Case Study:
the Bayer Colour Imaging Array

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Open-Source Tools and Resources for Audio-Visual Archives

Elías Querejeta Zine Eskola
Donostia (San Sebastián), Spain
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United States Patent [19]
Bayer

[11] **3,971,065**
[45] **July 20, 1976**

[54] **COLOR IMAGING ARRAY**

[75] Inventor: **Bryce E. Bayer**, Rochester, N.Y.
[73] Assignee: **Eastman Kodak Company**, Rochester, N.Y.

[22] Filed: **Mar. 5, 1975**
[21] Appl. No.: **555,477**

[52] **U.S. Cl.** ..... **358/41**; 350/162 SF; 350/317; 358/44
[51] **Int. Cl.²** **H04N 9/24**
[58] **Field of Search** ..... 358/44, 45, 46, 47, 358/48; 350/317, 162 SF; 315/169 TV

[56] **References Cited**
UNITED STATES PATENTS

2,446,791	8/1948	Schroeder	358/44
2,508,267	5/1950	Kasperowicz	358/44
2,884,483	4/1959	Ehrenhaft et al.	358/44
3,725,572	4/1973	Kurokawa et al.	358/46

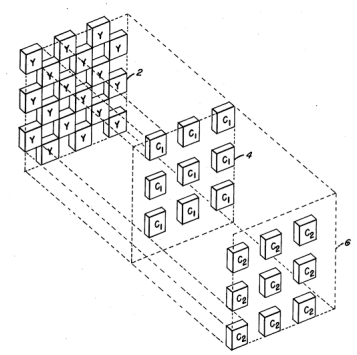
Primary Examiner—George H. Libman
Attorney, Agent, or Firm—George E. Grosser

[57] **ABSTRACT**

A sensing array for color imaging includes individual luminance- and chrominance-sensitive elements that are so intermixed that each type of element (i.e., according to sensitivity characteristics) occurs in a repeated pattern with luminance elements dominating the array. Preferably, luminance elements occur at every other element position to provide a relatively high frequency sampling pattern which is uniform in two perpendicular directions (e.g., horizontal and vertical). The chrominance patterns are interlaid therewith and fill the remaining element positions to provide relatively lower frequencies of sampling.

In a presently preferred implementation, a mosaic of selectively transmissive filters is superposed in registration with a solid state imaging array having a broad range of light sensitivity, the distribution of filter types in the mosaic being in accordance with the above-described patterns.

11 Claims, 10 Drawing Figures



Uncomfortable Truths

- sensors are colour blind
- Bayer sensors do not generate full RGB

```
less
movimenc(1)                The MovIm video codec                movimenc(1)

NAME
       movimenc - MovIm encoder

SYNOPSIS
       movimenc [input_options] -i input_file [encoding_options]
       [output_options] -o output_file

       movimenc -h

DESCRIPTION
       MovIm is a video codec specifically designed for both conservation and
       restoration of moving images.

       The openMovIm package includes the libmovim C library implementing
       MovIm and its associated movimenc, movimdec and movimplay utilities, as
       well as the openmovim Bash command-line interface allowing to encode,
       decode, play and analyse virtually any moving images.

       movimenc is a MovIm encoder.

OPTIONS
   GENERAL OPTIONS
:
```

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```
less
       --demosaic=(BLI|BCI|LR|VNG|SI|PG|AMZE|HQLI|AHD|DLMMSEE)
           demosaic a Bayer-encoded input_file into an RGB output_file

           This option allows to choose between different demosaicing
           algorithms, because the results may vary a lot, depending on the
           image content.

           The following algorithms are implemented:
           - BLI = bilinear interpolation
           - BCI = bicubic interpolation
           - LR = Lanczos resampling
           - VNG = variable number of gradients
           - SI = spline interpolation
           - PG = pixel grouping
           - AMZE = aliasing minimisation and zipper elimination
           - HQLI = high-quality linear interpolation (Malvar, He and Cutler.
           IEEE 2004)
           - AHD = adaptive homogeneity-directed (Hirakawa and Parks. IEEE
           2005)
           - DLMMSEE = directional linear minimum mean square-error estimation
           (Zhang and Xiaolin. IEEE 2005)

