# Iberoptics Sistemas Ópticos

# Polyspectral & SWIR imaging applied to food and agriculture

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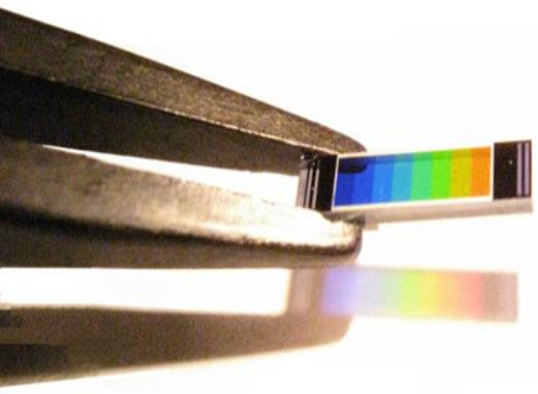
25/05/2021

# Multispectral cameras

## for Smart Agriculture and Agrifood industry

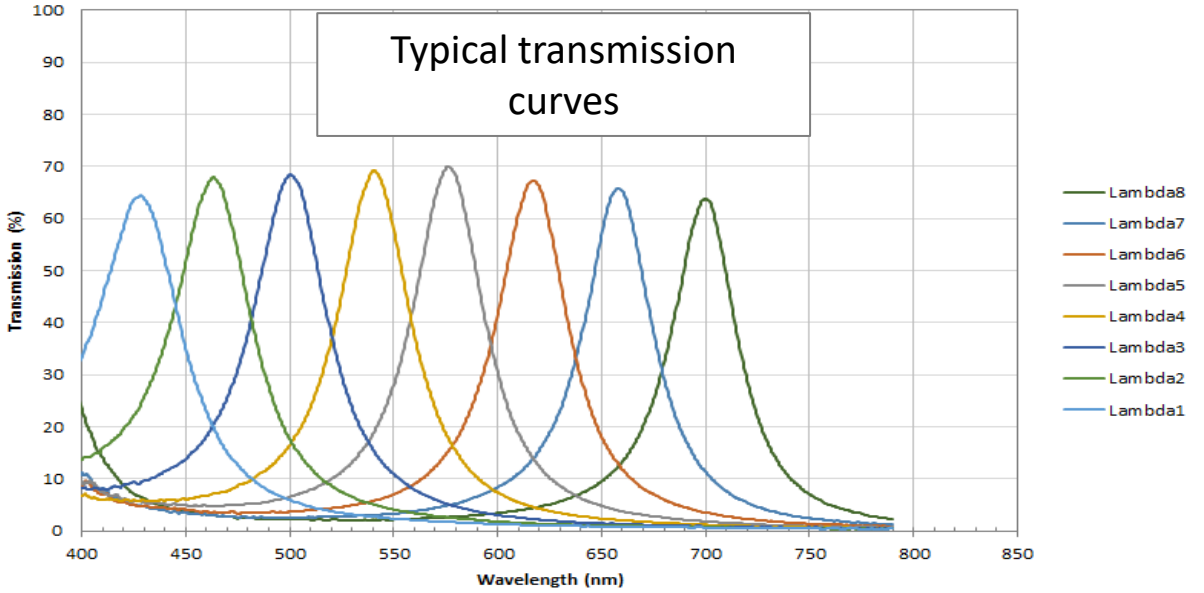
**WE ARE EXPERTS IN *MICRO-OPTICS***

## *COLOR SHADES*® TECHNOLOGY



**Typical specifications**

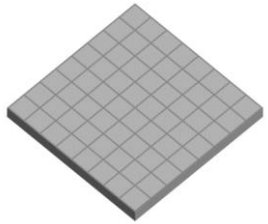
| | |
|---|---|
| Tmax : | 40% to 70% |
| FWHM : | 20nm à 40nm |
| Max Spectral Range : (shiftable) | 300nm |



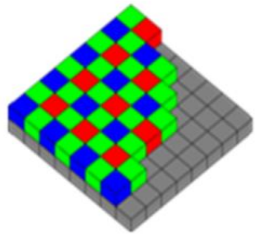

**The *COLOR SHADES*® filters show low resonance level (low Q factor).**

- ✓ **Low sensitivity to the incident angle.**
  Only slight spectral band changes up to 15°.
  The filters can be used with optical apertures up to F/2.
- ✓ **High sensitivity**
  Due to a high integrated transmission.

