

2006-09-16

└ Outline

- Ok, image processing theory has nothing to do with Linux, but helps to understand editing operations in application software.

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└ Summary of Part 1

└ Summary of Part 1

- Transfer photos to computer
 - Image formats
 - Meta data – EXIF, IPTC
 - Image editing and viewing
 - Organising photos
 - Publishing, photo albums
 - Software: exiftool, gimp, digikam, picasa
- Also: f-spot¹, MaPiVi², LightZone³

¹<http://f-spot.org/>
²<http://mapivi.sourceforge.net/>
³<http://sonic.net/~rae/lightcrafta/>

- exiftool, gimp, digikam, picasa: see part 1.
exiftool packages on my website
- f-spot: photo management (mono, gnome). Promising. Ships with SUSE since 9.3. Installs half of gnome as well.
- MaPiVi: photo management, and basic editing by ImageMagick. perl/tk. Bare-bones GUI, frequent editing crashes, possibly fast enough despite perl/tk. Promising for management, not editing.
- LightZone: Photo browser and editor, raw file support, colour space management, colour-managed printing. Binary-only, \$0.
- In Part 2:
Will show the issues, and what can and can't be done on Linux

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Photo Handling with Linux — Part 2

Image Processing Theory and Photo Editing

Most Frequent Editing Operations

Most Frequent Editing Operations

- Brightness (linear), Levels (non-linear)
- Contrast / Gamma (γ)
- Colour
 - White balance
 - Cast/Tint removal
- Cropping
- Anything to make image "look nicer"
 - Sharpening

- All operations shown with various applications later.

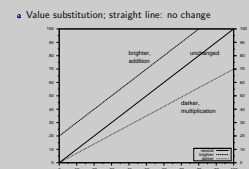
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Photo Handling with Linux — Part 2

Image Processing Theory and Photo Editing

Transfer Functions

Transfer Functions



- Maps each input brightness value to an output brightness value.
- Brightness change by multiplication: >1 brighter, <1 darker. Line rotates around (0,0).
Brightness change by addition: addition brighter, subtraction darker. Line moves up and down.

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Photo Handling with Linux — Part 2

└ Image Processing Theory and Photo Editing

└ Transfer Functions 2

Transfer Functions 2

- Levels
 - Brightness
 - value scaling (rotate line around (0,0))
 - value adding (move line up/down)
 - Contrast
 - Rotate line around its centre point
 - S-shape curve (~function), stretch/shrink around middle
 - Histogram equalisation
- Curves
 - Non-linear, arbitrary effects
 - Construct transfer-function curve in gimp

- Demonstrate curve changes with gimp (grey only here): levels + curves tool.
- Demonstrate brightness, contrast, gamma with nvidia-settings' Xserver colour correction.
- Colour is introduced later.

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Photo Handling with Linux — Part 2

└ Image Processing Theory and Photo Editing

└ Histogram

Histogram

- Histogram — number of times each brightness value is used
- Histogram equalisation: stretching the "ends" of the graph to minimum and maximum brightness levels, making full use of the dynamic range (auto balance).

- gimp: dialogues→histogram

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Photo Handling with Linux — Part 2

Image Processing Theory and Photo Editing

Colour

Colour

- What is colour?
 - Electromagnetic radiation
 - Light with specific wavelengths (or frequencies)
- Colours of objects?
 - Light reflected from the surface
- Visible spectrum: approx. 400nm–800nm
UV – violet – blue – green – yellow – orange – red – infrared

- Wavelength and frequency related by propagation speed: $f \cdot \lambda = c$
- Surface: paint something and what was underneath no longer matters
- Colour mixing on next slide

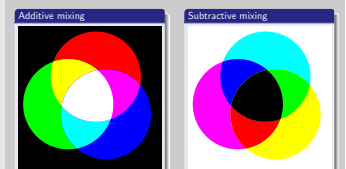
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Photo Handling with Linux — Part 2

Image Processing Theory and Photo Editing

Colour Mixing

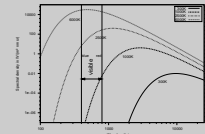
Colour Mixing



- Additive: no light = black; turn the coloured lights on.
- Subtractive: white light reflected from a coloured surface; mixing water colours into a dark blob.
 - In reality, inks (pigments) are non-ideal, so mixing all colours results in dirty brown rather than black. Hence addition of black ink.