   INFORMATIVE OPTIONS
       -h, --help
:
```

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```
01110101001010101000101101011110
01001101010101010101000010111010
01110101001010101000101101011110
00011101010101010101000010111010
01101010100101010100010110101111
00101010101010101000010111010100
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```
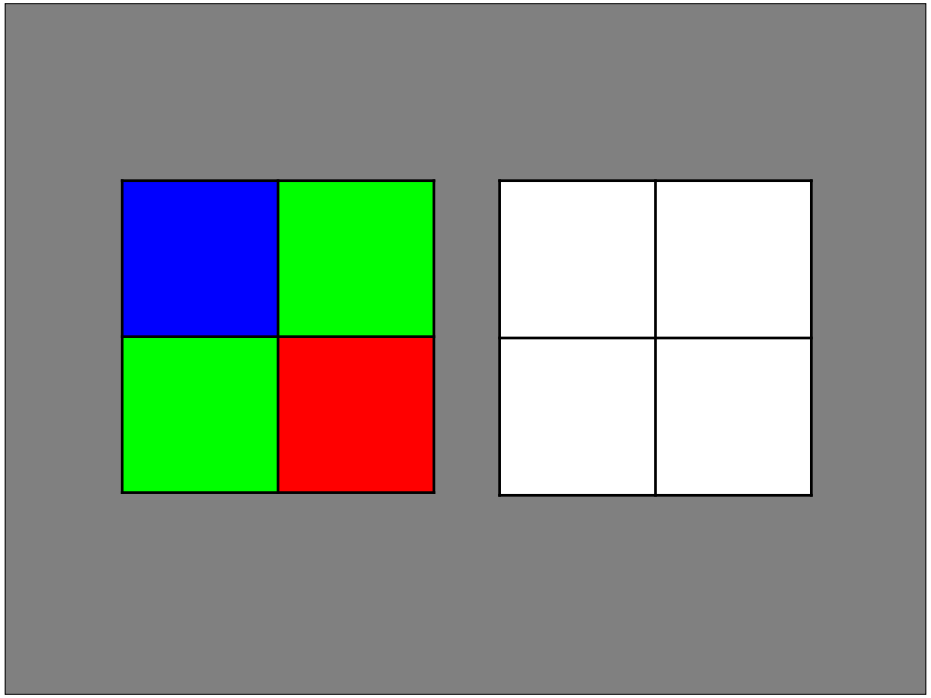
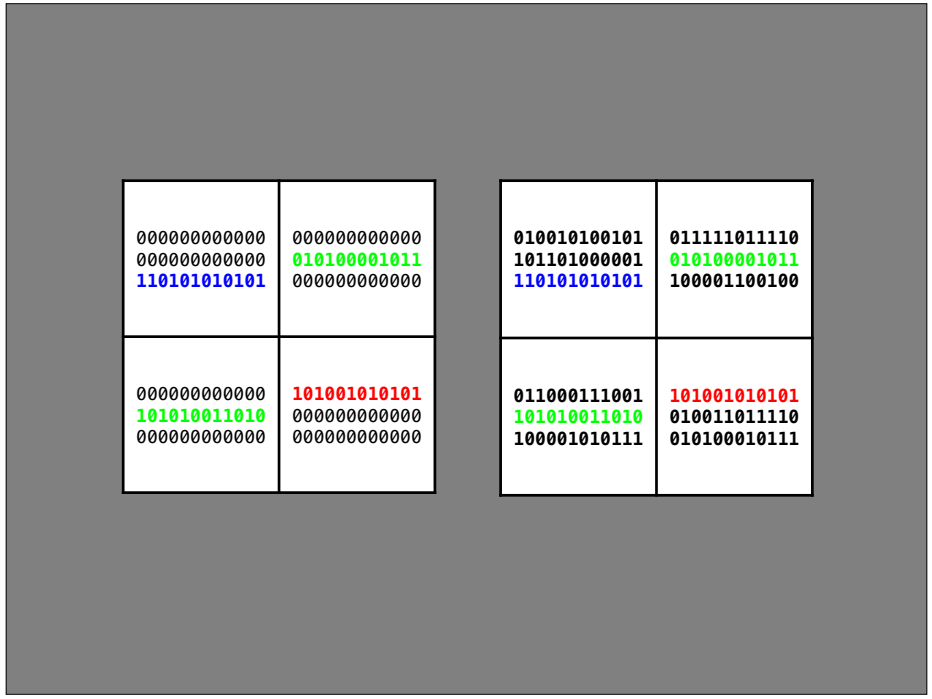

7



8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010010100101 011111011110
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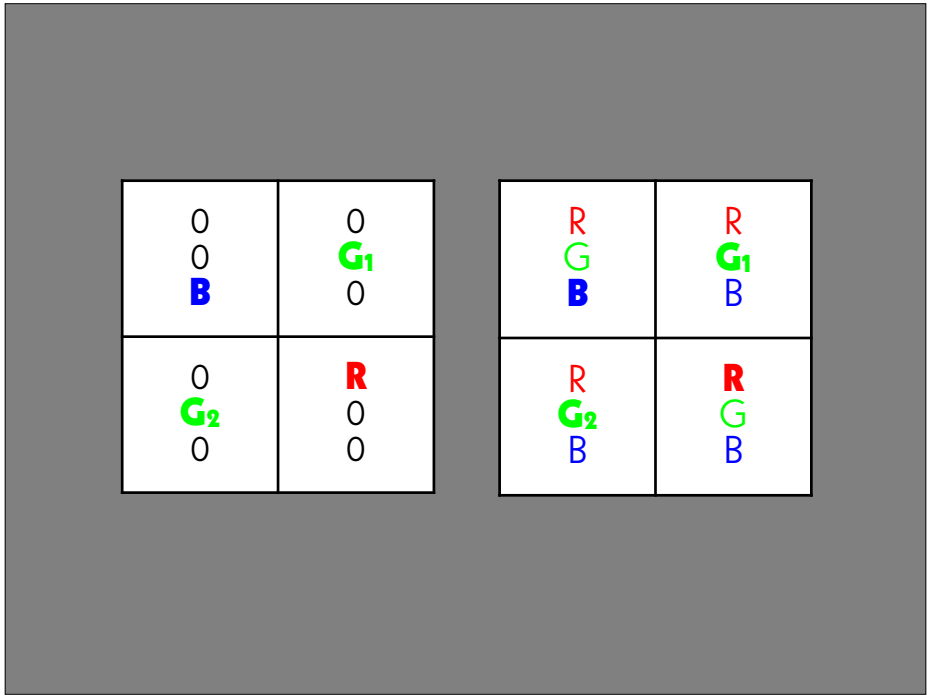
