

Tone Mapping SEI

JVT-T060

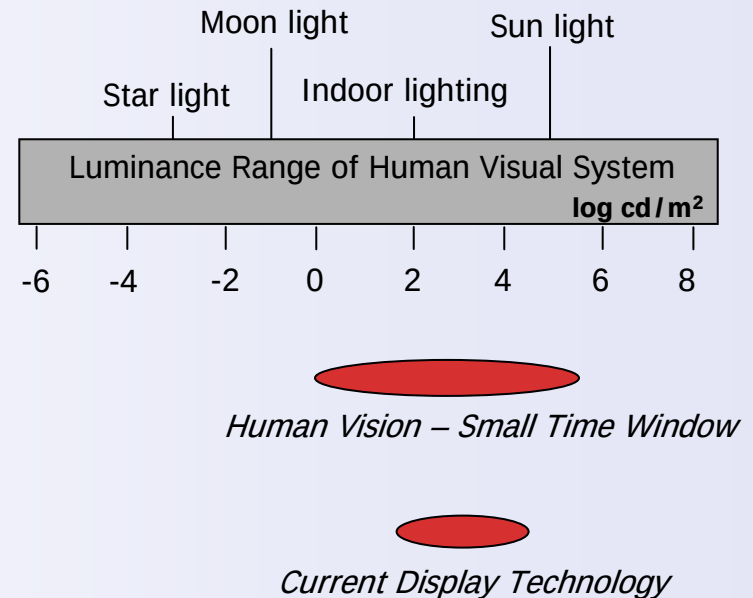
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Sharp Labs of America
March 29, 2006

- Update of proposal JVT-S087
 - Originally proposed in Geneva
 - Recommended to revisit in Klagenfurt
 - Suggested to make message more generic, allowing it to be further extended
 - Suggested to address temporal persistence of the message
- Overview
 - Dynamic Range
 - Display of high bit-depth data
 - Syntax and Semantics

Our goal:

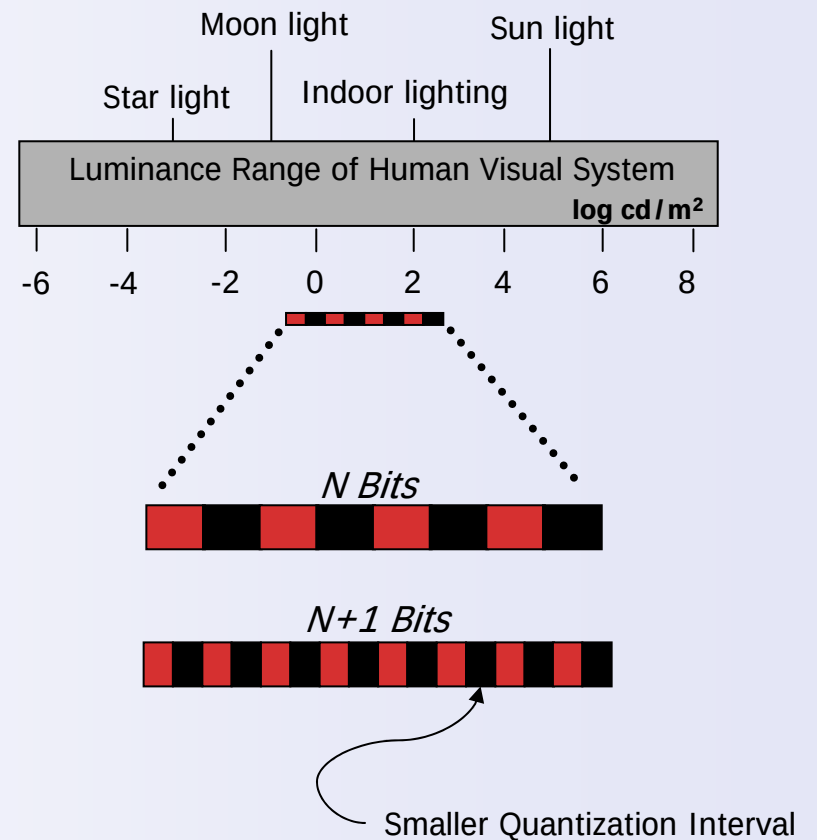
*Address the problem of **displaying** a high bit-depth image on a low bit-depth display*