# SNAPSHOT MULTISPECTRAL IMAGING (Custom Bayer Matrix)



Monochrome standard imager
Resolution : N x M

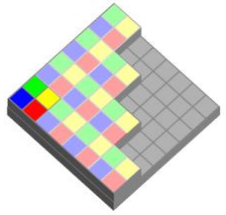


Standard RGB imager
Resolution : N x M
(after demosaicing)

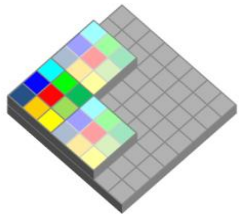
**Regular Color Imaging (RGB).**

**SILIOS multispectral approach : filtering at the pixel scale**

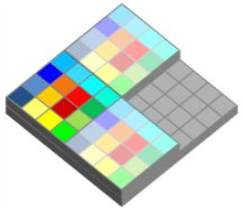
SNAP SHOT



4 interleaved images
Resolution : N/2 x M/2

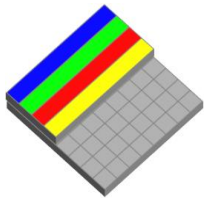


9 interleaved images
Resolution : N/3 x M/3



16 interleaved images
Resolution : N/4 x M/4

PUSH BROOM



Ex: 4 interleaved spectral lines for push broom camera system

**Multispectral Imaging.**

**Supply of a set of 4, 9 or 16 sub-images filtered or lines @ different λ**

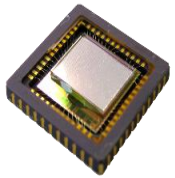
# ANY SENSOR

## Already developed :

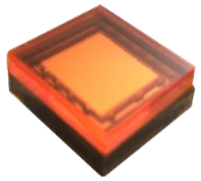
| Manufacturer | Model | Pixel number | Pixel number | Pixel pitch | Range | Macropixels configurations |
|---|---|---|---|---|---|---|
| MELEXIS | 75005EA | 172 x 1 | 172 | 66 | VIS/NIR | 1 x 8 |
| e2V/TELEDYNE | RUBY | 1280 x 1024 | 1.3 Mpx | 5.3 | VIS/NIR | 3 x 3 / 4 x 4 / 5 x 5 / 6 x 6 |
| e2V/TELEDYNE | ONYX | 1920 x 1080 | 2.1 Mpx | 5.3 | VIS/NIR | 3 x 3 |
| AMS | CMV4000 | 2048 x 2048 | 4.2 Mpx | 5.5 | VIS/NIR | 3 x 3 / 5 x 5 / stripes |
| VIIMAGIC | 9225 | 2068 x 1100 | 2.3 Mpx | 5.0 | VIS/NIR | 6 x 6 |
| NIT | NSC1602 | 648 x 488 | 0.3 Mpx | 7.5 | VIS/NIR | 2 x 2 |
| PHOTONIS | LYNX | 1280 x 1024 | 1.3 Mpx | 9.7 | VIS/NIR | Specific |

## Currently Under development :

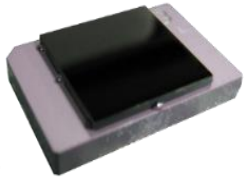
| Manufacturer | Model | Pixel number | Pixel number | Pixel pitch | Range | Macropixel configuration |
|---|---|---|---|---|---|---|
| AMS | CMV12000 | 4096 x 3072 | 12.6 Mpx | 5.5 | VIS | Specific |
| LYNRED | SNAKE | 640 x 512 | 0.3 Mpx | 15 | SWIR | Specific |



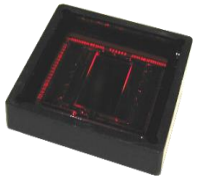
RUBY Sensor (e2V/Teledyne)



CMV4000 sensor (AMS/CMOSIS)



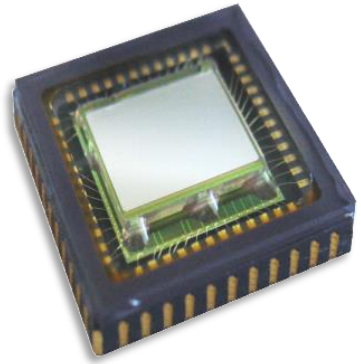
VIImagic Sensor (VIimagic)



