Multispectral camere with filter wheel (MSX)

MSX is software for noncommercial use for operating multispectral imaging in VISIBLE, NEAR INFRARED, AND LONG WAVE INFRARED through the use of Monochromatic, RGB, and Thermal sensors (LWIR).

Monitoring the temperature distribution is essential for various reasons: inspection, defect analysis, quality control, rescue, etc., for various fields from industrial, construction, bio-medical, and emergency relief to cultural heritage.

This software allows you to control the acquisition of multispectral images in several wavelength bands, Vis-NIR and LWIR. Thermal frames represent a management in Temperature (°C) radiometric mode.

The Graphical User Interface (GUI) is represented below in Figures 1, 2, and 3.

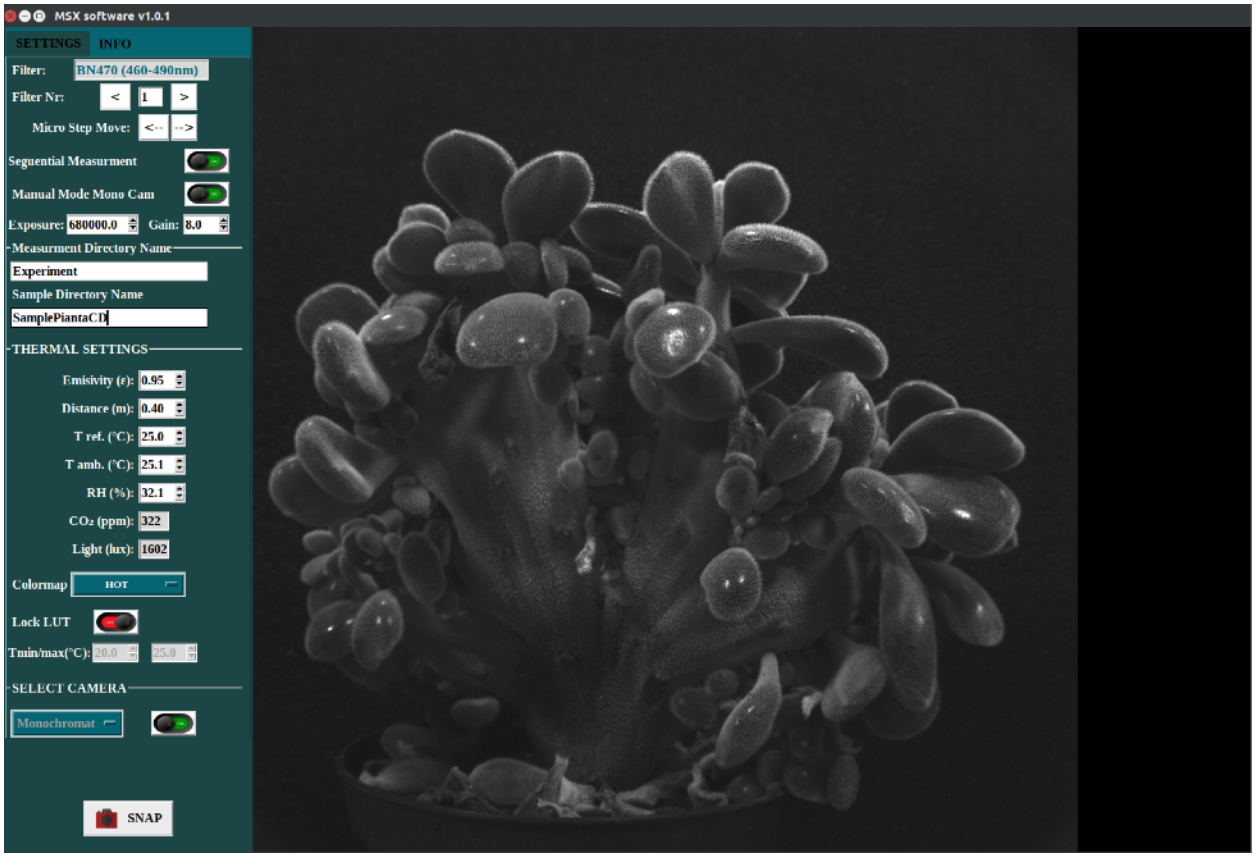

Figure 1: Monochromatic view (Basler aca2040-90umNIR)

