

RoX

The Reflectance Box, a hyperspectral instrument for unattended observation of surface reflectance.

ROXX

Contents

1. Description and Dimension
2. Overview and Operation
3. Permanent Installation
4. Raw Data
5. Post Processing
6. Serial Interface

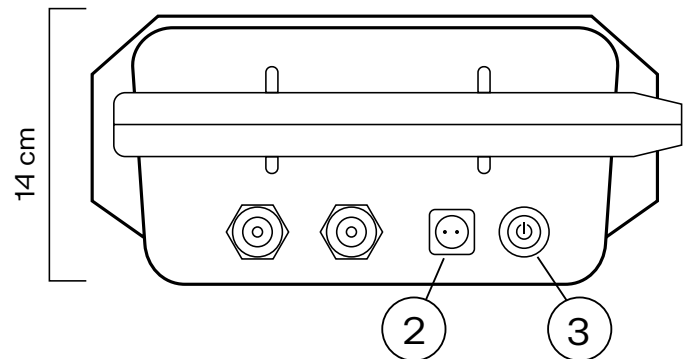
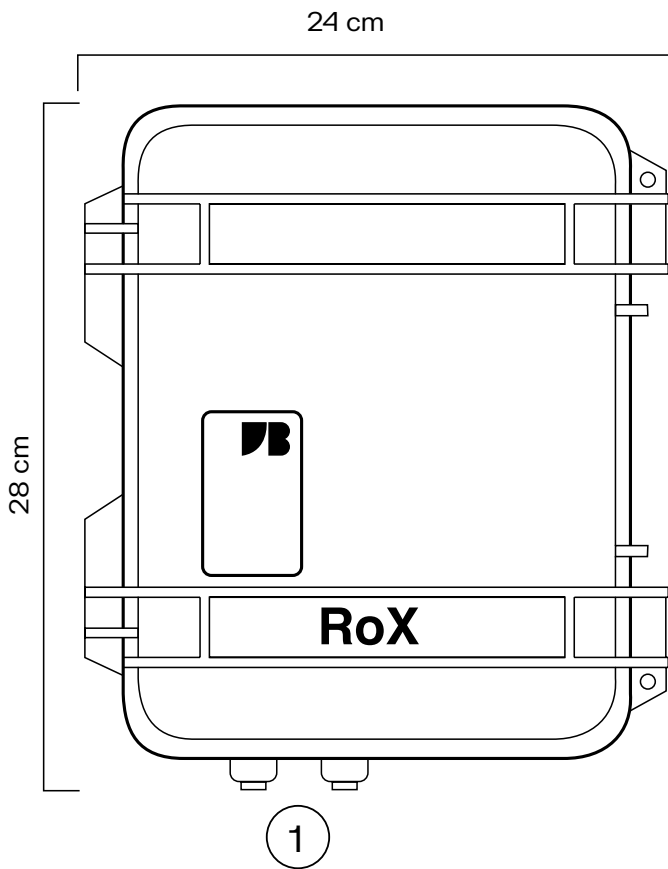
Appendix

- A. Dust and Bird Protection
- B. Embedded PC

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Dimensions:

Figure 1.1 The RoX rugged case is based on the waterproof 1200 Pelicase®. The dimensions are the extents of the case. Note that the fibers (1) should not be removed and thus increase the dimensions for shipment. At the front panel, the main power socket (2) is next to the On/Off Button (3).

**Included Items:**

1. RoX Spectroscopy System
2. AC/DC Wall Converter 60 W
3. Spare Cosine Receptor
4. 32 Gb SD card (2 times)
5. Micro USB Cable
6. Power Plug (unassembled)
7. Flight Case for shipping

TABLE 1.1

Parameters and features of the RoX as an automatic spectroscopy system for unsupervised operation.

Operational Performance	Parameter Description
Automatic Acquisition	Fully autonomus measurement mode for unattended data acquisition
Manual Acquisition	User triggered measurement mode
Signal Optimization	Automatic adaption to varying light conditions
Dark Current Measurement	Accurate dark current determination for each measurement
Fast Measurements	20 seconds under bright sunshine 60 seconds in overcast conditions
Various Metadata	Internal Temperature, Internal Humidity, GPS Position, GPS Time
Data Storage	SD card up to 32 gb (5 Years of measurements)
Power Supply	12V DC (10-14 V acceptable)
Power Consumption	15 Watt
Sleep Mode	User defined active and power saving time
Interface	RS-232 via cable