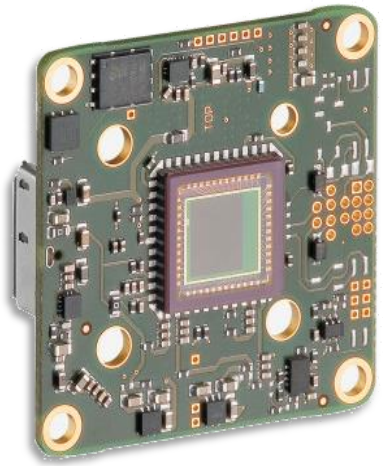
ONYX Sensor (e2V/Teledyne)

# CUSTOM MULTI-SPECTRAL IMAGING

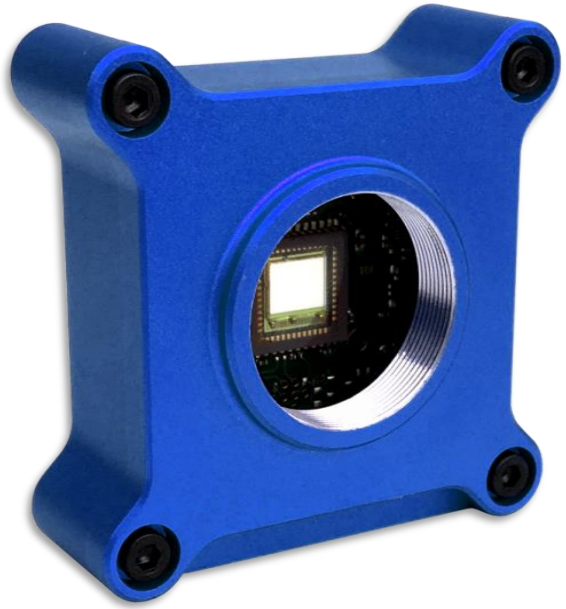
## We supply…



Multispectral Sensors

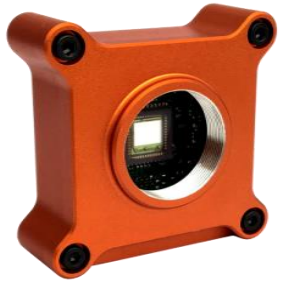


Multispectral e-Boards



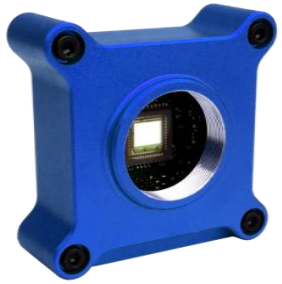
Multispectral Cameras

# CMS SERIES : VIS & NIR off the shelf cameras



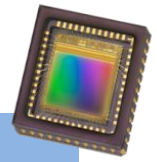
**CMS-C**
**430-700nm**

**CMS-V**
**550-830nm**



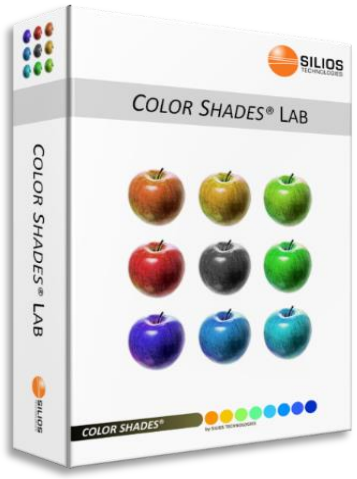
**CMS-S**
**650-930nm**

## 1.3 Mpx CMS Series



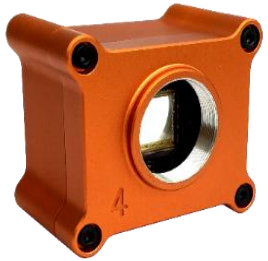
| | |
|---|---|
| Sensor | RUBY (e2V/TELEDYNE) |
| Technology | CMOS |
| Raw Resolution | 1280 x 1024 px² (1.3 Mpx) |
| Spectral Range | Model C : 430 – 700 nm<br>Model V : 550 – 830 nm<br>Model S : 650 – 930 nm |
| Channel bandwidth | 30 – 50 nm |
| Macropixel | 3 x 3 px² |
| Spectral channels | 8 |
| Panchromatic channel | 1 |
| Integration mode | Snapshot/Global or Rolling Shutter |