- Dynamic Range
 - Different definitions for video coding and display tasks
 - Video coding: dynamic range equal to bits
 - Display: dynamic range defined by minimum and maximum brightness levels
 - Human visual system
 - Resolves approximately five orders of magnitude within a small time window

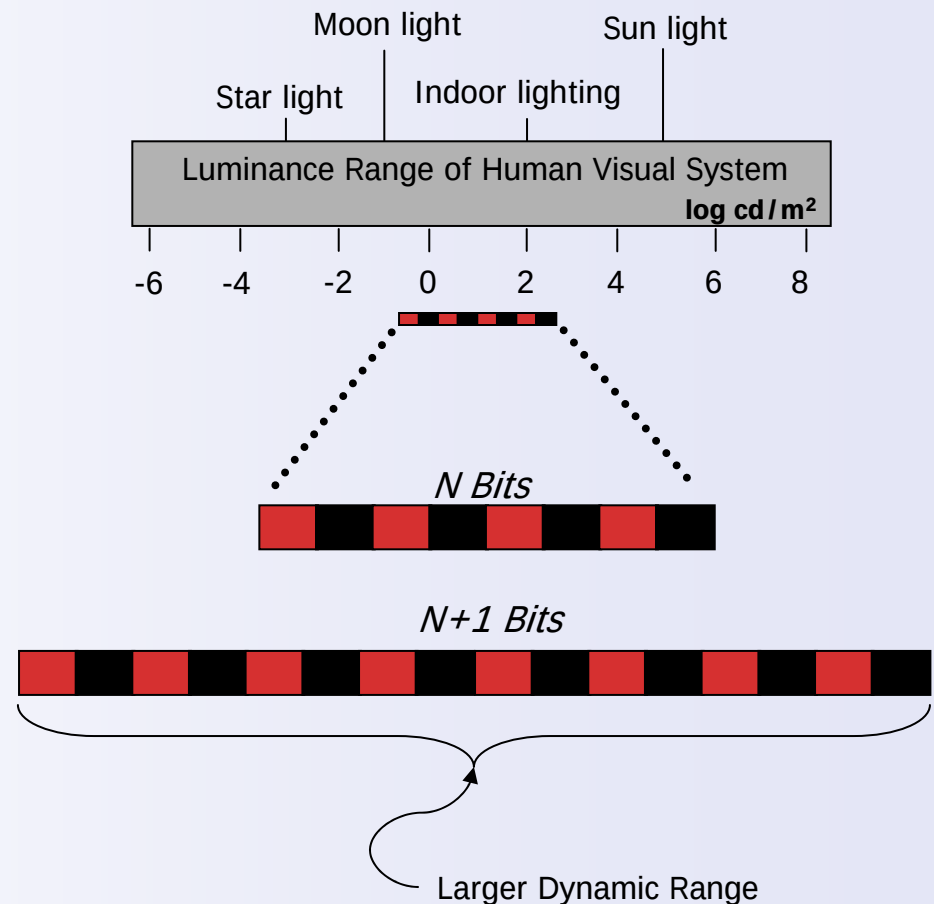


Bit-depth defined by above dynamic range, visibility thresholds, etc.

