

Objectives

The purpose of this Diploma Thesis is to compress efficiently a High Dynamic Range (HDR) image, while achieving the goals below:

- Efficient image compression for storing and effective transmission.
- Simple and fast encoding and decoding.
- Use of conventional compression methods (JPEG, JPEG2000, etc.).
- Backward compatible methods.
- Maintain compatibility with traditional LDR displays. Naive software ignores the restorative information (encoding parameters and residuals) and displays only the tone-mapped version of the original HDR image.

Introduction

We stand on the threshold of a new era in digital imaging, when image files will encode the color gamut and dynamic range of the original scene, rather than the limited subspace that can be conveniently displayed with 20 year-old monitor technology. In order to accomplish this goal, HDR images play a significant role and fill the requirements of high quality and excessive detail.



Figure 1: Low Dynamic Range vs High Dynamic Range imaging.

It is an essential need efficient algorithms to be developed that compress the required storing memory with minor loss in details.

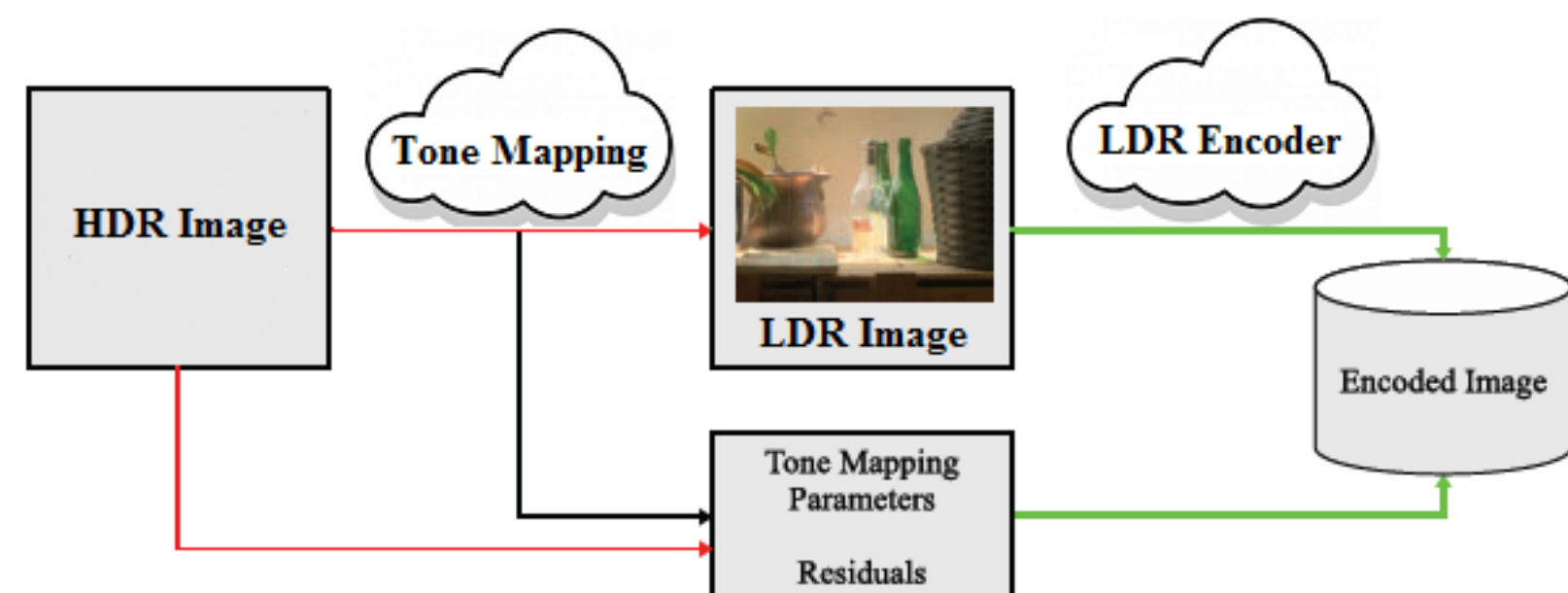


Figure 2: The general scheme of HDR image compression.