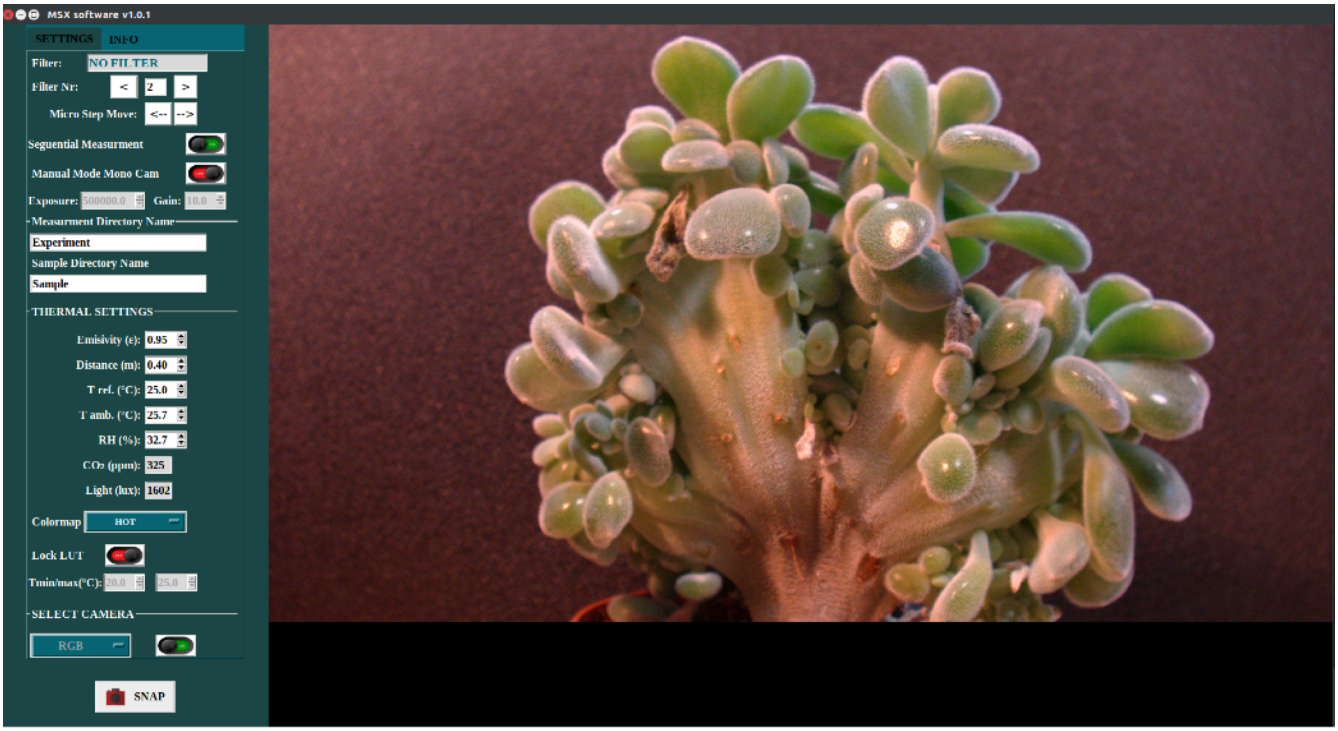

Figure 2: RGB view (HQ Raspi Cam - IMX477)