- Use of Dynamic Range
 - Fidelity
 - Smaller quantization interval
 - Same visual dynamic range
 - Applications: Very high fidelity

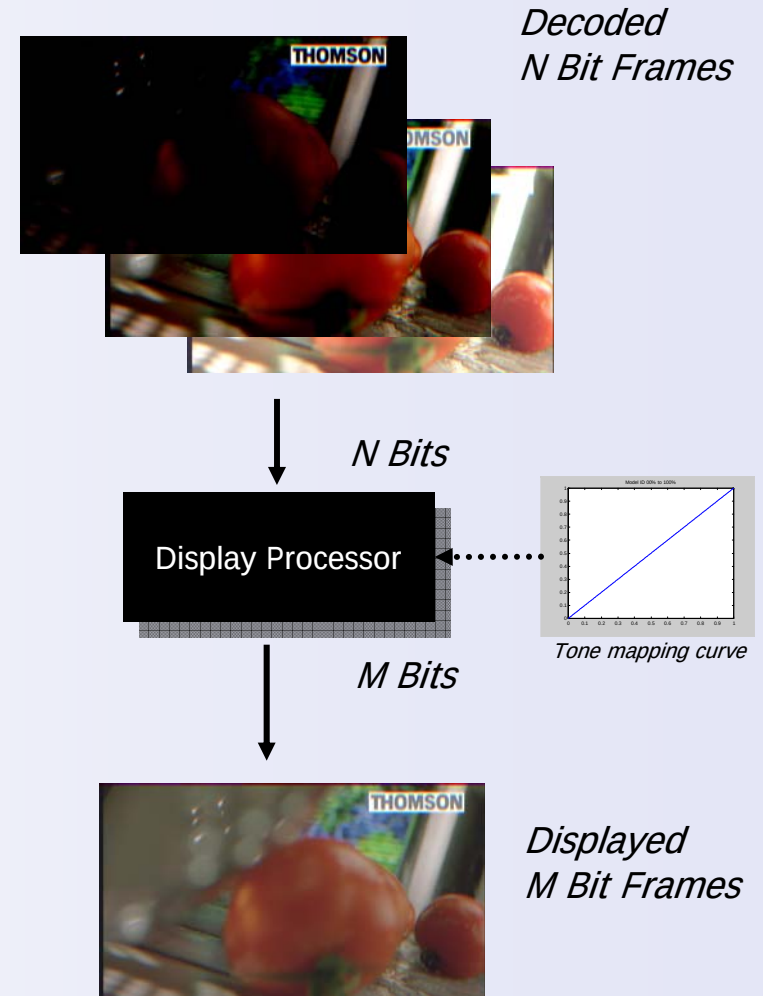


- Use of Dynamic Range
 - Expanded dynamic range
 - Unchanged quantization interval
 - Larger visual dynamic range
 - Applications
 - Off-line color correction
 - Tone mapping
 - Security analysis
 - Archival for improved displays



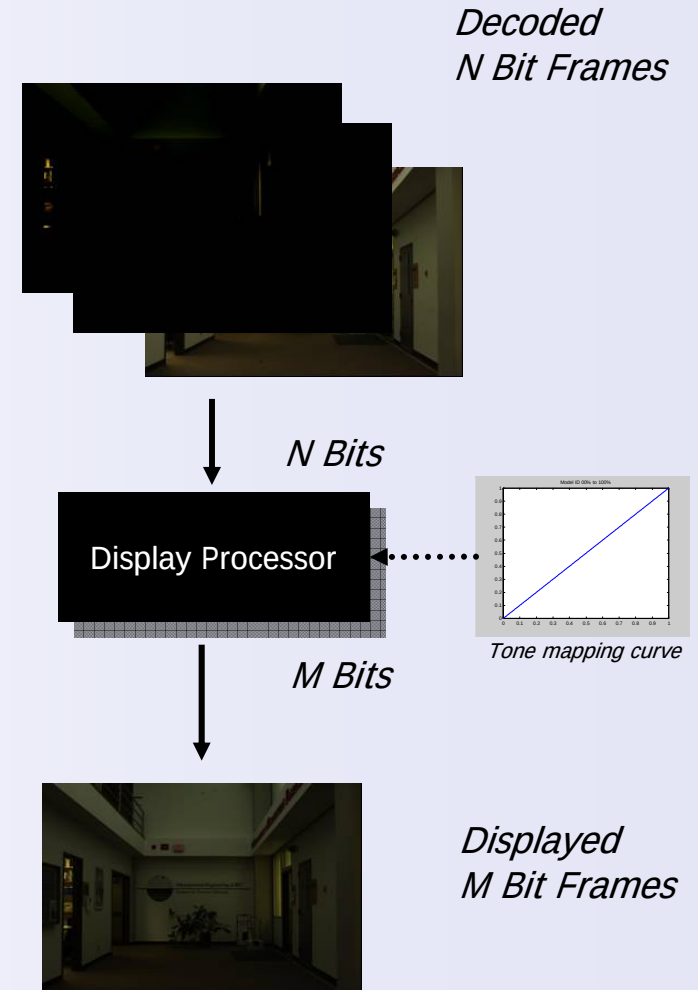
Applications typically operate between extremes