1st Method

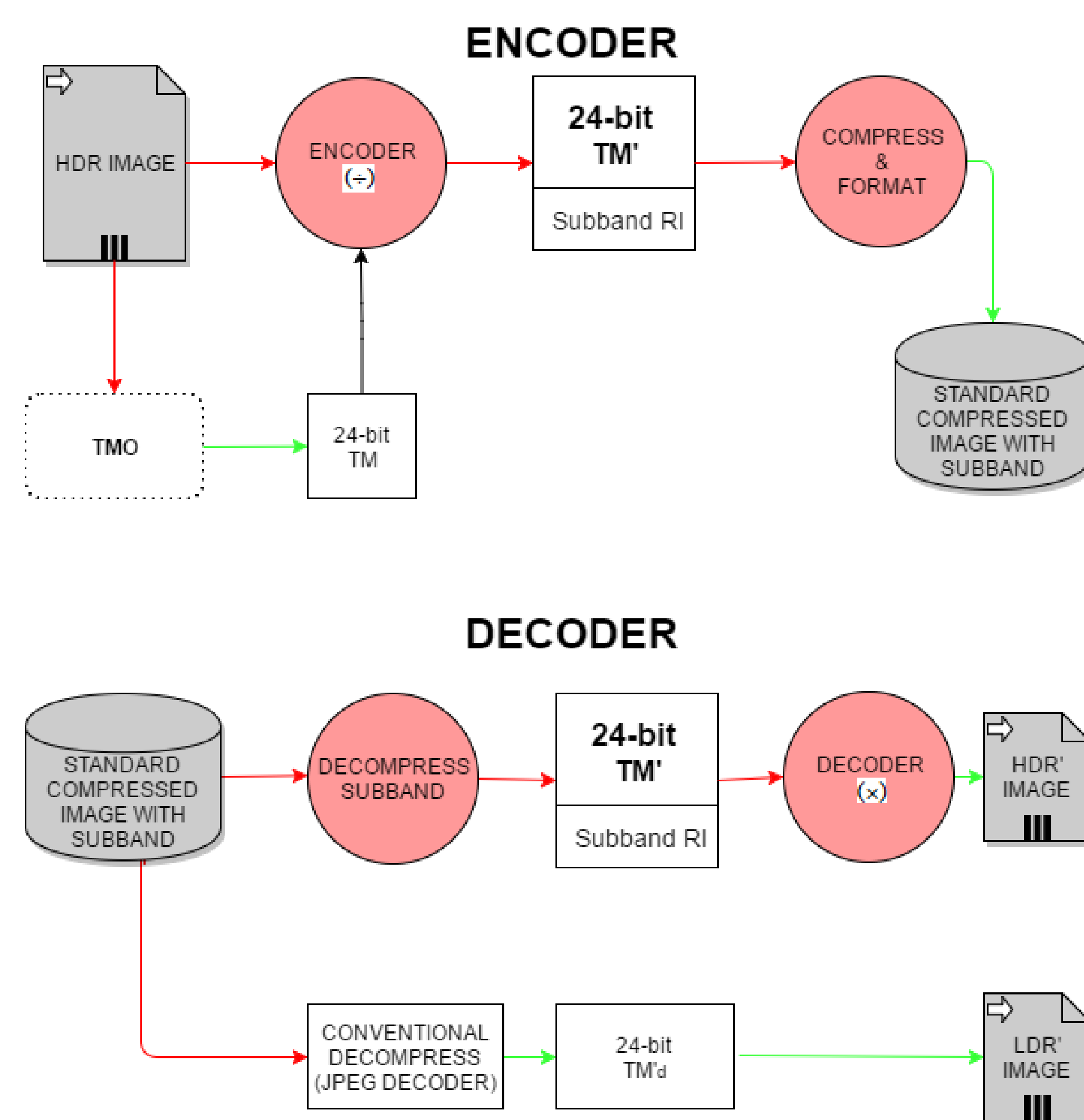


Figure 3: The encoding and decoding pipeline for JPEG-HDR by Ward and Simmons [1].

