

Lossless compression of Bayer Color Filter Arrays for Visualization and Re-development

Miguel Hernández
<miguel.hernandez@uab.es>

December 2014

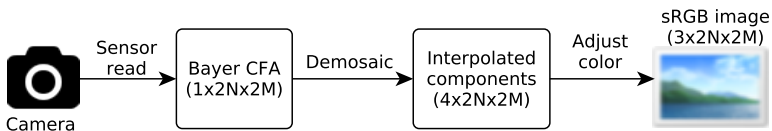
Contents

- 1 Compression pipelines
- 2 Our proposal
 - Visualization
 - Reversibility
 - Component upscaling
- 3 Compression results

Contents

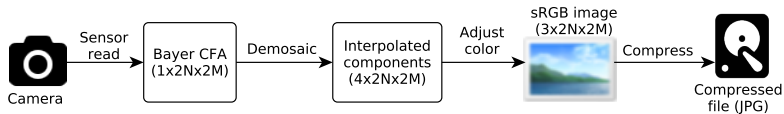
- 1 Compression pipelines
- 2 Our proposal
 - Visualization
 - Reversibility
 - Component upscaling
- 3 Compression results

Camera to sRGB

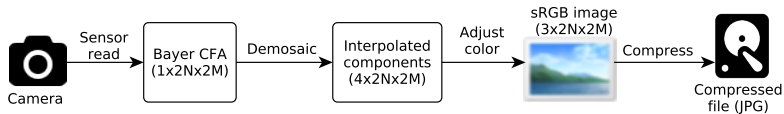


- Automatic (on-camera)
- Manual (professional)

Traditional compression pipeline (on-camera)



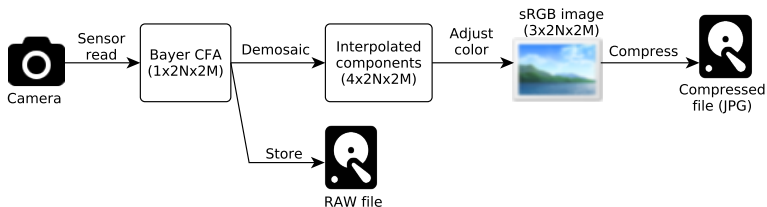
Traditional compression pipeline (on-camera)



On-camera (JPG):

- ☹️ Compression after interpolation
(↑ bitrate)
- ☹️ Cannot revert to Bayer CFA
- 😊 Directly visualizable

Traditional compression pipeline (professional)



On-camera (JPG):

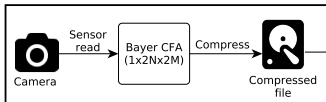
- ☹️ Compression after interpolation (↑ bitrate)
- ☹️ Cannot revert to Bayer CFA
- 😊 Directly visualizable

Professional (RAW):

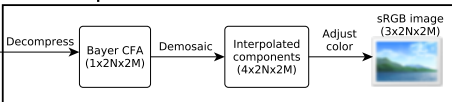
- ☹️ Low/no compression
- 😊 Can revert
- ☹️ Not directly visualizable
- ☹️ Usually privative formats

Compression pipeline in the literature

In camera

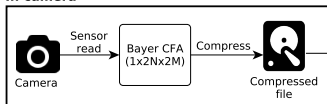


In user's computer

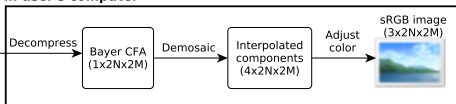


Compression pipeline in the literature

In camera



In user's computer



Compression before interpolation (\downarrow bitrate)



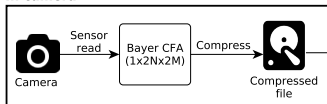
Can revert to Bayer CFA



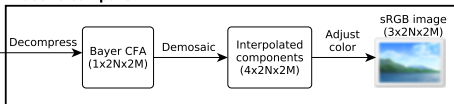
Visualization: special postprocessing software

