Applications of Digital Signal Processing in Agriculture

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The first workshop on ICT in Agriculture IoT and GIS in Agriculture

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Structure of the presentation

- What is digital signal processing
- Precise and cyber agriculture
- Bioacoustics signal processing
- Image processing
- Video processing

Digital Signal Processing

- Signal

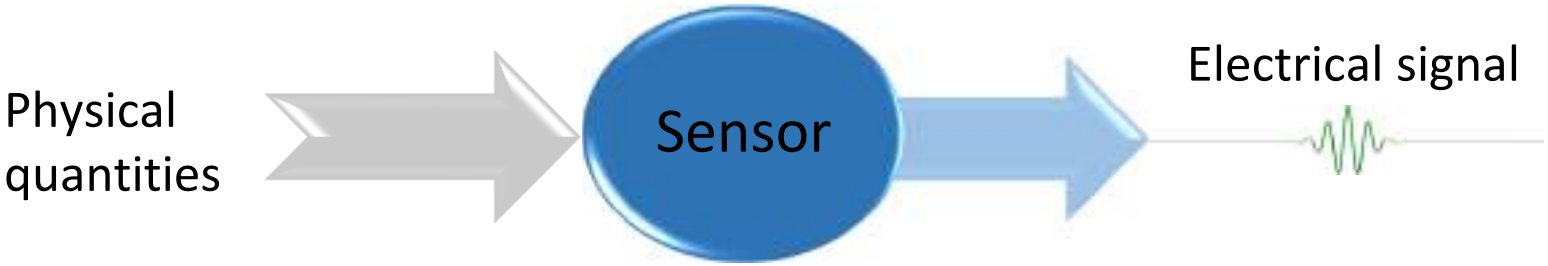
✓ physical manifestation of information about the behavior or attributes of some phenomenon that appears in many different physical, symbolic, or abstract formats

"The Signal"
William Powell Frith

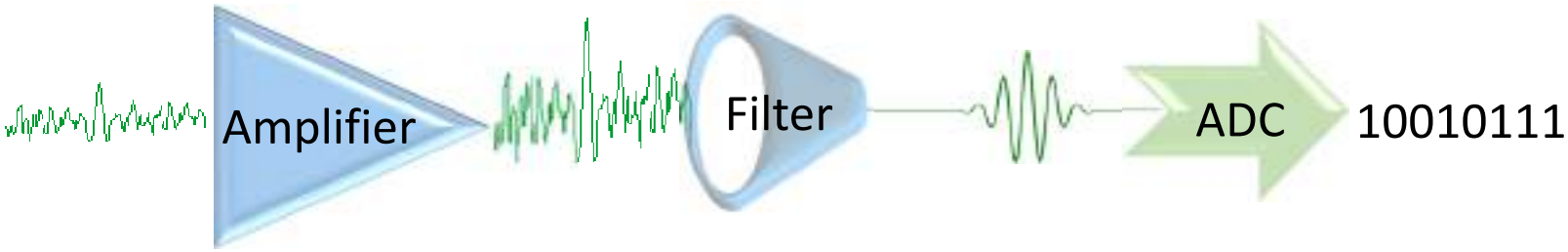
Digital Signal Processing

- Signal

✓ physical manifestation of information about the behavior or attributes of some phenomenon that appears in many different physical, symbolic, or abstract formats