2nd Method

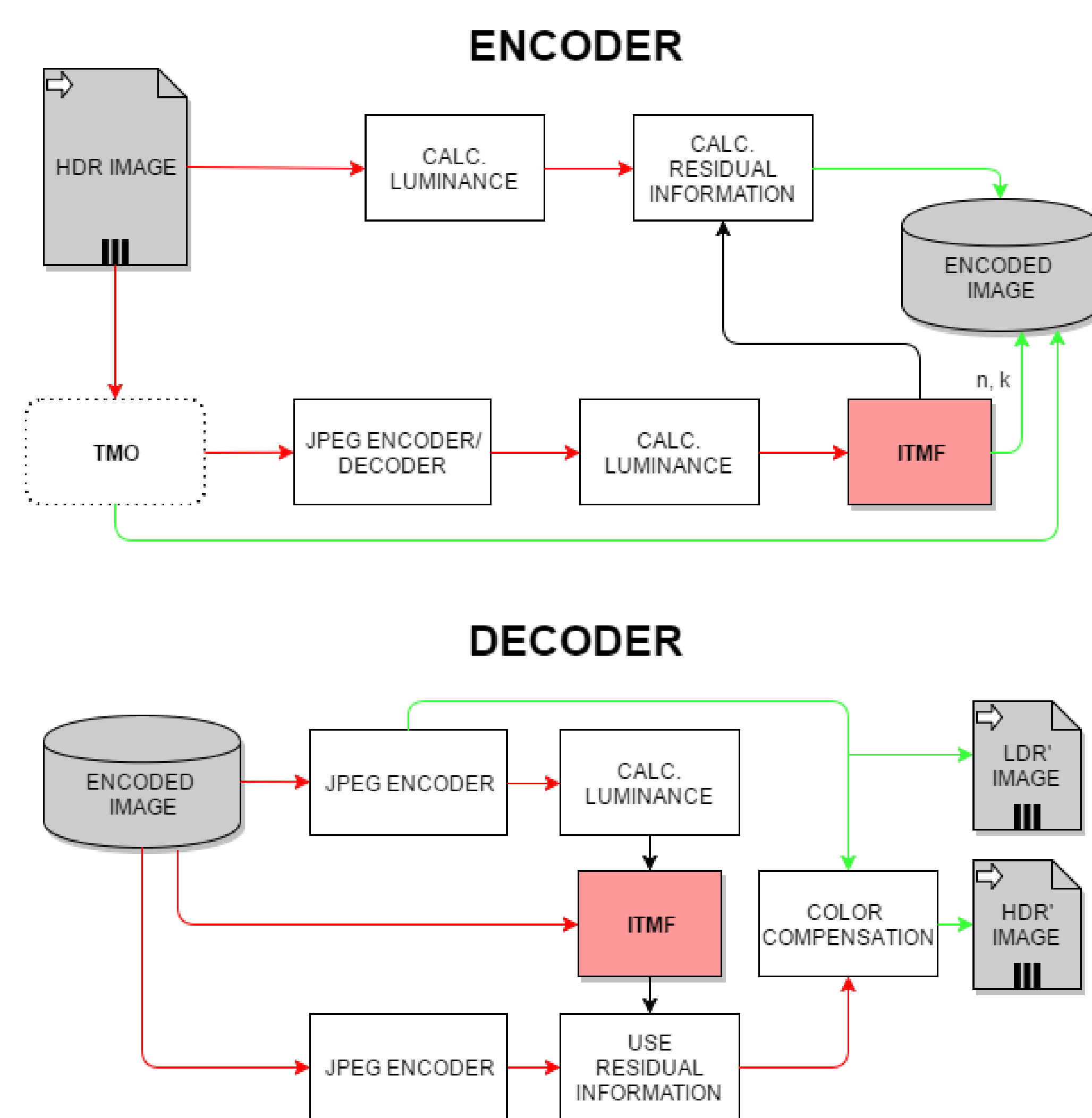


Figure 5: The encoding and decoding pipeline for the Okuda's compression scheme [2].

DataBase

Images	Size	Dynamic Range
Apartment	1536×2048	4.7
Atrium Night	1016×760	4.1
Dani Belgium	769×1025	4.1
Desk	874×644	5.2
Display 1000	1536×2048	3.4
Memorial	768×512	4.8
Mountain	732×1214	3.1
Rend07	512×512	8.9
Rend10	1024×1024	5.0
Tree	906×928	4.4

