Figure 1: Logo

This git is part of a master degree project by Jeroen Staab. You can find the initial proposal (Deutsch) here.

Hardware

Stardot Camera

Here we use two stardot webcameras. They are boradly used in eviromental outdoor sciences [@ Richardson, Harvard]. Temperature ranges from -40C° to +48C° are no problem [@ Stardot Handbook].

There are two ways to configure the camera. The first is also the recomended one - use a browser to access the web-backend via *http*. Alternativly you could also access the camera via *telnet*, *SSH* is not supported.

Works: FTP upload images to upload@raspberrypi.local via wlan0 from laptop.
Works: FTP upload images to upload@10.42.0.10 via eth0 from stardot.
Works: Use Raspi as Timeserver.
Optional: RGB+IR configuration. See EURAC archiv.zip

TODO: Find best camera position

Raspberry Pi

Works: Static IP
Works: FTP Server
TODO: Configure Raspi Nr. 2

Setup 0 (Background)

Stream images from public available webcam. Processing only.

TODO: App script to GIT.
TODO: Strucutre data into new folder per month.

Setup 1

Camera with internet in field. Raspberry processing images remotely.

TODO w. Simon: Upload from Stardot into UniWue-network without VPN. Raspi inside University (FTP from outside without VPN, because stardot without openvpn)

Setup 2 (Active)

Autonomos setup without internet. Camera and raspberry in case, powersupply only. Collect data peridically (SD-Card / FTP in wlan0).

Works: Static IP form stardot + raspi (via eth0, dhcp `raspberrypi.local` via wlan0).
Works: Configure cameras by port forwaring to `localhost:8080` when connecting via ssh.
Optional: Platzsparendes LAN Kabel? 1:1 verdahtet?

TODO: Use realtimeclock
TODO: Use Solar-Power Strombedarf? Welche 12V und MicroUSB Traffos? Verbraucht RaspiCam weniger Strom?

Stardot Cameras

Fix IP

Was `10.42.0.64` since initialisation.

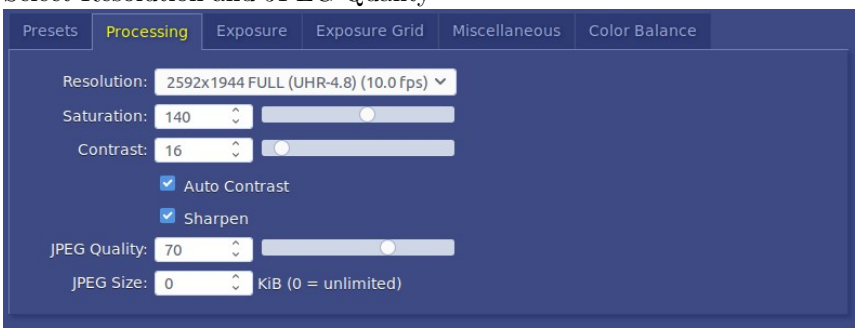
Access Configuration Back-end

1. Access `10.42.0.64` (netcamsc) via browser
2. Click `config`. Password admin.

Image optimization

1. Hardware Focus: To focus the camera loosen the screw on top of lense, then gently turn the very first bit of the lense (not the ring with screw on). Turn left for close objects, right for far.