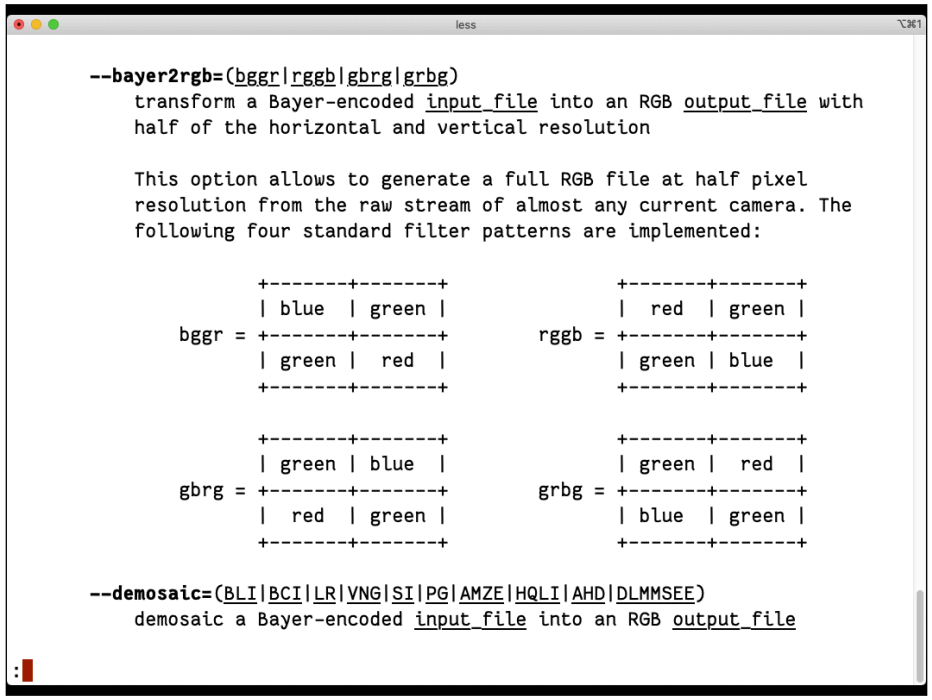
101010011010 010011011110
100001010111 010100010111

9


0 0
0 G1
B 0
0 R
G2 0
0 0
R R
G G1
B B
R R
G2 G
B B

10


less
--bayer2rgb=(bggr|rggb|gbrg|grbg)
transform a Bayer-encoded input_file into an RGB output_file with
half of the horizontal and vertical resolution
This option allows to generate a full RGB file at half pixel
resolution from the raw stream of almost any current camera. The
following four standard filter patterns are implemented:
bggr = | blue | green | / | green | red |