## Free software

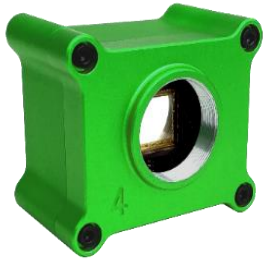



**COLOR SHADES Lab (SDK)**
**+**
**DLL for :**
**✓ Hypercube extraction**
**✓ Crosstalk correction**

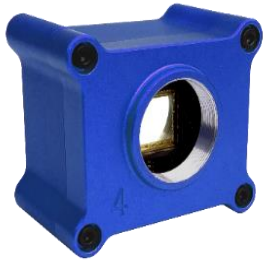
# CMS4 SERIES : VIS & NIR off the shelf cameras



**CMS4-C**
**430-700nm**

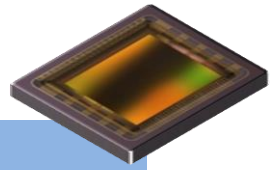


**CMS4-V**
**550-830nm**



**CMS4-S**
**650-930nm**

## 4.2 Mpx CMS4 Series



| | |
|---|---|
| Sensor | CMV4000 (AMS) |
| Technology | CMOS |
| Raw Resolution | 2048 x 2048 px² (4.2 Mpx) |
| Spectral Range | Model C : 430 – 700 nm<br>Model V : 550 – 830 nm<br>Model S : 650 – 930 nm |
| Channel bandwidth | 30 – 50 nm |
| Macropixel | 3 x 3 px² |
| Spectral channels | 8 |
| Panchromatic channel | 1 |
| Integration mode | Snapshot/Global Shutter |

## Free software

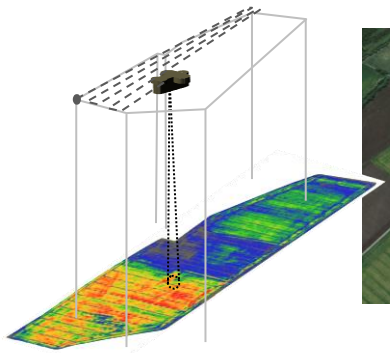

**COLOR SHADES Lab (SDK)**
**+**
**DLL for :**
**✓ Hypercube extraction**
**✓ Crosstalk correction**

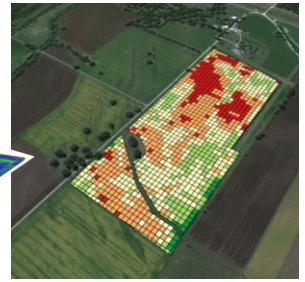

# A Versatile Solution :
# Some Application Examples in Smart Agriculture

# PRECISION FARMING

## PLANT HEALTH MONITORING, BIOMASS

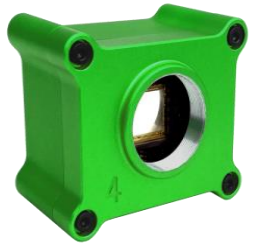
**Drone Embedded Multispectral e-boards**
**(air or land)**





# EARLY DISEASES DETECTION (camera model : CMS4-V)

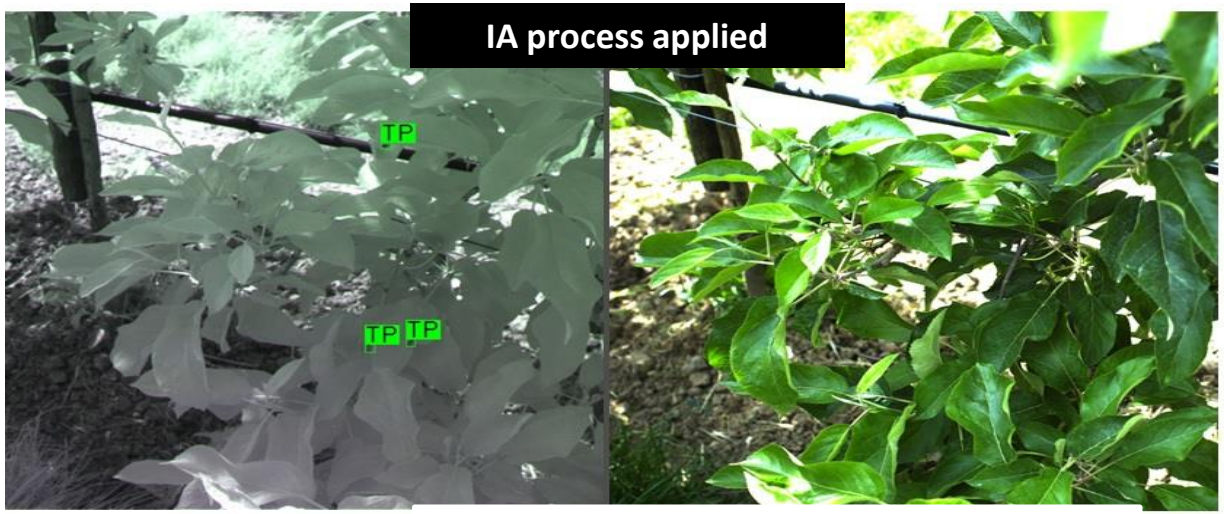
## Detection of diseases in Orchards for smart spraying

