DICOM Correction Proposal Form

Correction Number	CP-367

Log Summary: Palette Color LUT for enhanced MR images

Type of Modification	Name of Standard
Clarification	PS 3.3 2003

Rationale for Correction

In the Enhanced MR object, the capability to add color on a per-frame basis was added by conditionally including the Supplemental Palette Color LUT Module and specifying Pixel Presentation at a frame and top level. In addition an attribute called Largest Monochrome Pixel Value was added as a Type 3.

1. However, the Image Pixel Module which is also used in the Enhanced MR object also includes the LUT attributes but with different conditions which conflict with those on the Supplemental Palette Color LUT Module. The conditions in the Image Pixel Module need to be corrected accordingly.

2. Largest Monochrome Pixel Value is problematic for several reasons:

a) It is a type 3 and hence may not be present yet the behavior is predicated on its presence.

b) There is no meaningful value to assign to the attribute in the case when an image is purely color (i.e. all the stored pixel values from 0 to 2^n-1 are indices into the LUT); i.e. in retrospect the first stored pixel value to be mapped rather than the last stored pixel value not to be mapped should have been described.

Fortunately, since the LUT Descriptors already include as their second value the "first stored pixel value mapped", the Largest Monochrome Pixel Value is not actually needed at all, and the entire behavior can be re-described in terms of the second value of LUT Descriptors.

As an aside, it is also never specified in the standard anywhere that the LUT descriptors for the red, green and blue channels should be identical, so this is corrected.

Sections of documents affected

PS 3.3 C.7.6.3

PS 3.3 C.8.13.1

PS 3.3 C.8.13.3.1.2.1

Correction Wording:

Amend PS 3.3:

C.7.6.3   Image Pixel Module

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Table C.7-11
IMAGE PIXEL MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
…	…	…	…

Red Palette Color Lookup Table Descriptor	(0028,1101)	1C	Specifies the format of the Red Palette Color Lookup Table Data (0028,1201) Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR **or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED**. See C.7.6.3.1.5 for further explanation.
Green Palette Color Lookup Table Descriptor	(0028,1102)	1C	Specifies the format of the Green Palette Color Lookup Table Data (0028,1202) Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR **or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED**. See C.7.6.3.1.5 for further explanation.
Blue Palette Color Lookup Table Descriptor	(0028,1103)	1C	Specifies the format of the Blue Palette Color Lookup Table Data (0028,1203) Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR **or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED**. See C.7.6.3.1.5 for further explanation.
Red Palette Color Lookup Table Data	(0028,1201)	1C	Red Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR **or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED**. See C.7.6.3.1.6 for further explanation.
Green Palette Color Lookup Table Data	(0028,1202)	1C	Green Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR **or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED**. See C.7.6.3.1.6 for further explanation.
Blue Palette Color Lookup Table Data	(0028,1203)	1C	Blue Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR **or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED**. See C.7.6.3.1.6 for further explanation.

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C.7.6.3.1.5   Palette Color Lookup Table Descriptor

The three values of Palette Color Lookup Table Descriptor (0028,1101-1103) describe the format of the Lookup Table Data in the corresponding Data Element (0028,1201-1203) or (0028,1221-1223).

The first value is the number of entries in the lookup table. When the number of table entries is equal to 2^{16} then this value shall be 0. **The first value shall be identical for each of the Red, Green and Blue Palette Color Lookup Table Descriptors.**

The second value is the first stored pixel value mapped. This pixel value is mapped to the first entry in the Lookup Table Data. All image pixel values less than the first value mapped are also mapped to the first entry in the Lookup Table Data **if the Photometric Interpretation is PALETTE COLOR**.

> **Note: In the case of the Suplemental Palette Color LUT, the stored pixel values less than the second descriptor value are grayscale values.**

An image pixel value one greater than the first value mapped is mapped to the second entry in the Lookup Table Data. Subsequent image pixel values are mapped to the subsequent entries in the Lookup Table Data up to an image pixel value equal to number of entries + first value mapped – 1, which is mapped to the last entry in the Lookup Table Data. Image pixel values greater than or equal to number of entries + first value mapped are also mapped to the last entry in the Lookup Table Data. **The second value shall be identical for each of the Red, Green and Blue Palette Color Lookup Table Descriptors.**

The third value specifies the number of bits for each entry in the Lookup Table Data. It shall take the value of 8 or 16. The LUT Data shall be stored in a format equivalent to 8 or 16 bits allocated where the high bit is equal to bits allocated-1. **The third value shall be identical for each of the Red, Green and Blue Palette Color Lookup Table Descriptors.**

When the Palette Color Lookup Table Descriptor (0028,1101-1103) are used as part of the Palette Color Lookup Table Module or the Supplemental Palette Color Lookup Table Module, the third value shall be equal to 16.

> Notes: 1. A value of 16 indicates the Lookup Table Data will range from (0,0,0) minimum intensity to (65535,65535,65535) maximum intensity.
>
> 2. Since the Palette Color Lookup Table Descriptor (0028,1101-1103) Attributes are multi-valued, in an Explicit VR Transfer Syntax, only one value representation (US or SS) may be specified, even though the first and third values are always by definition interpreted as unsigned. The explicit VR actually used is dictated by the VR needed to represent the second value, which will be consistent with Pixel Representation (0028,0103).