2. Select Resolution and JPEG Quality



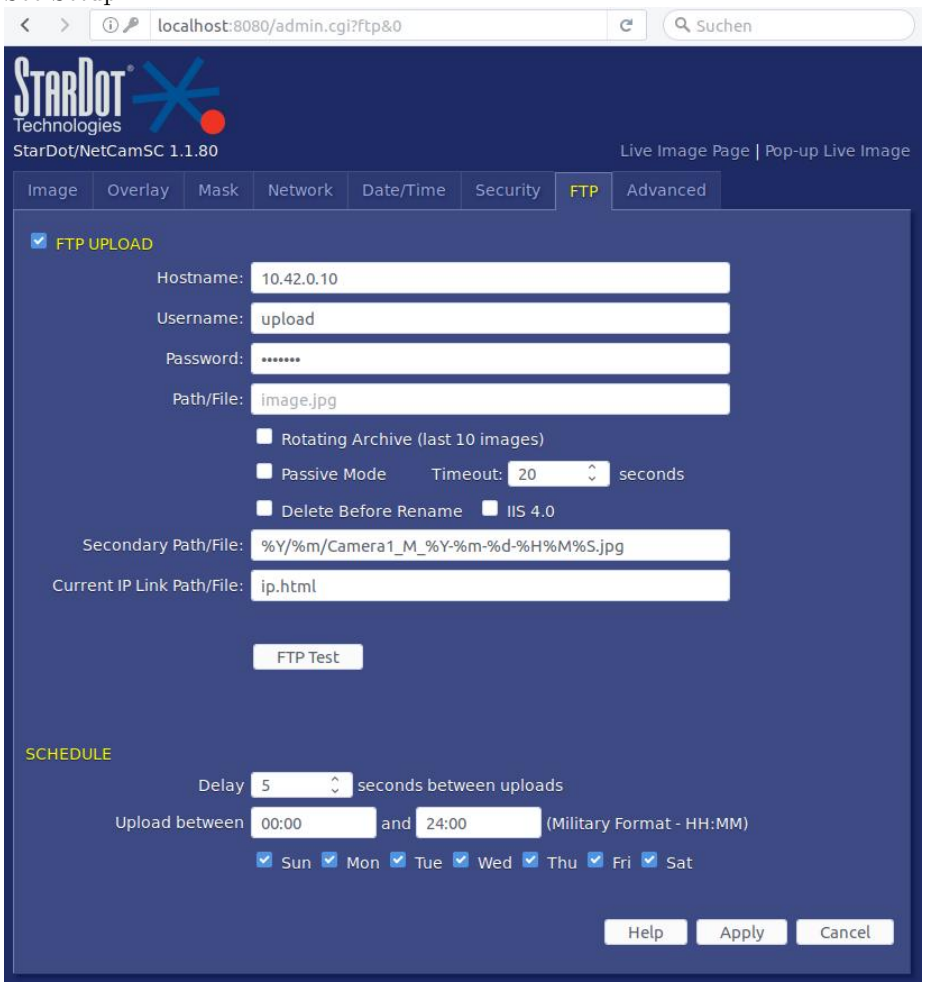
3. Select Exposure Grid

Configuration

See Handbook.

FTP

See Setup 2



Overlay

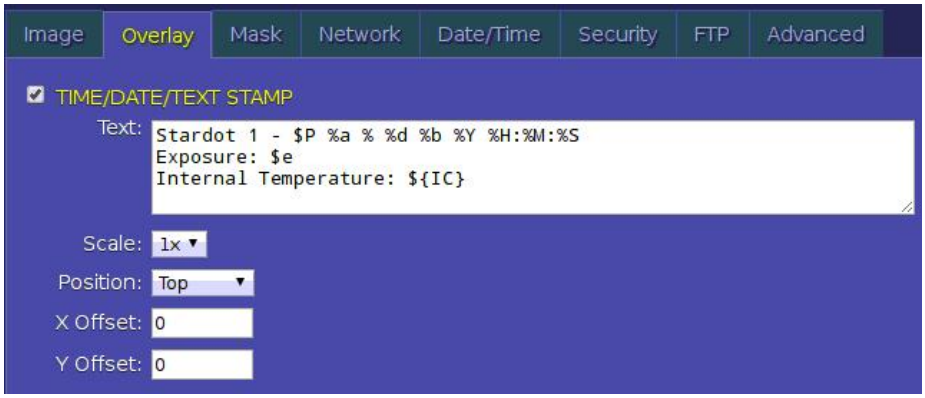


Figure 1: Screenshot

RaspberryPi 3

> The Raspberry Pi Foundation is a charity. All the money we make from selling computers, cases, cameras, and other products goes straight into our charitable fund to train teachers, provide free learning resources, teach kids, help build the foundations of digital making in schools, and much more. – Official RaspberryPi website

TODO: Place ready IMG here

System Settings

Inital commissioning of *RaspberryPi*. How to install Raspbian, use SSH and add new WIFI Networks.

Setup Configuration

This section documents the general server side configuration for interacting with Stardot and processing image with *wuepix*.

Getting started

Operating System

Here we downloaded the latest *Raspbian Jessie Lite*, released on 11th January 2017 with kernel version 4.4. I choose the lite version without the *PIXEL desktop* to save unnecessary disk space for archiving images.
> *Raspbian* is a free operating system optimized for the Raspberry Pi hardware. This *Debian* based *Linux* is has a big online community, is well tested and thousands available packages using *apt*.