- Display of high bit-depth images
 - Convert high bit-depth image to lower bit-depth
 - Possible scenarios
 - Fidelity: sub-sample coded intensity values
 - Expanded dynamic range: **tone mapping**



Typical values: N=10 or 12, M=8

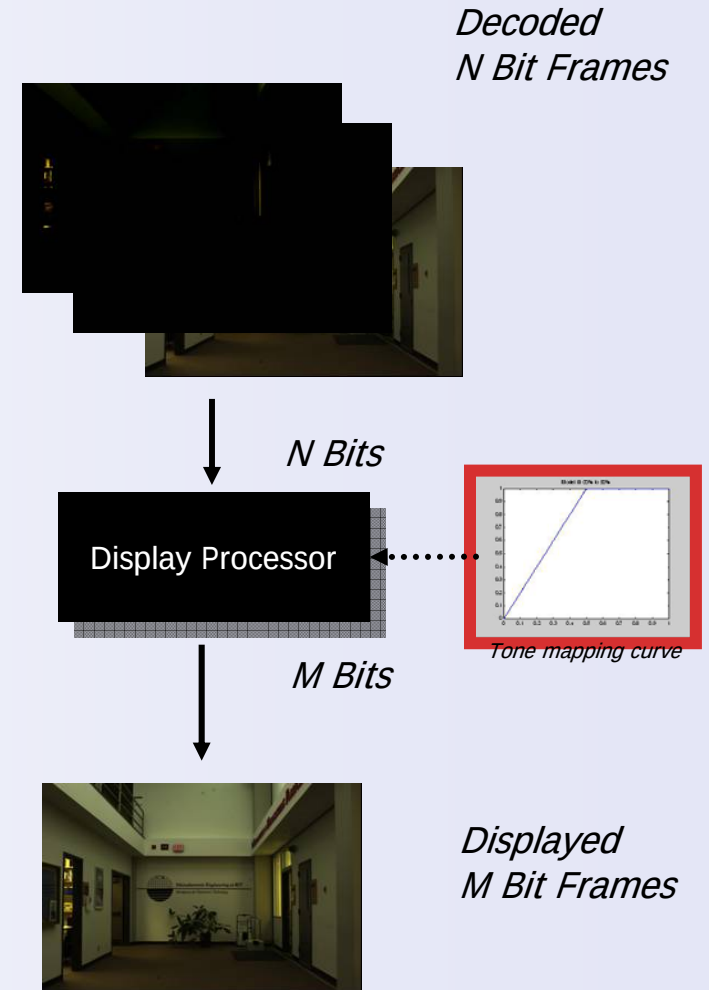
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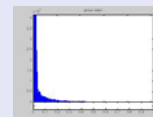
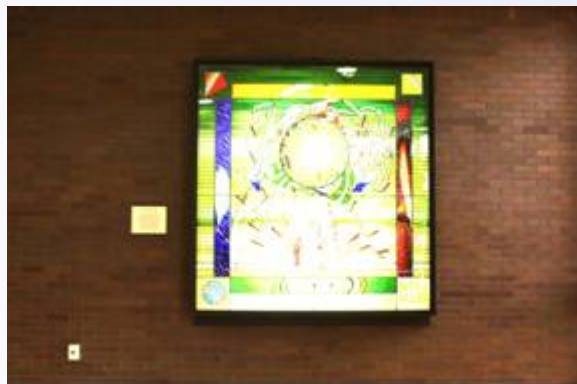
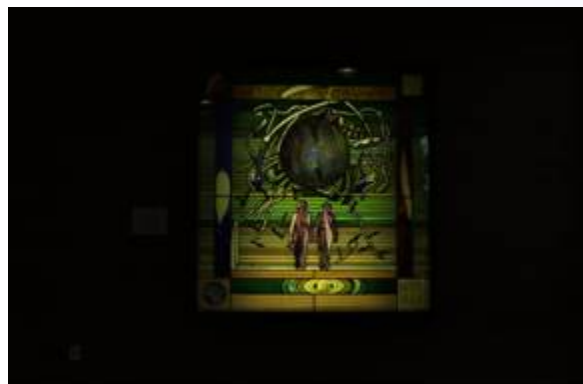
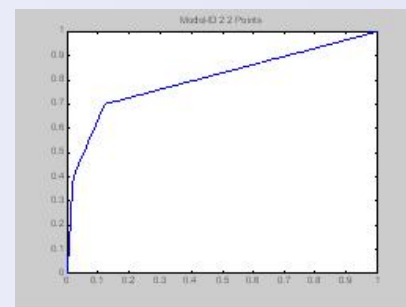
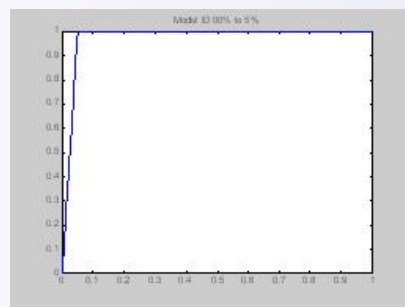
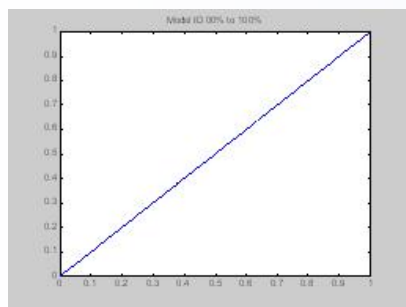
Display Process