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C.8.13.1   Enhanced MR Image Module

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Table C.8.13-1
ENHANCED MR IMAGE MODULE ATTRIBUTES

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Attribute Name	Tag	Type	Attribute Description
…	…	…	…

~~Largest Monochrome Pixel Value~~	~~(0028,9099)~~	~~3~~	~~Largest value in the monochrome portion of any frame whose Pixel Presentation (0008,9205) in the Frame Content Macro has a value COLOR. Color values must be greater than the Largest Monochrome Pixel Value. See section C.8.13.2.1.2.1 for further explanation.~~

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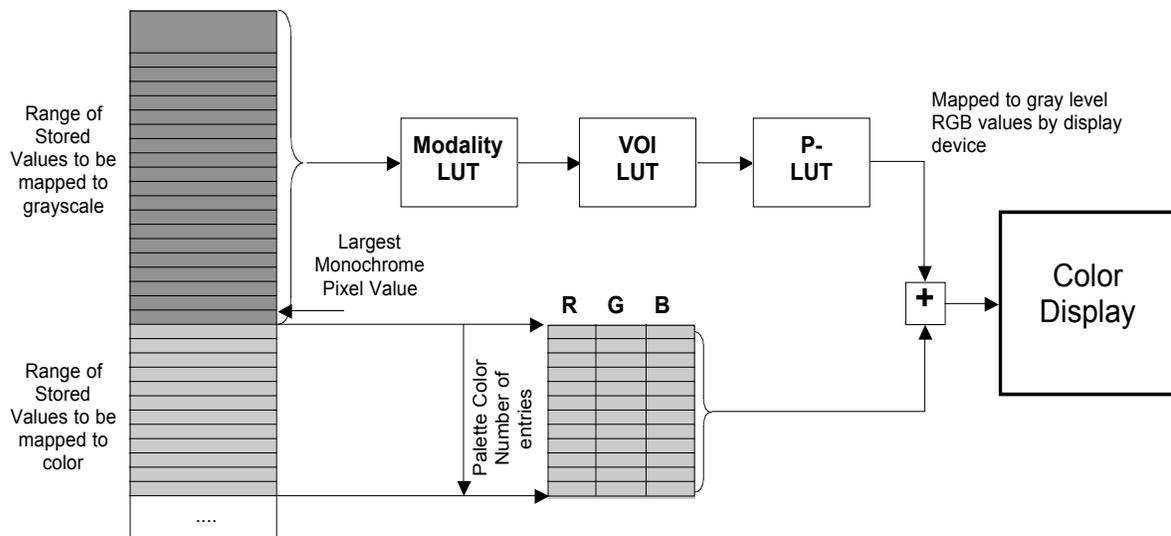### C.8.13.3.1.2.1   Supplemental Palette Color LUTs

Figure C.8.13-1 presents two separate image visualization pipelines that can be used for interpreting the stored pixel values.

If Pixel Presentation (0008,9205) equals COLOR, the stored values are split into two ranges. The stored values up to **one less than** ~~the value specified in~~ the **second value of the Red, Green and Blue Palette Color Lookup Table Descriptor (0028,1101-1103)** ~~attribute Largest Monochrome Pixel Value (0028,9099)~~ are passed through the gray scale visualization pipeline. The values **equal to or** greater than the **second value of Red, Green and Blue Palette Color Lookup Table Descriptor (0028,1101-1103)** ~~Largest Monochrome Pixel Value (0028,9099)~~ are mapped by the Palette Color LUTs.

> **Note: Some images may be purely color, and there will be no grayscale range of stored pixel values "below" those that are passed through the color lookup tables.**

The complete range of stored pixel values can also be displayed via the grayscale visualization pipeline only, but the information content may be less useful because the color information is not available.

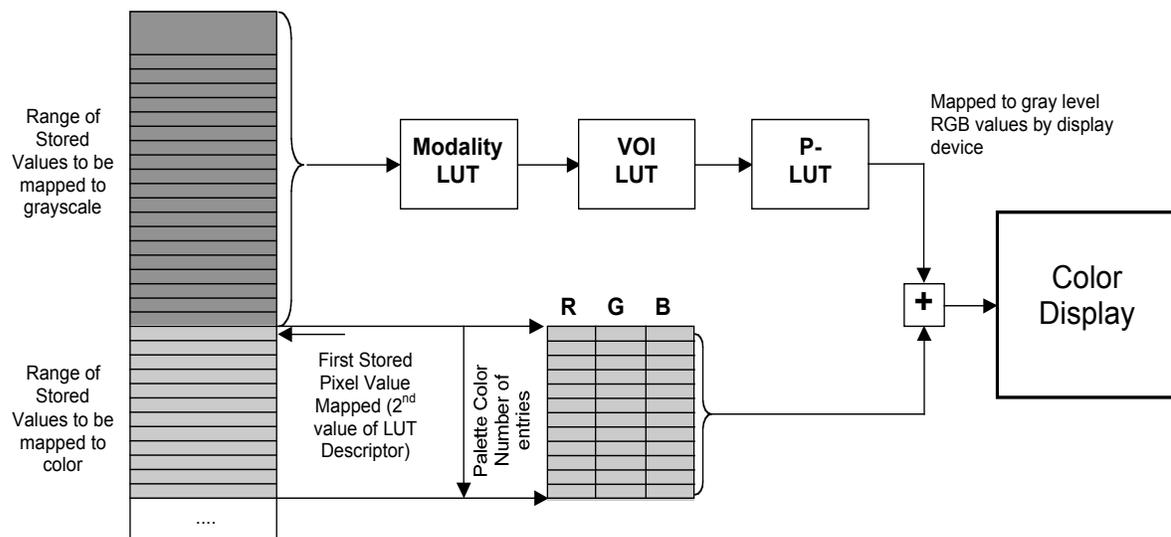| |
|---|
| *Replace this figure:* |

With this figure:

Figure C.8.13-1
MONOCHROME2 Photometric Interpretation with Supplemental Palette Color mapping

Retire the offending attribute from PS 3.6:

(0028,9099)	*Largest Monochrome Pixel Value*	*US*	*1*	***Retired***