CMS4-V

# EARLY DISEASES DETECTION (camera model : CMS4-V)

IA process applied



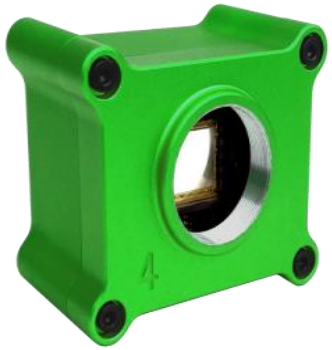

CMS4-V image

RGB image

IA process applied


CMS4-V image

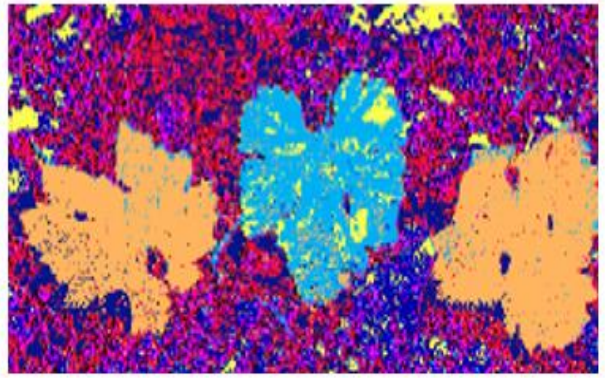
RGB image



CMS4-V

# EARLY DISEASES DETECTION (camera model : CMS-V)

## Detection of diseases in Vineyards



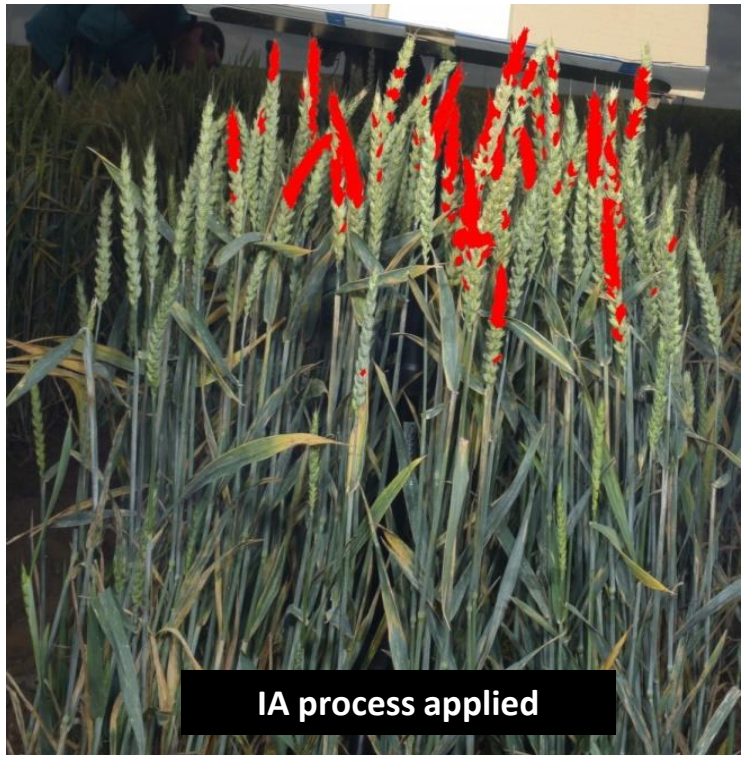
Example of ESCA disease (Black Measles)