Prepare SD-Card

Write Raspbian image to card

Write the iso-image on the SD-Card using Ubuntu's USB-Creator.

Partitions

Partition SD Card

Enable SSH

> For headless setup, SSH can be enabled by placing a file named 'ssh', without any extension, onto the boot partition of the SD card. – https://www.raspberrypi.org/documentation/remote-access/ssh/

First boot

connect via router (DCHP)

See how to use hostnames
`ssh pi@raspberrypi.local`

connected via cable

No access to router: Connect Raspberry via Ethernet-cable directly to Ubuntu laptop. Find out it's IP-Adress following this guide:

1. connect raspberry pi to laptop with Ethernet.
2. Go the edit connection setting. Navigate to ipv4 option. Select method : shared to other computer.
3. Open terminal and type: `cat /var/lib/misc/dnsmasq.leases`. You will get raspberry pi Ip from that.
4. Then connect typing: `ssh pi@[ip-adress]`

Initial configuration

For initial configurations open the Raspberry Pi configuration tool as superuser: `sudo raspi-config`.

Password

See `Passwords.md` (Obvious not in Git)

Locale

1. Choose `4 Internationalisation Options`
2. ~~Change Locale to German UTF8~~ I'm fine with english
3. Change Timezone to Europe/Berlin
4. Change Wi-fi Country to `DE Germany`

Update

As seen with the failed Telekom-Hack the internet-of-things is tageted by botnets. An up-to-date system prevents harm to the system and others. To close latest exploits update the system by typing `sudo apt update` followed by `sudo apt upgrade`.

Add to WIFI

Next connect the RasPi to our local wifi, following this documentation. Than remove the ethernet cable.

1. scan available networks: `sudo iwlist wlan0 scan`
2. Append the network to the `wpa-supplicant` configuration file in nano: `sudo nano /etc/wpa_supplicant/wpa_supplicant.conf. network={ ssid="testing" psk="testingPassword" }`
3. `sudo reboot`
4. Reconnect using Ethernet-IP to see if wifi works by tpying: `ifconfig wlan0` and checking the `inet addr` field.

Passwordless SSH access

> It is possible to configure your Pi to allow your computer to access it without providing a password each time you try to connect. To do this you need to generate an SSH key.
> –raspberrypi.org

On Raspi-Side:

```
ssh-keykeg
```

From Laptop:

```
cat ~/.ssh/id_rsa.pub | ssh pi@raspberrypi.local 'cat >> .ssh/authorized_keys'
```

TODO: Use raspi keys for pulling updates from privat github ;-)

Duplicate SD-Image

Identical configuration for both RasPis…

1. Place configured RasPis SD-Card in Laptop. Create Image
2. Place empty SD-Card into laptop. Write Image

The images also specify the disc size. To make the rest of the 64GB available for files it has to be expanded. Make sure the sd-image is completly pre-comfigrured before next steps (after expanding the image as created above will be 64GB no matter how many disc-capacity acctually is used!)

1. Place pre-configured image in RasPi and boot
2. `sudo raspi-config`
3. **Expand Filesystem**
4. `reboot`

TODO: Change hostname raspberrypi

Setup Configuration

Fix Ip for Raspberry

At the begin I struggeld with the static IP, but after reading this wiki everything works, incl. FTP. This is how to configure `/etc/network/interfaces` eth0 part:

```
auto eth0
allow-hotplug eth0
iface eth0 inet static
    address 10.42.0.10
    netmask 255.255.255.0
    gateway 10.42.0.1
```

FTP Server

> FTP (File Transfer Protocol) can be used to transfer files between a Raspberry Pi and another computer. Although with default program sftp-server of Raspbian the users with sufficient privilege can transfer files or directories, access to the filesystem of the limited users is also required often. Follow the steps below to set up an FTP server. – raspberrypi.org

Run (line by line):

```
sudo apt-get install pure-ftpd

groupadd ftpgroup
sudo groupadd ftpgroup
sudo useradd ftpuser -g ftpgroup -s /sbin/nologin -d /dev/null
sudo mkdir /home/pi/FTP
sudo chown -R ftpuser:ftpgroup /home/pi/FTP
sudo pure-pw useradd upload -u ftpuser -g ftpgroup -d /home/pi/FTP -m

sudo pure-pw mkdb
sudo ln -s /etc/pure-ftpd/conf/PureDB /etc/pure-ftpd/auth/60puredb
sudo service pure-ftpd restart
```

FROM ubuntu TO `ftp://upload@raspberrypi.local` works. FROM ubuntu TO `ftp://upload@10.42.0.10` works. FROM stardot TO `ftp://upload@10.42.0.10` works.

