Errando
tra analogico e digitale

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Andare avanti, guardare indietro
Università degli Studi della Tuscia, Viterbo, Italia
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errare

v. intr. [lat. *errare* «vagare; sbagliare»] (*io èrro*, ecc.; aus. *avere*). – **1. a.** Andare qua e là senza direzione o meta certa: *e. per i campi, per i monti, per le strade*; fig.: *e. con gli occhi, con lo sguardo*; *errava col pensiero dietro i fantasmi della sua immaginazione*; estens., di cose: *Tal dell'arpa diffuso erra il concento* (Foscolo). Poet. anche trans.: *mari e poggi errando, Tutto l'orbe trascorre* (Leopardi); *Dante ... errava Pensoso peregrin la selva fiera* (Carducci). **b.** Sviarsi: *e. dalla via, e. dal retto sentiero*; fig.: *O forse erra dal vero, Mirando all'altrui sorte, il mio pensiero* (Leopardi). Quindi: **2. a.** Ingannarsi in un'opinione, sbagliare in ciò che si crede o si afferma: *Come Livio scrive, che non erra* (Dante); *ha errato a dir così*; *errando s'impara*; *se erro, correggimi*; *le cose stanno in questi termini, se non erro*; *e. in materia di fede*. In senso morale, commettere colpa: *ho errato, e sono pronto a fare la penitenza*. Con l'una o con l'altra accezione, nella frase prov. *errare è umano, perseverare nell'errore è diabolico* (più frequente nella forma lat., alla quale non si può peraltro assegnare un'origine precisa, *errare humanum est, perseverare autem diabolicum*). **b.** Con uso trans., è sinon. di *sbagliare* (ma meno com.): *e. il cammino*; *mai colpo il cavalier non erra* (T. Tasso). ◆ Part. pres. **errante**, con valore verbale e di agg. (v. la voce). ◆ Part. pass. **errato**, anche come agg. (v. errato[1]).

Errare

- Andare qua e là senza direzione o meta certa
- Sviarsi
- Ingannarsi in un'opinione, sbagliare in ciò che si crede o si afferma
- Con uso transitivo, è sinonimo di sbagliare (ma meno comune)

Da: Enciclopedia Italiana di scienze, lettere ed arti («La Treccani»)

Sommario

- sostenibilità dei media
- conservazione analogica e conservazione digitale
- restauro analogico e restauro digitale
- pratiche di archiviazione e il loro impatto ambientale

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Charles Poynton, John Graham-Cumming
Nicole Martin, Dave Rice, Misty De Meo, Yvonne Ng
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Materialità

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Fotografia fotochimica

bianco e nero

- emulsione sensibile al blu
- emulsione ortocromatica
- emulsione pancromatica

colore

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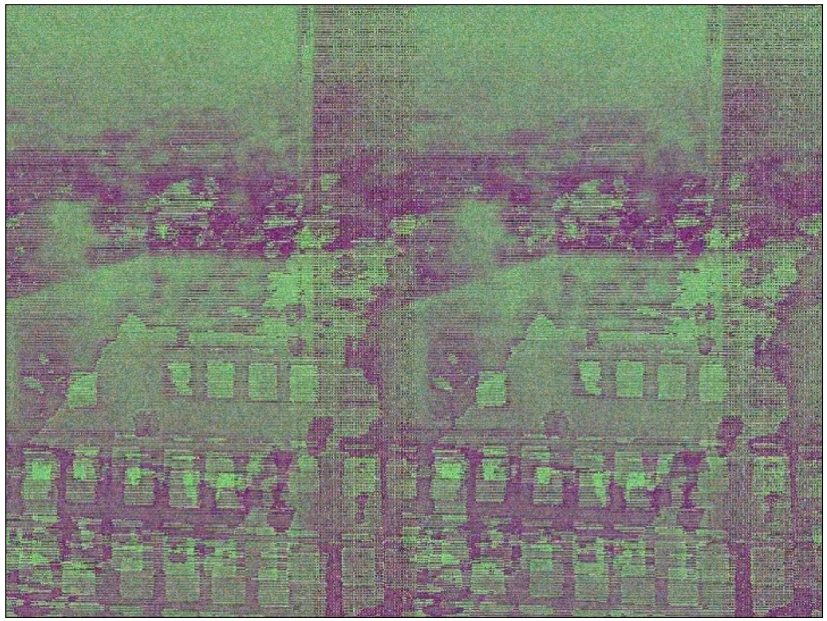

