

# Hyperspectral imaging (HSI) goes embedded



Hyperspectral Imaging (HSI) goes embedded

# Seeing the invisible with Miniature intelligent HSI Cameras - xiSPEC

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## Contributing technologies



Innovator in machine vision and scientific imaging.  
Excels in the smallest form factor, fastest speeds, lowest power consumption or widest interoperability.



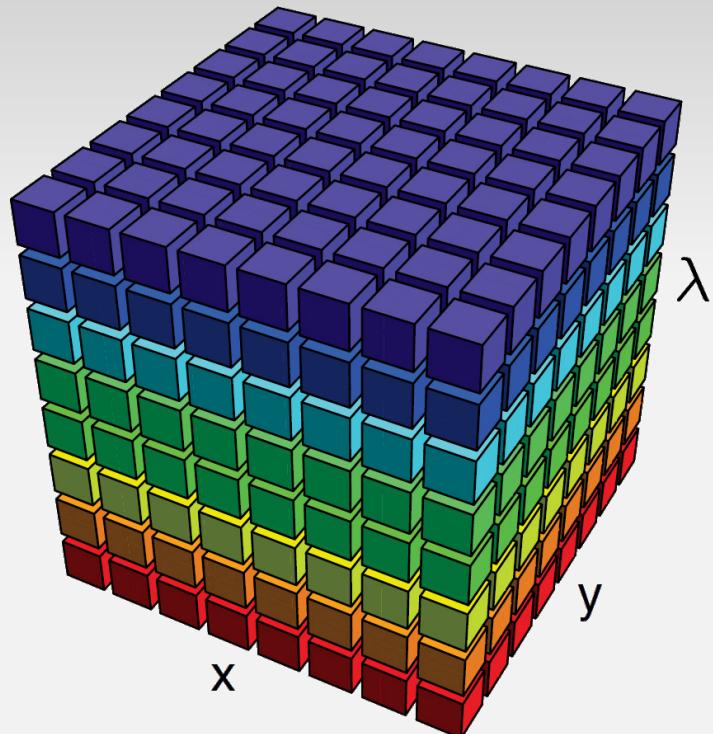
Creators of unique low-power, high-performance multi-core processor architecture optimized for imaging and computer vision tasks



A world-leading research center in nano-electronics.  
Manufactures CMOS sensors capable of Hyperspectral imaging

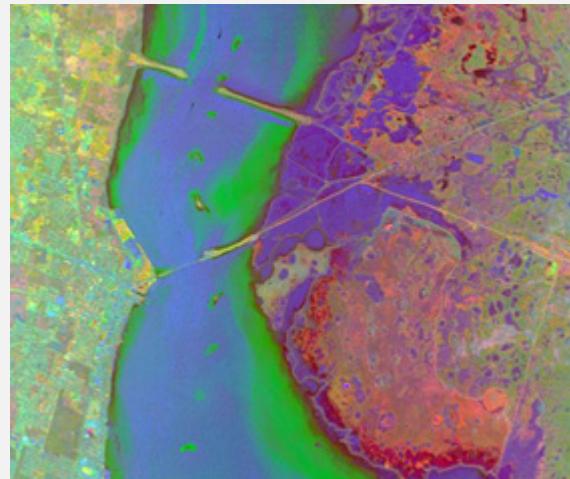
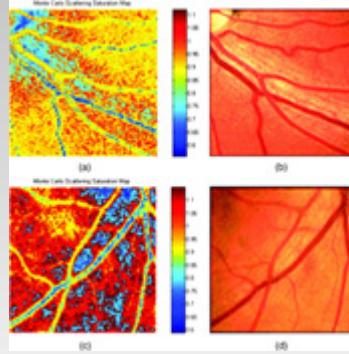
# What is HSI?

- It is a combination of
  - Spectroscopy
  - Imaging
- Spectrum at each pixel
- Spectral irradiance of a scene
- Datacube  $I(x,y,\lambda)$



## Where it is used?

- Medical Imaging
- Microscopy and Endoscopy
- Precision Agriculture
- Remote Sensing
- Mineralogy
- Environmental Monitoring
- Life science instrumentation
- Optical sorting
- Food inspection