`.bashrc`

Customized bash, uncomment last line vor VNC at login.

R

Install R on RaspberryPi 3

1. add `deb http://archive.raspbian.org/raspbian/ stretch main` to `/etc/apt/source.list`.
2. `sudo apt-get update`
3. `sudo apt-get install r-base`

Installed Version: 3.3.2

Install R-packages as root in case multiple users will access RasPi

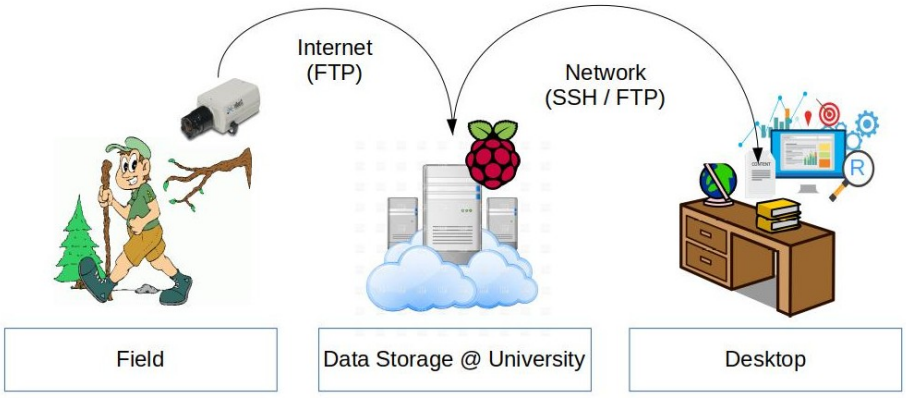
Change workingdirectory to `/hardware/raspberry` when developing code.

Setup 1

The initial setup trusts on the Stardot camera being connected to the Internet all the time. This is the case when it's mounted to building and connected to the local router and the advantages of Stardot Netcam SC come into play.
This setup is comparable to the *weucam* concept.

Technical Concept

The camera comes with integrated web technologies and uploads new images to a server via *File Transfer Protocol* (FTP) periodically. As discussed with Simon Sebold (IT manager at LSFE) the server could be either a RasPi integrated within the UniWü network or a VM.



Integrate in UniWü Network

If the RasPi is behind a firewall, as it is the case within the university network, it can not interact with the camera being mounted in the field. Therefor an according exception has to be setup by the university's ICT department, port-forwarding the FTP requests.

Setup 2

As discussed with Johannes Schamel, Manuel Engelbauer and Niklas Scheder on 2.2.2016 internet is not always available in the field. They prefer an autoneus setup storing images locally. The setup should depend only on energy supply. The researchers would go into the field to collect the data.

Technical Concept

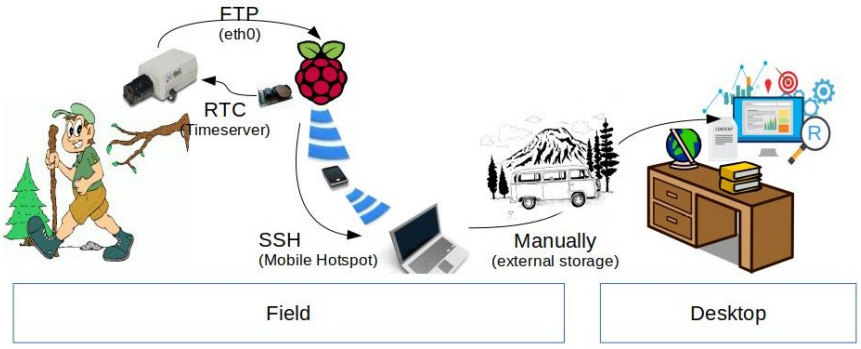


Figure 1: Technical Concept of Setup 2

IP Adresses:
Stardot: 10.42.0.64
Raspberry: 10.42.0.10

Access Instument

Use a Mobile Hotspot

Use your smartphone to host a little wifi hotspot. Attention: `SSID` and `WPA-Key` have to be configured on RaspberryPi!