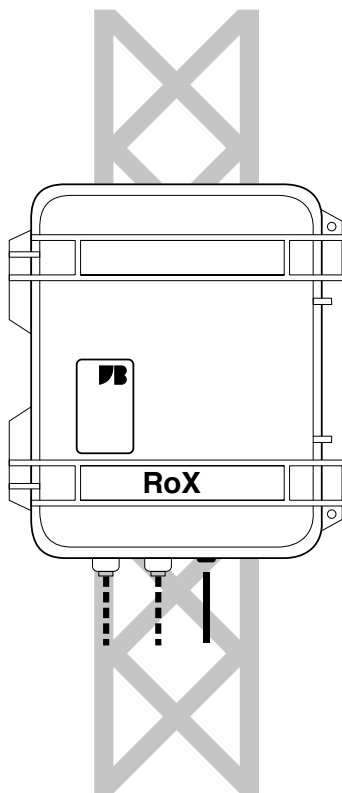
TABLE 2.1

Optical Parameters of the two internal spectrometer

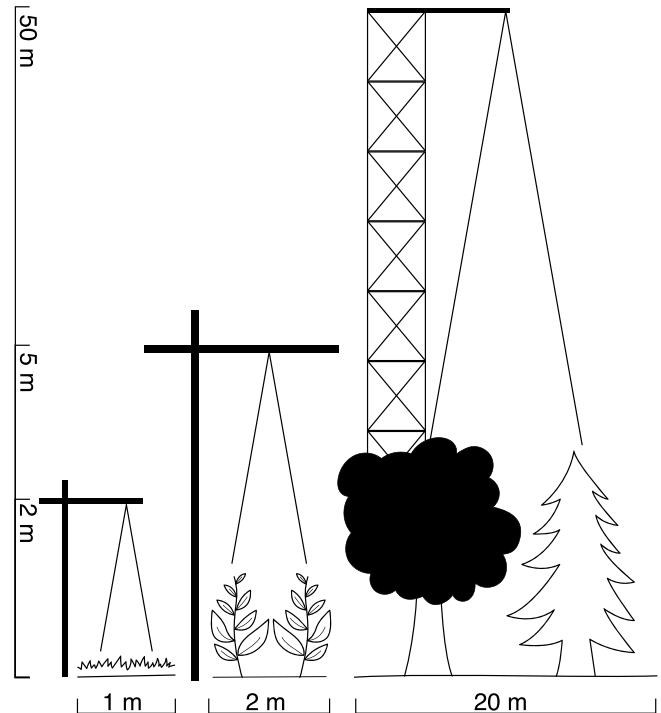
Operational Performance FLUO	Value	Description
Spectral Range	~ 400 - 950 nm	Covering the visible to near-infrared
Spectral Sampling Interval (SSI)	~ 0.65 nm	1024 Pixels
Spectral Resolution	~ 1.5 nm	Full Width at half Maximum (FWHM)
Signal to Noise Ration (SNR)	~ 250	
Dynamic Range	16 Bit	
Field Of View (FOV)	~ 180° Upwards; ~ 20° Downwards	Dual field of view optical path

The Field of View

Prior to setup of the RoX over a canopy, considerations about the homogeneity inside the field of view are essential. A low vegetation type (e.g. grass) with a homogenous pattern yields useful data from low observation heights. Larger, more coarse vegetation (eg. corn or shrubs) or even forest will require a larger field of view, thus a higher observation position. The opening angle of the downward looking fiber is 23° which leads to recommendations given in Fig 1.2 Furthermore, consider that the 3D canopy architecture or rows of managed vegetation (e.g. vineyards) can have a significant effect on the diurnal pattern of the retrieved reflectance signal. The tower itself should be placed north of the field of view to eliminate shadows of the structure inside the observed vegetation. A nadir setup reduce these effects and generates measurements comparable to airborne, satellite and other instruments.



(Figure 2.2) RoX installed at tower. Fiber ports and power sockets are facing downwards.



(Figure 1.2) Typical tower setups for grass, corn and forest with reasonable size estimations based on working setups. Drawing not to scale.

Tower Type Setup

The necessary height of the installation drives the tower type. Towers up to a size of 5 m are available in relatively easy to deploy forms and can be erected within a day (Contact JB for tower types). Larger structures may already be available at the research site or require bigger efforts in construction. The RoX usually has a fiber length of 7 m (longer fibers are an option). If the instrument should remain accessible close to the ground the overall height of the tower is limited to about 5 m. On a bigger tower, the instrument may be attached to the tower directly at an elevated position. The weight of the instrument (3 kg) and additional cables, optics and accessories should be well within the limitations of the support under all environmental conditions (e.g. wind or snow). To attach the RoX directly to a tower, mounting screws are available at the back of the instrument. Install the RoX with fiber ports and power plug facing downwards to prevent direct exposure to rain. Lead the downward looking fibers above the vegetation of interest and level the

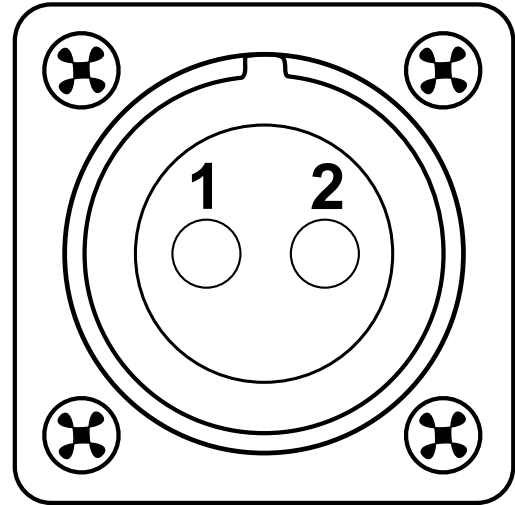
optics nadir. Lead the upward looking fibers with the cosine receptors to the very top of the tower and guarantee that the observed hemisphere is completely free from obstacles. Level the cosines. Using a bird and dust protection system is recommended to keep the sensitive upward looking optics functioning for long periods. Do not bend the optical fibers below a radius of 8 cm. The RoX has a durable weather-proof casing and can withstand extreme environmental conditions. However it is recommended to shield the instrument from direct sun to reduce the risk of overheating. This is essential in hot environments to ensure valid measurement conditions. The RoX will switch off when the internal temperature exceeds 55°C. Temperature sensors allow to track the temperature of the instrument. It is good practice to regularly drop and replace drying agent in the case (e.g. silica). Humidity of the instrument can be tracked via two internal sensors. Remote data download can be realized using the SERIAL INTERFACE.

Power

The RoX is rated 15 W peak power and requires a 12 V DC input. However the average consumption is usually lower and very low during standby periods. Running the RoX from the grid power using the included AC/DC adapter ensures complete datasets. In off grid scenarios a solar driven setup including a buffer battery is possible and can be provided by JB. However this can lead to data gaps during very dark weather periods. To allow a battery driven operation, the RoX internal DC/DC converter allow an input voltage range of 10- 14 V. Higher or lower voltage will lead to a shutdown of the instrument. Further, the RoX is polarity protected. To implement the instrument in existing 12 V power grids, an additional plug is included. Refer to Figure 3 for pin layout of the plug.

Safety

During all installation and operation take precaution for your own safety. Especially do not climb unsafe towers and take precaution if AC wiring is performed. Ask trained personnel or JB whenever you're in doubt on a safety question.