- Why is there no yellow between green and red?
The way this is drawn has (0.7,0.7,0) (red,green,blue) at 120°; full yellow would need (1,1,0).
- This wheel only shows hue, not saturation or brightness.
- Excellent interactive colour wheel, from Jemima Pereira:
<http://jemimap.freeshell.org/style/color/wheel.html>
Shows transitions black-white/black-colour/white-colour for any colour. HSV colour space.



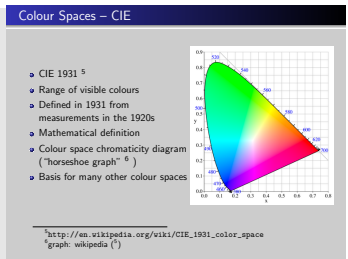
- Black body radiation: light emerging from a small hole in an empty black (inside!) box at a given temperature.
For purposes of understanding, incandescent light (radiation emitted from a heated filament) is similar.
- $\hbar = 6.626 \times 10^{-34}$ Js Planck's quantum constant
 $c = 299792458$ m/s speed of light in vacuum
 $k = 1.380 \times 10^{-23}$ J/K Stefan-Boltzmann constant
- Visible light: approx 400 nm–800 nm, or 350 nm–750 nm (depending on the source)

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Photo Handling with Linux — Part 2

Image Processing Theory and Photo Editing

Colour Spaces – CIE



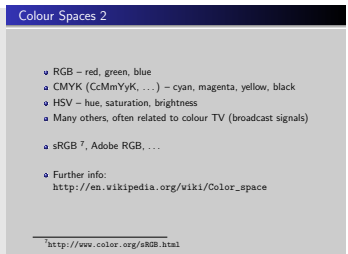
- CIE: Commission Internationale de l'Eclairage, International Commission on Illumination, in Vienna.
<http://www.cie.co.at/cie/>
- Recognized by ISO as an international standardization body.
- Human vision: retina receptors for long, medium, and short wavelengths (red, green, blue).
Any colour sensation can theoretically be expressed with these three values.
- Graph, along curved outline: monochromatic light, wavelength in nanometre.

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Photo Handling with Linux — Part 2

Image Processing Theory and Photo Editing

Colour Spaces 2



- RGB: most common for digital photos
- CMYK: essential for the printing industry and document printing.
Inks are C M Y K afterall!
- HSV: common with colour adjustment interfaces. TV?
- Size of sRGB, Adobe RGB: page 6 of http://www.adobe.com/digitalimag/pdfs/color_managed_raw_workflow.pdf

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Photo Handling with Linux — Part 2

Image Processing Theory and Photo Editing

Colour Editing

Colour Editing

Gimp⁸

- Application of transfer functions
- Tint/cast: apply brightness changes to individual colour component(s)
- Can change single colours
- Colour balance adjustment, but not white balance
- Excellent curve tool
- Tools too far to reach for efficient working
- Inefficient handling of multiple images

⁸<http://gimp.org/>

- gimp: use levels tool for changing brightness of single colour component (R, G, or B). All other software has sliders for that.
- Colour balance adjustment (in 3 levels only, not combined), but no white balance.
- Shooting creates a range of similar images: tool settings can't quickly be copied between images.

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Photo Handling with Linux — Part 2

Image Processing Theory and Photo Editing

Colour Management

Colour Management

- Colour profiles (ICC profiles)⁹
 - Description of device characteristics
 - For each device: scanner, screen, printer
- Calibration
 - By visual comparison of displayed test patterns
 - By measuring colour patches with a hardware device
 - By scanning colour reference chart
- Software applies profiles of the devices used
- Keep profiles with images!