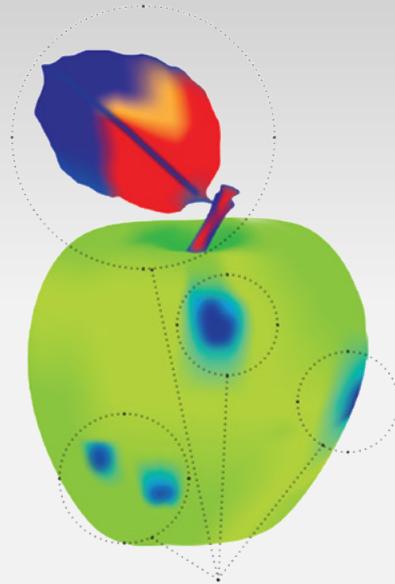
# HSI – seeing the invisible



MONOCHROME IMAGING



COLOR IMAGING



CHEMICAL COLOR IMAGING

## The Evolution of Machine Vision

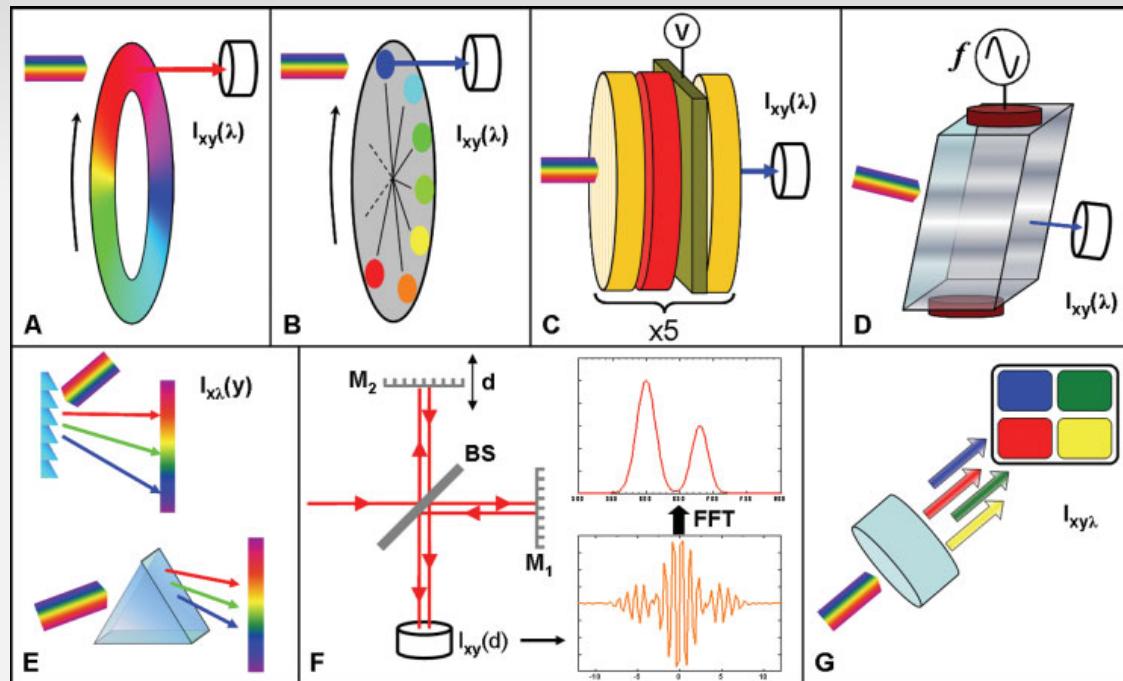


Image courtesy of Perception Park GmbH

## State of the art HSI methods

## • 4 basic methods

- Wavelength scan (A..D)
- Spatial scan (E)
- Time scan (F)
- “Compromise” (G)



## Major obstacles for massive deployment of HSI

- State of the art HSI systems are:
  - Handicraft manufactured
  - Fragile
  - Expensive
  - Bulky and heavy
  - Non customizable
  - Slow
  - Power hungry

## (R)evolution: xiSPEC – USB3 HSI camera



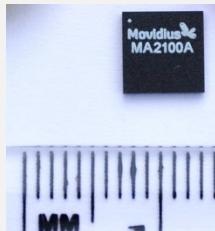
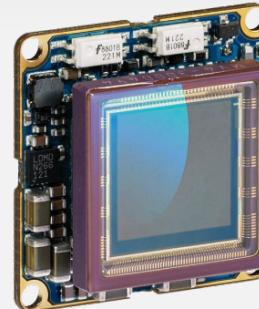
- Ingredients:
  - + Take super compact HSI sensor (IMEC)
  - + Add the world's smallest USB3 camera core (XIMEA)
  - + Add single board computer
  - = HSI embedded camera
- Next generation – intelligent HSI camera:
  - + Onboard Movidius Myriad 2 instead of single board computer

## xiSpec – USB3 HSI camera family for Embedded applications



- World smallest USB3 camera
- Compact housing: 26x26x26mm, 27g
- Low power consumption: 1.8W