rggb = | red | green | / | green | blue |
gbrg = | green | blue | / | red | green |
grbg = | green | red | / | blue | green |
--demosaic=(BLI|BCI|LR|VNG|SI|PG|AMZE|HQLI|AHD|DLMMSEE)
demosaic a Bayer-encoded input_file into an RGB output_file
:

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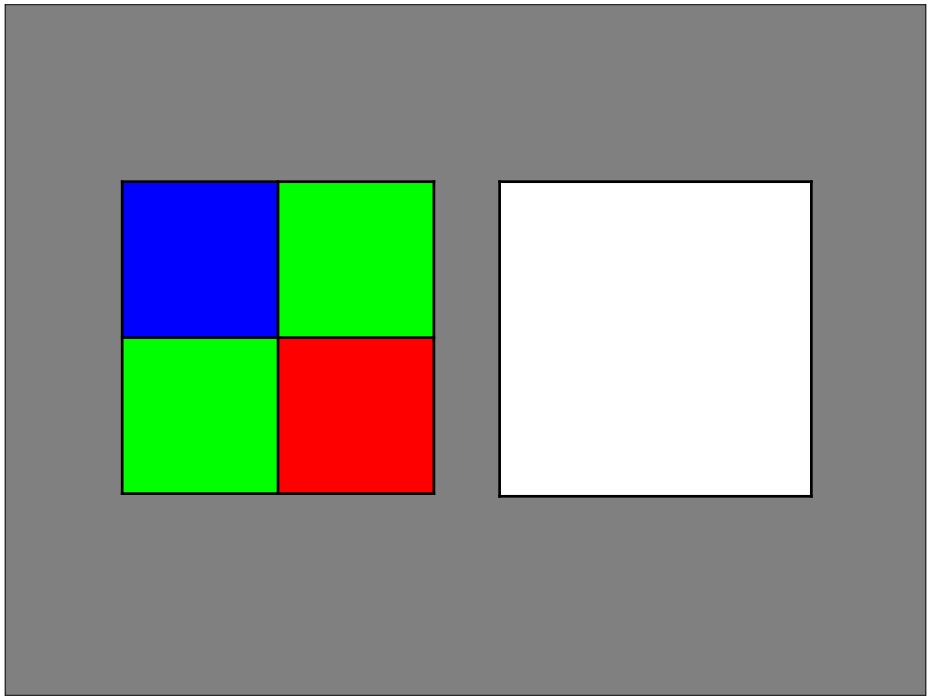

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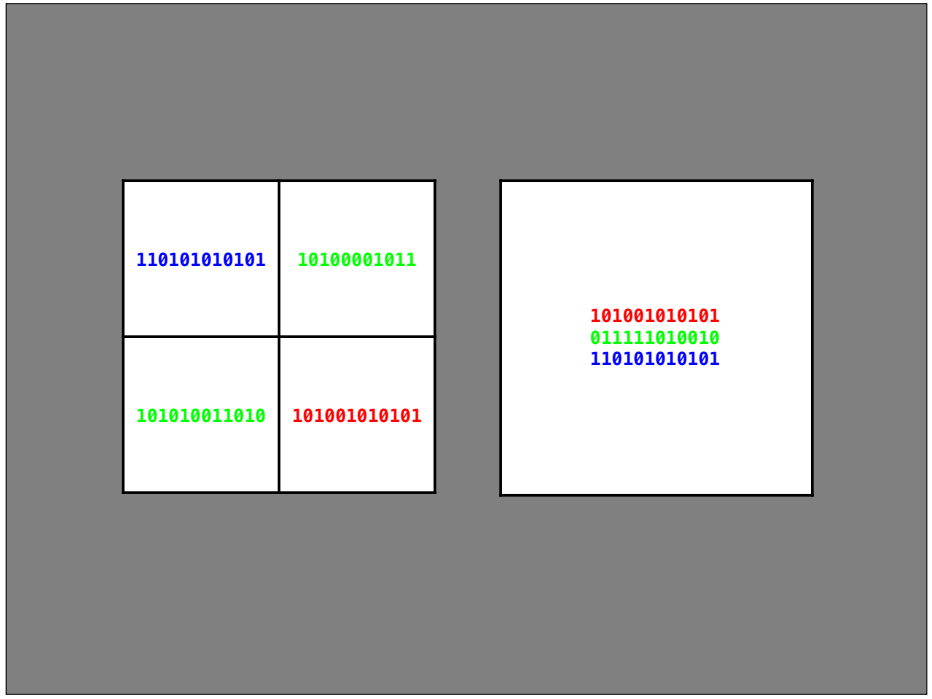

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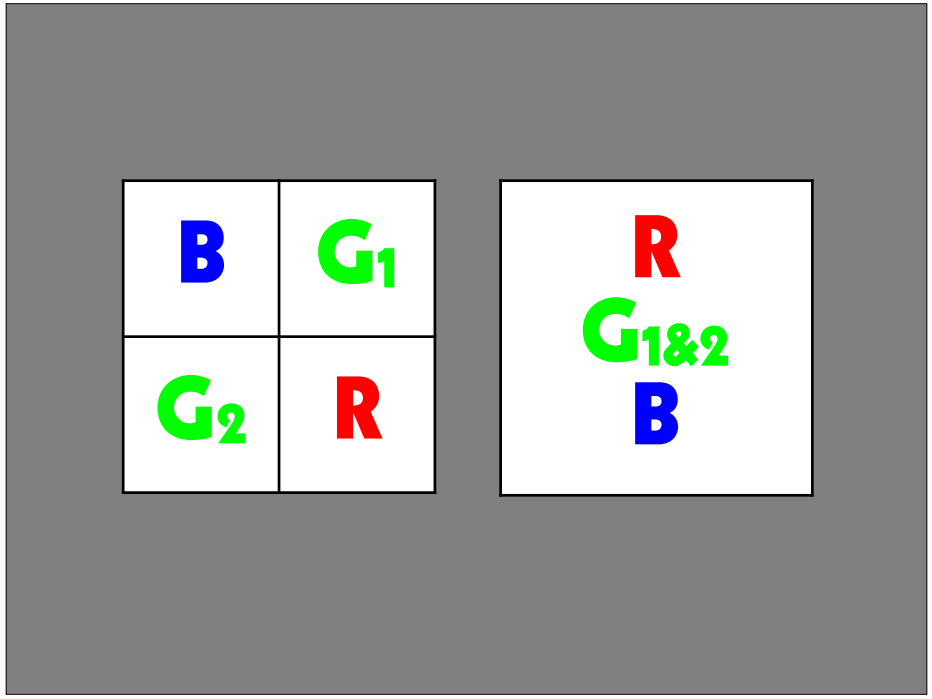

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less

INFORMATIVE OPTIONS

-h, --help
display a help message

--version
display the running version

NOTES
The illuminant's default value may switch from D65 to D60 in future.

SEE ALSO
movimdec(1) and **movimplay**(1); **libmovim**(1); **openmovim**(1).

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LICENSE
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DISCLAIMER
The **openMovIm** package is provided "as is" without warranty or support of any kind.

2021-05-08 https://avpres.net/MovIm/ movimenc(1)
(END)

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-bash