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Conservazione

Stabilità/instabilità chimica

- composizione
- fabbricazione, utilizzo e stoccaggio
- temperatura e umidità
- decomposizione

Standard

- decisi prevalentemente dall'industria
- possono cambiare nel corso degli anni
- cum grano salis

Storage Conditions	Glass Plates	Nitrate	Acetate		Polyester		Photo Prints		Ink Jet Prints	Magnetic Tape		CDs DVDs
			B&W	Color	B&W	Color	B&W	Color		Acetate	Polyester	
ROOM	Fair	No	No	No	Fair	No	Fair	No	Fair	No	No	Fair
COOL	Good	No	No	No	Good	No	Good	No	Fair	Fair	Good	Good
COLD	Very Good	Good	Good	Good	Very Good	Good	Very Good	Good	Good	Good	Fair	Good
FROZEN	No	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	No	No	No

Storage Conditions	Glass Plates	Nitrate	Acetate		Polyester		Photo Prints		Ink Jet Prints	Magnetic Tape		CDs DVDs
			B&W	Color	B&W	Color	B&W	Color		Acetate	Polyester	
ROOM	Fair	No	No	No	Good	No	Good	No	Fair	No	No	Fair
COOL	Good	No	No	No	Good	No	Good	No	Fair	Fair	Good	Good
COLD	Very Good	Good	Good	Good	Very Good	Good	Very Good	Good	Good	Good	Good	Good
FROZEN	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Good	Good	No

Quattro zone climatiche

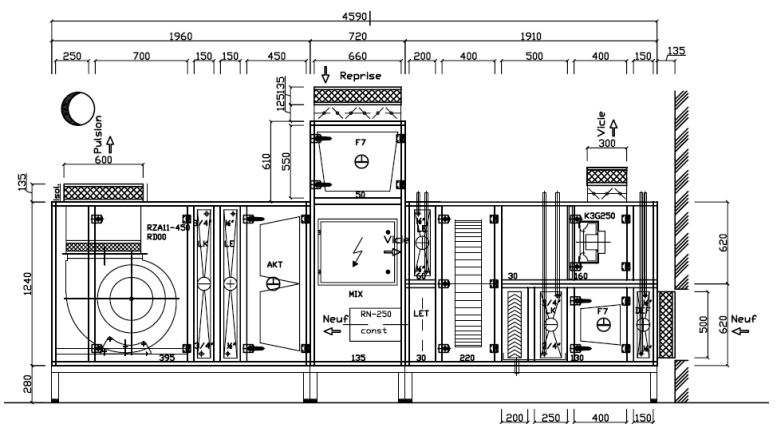
	T	RH	anni
lavoro	20 °C	50%	—
fresco	16 °C	35%	110
freddo	4 °C	45%	67
congelato	– 8 °C	50%	23

Valori climatici nei depositi

- fluttuazioni giornaliere e stagionali più ampie
- unità trattamento aria con flusso a circuito semi-chiuso
- filtrazione dei prodotti di decomposizione dall'aria

Disposizione

- arrivo e estrazione dell'aria
- scaffalatura



Inquinanti nell'aria…

- $SO_2 < 10\ \mu g/m^3$
- $NO_x < 10\ \mu g/m^3$
- $O_3 < 25\ \mu g/m^3$

Inquinanti nell'aria…

- $SO_2 < 1\ \mu g/m^3$
- $NO_x < 5\ \mu g/m^3$
- $O_3 < 25\ \mu g/m^3$

- $CO_2 < 4{,}5\ g/m^3$
- polveri fini $< 75\ \mu g/m^3$

… e «possibilmente poco»