- Display of high bit-depth images
 - Convert high bit-depth image to lower bit-depth
 - Possible scenarios
 - Fidelity: sub-sample coded intensity values
 - Expanded dynamic range: **tone mapping**

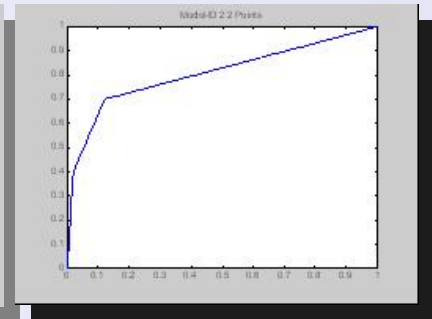
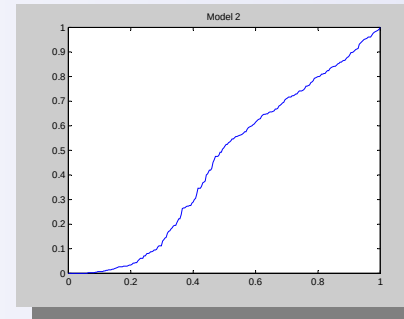
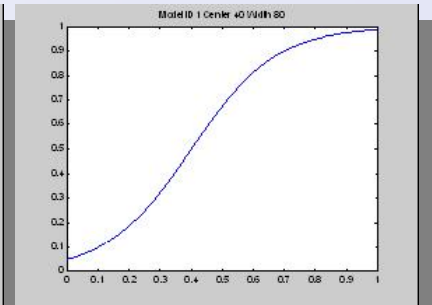
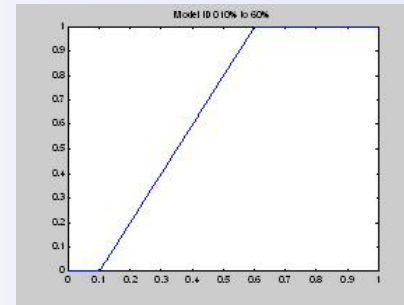