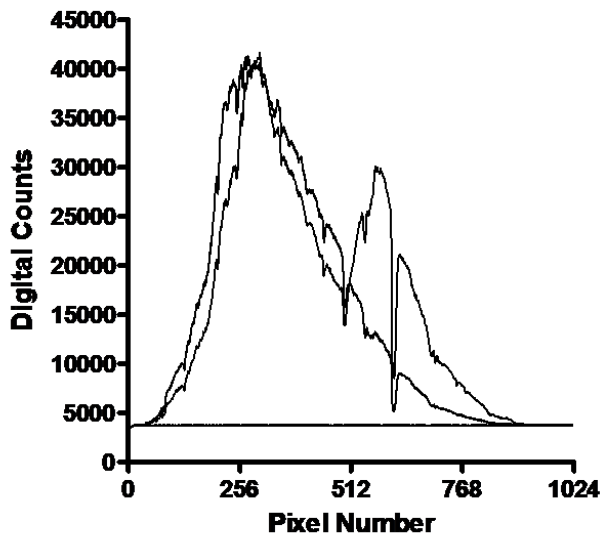
(Figure 3.2) Electrical layout of the power socket of the RoX instrument, mounted to the front wall.

1 = 12 V Power in (positive)

2 = Ground (negative)

Environmental Hazards

If the tower of the FloX is the highest structure in the surrounding, it needs a lightning conductor. Eventually use fences to keep humans or cattle out. The use of a webcam watching the instrument and the vegetation is very useful for scientific and monitoring purpose.



(Figure 1.3) Typical spectral data as stored in the RoX measurement file. The spectra show the upward and downward looking channel raw data (counts) and the recorded dark current for each channel.

SD Card Content

The RoX uses a standard SD card with a size up to 32 gb as data storage. If no SD card is inserted or the SD card is full, the instrument will not store data. In the root folder of the RoX, the "config.txt" is located (see Overview and Operation). In an empty SD card, the RoX will generate a new config file with standard parameters. In the root folder, the instrument creates a folder for each day it was active. This folder is labelled after the RoX clock time date (YYMMDD). Inside this folder, the RoX creates two files containing spectral measurements. The file storing the spectra begins with "F" followed by the time, the instrument was switched on (hhddmm). The file can be opened via a generic text editor and many other software suits. It is good practice to make a backup of the SD card content whenever the field site of the instrument is visited. Typically one file for each spectrometer is generated each day. If the instrument is switched on several times a day, (eg. solar power low) multiple files can appear within the same folder. To limit the file size, a new file will be generated if 1000 cycles are exceeded. A nightlog file shows internal measurement parameters, to track the conditions during night.

Raw Data Structure

The spectral data inside the measurement files is raw data, thus digital counts are stored. To convert these digital counts to actual physical values (eg. radiance) and to calculate fluorescence or other results, a post-processing is required (see POST PROCESSING). Most users are interested in the processed products, however the structure and content of the data files is explained in the following. One measurement cycle is stored within 6 lines, whereas the first line is the header containing metadata. In line 2-6, the spectral data is given in the order: 1 upward looking (WR1), 2 downward looking (VEG), 3 upward looking (WR2), 4 dark current of WR, 5 dark current of VEG. Since the upward looking and downward looking channels have different integration time to achieve an optimal use of the dynamic range, they may be affected by different dark currents. This is accounted for, by acquiring two dark current measurements with the two different integration times. Furthermore, the instrument measures twice the upward looking channel to quantify the stability of illumination during the measurement. The spectrometer stores 1024 pixels for each spectrum. A typical spectrum is given in Figure 1. The metadata within the header of each measurement contains essential data for processing, such as integration time or the actual time of the measurement. Furthermore, it contains additional sensor values such as temperature and humidity measures to assess the instruments operational state. An implemented GPS sensor is used whenever GPS signal is available to also store UTC time and date as well as the approximate position of the instrument. Additional parameters are appended to the header and differ with firmware versions.

TABLE 1.3

Metadata of the RoX header line. Field indicates the position of the described value in the semicolon separated line.

Field	Label	Unit	Description
1	Cycle Number		Increments with each measurement cycle
2	Date	YYMMDD	Current Date, User Defined
3	Time	hhmmss	Current Time, User Defined
4	Mode	auto or manual	Indicates the mode of operation
6	IT_WR	μs	Integration Time of the upward looking channel
8	IT_VEG	μs	Integration time of the downward looking channel
10	Cycle Duration	ms	Time that the measurement cycle took
12	Mainboard temperature	°C	Temperature of the mainboard
14	Mainboard humidity	°C	Humidity at the main controller
15	Firmware and ID		Running firmware and Device Identifier
17	GPS Time UTC	hhmmss	Time as retrieved from GPS satellite
19	GPS Date UTC	YYMMDD	Date as retrieved from GPS satellite
21	GPS Latitude	decimal degree	Latitude from GPS
23	GPS Longitude	decimal degree	Longitude from GPS
25	Voltage	V	Level of supply voltage
34	gps_CPU	ms	CPU Time of the last GPS timestamp
38	veg_CPU	ms	CPU Time of the VEG measurement

Introduction

Extending the standard unsupervised operation, the RoX provides an interface for advanced control. The interface is based on the common RS-232 protocol and accessible either via micro USB socket or wireless via XBee modem, both appearing as emulated COM port on a host computer. This means a direct serial connection can be established by plugging a micro USB cable to the RoX' socket next to the SD card and any computer regardless of the operating system. The same connection is enabled wireless up to 100 m range using the Xbee modem, included in the instrument. Connecting this with any given computer will open the same serial channel enabling extended commands and data download. On most operating systems, the drivers for RoX and Xbee modem will install automatically (contact JB for troubleshooting).

