



Ghiro Documentation

Release 0.1

September 19, 2014

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Ghiro is an *Open Source* software for digital photo and digital image forensics. The forensic analysis is fully automated, report data can be searched or aggregated in different perspectives.

This documentation will explain what Ghiro is, which techniques it uses for forensic analysis, how to set up it and how to use it.

Introduction

1.1 Why Ghiro?

Sometime forensic investigators need to process digital images as evidence. There are some tools around, otherwise it is difficult to deal with forensic analysis with lot of images involved. Images contain tons of information, Ghiro extracts these information from provided images and display them in a nicely formatted report. Dealing with tons of images is pretty easy, Ghiro is designed to scale to support gigs of images. All tasks are totally automated, you have just to upload you images and let Ghiro does the work. Understandable reports, and great search capabilities allows you to find a needle in a haystack. Ghiro is a multi user environment, different permissions can be assigned to each user. Cases allow you to group image analysis by topic, you can choose which user allow to see your case with a permission schema.

1.2 Use Case

Ghiro can be used in many scenarios, forensic investigators could use it on daily basis in their analysis lab but also people interested to undercover secrets hidden in images could benefit. Some use case examples are the following:

- If you need to extract all data and metadata hidden in an image in a fully automated way
- If you need to analyze a lot of images and you have not much time to read the report for all them
- If you need to search a bunch of images for some metadata
- If you need to geolocate a bunch of images and see them in a map
- If you have an hash list of “special” images and you want to search for them

Anyway Ghiro is designed to be used in many other scenarios, the imagination is the only limit.

1.3 Supported image types

The following file type are supported:

- Windows bitmap .bmp
- Raw Canon .cr2
- Raw Canon .crw
- Encapsulated PostScript .eps
- Graphics Interchange Format .gif

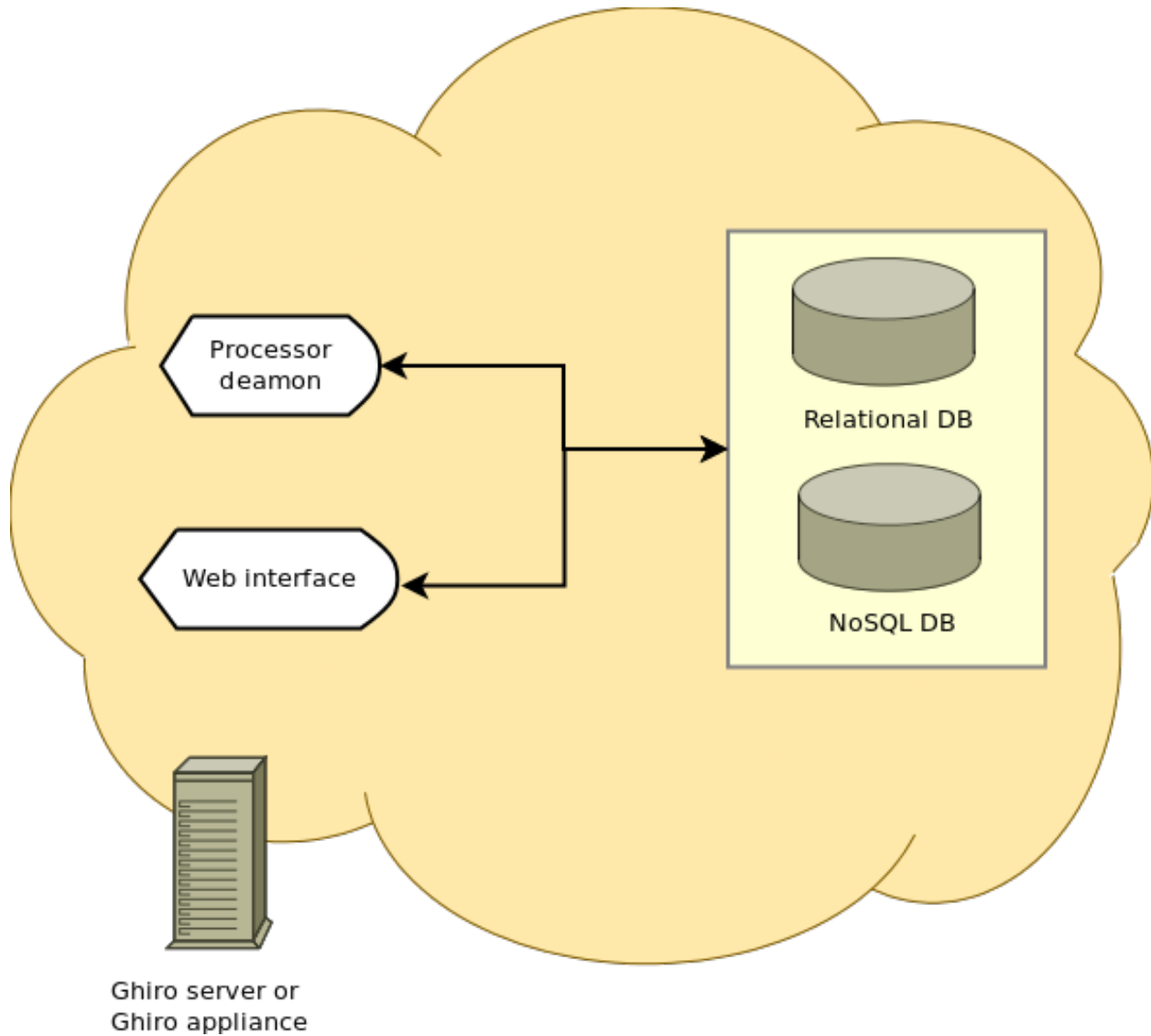
- JPEG File Interchange Format .jpg or .jpeg
- Raw Minolta .mrw
- Raw Olympus .orf
- Portable Network Graphics .png
- Raw Photoshop .psd
- Raw Fujifilm .raf
- Raw Panasonic .rw2
- Raw TARGA .tga
- Tagged Image File Format .tiff