Typical values: N=10 or 12, M=8

Display Process - Examples



- Proposed solution
 - SEI message to communicate tone mapping parameters to display device
 - Four tone mapping functions defined
 - Inherent support of fidelity mode
 - Tone mapping operators may be used explicitly
 - Operators also allow implicit definition of more sophisticated tone mapping procedures
 - Additional Features
 - Temporal persistence (same as Pan Scan SEI)
 - Support for future tone mapping models



Syntax

A.1.1 Tone mapping SEI message syntax

tone_mapping(payloadSize) {	C	Descriptor
tone_map_id	5	ue(v)
tone_map_cancel_flag	5	u(1)
if(!tone_map_cancel_flag) {		
tone_map_repetition_period	5	ue(v)
coded_data_bit_depth	5	u(8)
sei_bit_depth	5	u(8)
model_id	5	ue(v)
if(model_id == 0) {		
min_value	5	u(32)
max_value	5	u(32)
}		
if(model_id == 1) {		
sigmoid_midpoint	5	u(32)
sigmoid_width	5	u(32)
}		
if(model_id == 2) {		
for(i=0; i < (1<<sei_bit_depth); i++)		
start_of_coded_interval[i]	5	u(v)
}		
if(model_id == 3) {		
num_pivots	5	u(16)
for(i=0; i < num_pivots; i++)		
{		
coded_pivot_value[i]	5	u(v)
sei_pivot_value[i]	5	u(v)
}		
}		
}		
}		

tone_map_id contains an identifying number that may be used to identify the purpose of the tone mapping model. The value of tone_map_id shall be in the range of 0 to $2^{32}-1$, inclusive.

Values of tone_map_id from 0 to 255 and from 512 to $2^{31}-1$ may be used as determined by the application. Values of tone_map_id from 256 to 511 and from 2^{31} to $2^{32}-1$ are reserved for future use by ITU-T|ISO/IEC. Decoders encountering a value of tone_map_id in the range of 256 to 511 or in the range of 2^{31} to $2^{32}-1$ shall ignore (remove from the bitstream and discard) it.

Note – the tone_map_id flag can be used to support tone mapping operations that are suitable for a different of display scenarios. For example, different values of tone_map_id may correspond to different display bit-depths.

tone_map_cancel_flag equal to 1 indicates that the SEI message cancels the persistence of any previous tone mapping SEI message in output order. tone_map_cancel_flag equal to 0 indicates that tone mapping information follows.

tone_map_repetition_period specifies the persistence of the tone mapping SEI message and may specify a picture order count interval within which another tone mapping SEI message with the same value of tone_map_id or the end of the coded video sequence shall be present in the bitstream.. The value of tone_map_repetition_period shall be in the range of 0 to 16 384, inclusive.

tone_map_repetition_period equal to 0 specifies that the tone map information applies to the current decoded picture only.

tone_map_repetition_period equal to 1 specifies that the tone map information persists in output order until any of the following conditions are true.

- A new coded video sequence begins
- A picture in an access unit containing a tone mapping SEI message with the same value of tone_map_id is output having PicOrderCnt() greater than PicOrderCnt(CurrPic).

tone_map_repetition_period equal to 0 or equal to 1 indicates that another tone mapping SEI message with the same value of tone_map_id may or may not be present.

tone_map_repetition_period greater than 1 specifies that the tone map information persists until any of the following conditions are true.