```
[14:06:58]imac01@iMac01:~/Desktop$ man movimenc
[14:10:24]imac01@iMac01:~/Desktop$ man openmovim
```

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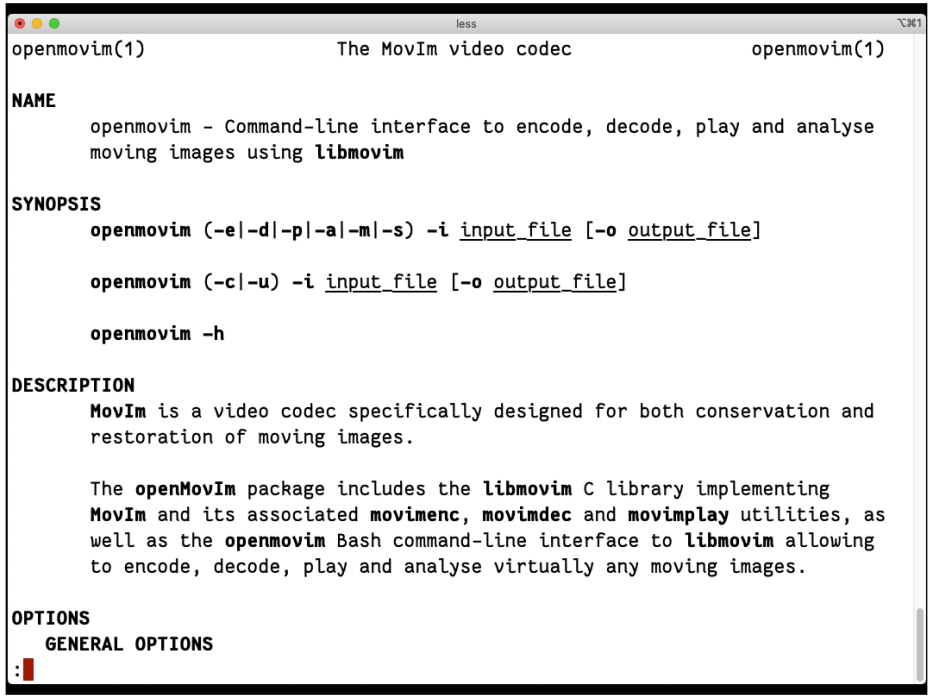
less
openmovim(1) The MovIm video codec openmovim(1)
NAME
openmovim - Command-line interface to encode, decode, play and analyse moving images using libmovim
SYNOPSIS
openmovim (-e|-d|-p|-a|-m|-s) -i input_file [-o output_file]
openmovim (-c|-u) -i input_file [-o output_file]
openmovim -h
DESCRIPTION
MovIm is a video codec specifically designed for both conservation and restoration of moving images.
The openMovIm package includes the libmovim C library implementing MovIm and its associated movimenc, movimdec and movimplay utilities, as well as the openmovim Bash command-line interface to libmovim allowing to encode, decode, play and analyse virtually any moving images.
OPTIONS
GENERAL OPTIONS
:

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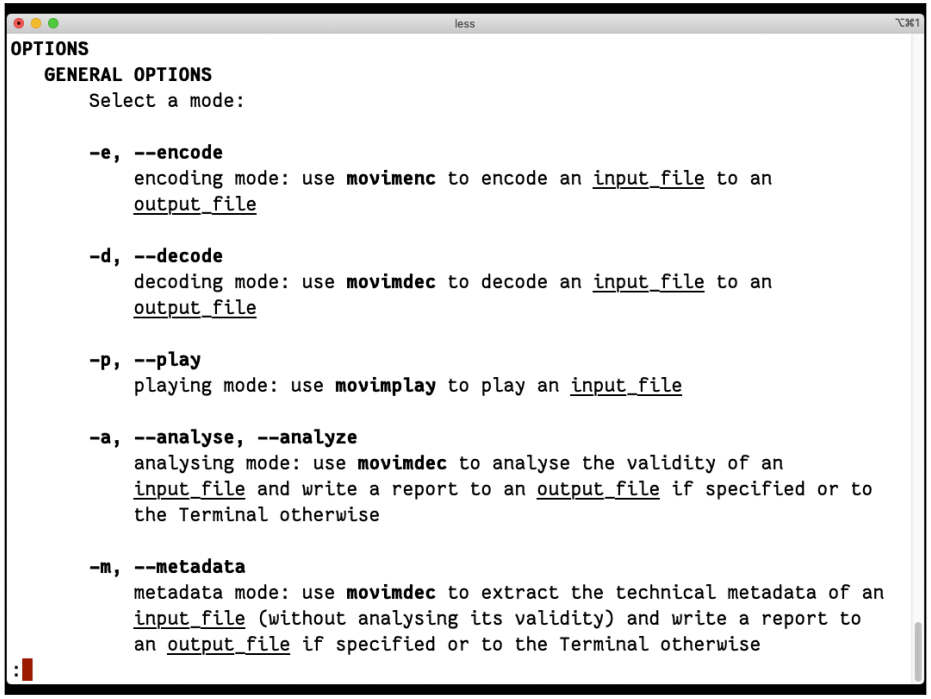
less
OPTIONS
GENERAL OPTIONS
Select a mode:
-e, --encode
encoding mode: use movimenc to encode an input_file to an output_file
-d, --decode
decoding mode: use movimdec to decode an input_file to an output_file
-p, --play
playing mode: use movimplay to play an input_file
-a, --analyse, --analyze