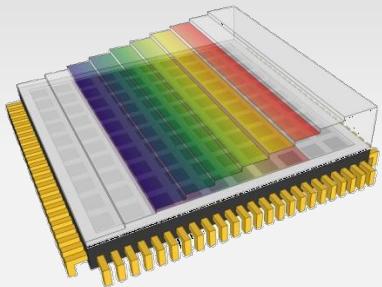
- Single PCB
- Board level: 25x25x14mm, 7g
- Optimized for embedded applications



- Next generation based on Movidius Myriad 2

# HSI sensor types

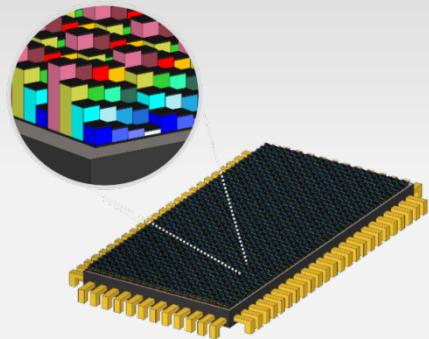
## Linescan



### 'wedge' design

- 😊 High number of bands
- 😊 Time sequential

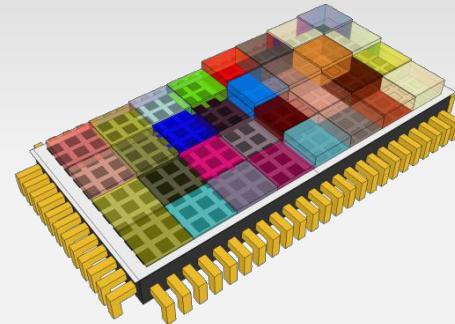
## Snapshot Mosaic



### 'per-pixel' design

- 😊 Simultaneous acquisition
- 😊 A few spectral bands

## Snapshot Tiled

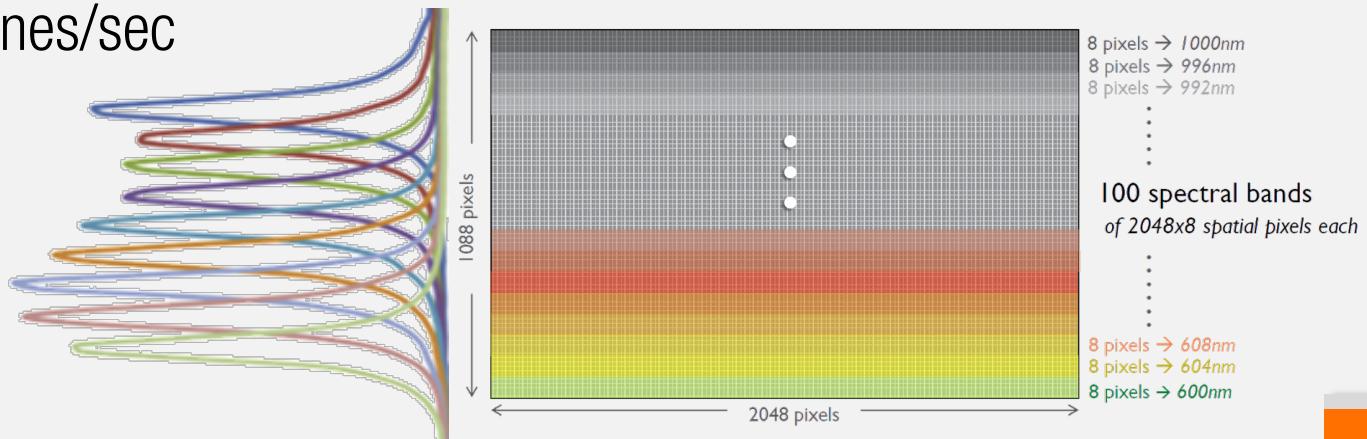
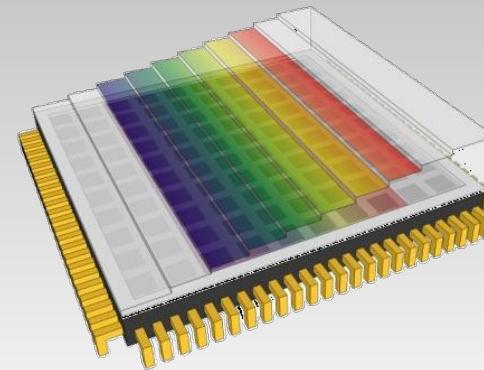