- HCl
- NCHO

- MgO, ZnO et similia

Acidi scissi

- $CH_3COOH < 10\ mg/m^3$
- $HNO_3 < 2\ mg/m^3$

Acidi scissi

- $CH_3COOH < 1$ ppm
- $HNO_3 < 1$ ppm

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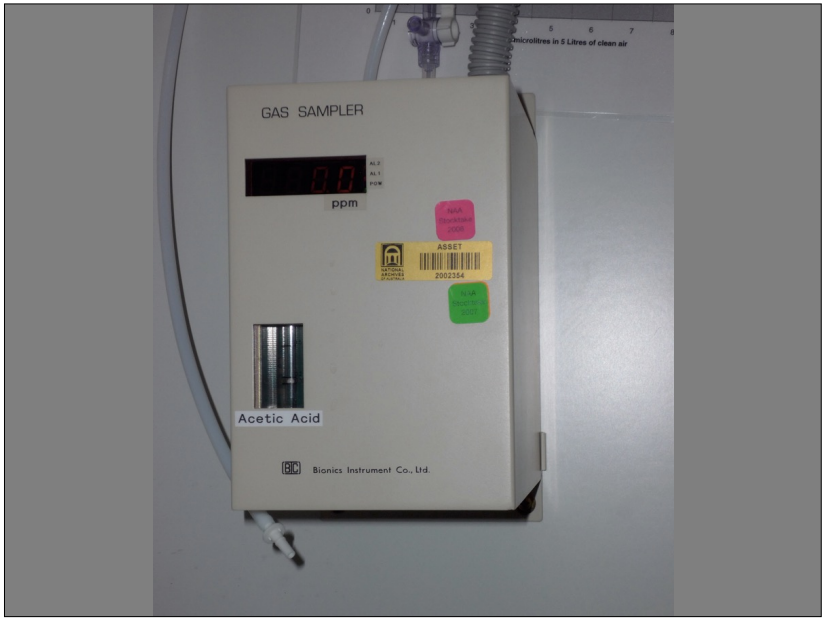

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Darsi il tempo necessario

- cemento armato
- verniciatura

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Digital Video

- resolution
- bit depth
- linear, power, logarithmic
- colour model
- chroma subsampling and compression
- illuminant

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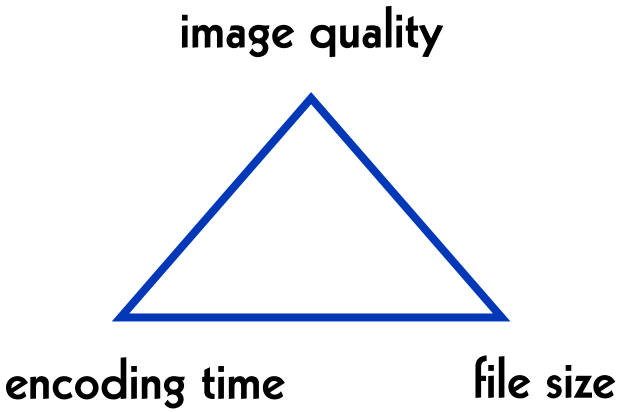


Compression

- uncompressed
- lossless compression
- lossy compression
- chroma subsampling
- born compressed

Uncompressed

+ data processing is simpler
+ less computing power is needed

− more storage is need
− slower writing, transmission and reading

examples: TIFF, DPX, DNG, OpenEXR

Lossless Compression

+ less storage is need
+ faster writing, transmission and reading

− data processing is more complex
− more computing power is needed

examples: JPEG 2000, FFV1

Lossy Compression

- optimised for postproduction

  examples: ProRes 422, ProRes 4444; DNxHD, DNxHR

- optimised for access

  examples: H.264 (AVC), H.265 (HEVC), H.266 (VVC); AV1

SMPTE REGISTERED DISCLOSURE DOCUMENT

Apple ProRes Bitstream Syntax and Decoding Process

read | script | write

script to modify

- container
- codec
- both container and codec
- metadata
- filename

ProRes-born Content

from

- ProRes stored in a QuickTime (.mov) container

to

- ProRes stored in a Matroska (.mkv) container

Update the Container

- ➔ read file from source LTO
- ➔ demultiplex file
  - ProRes 422, 10 bit [yuv422p10le]
  - ProRes 4444, 10 bit [yuv444p10le or yuva444p10le] or 12 bit [yuv444p12le]
- ➔ multiplex file
- ➔ write file to destination LTO