Serial Operation

To activate the serial connection, first switch on the RoX and second connect either USB cable or modem to the computer. Make sure a new COM port appears in your device and note the number or identifier of this COM port. Use any available interface software to open the COM port (eg. Termite) with a Baudrate of 57600. Ensure the software will append a newline character "\n" to submitted ASCII commands. In automatic operation, the instrument will stream the collected data via the serial port after each measurement cycle. If the serial connection was properly established a data stream will be received periodically from the instrument. Between cycles, the instrument will wait for serial commands. To stop automatic measurements and switch to manual mode send a "C" via the serial terminal. This will command the RoX to halt measurements after the current cycle is completed and then send a list of possible serial commands. Commands are case sensitive. Some commands require a following number, which is given after the command, separated with a blank. All commands will send a reply or lead to a measurement action of the instrument. Invalid commands are ignored. Note that a couple of commands will alter the instrument settings and thus change the content of the config.txt, being valid after RoX reboot. Changes can also be made directly to the config.txt using a text editor.

TABLE 1.4 Serial Commands for file handling and data transfer

ASCII Command	Standard Value/Example	Description *will apply to config.txt
ff		Send the file folder structure of the SD card
f1		Send the current FLUO raw file
f2		Send the current FULL raw file
fn		Send all files acquired today
fd YYMMDD	fd 190203	Send all files acquired at the specified data
fc		Send calibration file
ss	Off	Toggles serial stream, providing extended feedback *
S x	S 20	Defines the resolution of the serial stream spectra *
st	On	Toggles serial data transfer, to send data after cycle *
DM	DM 2	Set the power mode of the optional embedded computer * (0=always on, 1=on during day, 2=only once after off)

TABLE 2.4

Serial Commands for instrument control. Note, that beyond the given list, a number of additional commands exist for calibration and special purpose.

ASCII Command	Standard Value/Example	Description <small>*will apply to config.txt</small>
O		Optimise integration time without measurement
M		Measure without optimising integration time
m		Measure with optimizing. Equivalent to normal cycle or pressing the button in manual mode.
		Sets the FLUO integration time to x ms (10 ms to 10s)
l2 x	l2 100	Sets the FULL integration time to x ms (10 ms to 10s)
a2 x	a1 1	Sets the number of averages for the FULL *
i x	i 60	Sets the interval between measurements * to x s (range 0 s to 3600 s) to x s (range 0 s to 3600 s)
G		Send the current GPS data
c		Send the config.txt settings
T		Set date&time. You'll be asked to set YY, MM, DD, mm, ss
V	V 10.0	Set the threshold for low voltage shutdown. * Chose this value to protect the power supply battery.
On hh	On 8	Sets the starting hour to hh *
Off hh	Off 20	Sets the shutdown hour to hh *

Remote Data Access

If a RoX instrument is installed in a remote area without direct access data can be downloaded using the serial interface. The actual technical implementation is site dependent but will require a computer with internet access. This computer is connected either via cable or Xbee modem to the RoX. data can be streamed directly while measurements are running with serial transfer (st) enabled or retrieved in the evening (fn). The computer needs to log this serial stream to the harddrive (eg. Termite->Logfile). A download of this daily logfile can be handled via scripts or additional programs.

The RoX can be equipped with an internal embedded computer featuring an interface software to download the data. This solution is preferred, since the RoX can activate this computer only once per day (DM = 2) to push the data to a server. This will save a maximum of power. The embedded computer however requires integration into existing internet structure via wireless LAN or Ethernet. A mobile network internet access is possible but reliability is case dependent.

Note that Remote Data Access is under development and will expand in the near future supporting FTP upload and other options.

Overview

The RoX data processing is entirely based on the open source R software (R Core Team, 2017). The core functions of the data processing are contained in two R packages (FieldSpectroscopyCC and FieldSpectroscopyDP) openly available on GitHub platform at <https://github.com/tommasojulitta> and released under the licence GNU v3.0. The Graphical User Interface is provided to RoX customers as an R script to facilitate the analysis of the data collected, although the source code is available to JB customers and potentially adaptable to user's needs.

Processing Chain Concept

The concept behind the processing of the data follows a specific workflow:

1. DATA PROCESSING

The data processing relies on the following conceptual steps:

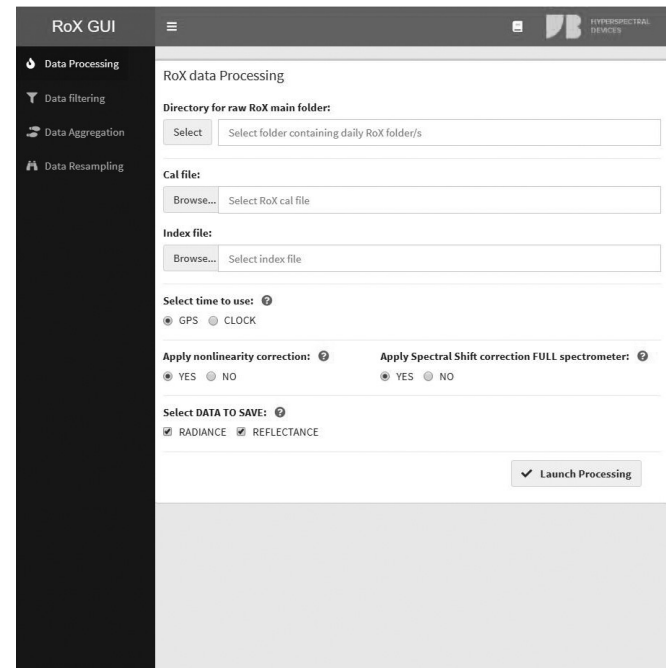
1. Reading of input files (raw data, see Raw Data).
2. Conversion of raw data to radiance data (using the JB provided calibration files).
3. Calculation of apparent reflectance factors.
6. Calculation of Reflectance based Spectral Vegetation Indices (SVIs).
7. Sun Induced Chlorophyll Fluorescence retrieval.
8. Calculation of Quality flags.