### 'area' design

- 😊 Simultaneous acquisition
- 😊 Low spatial resolution

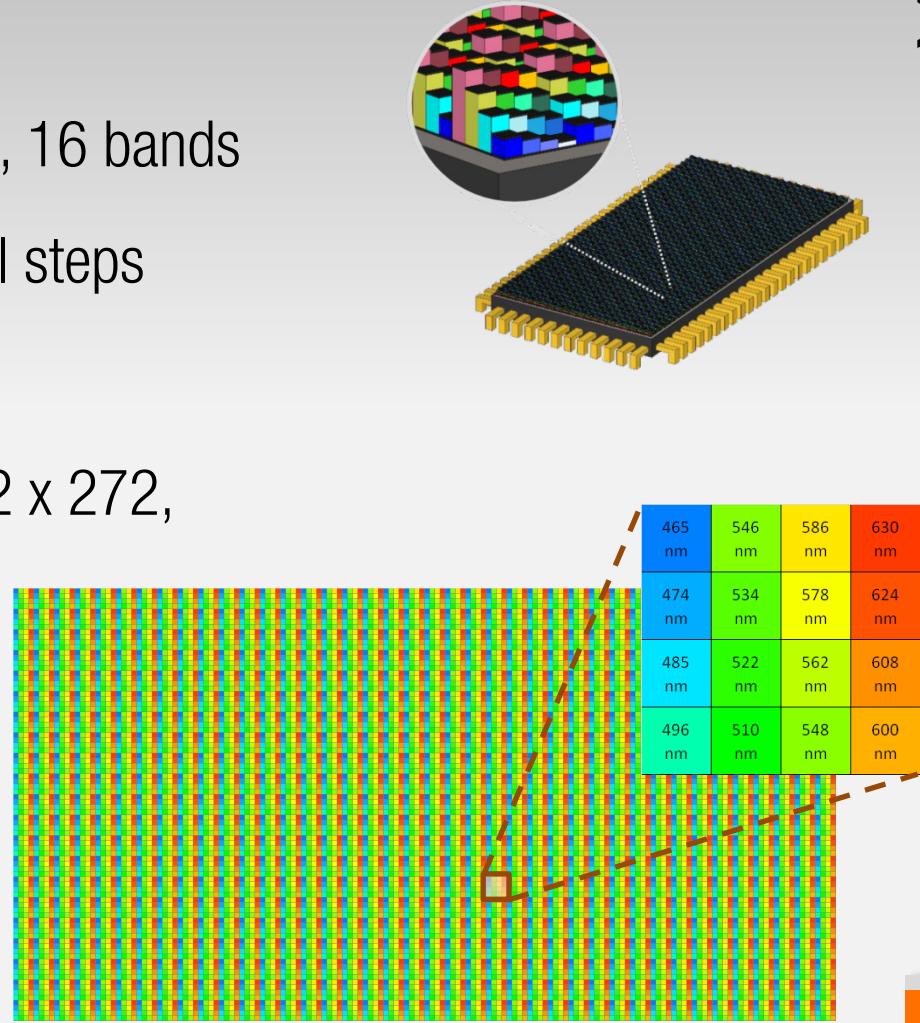
## Linescan, 100 bands, NIR

- High resolution, fast and flexible
- 100+ spectral bands
- 600-1000nm, 4nm incremental steps
- FWHM 10...15nm
- Spatial resolution 2048 x (100+ each band x 8 pixels)
- up to 1360 lines/sec



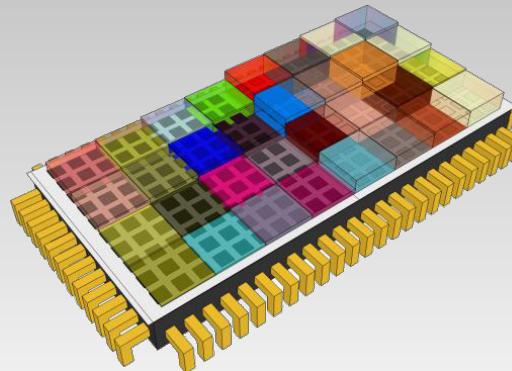
Snapshot Mosaic 4x4, 16 bands, VIS

- Extremely compact and robust
- Spectral resolution: 4x4 mosaic, 16 bands
- 470-630nm, 11nm incremental steps
- FWHM 10...15nm
- Spatial resolution per band: 512 x 272,  
up to 2mpix with interpolation
- up to 170 data-cubes/sec



Snapshot Tiled, 32 bands, NIR

- User friendly, requires optical duplicator
- Spectral resolution: 32 bands
- 600-1000nm, 12nm incremental steps
- FWHM 10...15nm
- Spatial resolution per band: 256 x 256
- up to 170 data-cubes/sec