⁹<http://www.color.org/iccprofile.html>

- Heaps of info:
<http://www.normankoren.com/makingfineprints1A.html>
- Monitor calibrators review (missing: Pantone Huey):
http://www.drycreekphoto.com/Learn/monitor_calibration_tools.htm
Pantone huey:
<http://www.tedsimages.com/text/links.htm#huey>
- Profiles:
http://en.wikipedia.org/wiki/ICC_profile
- ICC profile specification:
http://www.color.org/icc_specs2.html

- Argyll¹⁰
 - Collection of little tools to create and load profiles
- Gimp 2.2 (current) doesn't support profiles
- GAMMApage¹¹ aid for adjusting display gamma
 - Many other similar tools, e.g. KDE
 - Load per-colour gamma into X server (xgamma)
- Create profile using other OS (use same hardware!)
- Use a grey card

¹⁰<http://www.argyllcms.com/>¹¹<http://www.pctypsa.com/software/GAMMApage.html>

- Colour management with Linux
http://en.wikipedia.org/wiki/Linux_color_management
- Said to work with Argyll (space in URL!): http://www.xrite.com/documents/literature/en/L11-143_DTP94_en.pdf
but information is sparse.
- Be sure to check out <http://www.shootsmarter.com/>
for monitors, calibration and colour.
- Grey card: known reflectivity, neutral colour
For film: exposure metering
For digital: white balance
- Gimp 2.3/2.4 is expected to have profile capability

- Make the best of your camera's image capabilities
 - 16-bit editing, white balance information, tone curves
- dcraw – command line; 2 gimp plugins based on dcraw
 - gimp is only 8 bit, all adjustments before loading photo

- Commercial (from ¹²):

	Adobe Camera Raw	Bibble Browser	Breeze Browser	Capture One Pro	Canon Digital Photo	Raw Shooter
Microsoft	X	X	X	X	X	X
Apple	X	X	X	X	X	
Linux		X				

¹²<http://www.sphoto.com/techinfo/rawconverters/rawconverters.htm>

- dcraw: <http://cybercom.net/~dcoffin/dcraw/>
rawphoto plugin: <http://ptj.rozeta.com.pl/Soft/RawPhoto>
UFRaw plugin: <http://ufraw.sourceforge.net/>
- gimp 2.2.10 raw plugin: brightness, colour etc adjustments
duplicated into the plugin; loading reduces data to 8 bit.
Black saturation warning pixels imported into image...
- <http://www.sphoto.com/techinfo/rawconverters/rawconverters.htm>
This also has a feature comparison.
- Note Raw Shooter is discontinued.
(While this shifts the ratio of Linux-available converters up, it still doesn't increase choice.)
- Linux choice is clear...

- Image browser, and quickly accessible tools
 - Sharpening, noise reduction, colour adjustments, crop, ...
 - Below average: curve tool
- Adjustments can be easily copied, and saved!
- User-definable queues for processing; workflow support
- Full colour profile and colour space support
- Fast development; good support forum
- No 64 bit version; bad file extension handling; no undo

¹³<http://www.bibblelabs.com/>

- Bibble version 4.8.1a
- Thread-support; but work queue background processing priority can't be lowered.
- Documentation: manual, how-to videos.
- Lousy choice of .bib as extension for the settings files.
- Demonstrate: fix underexposure, white balance

- Relevant for the characteristic is the LCD panel type ¹⁴
 - TN — fast, cheap
 - Colours, brightness different with each viewing angle
 - Only 6 bit per colour (262144 colours)
 - Unsuitable for photo work
 - P-MVA / PVA
 - Newer models acceptable for photo work
 - S-IPS
 - Good colour precision and maximum viewing angle
 - Expensive, slow; current models fast enough for TV
 - Best choice for photo work
- Monitor vendors never specify the panel type... ^{15, 16}

¹⁴<http://www.xbitlabs.com/articles/other/display/lcd-guide.html>

¹⁵<http://www.flatpanels.dk/panels.php>

¹⁶<http://aryarya.net/wasryu/lcdmemo.html>

- The LCD panel is bought in, and assembled into a monitor with backlighting and interface and drive electronics.
- TN panel: Brightness quickly reaches zero below the perpendicular (looking up at the monitor).
 - 6 bit = 256k colours, advertised as “16.2 million colours with FRC”. FRC = Frame Rate Control (interpolating colours with the vertical refresh rate).
- P-MVA / PVA panel: Reduced colours at directly perpendicular viewing angles.
- S-IPS panel: Dark blacks turn purple on extreme viewing angles.
 - Almost always 8 bit per colour (“16.7 million colours”).