Chroma Subsampling

from analogue television and video to digital television and video

4:4:4 sampling

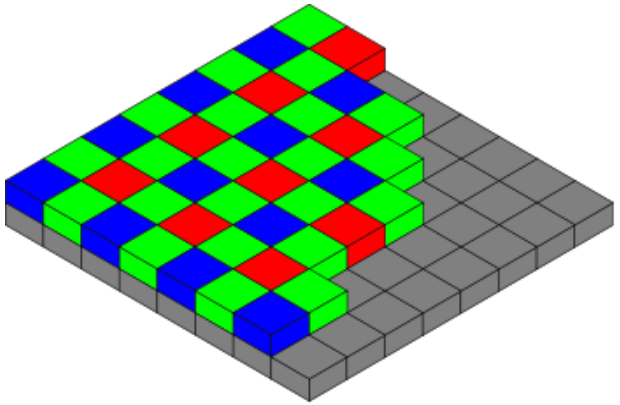
- 4:2:2 subsampling for postproduction
- 4:2:0 and 4:1:1 subsampling for access

Born Compressed

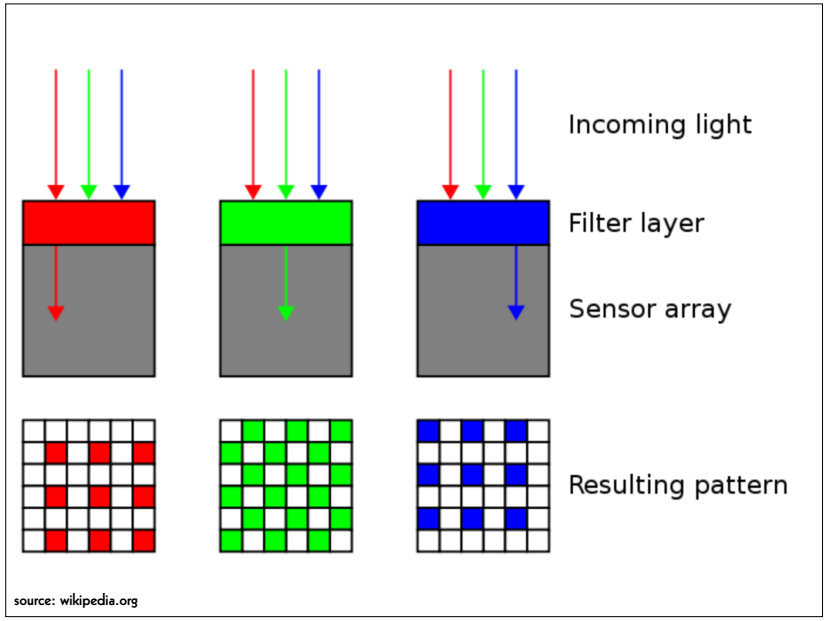
- optimised for both image acquisition and postproduction

  examples: CineForm RAW, ProRes RAW, Blackmagic RAW

Bayer



source: wikipedia.org



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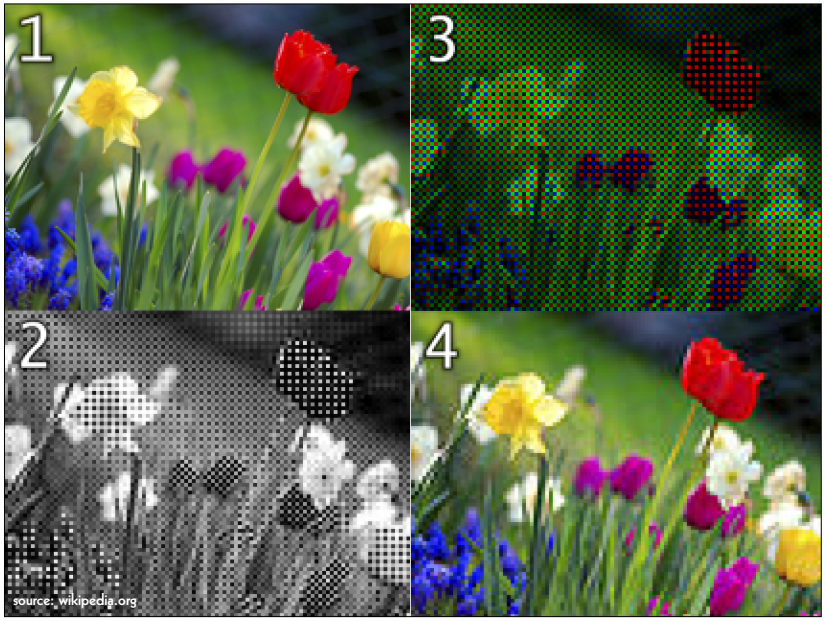