Compression pipeline in the literature

In camera

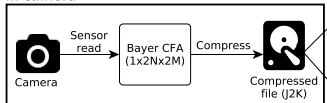


In user's computer

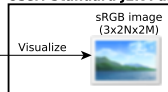


Proposed compression pipeline

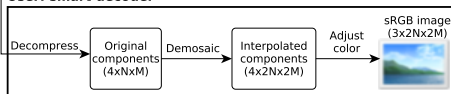
In camera



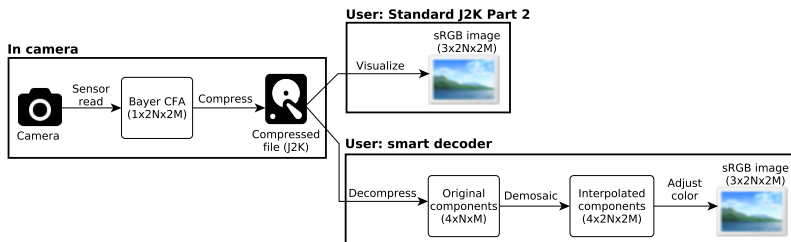
User: Standard J2K Part 2



User: smart decoder



Proposed compression pipeline

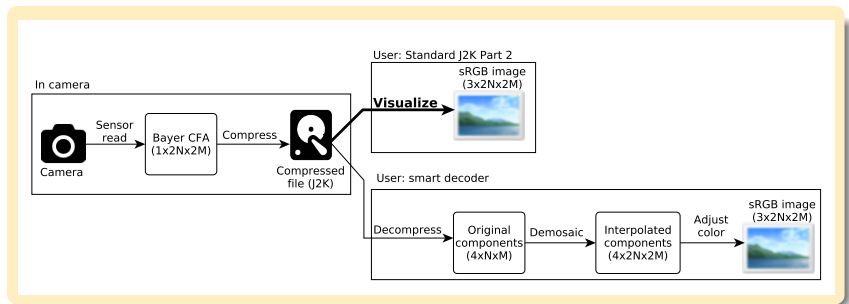


- 😊 Compression before interpolation (\downarrow bitrate)
- 😊 Can revert to Bayer CFA
- 😊 Visualization: JPEG2000 Part 2 decoder

Contents

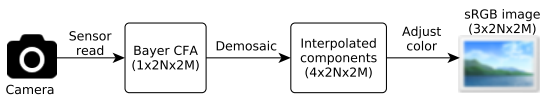
- 1 Compression pipelines
- 2 Our proposal
 - Visualization
 - Reversibility
 - Component upscaling
- 3 Compression results