2. DATA FILTERING

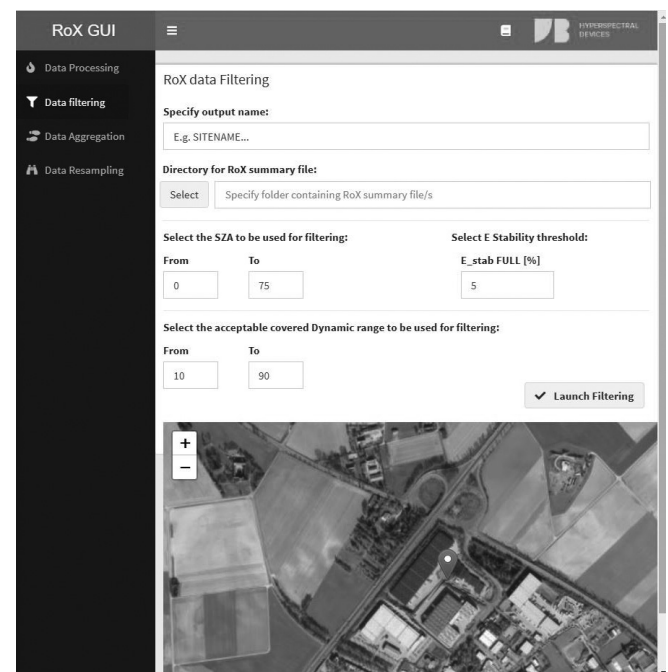
The data filtering procedure allows the user to clean the data making use of the quality flags derived during the processing (e.g. spectra saturation, illumination condition stability, Solar Zenith Angle intervals).

3. TEMPORAL AGGREGATION

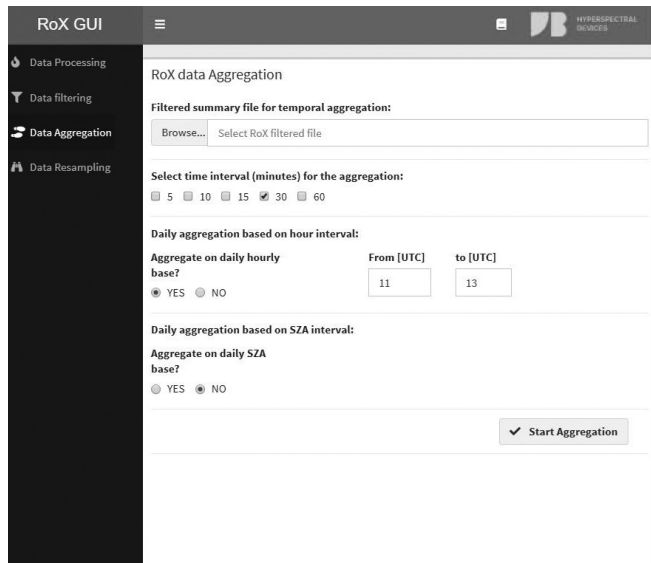
The temporal aggregation functions aim to aggregate the summary file in the temporal domain. RoX can acquire data at different speed according to the light condition and the RoX configuration made by the user. In case a temporal interval is required it can be specified here.



(Figure 1.5) RoX data processing GUI. Data processing section



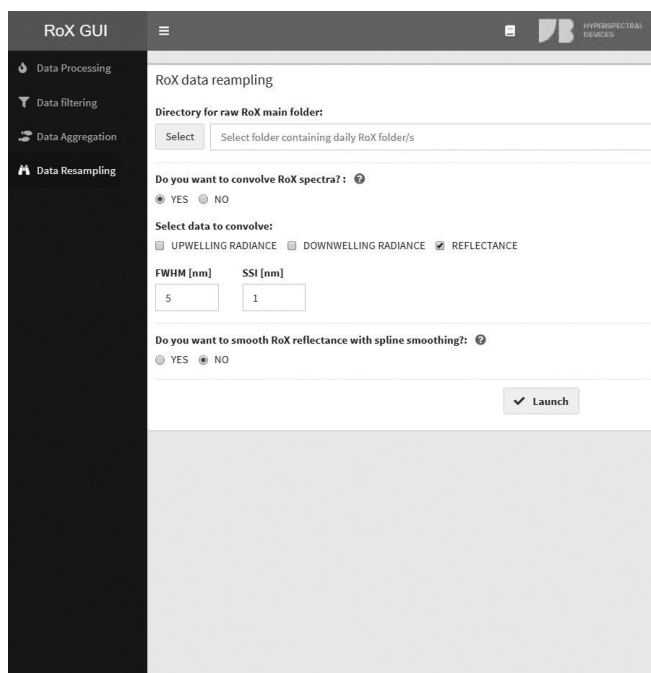
(Figure 2.5) RoX GUI, data filtering section



(Figure 3.5) RoX GUI. Temporal aggregation section.

4. SPECTRAL RESAMPLING

In case the user is interested in making a spectral resampling or to degrade the spectral resolution of the FULL range spectrometer, the spectral resampling functions allow this by specifying the requested spectral resolution (Full Width at Half Maximum, FWHM) or to eventually apply a smoothing on the reflectance.



(Figure 4.5) RoX GUI, spectral resampling section.

Graphical User Interface

The RoX GUI runs on Windows OS (XP, 7, 10). It requires R software (version 4.0.2 and later) and RStudio to be installed in the pc. The following steps need to be followed in order to launch the GUI: 1) Open R studio; 2) Select the GUI.R to be processed (e.g. RoX_GUI_20.5.R); 3) Source the code or Run App.

On first usage of the GUI the dependencies on other R packages are loaded. Before proceeding with data processing check if all the dependencies are loaded correctly and no errors appear.

RoX Processing GUI appears as reported in Figure 1.5.

In the data processing section the user is requested to make the following actions:

- 1) Select the path where the RoX data are stored
- 2) Load the calibration file
- 3) Load the indices file
- 4) Select the time to be used for the data processing
- 5) In case clock time is selected insert the LAT LON values. If GPS time is selected coordinates will be automatically retrieved from RoX raw data.
- 6) Select if the data processing needs to account for spectrometer non linearity (NL) correction.
- 7) Select if the possible spectral shift of the FULL spectrometer has to be automatically corrected.
- 8) Select the output data to be saved.
- 9) Launch the processing with the start processing button.