analysing mode: use movimdec to analyse the validity of an input_file and write a report to an output_file if specified or to the Terminal otherwise
-m, --metadata
metadata mode: use movimdec to extract the technical metadata of an input_file (without analysing its validity) and write a report to an output_file if specified or to the Terminal otherwise
:

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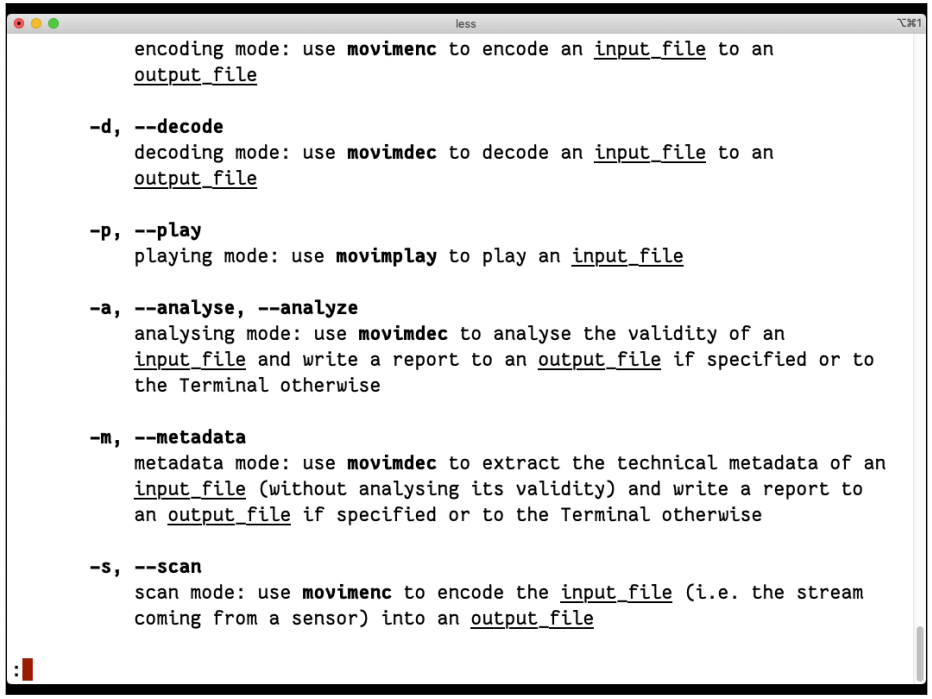
less
encoding mode: use movimenc to encode an input_file to an output_file
-d, --decode
decoding mode: use movimdec to decode an input_file to an output_file
-p, --play
playing mode: use movimplay to play an input_file
-a, --analyse, --analyze
analysing mode: use movimdec to analyse the validity of an input_file and write a report to an output_file if specified or to the Terminal otherwise
-m, --metadata
metadata mode: use movimdec to extract the technical metadata of an input_file (without analysing its validity) and write a report to an output_file if specified or to the Terminal otherwise
-s, --scan
scan mode: use movimenc to encode the input_file (i.e. the stream coming from a sensor) into an output_file
:

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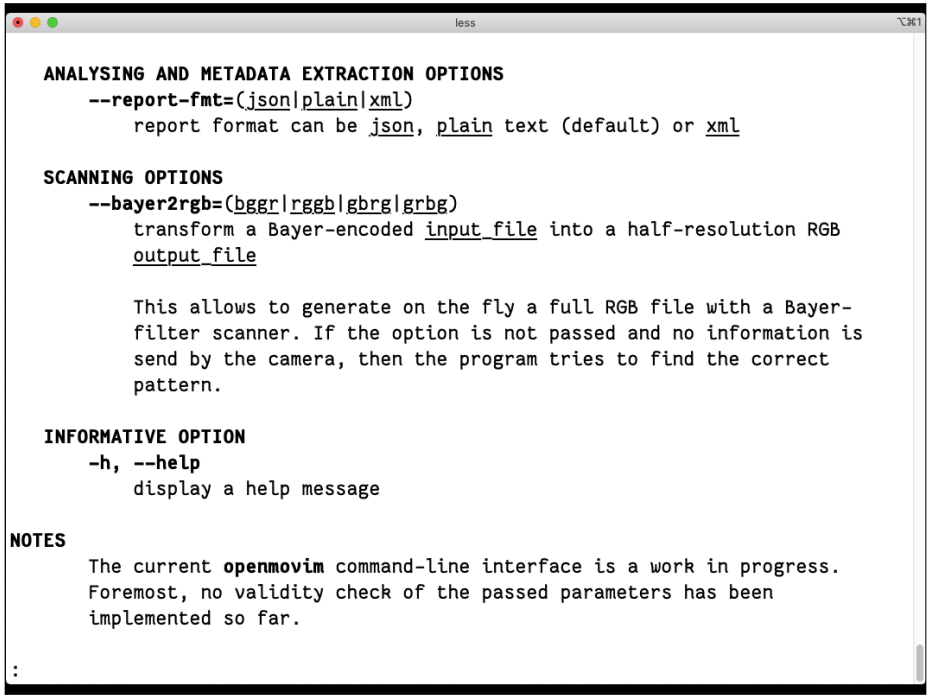
less