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Proposed Terminology

pixel

= picture element

sensel

= sensor element

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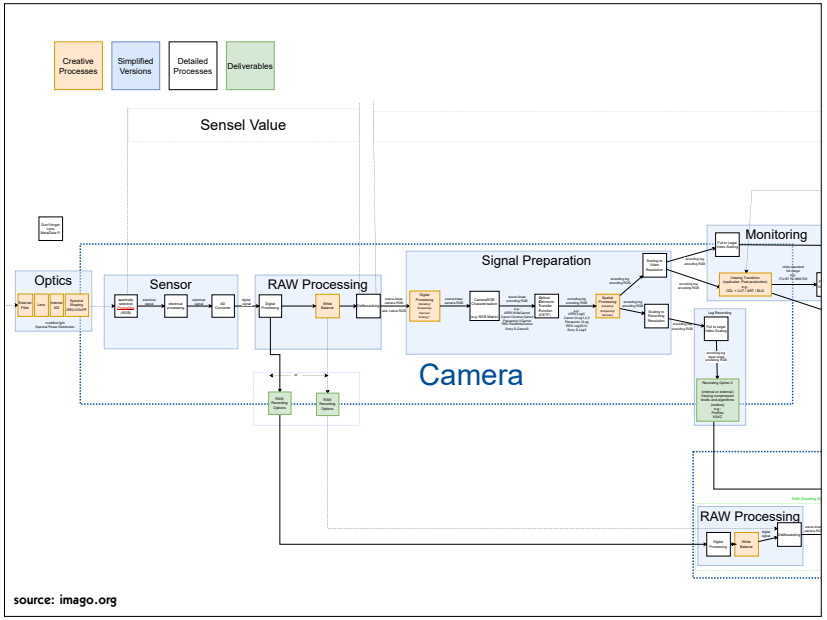

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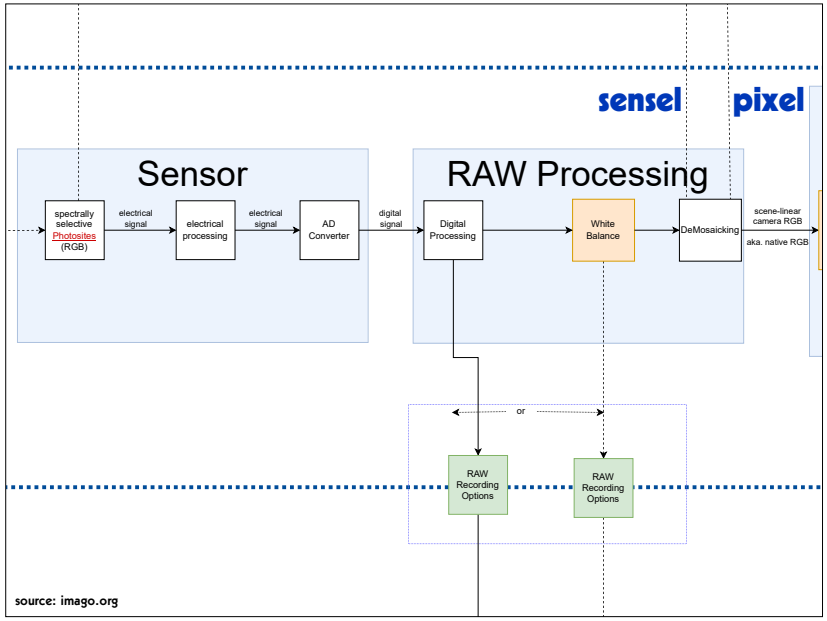