- A new coded video sequence begins
- A picture in an access unit containing a tone mapping SEI message with the same value of tone_map_id is output having PicOrderCnt() greater than PicOrderCnt(CurrPic) and less than or equal to PicOrderCnt(CurrPic) + tone_map_repetition_period.

tone_map_repetition_period greater than 1 indicates that another tone mapping SEI message with the same value of tone_map_id shall be present for a picture in an access unit that is output having PicOrderCnt() greater than PicOrderCnt(CurrPic) and less than or equal to PicOrderCnt(CurrPic) + tone_map_repetition_period; unless the bitstream ends or a new coded video sequence begins without output of such a picture.

coded_data_bit_depth specifies the bit-depth of the coded data.

sei_bit_depth specifies the bit-depth of the output of the dynamic range mapping function (or tone mapping function) described by the SEI message. The tone mapping function specified with a particular sei_bit_depth is suggested to be reasonable for all display bit depths that are equal to or less than the sei_bit_depth.

model_id specifies the model utilized for mapping the higher bit-depth data into the lower bit-depth range.

Note – a model_id of 0 corresponds to a linear mapping with clipping; a model_id of 1 corresponds to a sigmoidal mapping; a model_id of 2 corresponds to a user-defined table mapping, and a model_id of 3 corresponds to a piece-wise linear mapping. All mappings are expressed in the RGB color space and applied to each RGB component separately.

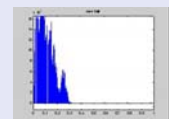
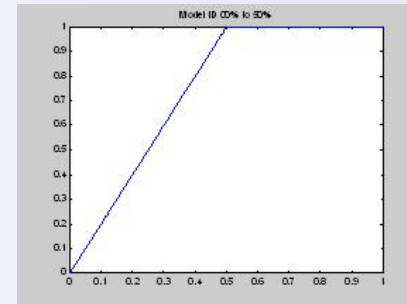
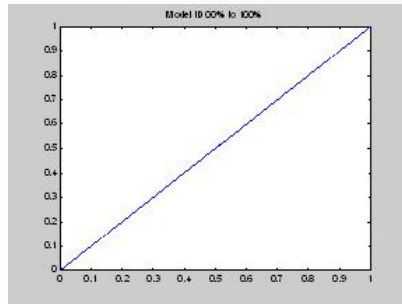
min_value specifies the pixel value in the high bit-depth coded data that maps to the minimum value in the signaled sei_bit_depth, i.e. 0. It is used in combination with the max_value parameter. All values in the coded data that are less than or equal to min_value are mapped to 0 in low bit depth.

■ Conclusions

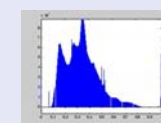
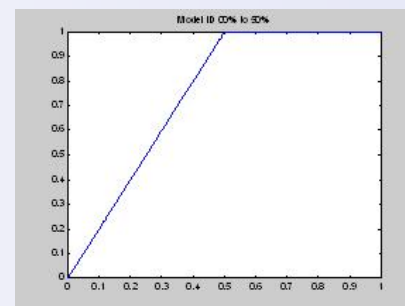
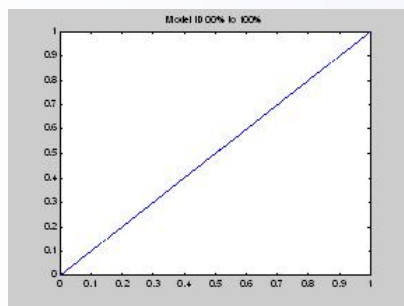
- Increasing visual dynamic range an important use for 4:4:4 coding
- Inaccurate interpretation of dynamic range severely degrades displayed image quality
- No current mechanism to signal dynamic range in AVC syntax
- *Propose adoption of Tone Mapping SEI as part of AVC Advanced High Profile Amendment*

Additional Examples

Display Process - Examples



Display Process - Examples



Display Process - Examples

