte 22 **$GBATX_{12}$**

Byte 23 **$GBATY_{12}$**

The AT coordinate X and Y fields are signed values, and may take on values that are permitted according to Figure 7.

9) Subclause 7.4.6.4

The parameters "EXTTEMPLATE", "$GBATX_i$" and "$GBATY_i$" (i={5,...,12}) are inserted in Table 34 as follows (with the additions underlined):

Table 34 – Parameters used to decode a generic region segment

Name	Value
MMR	As shown in 7.4.6.2.
GBTEMPLATE	As shown in 7.4.6.2.
TPGDON	As shown in 7.4.6.2.
EXTTEMPLATE	As shown in 7.4.6.2.
USESKIP	**0**
GBW	As specified by the region segment bitmap width in this segment's region segment data header.
GBH	As specified by the region segment bitmap height in this segment's region segment data header.
$GBATX_1$	See 7.4.6.3.
$GBATY_1$	See 7.4.6.3.
$GBATX_2$	See 7.4.6.3.
$GBATY_2$	See 7.4.6.3.
$GBATX_3$	See 7.4.6.3.
$GBATY_3$	See 7.4.6.3.
$GBATX_4$	See 7.4.6.3.
$GBATY_4$	See 7.4.6.3.
$GBATX_5$	See 7.4.6.3.
$GBATY_5$	See 7.4.6.3.
$GBATX_6$	See 7.4.6.3.
$GBATY_6$	See 7.4.6.3.
$GBATX_7$	See 7.4.6.3.
$GBATY_7$	See 7.4.6.3.
$GBATX_8$	See 7.4.6.3.
$GBATY_8$	See 7.4.6.3.
$GBATX_9$	See 7.4.6.3.
$GBATY_9$	See 7.4.6.3.
$GBATX_{10}$	See 7.4.6.3.
$GBATY_{10}$	See 7.4.6.3.
$GBATX_{11}$	See 7.4.6.3.
$GBATY_{11}$	See 7.4.6.3.
$GBATX_{12}$	See 7.4.6.3.
$GBATY_{12}$	See 7.4.6.3.

10) Annex D.4.2

The notations of Bit 2 are added to show the presence of the generic region segment using templates with 12 AT pixels, and reserved bits are changed to Bits 3-7 as follows (with the additions and revisions underlined):

Bit 2 If this bit is **0**, no generic region segments uses the templates with 12 AT pixels. If the file contains one or more generic region segments using such templates, this bit must be **1**.

Bits 3-7 Reserved; must be **0**.

11) Annex F

New Table F.8 is inserted immediately after Table F.7 for a new profile as follows:

Table F.8 – Profile description for profile `0x00000008`

Profile identification	`0x00000008`
Requirements	Maximum compression for graphic arts
Generic region coding	Arithmetic only; only 16-pixel template
Refinement region coding	Not available
Halftone region coding	No skip mask used
Numerical data	Arithmetic only
Resources required	Very high-speed processor
Application examples	Pre-press in printing
Additional constraints	• Every page must have at least two stripes. • Set **GBTEMPLATE** = **0** and **EXTTEMPLATE** = **1**. • Restrict AT pixel locations to immediately preceding 32 lines (from 0 to –31 in the vertical coordinate) in Figure 7. • Use only generic coding.
NOTE – The profiles in Table F.1 and F.2 are unchanged (e.g., any 16-pel template used is limited to 4 adaptive pixels; see Figure 3).	

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