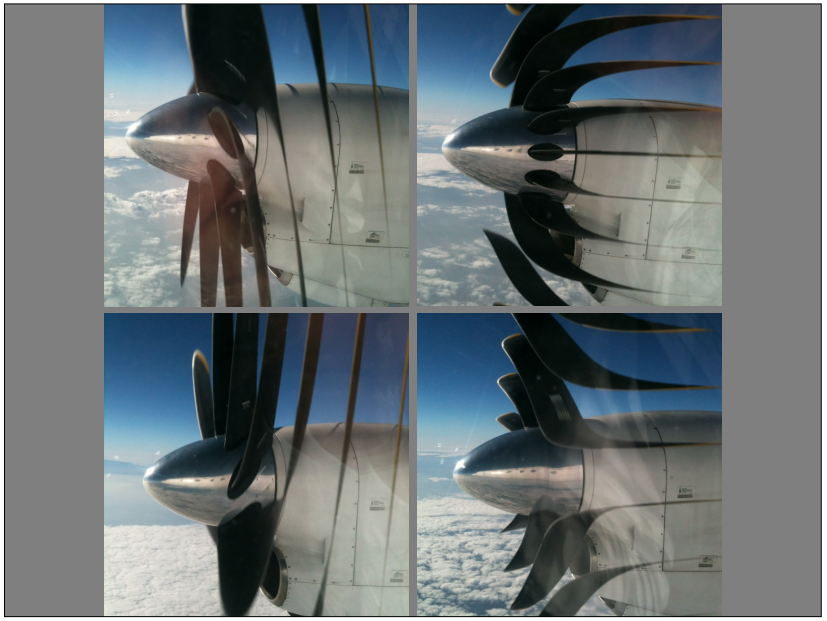

Magnetic Tape

- in use since the 1950s by IT
- cartridges are always on polyester base (old open reels can be on triacetate base)

Packaging

- open reel
- cassette
- cartridge

Recording

- linear or diagonally
- analogue or digital

LTO

- Linear Tape-Open
- answer from the IT industry to the bank and insurance sector
- in 2000 LTO-1
- currently LTO-9
- currently the LTO Consortium consists in: Hewlett Packard Enterprise, IBM and Quantum

LTO-8

- only one-generation backward reading capabilities
- format M8 = LTO-7 cartridges formatted as LTO-8
- M8 can be used on LTO-8 drives only

LTO-9

- LTO-9 drives manufactured by IBM only
- LTO-9 cartridges manufactured by Fujifilm and Sony Group only
- only one-generation backward reading capabilities
- only 50 % capacity increase
- backward reading capabilities for regular LTO-8 (L8), but not M8

LTO-10

- Will there be two-generation backward reading capabilities?
- Is LTFS strong enough?
- Release probably in 2025.

Formatting

TAR

- from LTO-1 to LTO-4 only possibility
- still possible possible today

LTFS

- possible (and recommended) since LTO-5

TAR

- standard TAR
  - ➔ bloc size
  - ➔ number of archives per cartridge
  - ➔ archives needing more than one cartridge
- TAR with a proprietary data encoding (e.g. BRU, Retrospect)

LTFS

- different versions
- almost one implementation per vendor, but…

  … "ltfs" and "mkltfs" common commands
- lossless compression (default) or uncompressed data
- unencrypted (default) or encrypted data

Storage of the Tapes

- in a tape library
- on a shelf
- in a fire-proved cabinet

Software

- proprietary or open source
- graphical user interface (GUI) and/or command-line interface (CLI)

Plan the Next Migration

- file naming
- barcodes
- checksums
- write the full index to the cartridge
- technical metadata
- code to retrieve the files

Restauro

Special Effects

- Swiss Effects, Zürich; Ruedi Schick (*1947)
- Hermann Wetter (1935–2012), Genève
- Colour Film Services, London
- Probst Film Tricktechnik, Ostermundigen

Digital Image Workflow

- sooting on film
- digitisation of the camera negative
- digital post-production
- re-recording onto film negative
- printing of projection copies

Digital Post-Production

- cutting
- special effects
- add titles
- synchronisation with soundtrack
- colour grading
- add subtitles

Grading (Timing)

analogue:

- 50 x 50 x 50 = 125 000

digital (8 bit):

- 256 x 256 x 256 = 16 777 216

digital (10 bit):