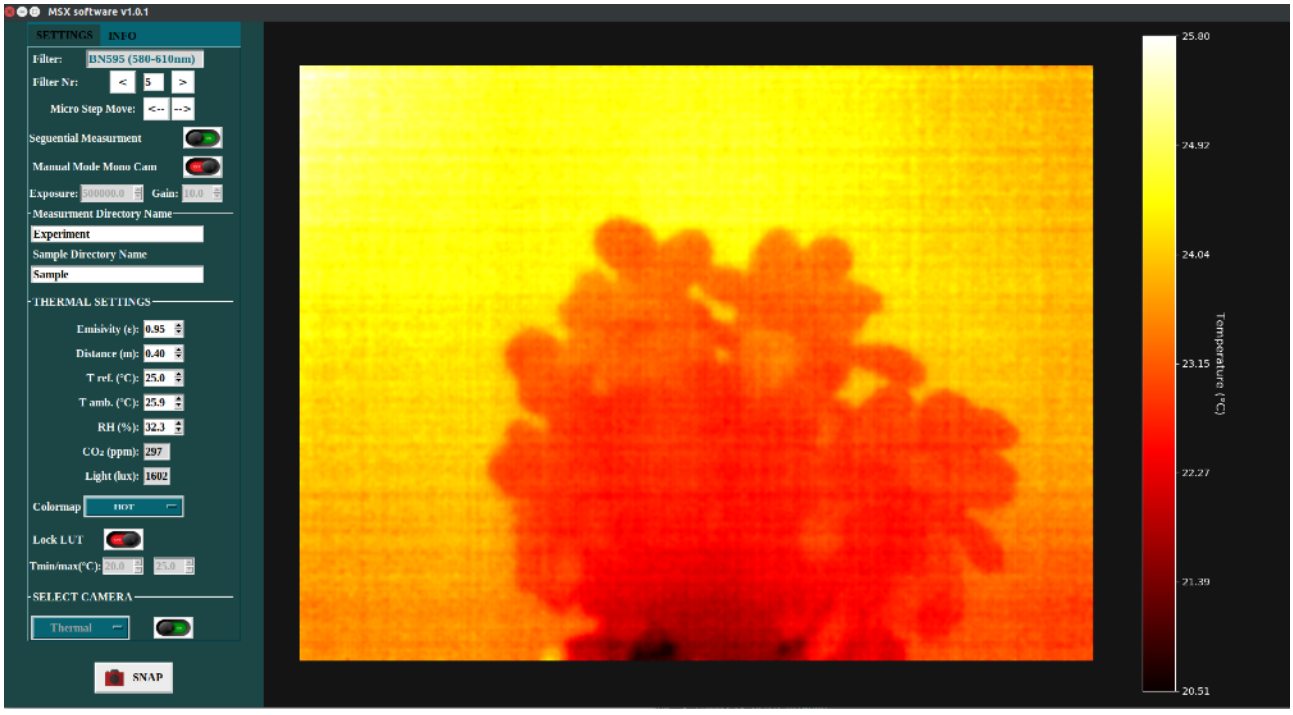

Figure 3: Thermal view (Seek Thermal Mosaic Core)

SNAP It grabs the single frame and saves it in .tiff and only for thermal also .png format.
< > These buttons switches to the next and previous filter and updates the filter label name with the wavelength bandpass description.

<- -> These buttons help to perform micro-movements of the filter wheel in case it is not ideally positioned in front of the optics.
Sequential Measurement If it is ON, after each acquisition, SNAP moves the filter wheel to the next filter; if it is OFF, it does not move, and multiple images can be acquired with the same filter.
Manual Mode Mono Cam If it is ON, you can set exposure and gain values in Exposure / Gain labels; if it is OFF, the exposure and gain is automatic mode.
Thermal Settings To set the experimental parameters for a precise temperature measurement. These parameters are needed for the temperature conversion calculus of the raw data.
Colormap Allow you to select the colormap for thermal visualisation.
Lock LUT If it is ON, in the Lookup Tables (LUT), you can set the temperature range to visualise the thermal sequence, i.e., the colormap; if it is OFF, the LUT is dynamic.

1.1 Installations and configurations

RUN MSX Software
Before launching it, check that the execute permission is granted to the user; if not, run the following command in the terminal

chmod u+x MSX

To start the program, you can double-click on the MSX application icon or use the following terminal command:

./MSX

Important: Before starting the thermal acquisition, it is necessary to select the type of camera that you would like to use and then click the button on the link of the **name** label to **ON**.

1.2 The main functions and usage

SNAP: It grabs the raw data or only for selected camera and saves it in **.tiff** and for thermal sensors, both .tiff for rad that contain temperatures and **.png** format for visualization.

Thermal Settings. To set the experimental parameters for a precise temperature measurement. These parameters are needed for the temperature conversion calculus of the raw data.
The parameters like Emisitity(ε), Tref(°C), and Distance (m) must be input for the specific experiment; only Tatm (°C) and Relative Humidity (%) are set from sensors. The flat field correction (FFC) is in automatic mode by default.
Colormap: To change a colormap type used for **thermal** output display.

1.3 Acquired DATA with MSX Camera

For each sample, the MSX camera can acquire a stack of 14 different images using the following MidOpt StabelEDGE Narrow bandpass filters with the following wavelength spectral, RGB sensor, and thermal characteristics:

1. BN470 (460-490 nm)
2. BN532 (525-550 nm)
3. BN595 (580-610 nm)
4. BN630 (625-645 nm)
5. BN660 (645-675 nm)
6. Bi685 (675-692 nm)
7. BN740 (730-755 nm)
8. BN785 (770-790 nm)
9. BN810 (798-820 nm)
10. BN850 (840-865 nm)
11. BN940 (928-955 nm)
12. No_Filter
13. RGB (400-700 nm)
14. Thermal (LWIR) (8-14 µm)