SSH + Portforwarding Stardot

Forward stardots web-backend to your local maschine (ubuntu laptop).
Make sure `<startdor-ip>:80` (the configuration backend of stardot) is pingable from raspi. Now start new ssh session from laptop with `ssh -L 8080:10.42.0.64:80 pi@raspberrypi.local`. This will forward the stardot webinterface to your local maschiene.

After loging into ssh open a browser and open `localhost:8080` -> should be the camera backend. (If you have troubles don't hestitate to contact me)

To se if everything is connected poperly you can pull the current image via *wget* by typing `wget -O now.jpg http://10.42.0.64/nph-jpeg.cgi` into the terminal.

Configuration

Archive Images via FTP

For handling large data archives easily, it is recomended to store the images in a chronological folder strucutre. Therefore configure Stardot and Raspberry as follows.

Stardot

The Stardot is comes with a full FTP client out of the box and pushes new images onto the RaspberryPi. Currently it's configured to take a picture every minute (24/7) and write them into monthly folder.

TODOKU Set secondary Path/File to `%Y/%m/Camera1_....`

Attention: The monthly folders have to already exist on the server, they will not be created automaticlly. Also make sure the ftpuser has writing rigths. Otherwise no images will be stored at all!

RaspberryPi

As mentioned above it is obligatory to provide the monthly folder structure on the server side (raspberrypi). Therefore CRON this script every month (`@monthly sudo bash ../raspberry/CRON_Monthly-Folder-Structure.sh`). It will `mkrdir ./YEAR/MONTH/` and permit `ftpuser` to write files in it.

Note 8.5.17: Initial test (generate new folder `./2017/05/`) was not sucessfull. Runnig it from `sudo crontab` now.
Note 16.5.17: Testing crontab interdaily - now works with `sudo bash ...`
Note 1.5.17: Monthly CRON worked
Idea: Can ftpuser also execute crontabs? - then no struggle with sudo permission?

Timeserver

Since we are doing time-series analyses the timestamps have to be accuate. In this case the timestamps are assigned by the camera when taking the picture. It defines the filename (See above Stardot configuration) and is printed to the uper left corner of every image. Consequently the camera has to know the accurate