In the data filtering section of the GUI the user is requested to:

- 1) Specify the site name.
- 2) Select the folder containing the summary file to be filtered.
- 3) Select the Solar Zenith Angle interval for the filtering.
- 4) Select the stability QA for illumination change (recommended 5%).
- 5) Select the acceptable Dynamic range for the data acquisition.
- 6) Launch the filtering.

* saturated spectra will be automatically removed

In the temporal aggregation section of the GUI the user is requested to:

- 1) Select the filtered summary file created in previous section.
- 2) Select the time interval for the aggregation.
- 3) Select, if desired, the hours' interval for the daily aggregation.
- 4) Select, if desired, the SZA degree interval for the daily aggregation.
- 5) Launch the aggregation

In the spectra resampling section of the GUI the user is requested to:

- 1) Select the folder containing the daily folders where the resampling has to be applied.
- 2) If the spectral convolution has to be applied, specify the resolution and the spectral sampling interval.
- 3) If the smoothing on the reflectance wants to be applied, specify the spline smoothing degree of freedom.
- 4) Launch the spectral resampling.

GUI Input

Input of the data processing section are:

1) RoX data path

Path where the RoX data are stored.

WARNING: *path refers to the main folder where the subfolders named as the day of the measurements are contained, as from the SD card data structure. Rox files smaller than 100 KB are excluded from the processing.*

2) Calibration file

Calibration files are provided from JB at the moment of the RoX delivery and contain the information related to spectral and radiometric factors to convert raw data into physical units ($W\ m^{-2}\ sr^{-1}\ nm^{-1}\ ms^{-1}$).

WARNING: *If calibration file is provided accounting for nonlinearity the processing must be launched applying the non-linearity correction.*

3) Indices file

Indices file is a .txt file format containing the vegetation indices information. Each index is defined by 5 fields: In-

dex name (Index, e.g. NDVI), bands center (wl, "800;670"), band width in nanometers (fwhm, e.g. "10;10"), index formulation (expression, e.g. $(ab)/(a+b)$), convolution in the selected spectral range (convolution, e.g. mean or gaussian), Spectrum where to calculate the indices (e.g. R for reflectance, L for reflected radiance). The indices file is open to modification by the users, who is free to add as many reflectance based indices as desired, appending them as new lines in the file.

4) Time to use

Two options are available: RoX internal clock and RoX GPS module. For outdoor installation GPS time is recommended. For indoor measurements GPS time could be not available and clock time is preferred.

5) Coordinates

In case GPS time is selected this information is discarded. If clock time is selected the users can manually insert the coordinates.

WARNING: *after coordinates insertion press enter.*

6) NL correction

Non linearity correction can be applied by selecting the relative flag. **WARNING:** This selection should be aligned with the calibration file provided by JB. In case of doubt contact JB directly.

7) FULL shift correction

A correction based on the position of atmospheric absorption feature can be applied to compensate for these changes.

8) Select data to save

Three options are available: Radiance, Reflectance and Parameter. In case Radiance or reflectance are selected, radiances or reflectance files are generated and saved during the data processing. If Parameter is selected, a summary file is produced during the processing (see Output for details).

Input of the data filtering section are:

1) Site name

The site name is requested since it will be used for naming the filtering results. This is useful to keep track of the results and refer them to the selected sites, if more instruments are available.

2) Directory for RoX summary file

A directory containing only the summary file/s has to be selected. The filtered data will be stored in the same folder. In case of multiple summary files as input a single filtered file will be created.

3) SZA range

The solar Zenith Angle (in degree) to be considered for the data cleaning. Be sure the specified range match with the input data.

4) Illumination stability threshold

The percentage of the stability in between the two consecutive white reference.

5) Covered Dynamic Range

The percentage of the dynamic range reached at every measurement. Recommended one are used by default.

Input of the temporal aggregation section are:

1) Filtered summary file

Summary file related to FULL spectrometer filtered according to criteria defined in previous section.

3) Time interval in minutes

Minutes interval to apply the aggregation on. This can be applied on different temporal range: 5,10,15,30, 60 minutes. More than one can be selected at the same time.

3) Daily aggregation terms

If desired a mean daily value can be calculated by specifying an hourly base interval.

4) SZA aggregation terms

If desired a mean daily value can be calculated by specifying a SZA base interval.

Input of the spectral resampling section are:

1) Directory of RoX folders

Path where the RoX data are stored.

WARNING: *path refers to the main folder where the subfolders named as the day of the measurements are contained, as from the SD card data structure. These folders must contain the desired spectra to be convolved (e.g. Upwelling, downwelling reflectance).*

2) Spectral convolution criteria

Specify if the user wants to deconvolve and resample the spectrum of Incoming and Reflected radiance and Reflectance of the FULL range spectrometer. In case the user is asked to define the FWHM and SSI of the deconvolution/resampling.

3) Reflectance smoothing criteria

Specify if the user wants to apply a spline smoothing to the reflectance factor from the FULL range spectrometer. In case the user is asked to specify the degree of freedom for the spline function.

GUI Output

Output files are saved in the main paths defined by the user. If radiance and reflectance output are selected to be saved, related files are stored in the same folder of the raw data. Output are saved separately for each spectrometer (FLUO and FULL suffix are used respectively) and for each channel: Incoming or reflected radiance.

The summary parameter file is saved in the main root aside a report of the data processing routine containing information on the number of measurements and days processed, the calibration files used and the processing configuration settings.

If data filtering and temporal aggregation is used, the output files are saved in the same input folder as specified by the user. The file name always included the aggregation parameter and site name for filtering. If the data resampling or smoothing is applied the new convolved spectra or smoothed reflectance are saved in the original folder.