- 1024 x 1024 x 1024 = 1 073 741 824

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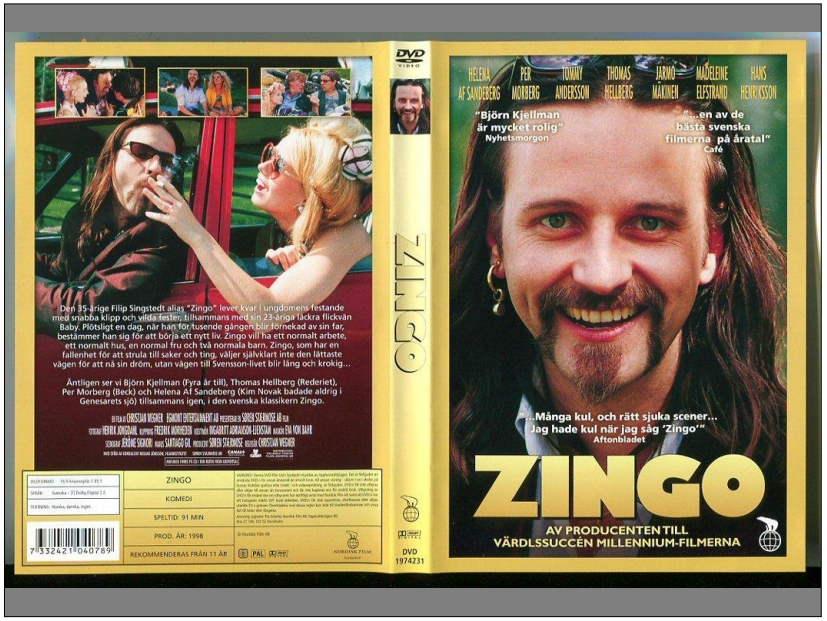

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Zingo

by Christjan Wegner, Sweden 1998

- Digital Film Lab, København
- Kris Kolodziejski (1957–2012)

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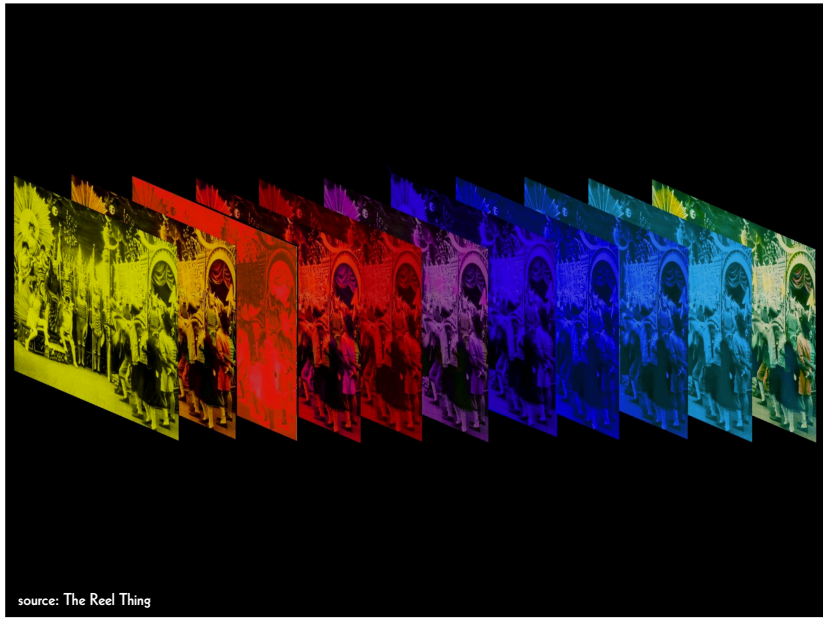

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```
/* to blend between two images */
template <class PIX, int nComponents>
class ImageBlender : public ImageBlenderBase {
  public :
    ImageBlender(OFX::ImageEffect &instance)
      : ImageBlenderBase(instance) {}

      static PIX Lerp(const PIX &v1,
                      const PIX &v2,
                      float blend)
    {
      return PIX((v2 - v1) * blend + v1);
    }

    void multiThreadProcessImages(OfxRectI procWindow) {
      float blend = _blend;
      float blendComp = 1.0f - blend;

      for(int y = procWindow.y1; y < procWindow.y2; y++) {
        if(_effect.abort()) break;

        PIX *dstPix = (PIX *) _dstImg->getPixelAddress(procWindow.x1, y);

        for(int x = procWindow.x1; x < procWindow.x2; x++) {
          PIX *fromPix = (PIX *) (_fromImg ? _fromImg->getPixelAddress(x, y) : 0);
          PIX *toPix   = (PIX *) (_toImg   ? _toImg->getPixelAddress(x, y)   : 0);