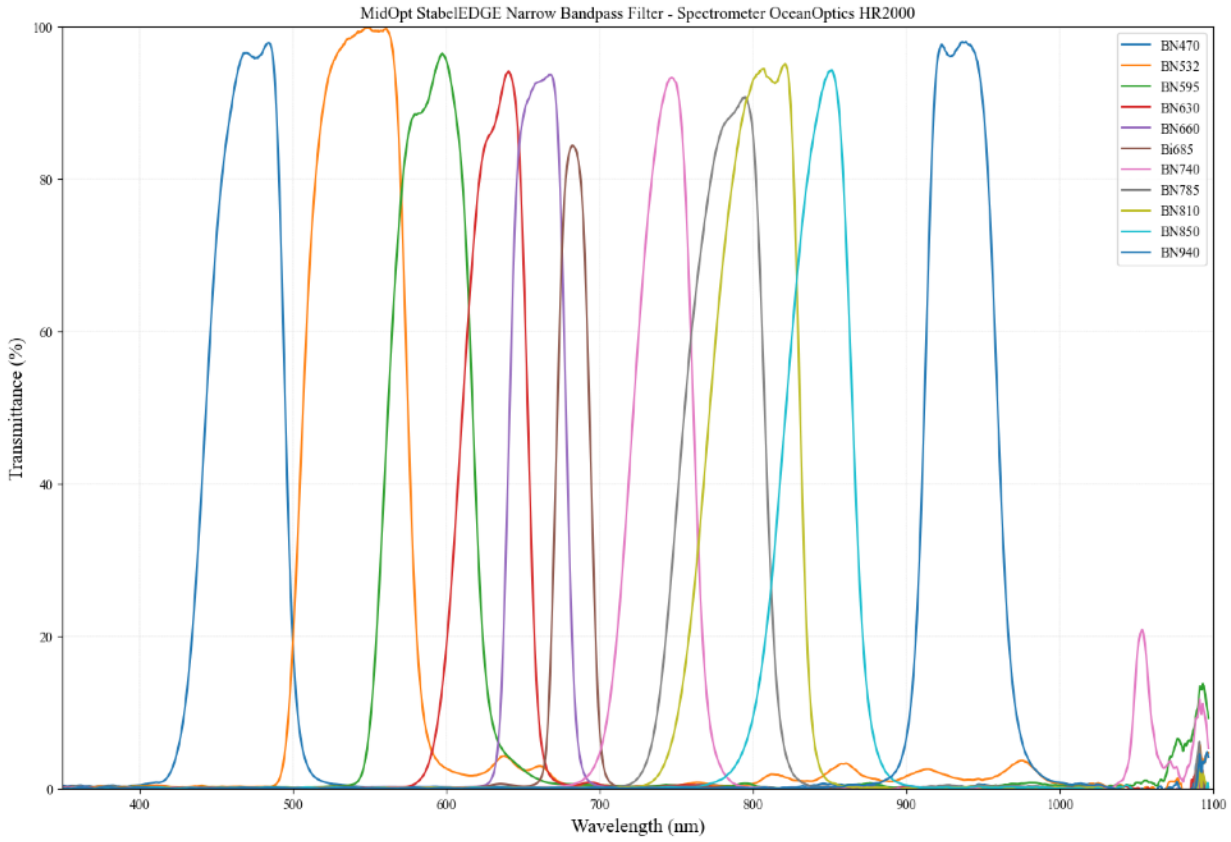

Figure 4: Narrow bandpass filter spectral transmittance

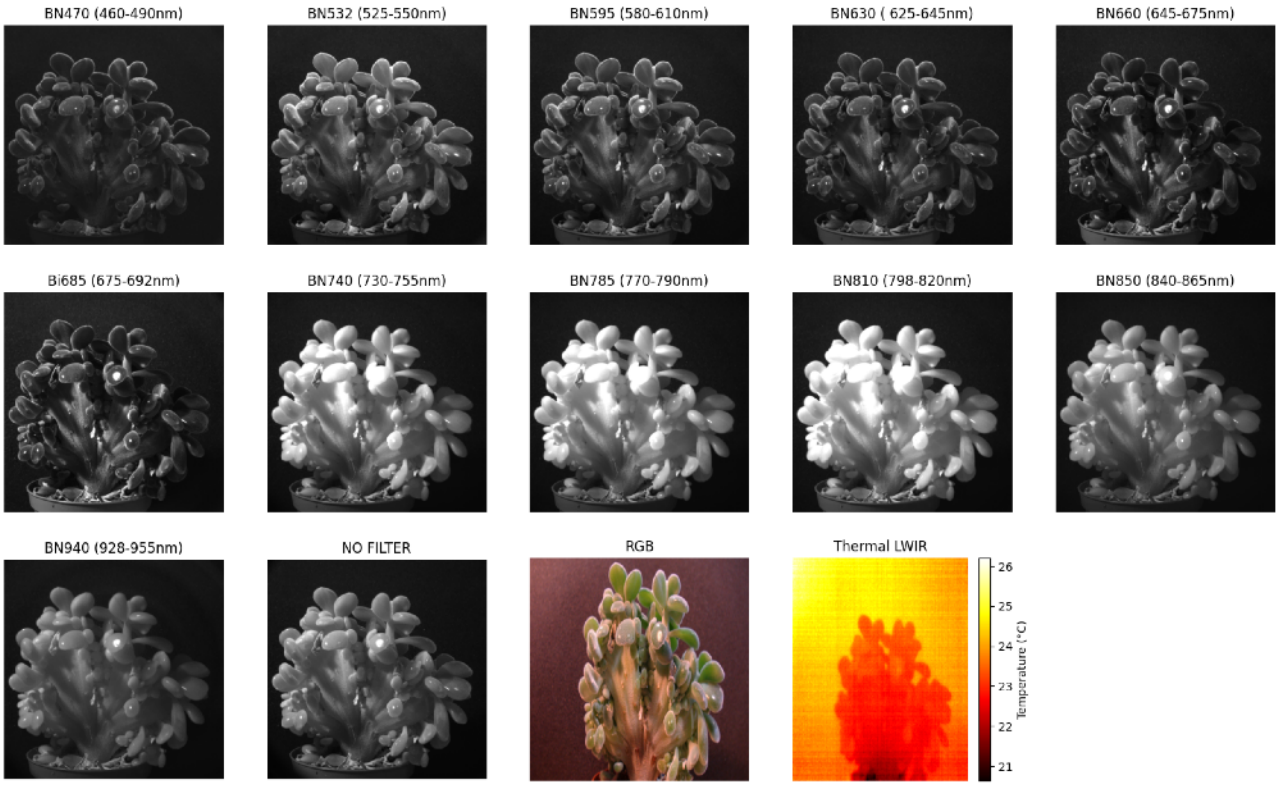

Figure 5: Multispectral stack of images data from MSX camera

MSX camera also has the environmental parameters acquisition with the following sensors:

- DHT22
  - Temperature (°C)
  - Relative humidity (\%)
- SEN0159
    - Dioxide of carbon (ppm)
- BH1745
  - Light intensity (lux)

All this data is stored in one **CSV** format file, **ENV_Data_DD_MM_YYYY.csv**, followed by the date. Each measurement of environmental data is stored in a new row of files, and a time of acquisition is added.

1.4 Description of the files from Monochromatic sensor

This file represents 12-bit data from the monochromatic sensor (Basler aca2040-90umNIR) that is stored with the name Filter_nome_filter.tiff for the respective used filter to tack the acquisition (e.g., Filter_BN470.tiff)

1.5 Description of the files from RGB sensor

This file represents 10-bit data from the monochromatic sensor (HQ Raspi Cam IMX277) stored in the name RGB_nome_filter.tiff for the respective filter used to tackle the acquisition.

1.6 Description of the files from Thermal sensor

The **.tiff** format file represents 16-bit data from the LWIR sensor (Seek Thermal Mosaic Core) that is stored in the Thermal_RAD_date_time.tiff for the respective used filter to tack the acquisition. The Temperatures are in Kelvin, the data are without decimal separation, and to convert it to Celsius:

T(°C) = (T Kelvin/100) - 273.15

In metadata, you found the Tamb, Tref, Dist, Emisivity, etc., set in the moment of acquisition.

1.7 Description of the files from Environmental sensors

The first column represents the time of acquisition, the second is the temperature in Celsius, the third is the relative humidity in percentage, the fourth is the carbon dioxide concentration in parts per million, and the last is the light in lux.

ENV_Data_DD_MM_YYYY

Time	T(°C)	R_H(%)	CO2(ppm)	Light(LUX)
17:50:17	24.2	67.1	371	1320
17:50:30	26.0	58.3	362	1320
17:50:53	26.0	58.3	363	1350
...	...	...	...	...