The summary file contains a list of parameters sorted by date and structured as reported in the following table.→

Field name	Description
doy.dayfract	Day of the year and day fraction
datetime [UTC]	Date time, format UTC
SZA	Solar Zenith Angle
Lat	Latitude
Lon	Longitude
temp1 [C]	Temperature of RoX
h1 [%]	Humidity at the main controller
Incoming at 750nm [W m ⁻² nm ⁻¹ sr ⁻¹]	Incoming radiance at wavelength 750 nm
Reflected 750 [W m ⁻² nm ⁻¹ sr ⁻¹]	Reflected radiance at wavelength 750 nm
PAR inc [W m ⁻²]	Photosynthetically Active Radiation
PAR ref [W m ⁻²]	Reflected Photosynthetically Active Radiation
APAR [umol m ⁻² s ⁻¹]	Absorbed Photosynthetically Active Radiation
E_stability full [%]	Percentage difference between WR1 and WR2. Full range
sat value L full [boolean]	Saturation value of downward channel. Full range
sat value E full [boolean]	Saturation value of upward channel 1. Full range
sat value E2 full [boolean]	Saturation value of upward channel 2. Full range
Dynamic range E full [%]	Dynamic range covered of upward channel. Full range
Dynamic range L full [%]	Dynamic range covered of downward channel. Full range
SSHIFT [nm]	Spectral shift of Full range spectrometer
Vis	Various VIs defined in indices.txt file

Appendix

Overview

The upward looking cosine receptors of FloX and RoX instruments are exposed directly to environmental hazards. To increase longevity, the Dust & Bird Protection system is used to keep the surface of the cosine receptor clean and to prevent bird damage. The active airstream also provides some protection against settling of insects, rain and snow on the optics. Further the Dust & Bird Protection is designed for robust attachment to tower structures and accurate levelling. The device, including the fan, is completely weather-proof. To prevent reflection towards other optical sensors, the device is manufactured from black UV resistant plastic.

Setup Considerations

The Dust & Bird Protection requires a careful setup to achieve reliable measurements (ref. PERMANENT INSTALLATION & MOBILE USE). The system should be positioned at the highest possible mounting point of the tower with nothing around, which obstructs the hemispherical field of view. The length of the optical fibers and the length of the 12 V power supply cable needs to be considered. Before setup, make sure there is a way to properly level the Dust & Bird protection using the bubble level on the device itself.

How To

To mount the cosine receptors into the Dust & Bird protection, first remove the back cover, held by a single black screw. Lead the fibers through the vertical opening in the back and fix the cosine receptors in the upper holder using the small screws. Make sure both cosine receptors are rising 1-2 mm above the holder. Eventually use tape or silicon to seal the vertical openings in the back.

To attach the Dust & Bird Protection to a mast, use U-Double-Screws or any other given option. A variety of standard spacings are supported by the mounting holes of the device. However it's fine to drill additional holes in the baseplate to support other ways of mounting.

After mounting to the mast, perform an accurate levelling of the device in order to achieve the optimum cosine response. Use the bubble level on top.

See the figures in the next page for details on dimensions and positions.

Electrical Connections

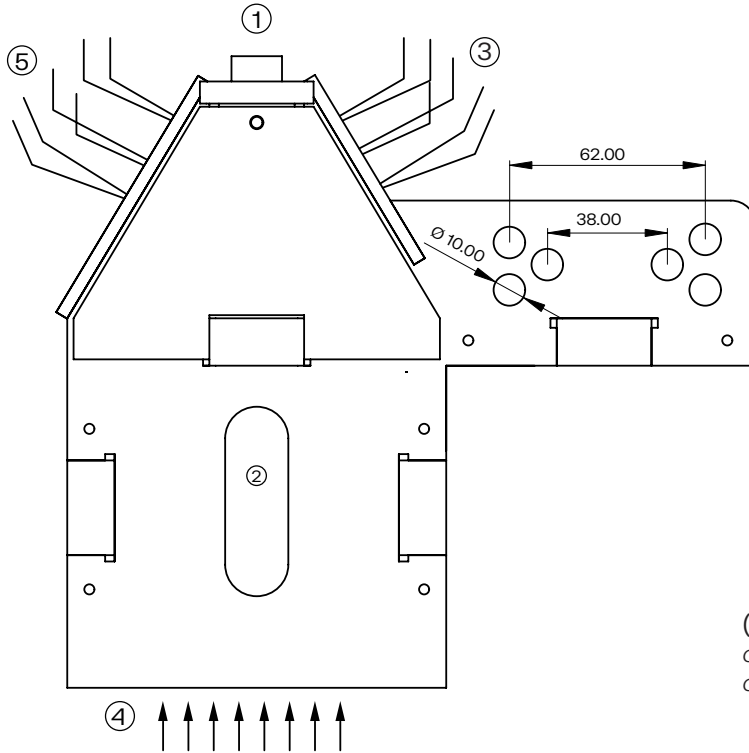
The Dust & Bird Protection fan runs on 12 V and requires 1 Watt peak power. Polarity is given on the cables (Tests have shown the fans are reverse polarity protected). Make sure the fan is always powered and running since only a consistent airstream will prevent settling of dust on the optics. In an off-grid power scenario it is recommended to wire the fan directly to the buffer battery, thus bypassing any charge controller which could eventually switch the fan off due to low battery.