          if(fromPix && toPix) {
            for(int c = 0; c < nComponents; c++)
              dstPix[c] = Lerp(fromPix[c], toPix[c], blend);
```

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```
    case kOfxStatErrMissingHostFeature : return "kOfxStatErrMissingHostFeature";
    case kOfxStatErrUnsupported        : return "kOfxStatErrUnsupported";
    case kOfxStatErrExists             : return "kOfxStatErrExists";
    case kOfxStatErrFormat             : return "kOfxStatErrFormat";
    case kOfxStatErrMemory             : return "kOfxStatErrMemory";
    case kOfxStatErrBadHandle          : return "kOfxStatErrBadHandle";
    case kOfxStatErrBadIndex           : return "kOfxStatErrBadIndex";
    case kOfxStatErrValue              : return "kOfxStatErrValue";
    case kOfxStatReplyYes              : return "kOfxStatReplyYes";
    case kOfxStatReplyNo               : return "kOfxStatReplyNo";
    case kOfxStatReplyDefault          : return "kOfxStatReplyDefault";
    case kOfxStatErrImageFormat        : return "kOfxStatErrImageFormat";
  }
  return "UNKNOWN_STATUS_CODE";
}

namespace Memory {
  void *allocate(size_t nBytes, ImageEffect *effect = 0) throw(std::bad_alloc) {
    void *data = 0;
    OfxStatus stat = OFX::Private::gMemorySuite->memoryAlloc((void *)(effect ? effect->
    if(stat != kOfxStatOK)
      throw std::bad_alloc();
    return data;
  }

  void free(void *ptr) throw() {
    if(ptr)
      OFX::Private::gMemorySuite->memoryFree(ptr);
  }
};
```

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Deep machine learning

- organise data in multidimensional arrays
- operations can be expressed in terms of matrix multiplication and Kronecker product
- require a lot of GPU computing power

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Data-based decision making

- detected anomalies are fixed via reinforcement learning

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Build OpenFX libs and examples passing

OpenFX image processing plug-in standard

The authoritative source for information about OFX is http://openeffects.org/

- OpenFX Build Instructions
- OpenFX Documentation - start here
- OpenFX Documentation: Reference
- Programming Guide By Example
- OpenFX Wiki

Here are some Ways to get involved with OpenFX.

Why a Standard?

VFX plug-in vendors were frustrated for years because host application vendors created proprietary plug-in interfaces. As a result, each plug-in vendor had to port their plug-ins to all the different hosts and hosts couldn't use each other's plug-ins, limiting the selection of effects available to artists. The need for a standard interface was clear, so Bruno Nicoletti of The Foundry led the effort to develop a standard. That standard is OFX.

OFX is a win for artists because there is no waiting for plug-in vendors to port their cool effects to your application. Once a host compositing or editing application adopts OFX, all OFX plug-ins on the market instantly become available on that host.

source: github.com/AcademySoftwareFoundation/openfx

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Building OpenFX: Libs and Plugins

OpenFX itself is only a set of C header files, the ones in include. This repo also includes the C++ support lib, giving a C++ API on top of the basic C, and two sets of example plugins; one set with the support lib, one set using the raw C API. There is also a host support lib for use when creating a new OpenFX host. These instructions show how to build the support libs and all the plugins, and install them into your plugin folder.

Prerequisites

OpenFX uses cmake and conan to build. Other dependencies are fetched by conan. The build requires Conan 2.1.0 or later, and CMake 3.28 or later.

Install cmake:

- Mac: `brew install cmake`
- Windows: `choco install cmake`
- Linux: `apt install cmake`

Install conan (version >= 2.1.0 recommended) using pip (and python3)

- `python3 -mpip install 'conan>=2.1.0'`

Standard Builds

To build and install everything use scripts/build-cmake.sh

source: github.com/AcademySoftwareFoundation/openfx

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Pros

- improves computer performance
- opens new human-machine interactions
- processes information faster than humans

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Cons

- implementation costs are high
- software development is expensive and the necessary development resources are scarce
- skilled programmers almost inexistent

Conclusions

- Without using this technology, we would never have been able to realise certain of our projects.
- It was a lot of work …
- … and there was a lot of fun!

Questioni

Raccomandazioni (1)

scansione

- **non scegliere una qualità superiore a quella dell'elemento analogico di partenza**
  tranne rare eccezioni debitamente giustificate nella documentazione d'accompagnamento

Raccomandazioni (2)

conservazione

- **scegliere la migliore qualità che l'archivio può sostenere a lungo termine**
  cioè che possa sostenere anche nel caso in futuro vengano tagliati i fondi

Raccomandazioni (3)

restauro

- **il troppo stroppia**
  va sottolineato che le caratteristiche proprie della materialità d'origine non sono affatto difetti e non vanno cancellate

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