1.4 Architecture

Ghiro is composed by the following components:

- The web interface: to interact with all features
- The processor daemon: it fetches waiting tasks from the queue, process and analyze images
- The relation database: it stores relational data, you can choose between MySQL, PostgreSQL and SQLite3
- The MongoDB database: it stores analysis data

Following the architecture in a simple schema:



1.5 Download Ghiro

Ghiro can be downloaded from the [official website](#), where the stable and packaged releases are distributed. Stable package is available in both .zip and .tar.gz format. The package above is strongly suggested for all users. Some people need to keep updated with Ghiro's changes, they can download (git clone) from our [official GitHub page](#). There are two different releases available.

1.5.1 Stable Branch

The stable branch follows the last stable release but provides faster bug fixes, so it is pretty the same of downloading the stable package from the [official website](#). You can download it with the following command:

```
git clone https://github.com/ghirensics/ghiro.git
```

1.5.2 Development Branch

The development branch is where the next Ghiro's release is developed. You can download Ghiro from here if you need to keep it always at the cutting edge or if you want to hack on Ghiro. You can download it with the following command:

```
git clone -b development https://github.com/ghirensics/ghiro.git
```

Warning: While being more updated, the development branch should be considered an *under development*. Therefore its stability is not guaranteed.

1.6 Virtual Appliance

The faster way to start playing with Ghiro is to download the Ghiro Virtual Appliance. You can download it from the [official website](#). In few minutes you will have a fully functional Ghiro setup to start to analyze your images. It is an OVA file, you have to import in your virtualization software (like VirtualBox or VMWare) and configure the networking as explained in the documentation. Just unzip the archive and read the README.txt file!

Techniques

2.1 Techniques

Several techniques are used to extract all data and metadata hidden in digital images. They are briefly described in this chapter.

2.2 MIME information

Multipurpose Internet Mail Extensions (MIME) is a standard to describe content type of a file, MIME is detected using magic number inside the image. Magic numbers implement strongly typed data and are a form of in-band signaling to the controlling program that reads the data type(s) at program run-time. Many files have such constants that identify the contained data. Detecting such constants in files is a simple and effective way of distinguishing between many file formats and can yield further run-time information. The image MIME type is detected to know the image type you are dealing with, in both compacted (example: image/jpeg) and extended form.