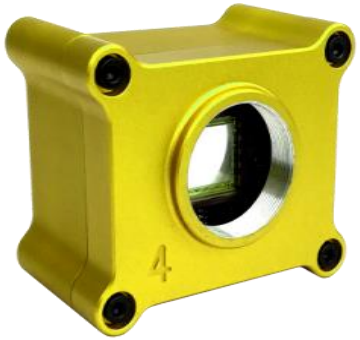
Positioning the CMS-V camera (in a dedicated body) onto a vineyard straddle tractor.

CMS-V

# DISEASES DETECTION
# (camera model : CUSTOM CMS4)

## Detection and quantification of diseases on wheat in the field




CUSTOM CMS4

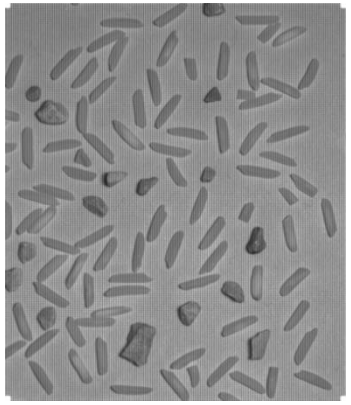
# AGRI-FOOD INDUSTRY

**Quality Control – Food security**

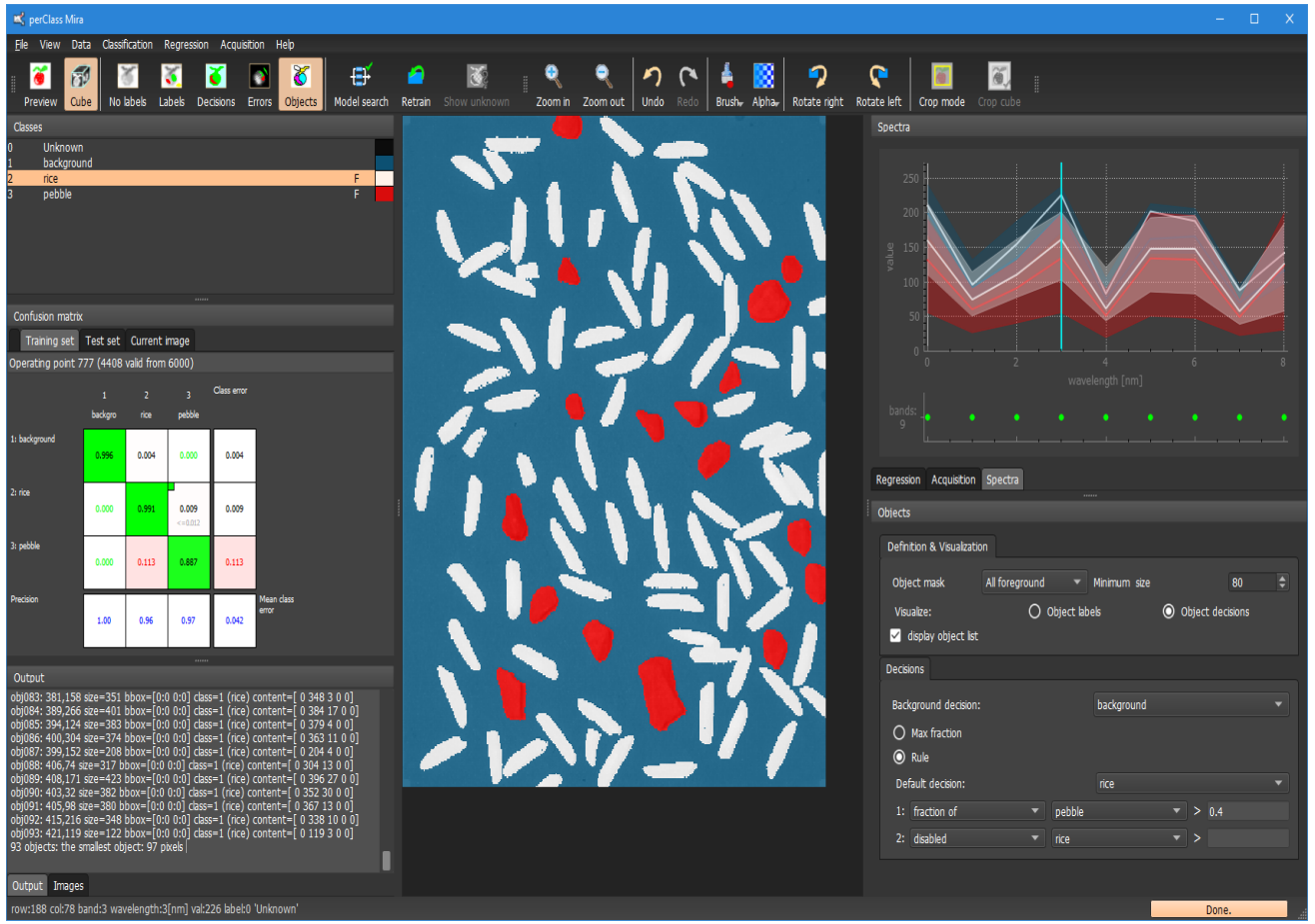
# FOOD SECURITY
# (camera model : CMS-S)