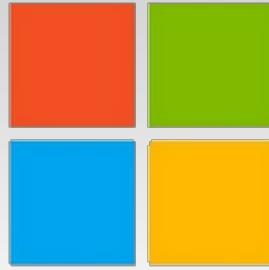
# Available cameras and new developments

Type	Model	Spectral range [nm]	Bands	Scans/sec max	Availability
Linescan VNIR	MQ022HG-IM-LS100-600-1000	600...1000	100+	1360 lines/s	✓ Now
Linescan VNIR	MQ022HG-IM-LS150-470-900	470...900	150+	1360 lines/s	In development
Snapshot Mosaic VIS	MQ022HG-IM-SM4X4-470-630	470...630	16	170 cubes/s	✓ Now
Snapshot Mosaic VNIR	MQ022HG-IM-SM5X5-600-1000	600...1000	25	170 cubes/s	✓ Now
Snapshot Tiled VNIR	MQ022HG-IM-ST32-600-1000	600...1000	32	170 cubes/s	✓ Now

## Compatibility

### Support for major operating systems:

- Windows
- Linux
- Mac-OS



### Support for major architectures:

- Intel x86/x64
- ARM
- Embedded platforms



## Is it enough to have just a HSI camera?

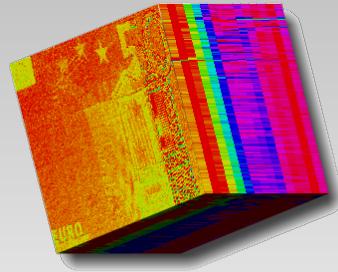
- There are  $2^{16} = 65,536$  shades per pixel on 16 bit B/W image
- There are  $2^{24} = 16,777,216$  colors per pixel on 24 bit RGB image
- There are  $2^{1,024} = 179,769,313,486, \dots, 624,224,137,216$  (**309 digits**) spectrums per pixel in 128 band 8 bit/sample HS data-cube

## Smart HSI software is needed to reduce amount of data

- Reduce dimensionality of the data
- Provide easy to understand data for traditional machine vision workflows

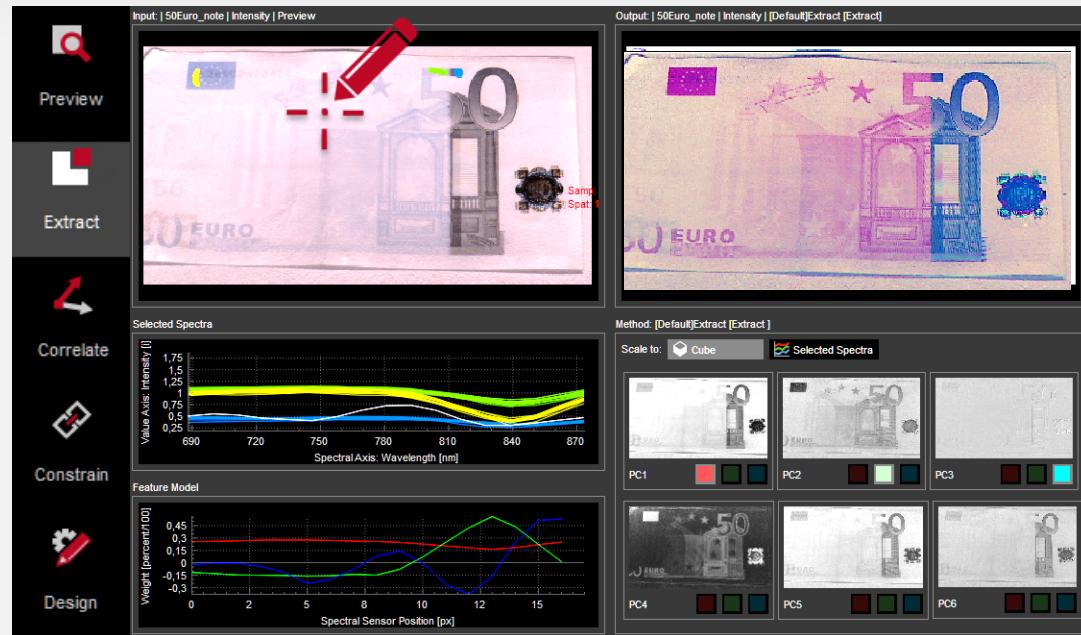
# HSI data processing workflow

- Data acquisition



- Spectra selection

- Extract method



- Validate

- Deploy

Thank you for your attention

QUESTIONS?