Warning Notes

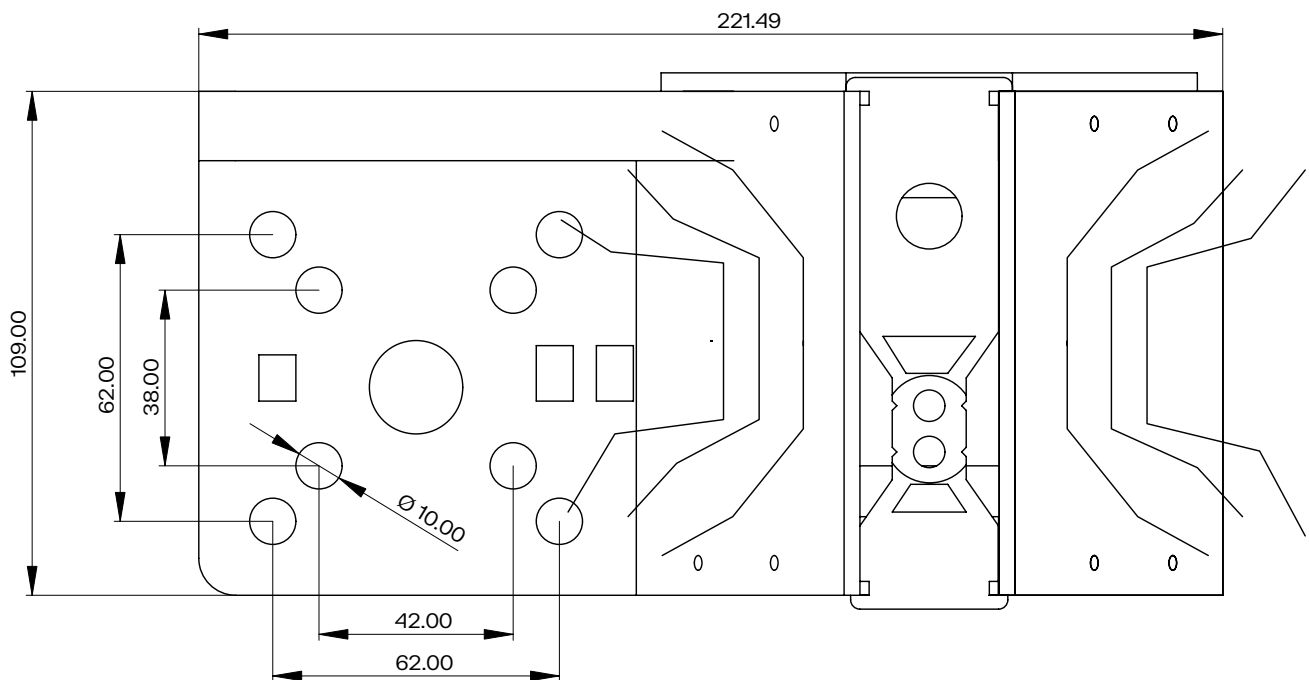
When climbing towers and ladders ensure you've a safe stand and proper safety gear. Do not work alone.

Do not bend the optical fibers below a radius of 8 cm. A lower radius will alter the calibration and a narrow bending can break the fiber.

(Figure 1.A) Back view of the device. Arrows are indicating the direction of the airstream. 1) Cosine Receptors 2) Fiber Intakes 3) Levelling Bubble 4) Fan with screws 5) Spikes to make birds feels uncomfortable



(Figure 2.A) Top view of the Dust & Bird protection, including dimensions (measured from hole center for spacings)



B REMOTE ACCESS EMBEDDED COMPUTER

Last Update: 2022-03-21

Overview

The embedded computer is a RoX/FloX accessory that provides remote access capabilities. The device is based on a Latte Panda single board computer and is flashed with a custom LINUX operating system. Via this computer the following options become available.

1. Data Transfer of connected JB Instruments to a cloud storage.
2. Remote Access via JB Technicians to remotely check the instrument state and adapt acquisition parameters.
3. Live Monitoring of instrument vitals via a web page that allows quick checking of the device state.
4. Enhanced connectivity via WIFI, Mobile Internet and LAN. All three connectivity options depend on the availability of infrastructure on site.

Parts

- Embedded Computer
- DATA Cable
- POWER Cable

Optional

- LAN Cables
- Mobile Network Modem
- External WIFI Antenna

Installation

Your RoX/FloX instrument's hardware and firmware must be prepared for installation of the remote access system. If in doubt, refer to your technical documentation or to your JB contact in order to verify the installed option.

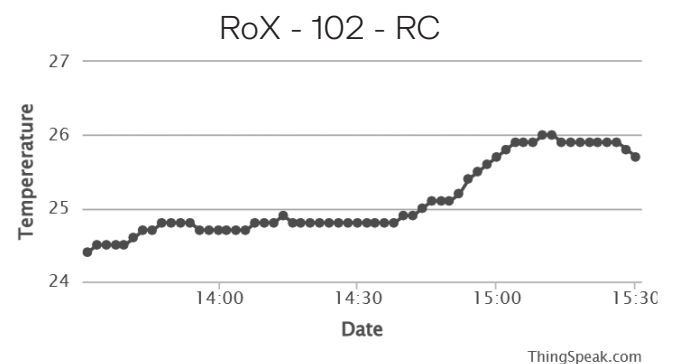
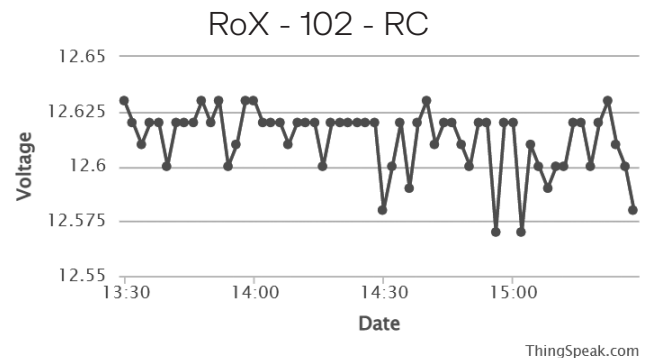
The embedded computer receives power via an USB-A double socket labelled with POWER. Connect the cable labelled with POWER to this outlet and to the micro USB socket of the embedded computer. In the FloX this USB socket is located right above the On button. In the RoX, the USB socket is hidden below the black lid. Remove the 4 big screws in the corner to allow access to the USB power socket.

Connect the cable labelled DATA to the micro USB port of the FloX/RoX instrument labelled with DATA near the SD-card. This port is located on the instrument's mainboard. Connect the USB-A plug of the cable to the embedded computer's black double USB socket.

Optionally connect the internal LAN cable to the LAN port of the embedded computer. This LAN cable is only available if the instrument was equipped with an optional IP67 external LAN socket.

Optionally plug in the mobile network modem to the black double stacked USB socket of the embedded computer. Use the upper port for the mobile modem and the bottom port for the data cable connection. Avoid bending of the USB-plugs.

Optionally wire the U.FL connector of the external WIFI antenna to the small U.FL socket on the edge of the embedded computer.



(Figure 1.B) Example of the instruments vital live feed.