ANALYSING AND METADATA EXTRACTION OPTIONS
--report-fmt=(json|plain|xml)
report format can be json, plain text (default) or xml
SCANNING OPTIONS
--bayer2rgb=(bggr|rggb|gbrg|grbg)
transform a Bayer-encoded input_file into a half-resolution RGB output_file
This allows to generate on the fly a full RGB file with a Bayer-filter scanner. If the option is not passed and no information is send by the camera, then the program tries to find the correct pattern.
INFORMATIVE OPTION
-h, --help
display a help message
NOTES
The current openmovim command-line interface is a work in progress. Foremost, no validity check of the passed parameters has been implemented so far.
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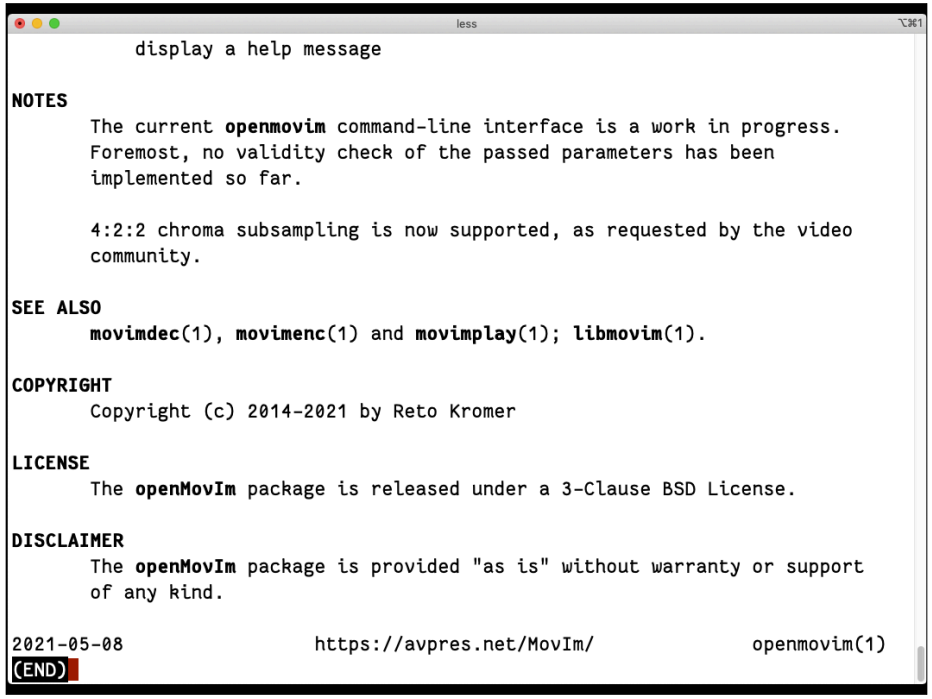

Two ways to use Bayer data

digital blow-up to RGB

- 3 times the amount of the generated data
- the file has the full sensor resolution
- only ⅓ of the data are real

digital reduction to RGB

- ¾ the amount of the generated data
- the file has ½ of the sensor resolution
- all data are real

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- Jérôme Martinez
- Michael Niedermayer

AV Preservation by reto.ch

zone industrielle Le Trési 3
1028 Préverenges
Switzerland

Web: reto.ch
Twitter: @retoch
Email: info@reto.ch