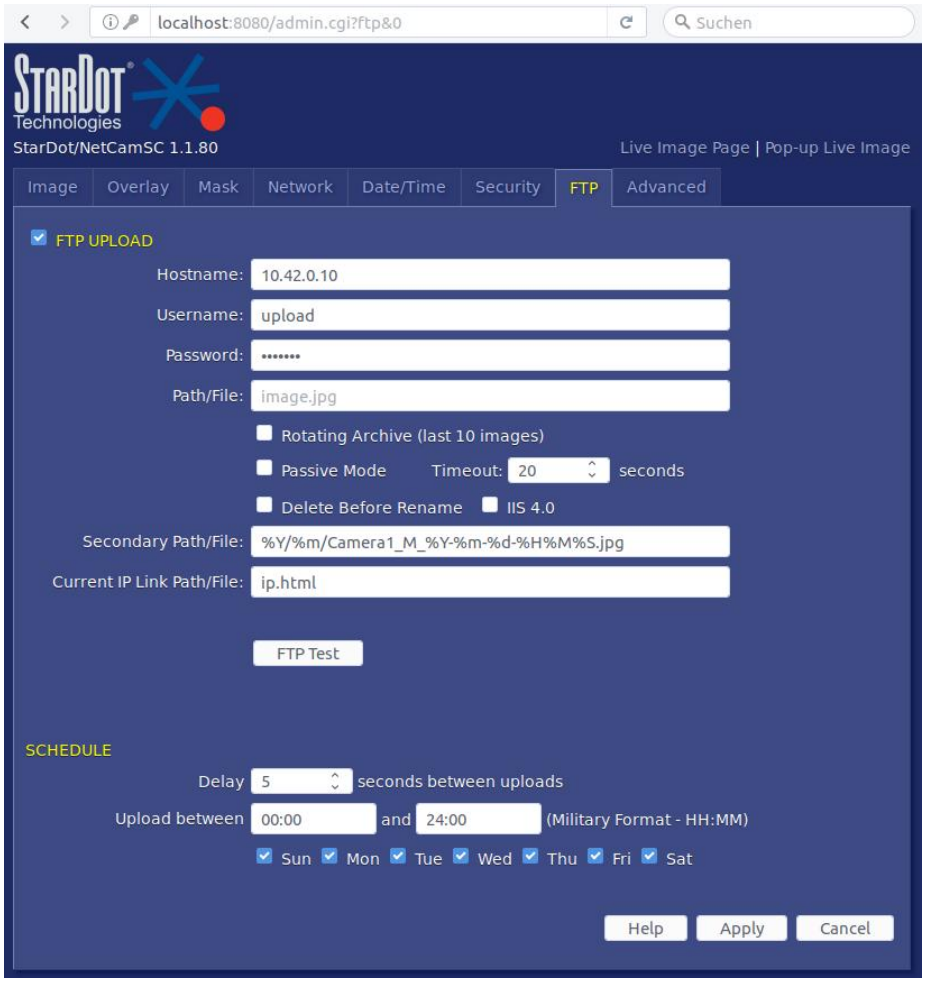


Figure 2: Screenshot FTP Configuration

time. While the devices are connected to the internet they will be able to set their clocks correctly using NTP.

Attention: Unfortunatly the two devices both trust on online timeservers only. When rebooting the instument in an offline enviroment they can not sync with timeservers and the timestamps will be wrong. Instead they continue with the date they had been shutdown making it very hard to retroactivly identify the temporal gap.

Solution: For operating in an offline enviroment a pysical clock is necessary. A *real time clock* (RTC) module with a standalone battery has to be attached to the RaspberryPi. Then the camera is configured to trust on the raspis time and the images are named accurate.

Stardot

Enter Stardot Backend -> Date/Time, toogle `Automatic` and enter ip-adress of RaspberryPi.

TODOKU: Insert Screenshot

RaspberryPi

TODO: Infos + Konfiguration. Hinweis zu Ersatzbaterien beachten: http://www.raspberry-pi-geek.de/Magazin/2015/03/Echtzeituhr-Modul-DS3231-sorgt-fuer-genaue-Zeitangaben
Konfiguration: http://raspberrypi.tomasgreno.cz/ntp-client-and-server.html
Amazon: https://www.amazon.de/DIYMall-Raspberry-DS3231-Uhrzeit-Knopfzelle/dp/B0126GGFQI

Powersupply

In rought field conditions, with no electricty network around, it should also be possible to operate with solar and batteries.

Energiebedarf

Stardot 12V * 0.5A
RasPi 5V * 1A

Solar

Sonnenstunden

https://www.wetter.de/klima/europa/deutschland-c49.html
https://de.statista.com/statistik/daten/studie/249925/umfrage/sonnenstunden-im-jahr-nach-bundeslaendern/

Emails Josef

Baterien

Sonstiger Schnickschnack

Solar Powersupply

Energiebedarf

Stardot 12V * 0.5A
RasPi 5V * 1A

Sonnenstunden

https://www.wetter.de/klima/europa/deutschland-c49.html
https://de.statista.com/statistik/daten/studie/249925/umfrage/sonnenstunden-im-jahr-nach-bundeslaendern/

Solarpaneel

Entweder statisch oder müssen der Sonne nachgeführt werden!

Dünnschicht Solarmodul 45Wp *von 119€ reduziert* 63€: https://www.conrad.de/de/duennschicht-solarmodul-45-wp-21-v-110719.html

Solarakku

Solarakku 12 V 50 Ah für 149€: https://www.conrad.de/de/solarakku-12-v-50-ah-vision-akkus-6fm50dx-blei-vlies-agm-b-x-h-x-t-197-x-170-x-165-mm-m6-schraubanschluss-1302636.html

Sonstiges

Diser Laderegler hat einen höheren Strom und vor allem einen USB anschlus

http://www.ebay.de/itm/12V-24V-20A-MPPT-Solarpanel-Solar-Laderegler-Controller-Regulator-USB-CPY-2420-/192130622142?hash=item2cbbe0a2be:g:SmUAAOSwuLZYyQ3a