Visualization



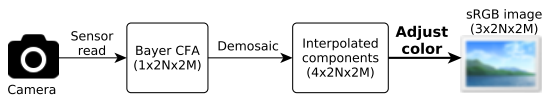
Visualization

Image processing pipeline

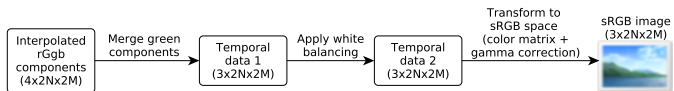


Visualization

Image processing pipeline

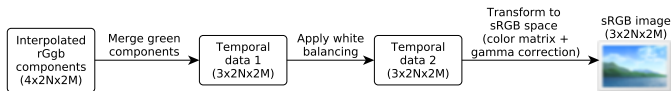


Color adjustment



Visualization

Color adjustment

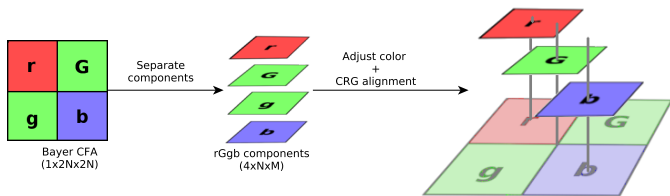


Visualization with JPEG2000 Part 2



Visualization

Component alignment



Visualization

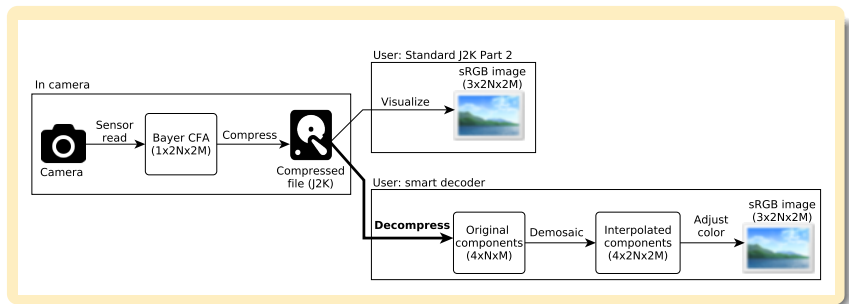
Without CRG



With CRG

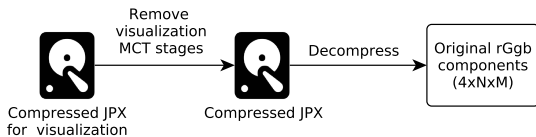


Reversibility



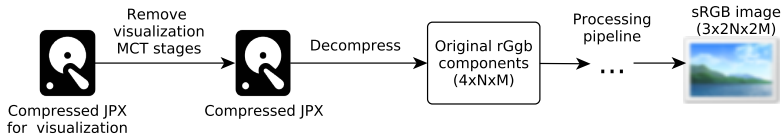
Reversibility

Smart decoder

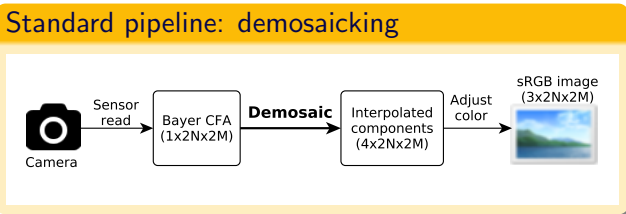


Reversibility

Smart decoder



Component upscaling



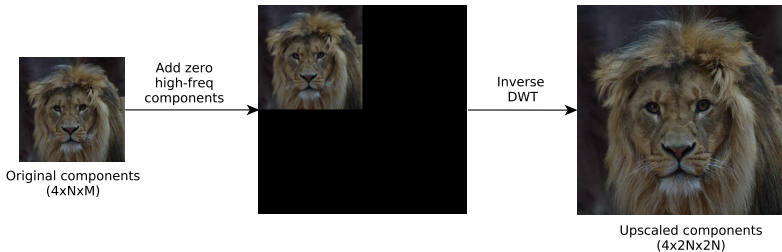
Very good quality



Non-linear operations:
not possible inside JPEG2000

Component upscaling

Alternative 1: inverse DWT



No compression penalty



Not as good as demosaicking

Contents

- 1 Compression pipelines
- 2 Our proposal
 - Visualization
 - Reversibility
 - Component upscaling
- 3 Compression results

Compression results: size(bits) / 4NM

Algorithm	sRGB (3x2Nx2N) 8 bppc	sRGB (3x2Nx2N) 13 bppc	CFA (1x2Nx2N) 13 bpppc	rGgb (4xNxN) 13 bpppc
------------------	------------------------------------	-------------------------------------	-------------------------------------	------------------------------------

Compression results: size(bits) / 4NM

Algorithm	sRGB (3x2Nx2N) 8 bppc	sRGB (3x2Nx2N) 13 bppc	CFA (1x2Nx2N) 13 bpppc	rGgb (4xNxN) 13 bpppc
	JPEG2000, 5 DWT	8.736	25.272	7.588
JPEG-LS	8.508	24.597	10.018	7.187
Neves	–	24.501	7.272	6.512

Compression results: size(bits) / 4NM

Algorithm	sRGB (3x2Nx2N) 8 bppc	sRGB (3x2Nx2N) 13 bppc	CFA (1x2Nx2N) 13 bpppc	rGgb (4xNxN) 13 bpppc
	JPEG2000, 5 DWT	8.736	25.272	7.588
JPEG-LS	8.508	24.597	10.018	7.187
Neves	–	24.501	7.272	6.512

- rGgb@13 bpppc better than demosaicked@8 bpppc
- rGgb better than CFA

MCT results (bpppc)

Lossless JPEG2000,
rGgb components

No MCT	7.308
rKLT	7.205
rHaar(G,g)	7.263

MCT results (bpppc)

Lossless JPEG2000,
rGgb components

No MCT	7.308
rKLT	7.205
rHaar(G,g)	7.263

- Small difference
(~ 0.1 bpppc)
- rHaar: $\sim 44\%$ of rKLT

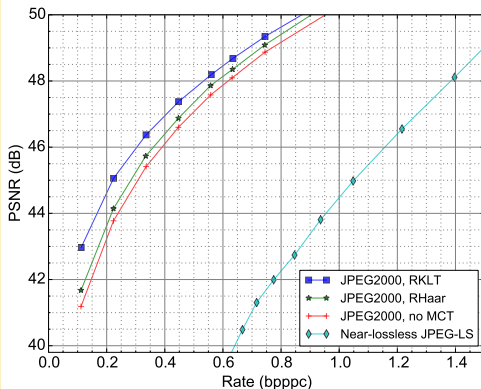
MCT rate-distortion comparison

MCT results (bpppc)

Lossless JPEG2000,
rGgb components

No MCT	7.308
rKLT	7.205
rHaar(G,g)	7.263

- Small difference (~0.1 bpppc)
- rHaar: ~44% of rKLT



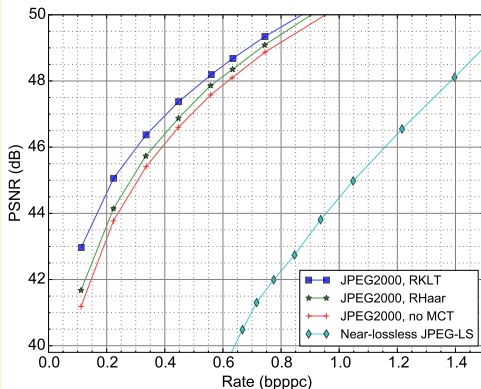
MCT results (bpppc)

Lossless JPEG2000,
rGgb components

No MCT	7.308
rKLT	7.205
rHaar(G,g)	7.263

- Small difference (~ 0.1 bpppc)
- rHaar: $\sim 44\%$ of rKLT

MCT rate-distortion comparison



rKLT vs no MCT: small differences

- @0.1 bppc: 1.8 dB better
- @2.2 bpp: very similar
- @4.5 bppc: 0.4 dB worse