2.3 Metadata information

Metadata may be written into a digital photo file that will identify who owns it, copyright and contact information, what camera created the file, along with exposure information and descriptive information such as keywords about the photo, making the file searchable on the computer and/or the Internet. Some metadata are written by the camera and some is input by the photographer and/or software after downloading to a computer. Metadata are divided in several categories depending on the standard they come from. The following categories are extracted and analyzed:

- **EXIF metadata extraction**

- Standard Exif tags
- Canon MakerNote tags
- Fujifilm MakerNote tags
- Minolta MakerNote tags
- Nikon MakerNote tags
- Olympus MakerNote tags
- Panasonic MakerNote tags
- Pentax MakerNote tags

- Samsung MakerNote tags
 - Sigma/Foveon MakerNote tags
 - Sony MakerNote tags
- **IPTC metadata extraction**
 - IPTC datasets
- **XMP metadata extraction**
 - Dublin Core schema (dc)
 - XMP Basic schema (xmp)
 - XMP Rights Management schema (xmpRights)
 - XMP Media Management schema (xmpMM)
 - XMP Basic Job Ticket schema (xmpBJ)
 - XMP Paged-Text schema (xmpTPg)
 - XMP Dynamic Media schema (xmpDM)
 - Adobe PDF schema (pdf)
 - Photoshop schema (photoshop)
 - Camera Raw schema (crs)
 - Exif schema for TIFF Properties (tiff)
 - Exif schema for Exif-specific Properties (exif)
 - Exif schema for Additional Exif Properties (aux)
 - IPTC Core schema (Iptc4xmpCore)
 - IPTC Extension schema (Iptc4xmpExt)
 - PLUS License Data Format schema (plus)
 - digiKam Photo Management schema (digiKam)
 - KDE Image Program Interface schema (kipi)
 - Microsoft Photo schema (MicrosoftPhoto)
 - iView Media Pro schema (mediapro)
 - Microsoft Expression Media schema (expressionmedia)
 - Microsoft Photo 1.2 schema (MP)
 - Microsoft Photo RegionInfo schema (MPRI)
 - Microsoft Photo Region schema (MPReg)
 - Metadata Working Group Regions schema (mwg-rs)

2.4 Preview thumbnail extraction

Most digital camera and phones write a preview, called thumbnail, in image metadata. The thumbnails and data related to them are extracted from image metadata and stored for review.

2.5 Preview thumbnail consistency

Sometimes when a photo is edited, if the image editing software does not support image preview, the original image is edited but the thumbnail not. A simple comparison between the original image and the thumbnail could detect image edits.

2.6 GPS Localization

Embedded in the image metadata sometimes there is a geotag, a bit of GPS data providing the longitude and latitude of where the photo was taken. Geotagging is when a device such as an iPhone, Android smartphone or digital camera stores your location or geographical information, such as your GPS coordinates, within a photo. A geotagged photograph is a photograph which is associated with a geographical location by geotagging. Geotags are useful in helping people find a wide variety of location-specific information. For example, one can find images taken near a given location by entering latitude and longitude coordinates into a suitable image search engine. The geotag inside image metadata is read and the position where the photo was taken is displayed on a map.

2.7 ELA (Error Level Analysis)

Error Level Analysis (ELA) is a technique aimed to detect if an image is edited or not. It can be applied to compressed images, i.e. JPEG or PNG. The main idea is that an image in his original form has unique levels of compression. The analyzed image is resaved and differences in compression levels are calculated, if differences are detected a probability of edits is high. Ghiro calculates error levels and detects differences between them.

2.8 Hash digest generation

Most common hash are calculated for the image, to create an unique signature of it.

2.9 Hash list matching

Suppose you are searching for an image and you have only the hash. You can provide a list of hashes and all images matching are reported.

2.10 Signature engine

Signature provides evidence about most critical data to highlight focal points and common exposures. Signature engine to highlight common exposure on over 120 signatures

3.1 Setup Ghiri

Ghiri is supposed to run on a *GNU/Linux* native system. For the purpose of this documentation, we chose **latest Ubuntu Server** as reference system for the commands examples. Probably Ghiri could work on other systems like MacOSX but this is not tested and out of scope of this documentation.

3.2 Requirements

Ghiri has the following requirements:

- MongoDB: you need to run a MongoDB database (at least release 2.0)
- Python: that's how we roll (only Python 2.x, at least release 2.7)
- Python-magic: for MIME extraction
- Python 2.x bindings for gobject-introspection libraries, required by Gexiv2
- Gexiv2: for metadata extraction (at least release 0.6.1)
- Python Imaging Library (PIL): for image manipulation (at least release 1.1)
- Python-dateutil: for datetime manipulation
- Pymongo: driver for MongoDB (at least release 2.5)
- Django: for web interface (at least release 1.5)

If you choose MySQL or PostgreSQL as database you have to install their additional drivers.