## Detection of foreign bodies (pebbles) in Food (rice)

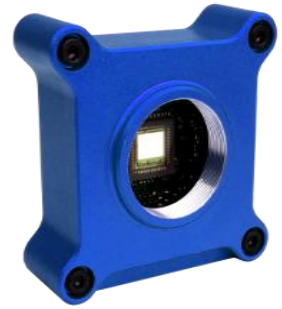
RGB image



Raw CMS-S image




Result of the processed classification



CMS-S

# Hyperspectral Cameras

## Hyperspectral camera: VNIR (400 – 1000 nm)

- Frame based snapshot Hyperspectral Camera.
- Resolution 1 MPx.  All pixels are true image pixels. No interpolation is used.
- Up to 1000 freely selectable spectral bands.
- Up to 149 frames per second (fps).

**Versatility of hyperspectral camera HSC-2:**

- Fabry-Perot interferometer based
- The frame-based approach with integrated positioning and IMU enables easy image stitching for the mosaics.
- Used with a wide variety of platforms including **drones and fixed wing UAVs**.

**Typical applications:**

- Agriculture and agro-food
- Forestry
- Water research
- General industry
- Medical and biosciences
- Forensics

# SWIR Cameras
## (InGaAs: 900-1700nm)

**Advantages and uses of the SWIR range:**

- there is large **water absorption** band @~1400/1500nm

Ideal for identification of water content in forestry or agricultural areas (hydric stress), bad weeds, diseases,…

For use in laboratories or outdoors in drones (but size matters!)

- many biological substances have footprint in this range and not in visible (or larger)

Ideal for food inspection and sorting

Excellent for Identification of strange bodies (little stones, pebbles or alike)

# SWIR Cameras
## (InGaAs: 900-1700nm)

### Available models:

**NIT-WiDy-SWIR**: unbeatable 120dB dynamic range; 640 x 512 px

- TECless; very low size, weight and consumption

**NIT-WiDy-SenS:** same features + high sensitivity mode (with TEC)

- still very low weight and size

**NIT-HiPe-SenS**: high end InGaAs camera; 640 x 512 px

- TEC + fan cooling -20ºC: long exposure time, high quantum efficiency 90% typ

**NIT-Sens-1280**: high sensitivity

- **1280 x 1024 px**
- Read-out-noise 27 $e^-$

**NIT-LiSa-SWIR-2048**: lineal camera

- 2048 x 1 px
- Ideal for in-line food sorting and inspection

Ideal for drones

Made in France; no import restrictions

# FTIR spectroscopy
## (1350 – 2500 nm)

Based on NeoSpectra chip: MEMS + FT-IR

**NeoSpectra Broad NIR Research Kit:**

- Fast, accurate desktop spectrometer
- Laboratory and Academia ready
- Material sensing solution combining hardware & software

**NeoSpectra Milk Analyzer:**

- NeoSpectra Broad NIR Analyzer based
- With milk results exceeding ICAR standards, SCC, and adulterants
- Excellent and superior accuracy on Fat, Protein and Lactose

**NeoSpectra Scanner:**

- Handheld
- Large 10 mm spot
- Ideal for soil, feed & food analysis in the field

**Thank you for your time and attention**

**…or at least for not snoring**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