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Photo Handling with Linux — Part 2

└─ Scanning

└─ Scanning

Scanning

- ▀ Scanners: film and flatbed
- ▀ Image types:
 - ▀ Colour, gray, bi-tone, 1 bit, 8 bit, 16 bit
 - ▀ Text
 - ▀ Photos (halftoned)

- Don't use flatbed for scanning 35mm film!
Though for medium format can be ok; medium format film scanners cost the earth.

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Photo Handling with Linux — Part 2

└─ Scanning

└─ Scanning Applications 1

Scanning Applications 1

- SANE ¹⁷ (scanner access now easy)
- ▀ Backend: library, drivers for each hardware
 - ▀ Knows the capabilities of each device
 - ▀ Frontend: user interface
 - ▀ Command line: scanimage
 - ▀ GUI: xsane (not as good: xscanimage, kooka)
 - ▀ Available options depend on hardware capabilities
 - ▀ Messy user interfaces with too many windows
 - ▀ LAN scanning capability
 - ▀ No colour management, no infrared cleaning, no multi-frame film-strip scanning

¹⁷<http://www.sane-project.org/>

- Good reverse-engineering work of scanner protocols.
- SANE API doesn't allow for prosumer or professional film scanners:
<http://lists.alioth.debian.org/pipermail/sane-devel/2006-January/015896.html>

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Photo Handling with Linux — Part 2

└ Scanning

└ Scanning Applications 2

Scanning Applications 2

VueScan ¹⁸ (US\$90)

- Good user interface, tabbed
- Handles most scanners, but no longer many cheap flatbeds
- Colour profiles
- Infrared cleaning
- Calibrated for many films on the market
- Multi-frame batch scanning

¹⁸<http://www.hamrick.com/vs.html>

- Professional application software.
- No 64 bit version and no interest in one.
- Under active development.
- The cheaper and less-featured “lite” version is probably not worth considering.

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Photo Handling with Linux — Part 2

└ Scanning

└ Text Extraction from Scanned Image

Text Extraction from Scanned Image

- OCR (optical character recognition)
- Results highly dependent on:
 - Text font and size, optical quality of original, algorithm.
 - Obviously need sufficient scan resolution.
- With OSS, results are disappointing. Can't compete with commercial software.

- Linux OCR software overview:
<http://www.linux-ocr.ekitap.gen.tr/>
Projects at research stage, abandoned, or of inadequate performance.
- OSS OCR can't compete with commercial programs:
<http://lists.alioth.debian.org/pipermail/sane-devel/2006-May/016834.html>
- Commercial-grade OCR solution available, but insanely expensive
<http://www.vividata.com/>

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Photo Handling with Linux — Part 2

└─ Printing

└─ Printing

Printing

- gimpprint, STP / ghostscript
 - Used by gimp, and in combination with print spooling
 - Supports Epson printers well
 - Colour accuracy has become a lot better
- TurboPrint¹⁸ (30€)
 - Supports many "no-information" printers, esp. Canon
 - Integrates well with CUPS
 - Good reputation for colour accuracy

¹⁸<http://www.turboprint.de/>

- Example: shading; gimpprint can't print 90% white
- TurboPrint is the only commercial software with a 64-bit version.

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Photo Handling with Linux — Part 2

└─ Printing

└─ Print Longevity 2

Print Longevity 2

- Good quality paper and original printer manufacturer's ink perhaps the best option.
- Ink prints need not be worse than photographic prints.
- If you want your prints to last, store them dry, cool, and in the pitch black. (Same as film.)
- Keep your digital files...

- First results from google: "longevity ink jet prints"
- Fed up with being threatened for making longevity claims - probably a very good recommendation!
<http://www.livick.com/method/inkjet/pg1.htm>
- Some "unscientific" tests. Says wilhelm-research.com test conditions bear little resemblance to real life. http://www.timhunkin.com/a115_inkjetprintlongevitytests.htm
- Large number of references to published articles.
<http://www.wilhelm-research.com/>
- Haltbarkeit 01/05. (German) Kodak, Agfa Photo: 120 lx bei 12h/Tag; andere 450–500 lx bei 10–12h/Tag.
Flur: 100 lx, Büro: 500 lx, bedeckter Sommertag: 20000 lx
http://www.wilhelm-research.com/faprinter/Kodak_Less_Light_2005_01.pdf