3.3 Getting started

3.3.1 Download and extract

Download Ghiri as explained in this documentation, if you download the stable package extract it. Enter in the Ghiri folder.

3.3.2 Requirements

If you don't have already it, install MongoDB with the following command (run as root or with sudo):

```
apt-get install mongodb
```

Install required libraries with the the following commands (run as root or with sudo):

```
apt-get install python-pip libgexiv2-1 python-imaging python-dateutil  
apt-get install build-essential python-dev python-gi
```

Install latest Django with the following command (run as root or with sudo):

```
pip install django
```

Install latest PyMongo with the following command (run as root or with sudo):

```
pip install pymongo
```

Install latest Pytjon magic with the following command (run as root or with sudo):

```
pip install python-magic
```

3.3.3 Preparing

The default databases are SQLite3 and MongoDB (you need to have it listening on localhost). If you need to change this see the configuration chapter below.

First of all you need to create an empty database with the following command (inside Ghiro's root):

```
python manage.py syncdb
```

You will be asked to create a superuser for administration, choose *yes* and fill all the required fields.

3.3.4 Running

To start the web interface run the following command (inside Ghiro's root):

```
python manage.py runserver
```

A web server running Ghiro will be available on <http://127.0.0.1:8000/> If you need to listen expose Ghiro to all addresses or change the port (in this example is 9000) run the following command (inside Ghiro's root):

```
python manage.py runserver 0.0.0.0:9000
```

To start processing images you have to start the processing deamon, run the following command (inside Ghiro's root):

```
python manage.py process
```

3.4 Configuration

Ghiro works pretty well with default options, which are SQLite3 as relational database and use MongoDB installed and listening on local host. If you want to change any setting the configuration file is located in *ghiro/local_settings.py*. The default settings will fit all common user needs.

Following is the default *ghiro/local_settings.py* file:


```

LOCAL_SETTINGS = True
from settings import *

DATABASES = {
    'default': {
        # Engine type. Ends with 'postgresql_psycopg2', 'mysql', 'sqlite3' or 'oracle'.
        'ENGINE': 'django.db.backends.sqlite3',
        # Database name or path to database file if using sqlite3.
        'NAME': 'db.sqlite3',
        # Credentials. The following settings are not used with sqlite3.
        'USER': '',
        'PASSWORD': '',
        # Empty for localhost through domain sockets or '127.0.0.1' for localhost through TCP.
        'HOST': '',
        # Set to empty string for default port.
        'PORT': '',
    }
}

# MySQL tuning.
#DATABASE_OPTIONS = {
# "init_command": "SET storage_engine=INNODB",
#}

# Mongo database settings
MONGO_URI = "mongodb://localhost/"
MONGO_DB = "ghirodb"

# Max uploaded image size (in bytes).
# Default is 150MB.
MAX_FILE_UPLOAD = 157286400

# Allowed file types.
ALLOWED_EXT = ['image/bmp', 'image/x-canon-cr2', 'image/jpeg', 'image/png',
               'image/x-canon-crw', 'image/x-eps', 'image/x-nikon-nef',
               'application/postscript', 'image/gif', 'image/x-minolta-mrw',
               'image/x-olympus-orf', 'image/x-photoshop', 'image/x-fuji-raf',
               'image/x-panasonic-raw2', 'image/x-tga', 'image/tiff', 'image/pjpeg']

# Override default secret key stored in secret_key.py
# Make this unique, and don't share it with anybody.
# SECRET_KEY = "YOUR_RANDOM_KEY"

# Language code for this installation. All choices can be found here:
# http://www.i18nguy.com/unicode/language-identifiers.html
LANGUAGE_CODE = "en-us"

ADMINS = (
    # ("Your Name", "your_email@example.com"),
)

MANAGERS = ADMINS

# Allow verbose debug error message in case of application fault.
# It's strongly suggested to set it to False if you are serving the
# web application from a web server front-end (i.e. Apache).
DEBUG = True

```

```
# A list of strings representing the host/domain names that this Django site
# can serve.
# Values in this list can be fully qualified names (e.g. 'www.example.com').
# When DEBUG is True or when running tests, host validation is disabled; any
# host will be accepted. Thus it's usually only necessary to set it in production.
ALLOWED_HOSTS = ["*"]
```

If you change the configuration after the first setup, before editing this file you have to stop both Ghiro's web interface and processing daemon, you may restart them after the edit.