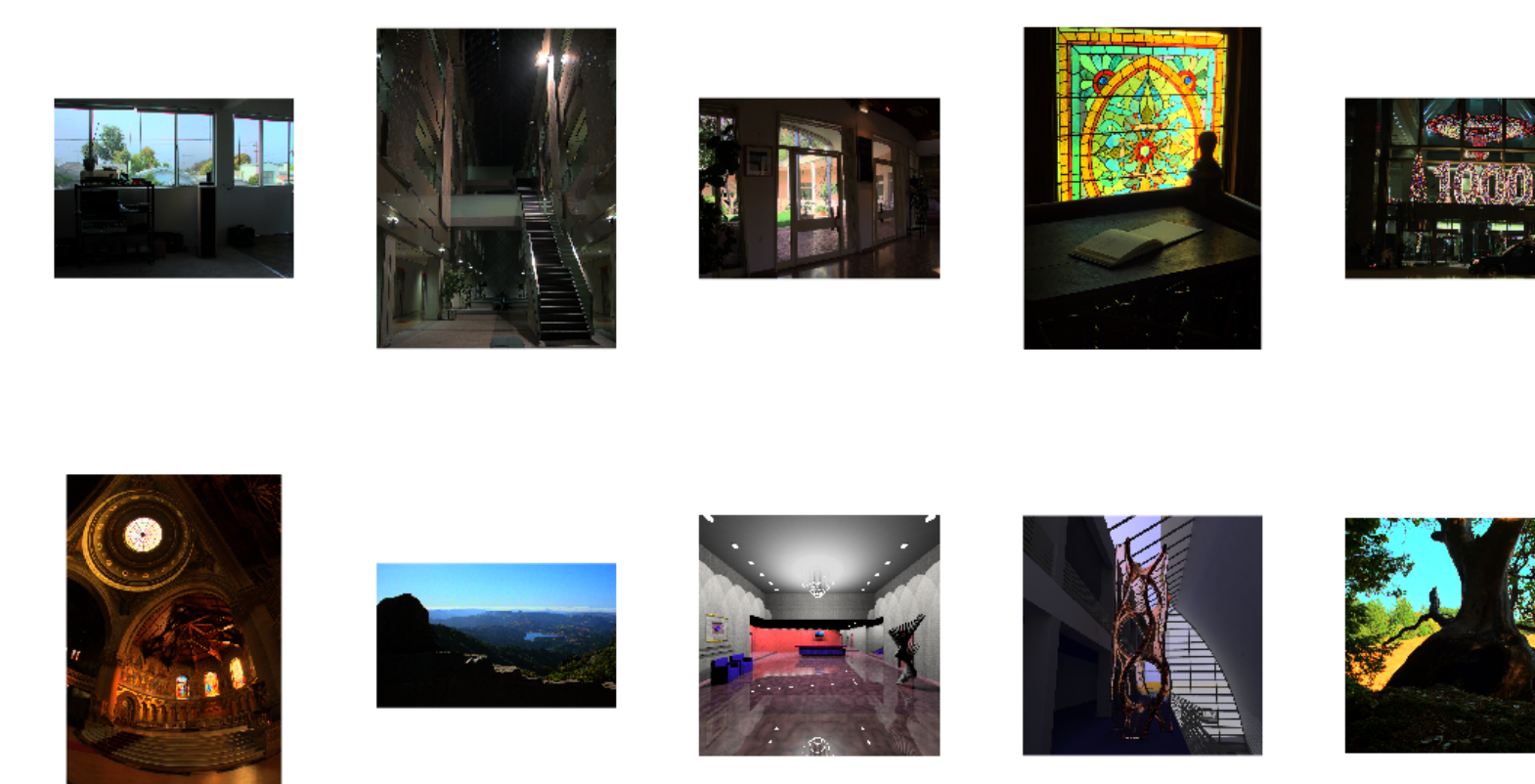


Figure 4: The set of HDR images used for the evaluation of the algorithms.

Results

The two methods were evaluated by the following quality metrics:

- Mean Square Error.
- Mean Distance in $L^*a^*b^*$ color space.
- Mean Square Error with Daly's Nonlinearity.

The tables below present the mean value of these metrics for the selected Database, whose images vary both in size and dynamic range, resulting to general conclusions.

Metrics	Method 1	Method 2
CR	20.6%	6.05%
MSE	$2.5 \cdot 10^{-4}$	$10.5 \cdot 10^{-4}$
MD $L^*a^*b^*$	1.89	1.53
DN MSE	$2.24 \cdot 10^{-6}$	$2.7 \cdot 10^{-6}$

Table 1: Mean of the quality metrics calculated for the Database (JPEG quality used: 90%).

Results

Metrics	Method 1	Method 2
CR	5.8%	4.1%
MSE	$1.37 \cdot 10^{-4}$	10^{-4}
MD $L^*a^*b^*$	1.75	1.65
DN MSE	$1.92 \cdot 10^{-6}$	$1.25 \cdot 10^{-6}$

Table 2: Mean of the quality metrics calculated for the Database (JPEG quality used: 100%).

Conclusion

Using the above methods, can be achieved an efficient compression to HDR images. The error in most of the images could be considered negligible, since it is not perceptible from the human eye. In the images that cannot be compressed with negligible error, further restorative information should be stored in order to achieve better results.

References

- [1] Greg Ward and Myrriann Simmons. Jpeg-hdr: A backwards-compatible, high dynamic range extension to jpeg. *SIGGRAPH 2005 Courses*, 2005.
- [2] Masahiro Okuda and Nicola Adami. Two-layer coding algorithm for high dynamic range images based on luminance compensation. *J. Vis. Commun. Image Represent.* 18:5, pages 377 – 386, 2007.

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