If you changed any setting related to the database configuration you have to re-build your database with the command (inside Ghiro's root):

```
python manage.py syncdb
```

3.5 Running Ghiro as service

If you want to run Ghiro as an enterprise service you have to get rid of Django web server and run Ghiro with a production ready tool.

3.5.1 Database

We do not suggest SQLite3 for production environment, please go for MySQL or PostgreSQL. In this example we are going to show you how to configure Ghiro with MySQL.

Setup MySQL and Python drivers with the following command (run as root or with sudo):

```
apt-get install mysql-server python-mysqldb
```

Go through the wizard and set MySQL password. Configure Ghiro to use MySQL as explained in configuration paragraph.

3.5.2 Apache as a front-end

Now we are going to configure Apache as a front end for Ghiro's django application.

Setup Apache and mod_wsgi with the following command (run as root or with sudo):

```
apt-get install apache2 libapache2-mod-wsgi
```

An example of virtual host configuration is the following (Ghiro is extracted in /var/www/ghiro/ in this example):

```
<VirtualHost *:80>
    ServerAdmin webmaster@localhost
    WSGIProcessGroup ghiro
    WSGIDaemonProcess ghiro processes=5 threads=10 user=nobody group=nogroup python-path=/var/www/ghiro
    WSGIScriptAlias / /var/www/ghiro/ghiro/wsgi.py
    Alias /static/ /var/www/ghiro/static/
    <Location "/static/">
        Options -Indexes
    </Location>

    ErrorLog ${APACHE_LOG_DIR}/error.log

    # Possible values include: debug, info, notice, warn, error, crit,
```

```
# alert, emerg.
LogLevel warn

CustomLog ${APACHE_LOG_DIR}/access.log combined
</VirtualHost>
```

Restart apache. Now the web application is listening on port 80/tcp, just put the IP address in your browser.

3.5.3 Run the processor with upstart

You can automatically run the processor with upstart.

Create the file `ghiro.conf` in `/etc/init/` with the following content:

```
description      "Ghiro"

start on started mysql
stop on shutdown
script
    chdir /var/www/ghiro/
    exec /usr/bin/python manage.py process
end script
```

To stop the processor use the following command (run as root or with `sudo`):

```
service ghiro stop
```

To start the processor use the following command (run as root or with `sudo`):

```
service ghiro start
```

Usage

4.1 Usage

Ghiro's web application is composed by several parts to organize information and analysis data.

4.1.1 Dashboard

This is the summary of all Ghiro activities, here you can figure what is going on, which are the last cases and analysis, and take a look to analysis trend.

4.1.2 Cases

Image analysis are grouped in cases. Different users and permissions can be assigned to each case. You can upload images via an upload form ("Add image" function) or you can get the images from a path on the Ghiro's server ("Add folder" function). Here you can see all analysis related to images grouped by case.

4.1.3 Images

Here you can see all image analysis in the system (all images you have permission to see).

4.1.4 Search

You can search for several image properties or for image location.

4.1.5 Hashes

You can load hash lists to detect if an image met an hash.

4.1.6 Administration

Ghiro user administration: you can administer all Ghiro's users.

4.2 Administration

Some hints about Ghiro administration.

4.2.1 Run processor in debug mode

If you need to run the image processor daemon in debug mode to debug tracebacks run the following command (inside Ghiro's root):

```
python manage.py process --traceback
```

4.2.2 Create a new superuser

If you need to create a new superuser from the command line, for example because you closed you out from the web interface, run the following command (inside Ghiro's root):

```
python manage.py createsuperuser
```

4.2.3 Upload images via command line utility

If you need to load tons of images you can do it from command line. For example if you want to add all images in folder /target/images to case with id 2 and owner user name "foobar" run the following command (inside Ghiro's root):

```
python manage.py submit -u foobar -c 2 -t /target/images
```

And all images will be loaded in a batch.

5.1 Contribute, bugs and feature requests

To report bugs or request for new features you can use the ticketing system in [official GitHub page](#). or you can just drop us an email or DM us on Twitter. Any pull request will be really appreciated.

5.2 Disclaimer

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