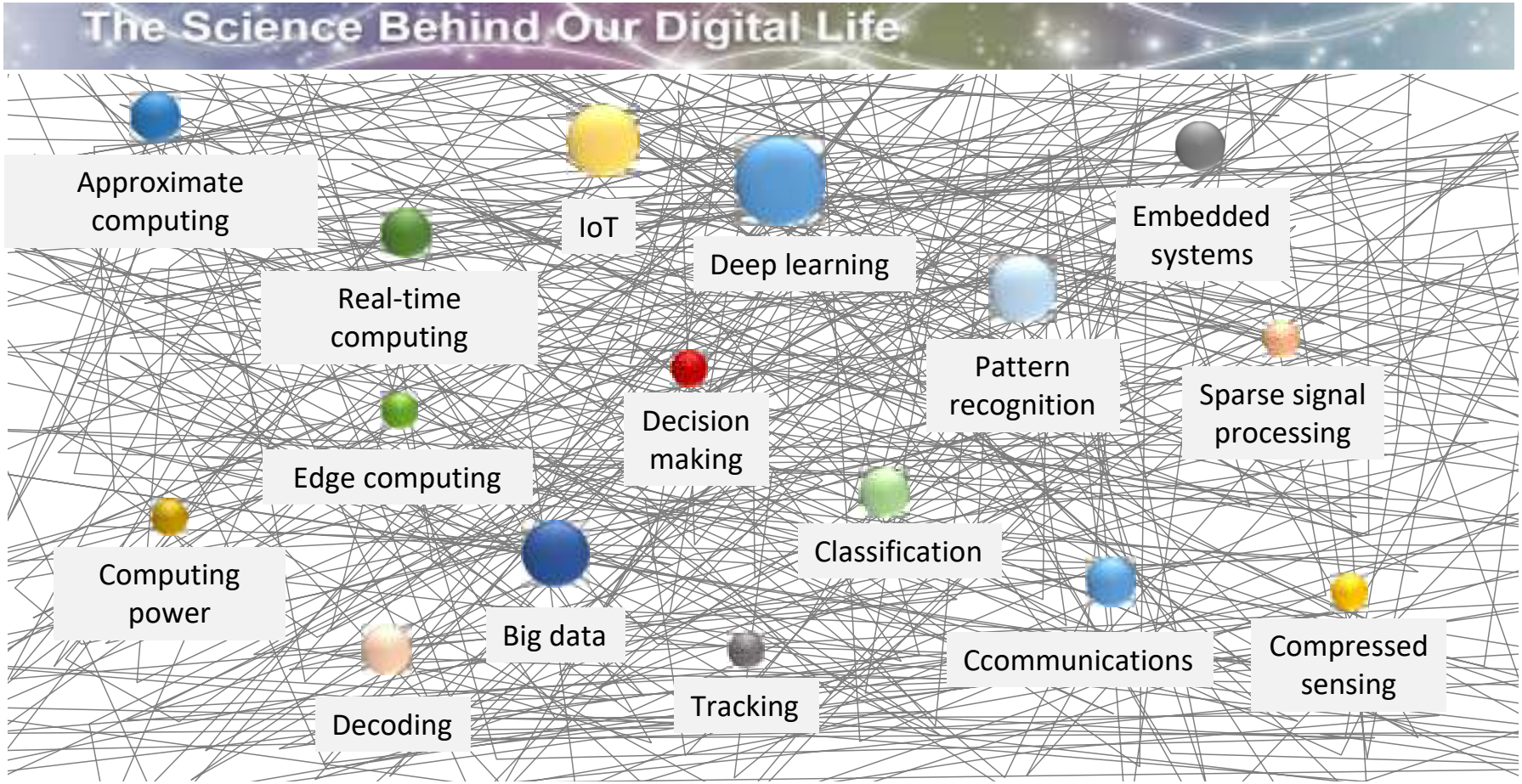
Digital Signal Processing



- Signal processing

✓ enabling technology that encompasses the theory, algorithms, applications, and implementations of generation, transformation, interpretation and transferring information contained in signals

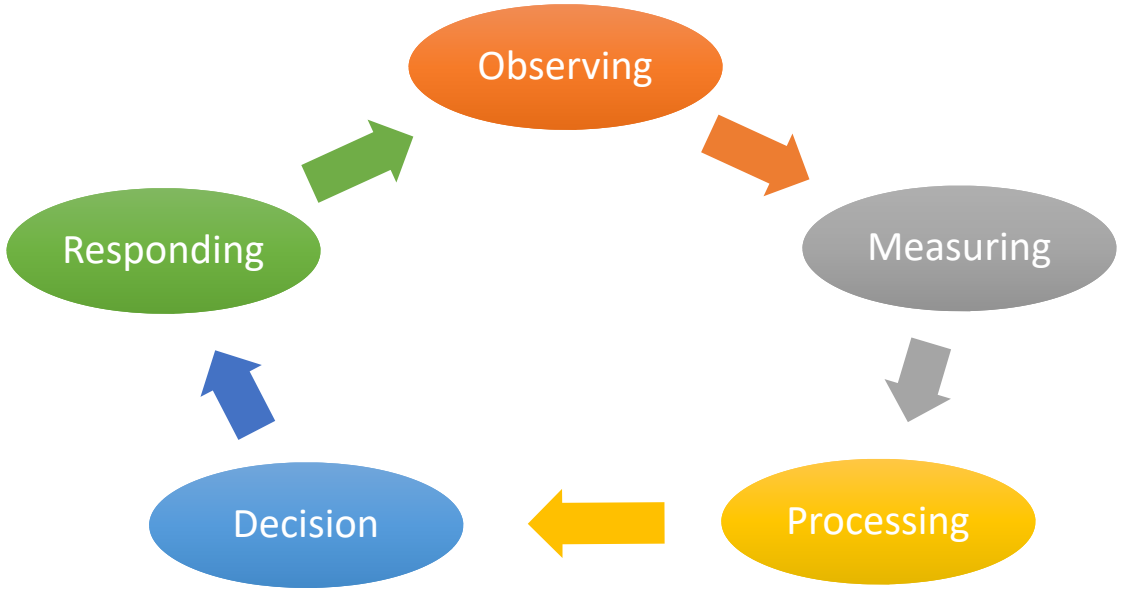
Digital Signal Processing



Precise and Cyber Agriculture

- Precision Agriculture

✓ farming management concept based on observing, measuring and responding



Precise and Cyber Agriculture

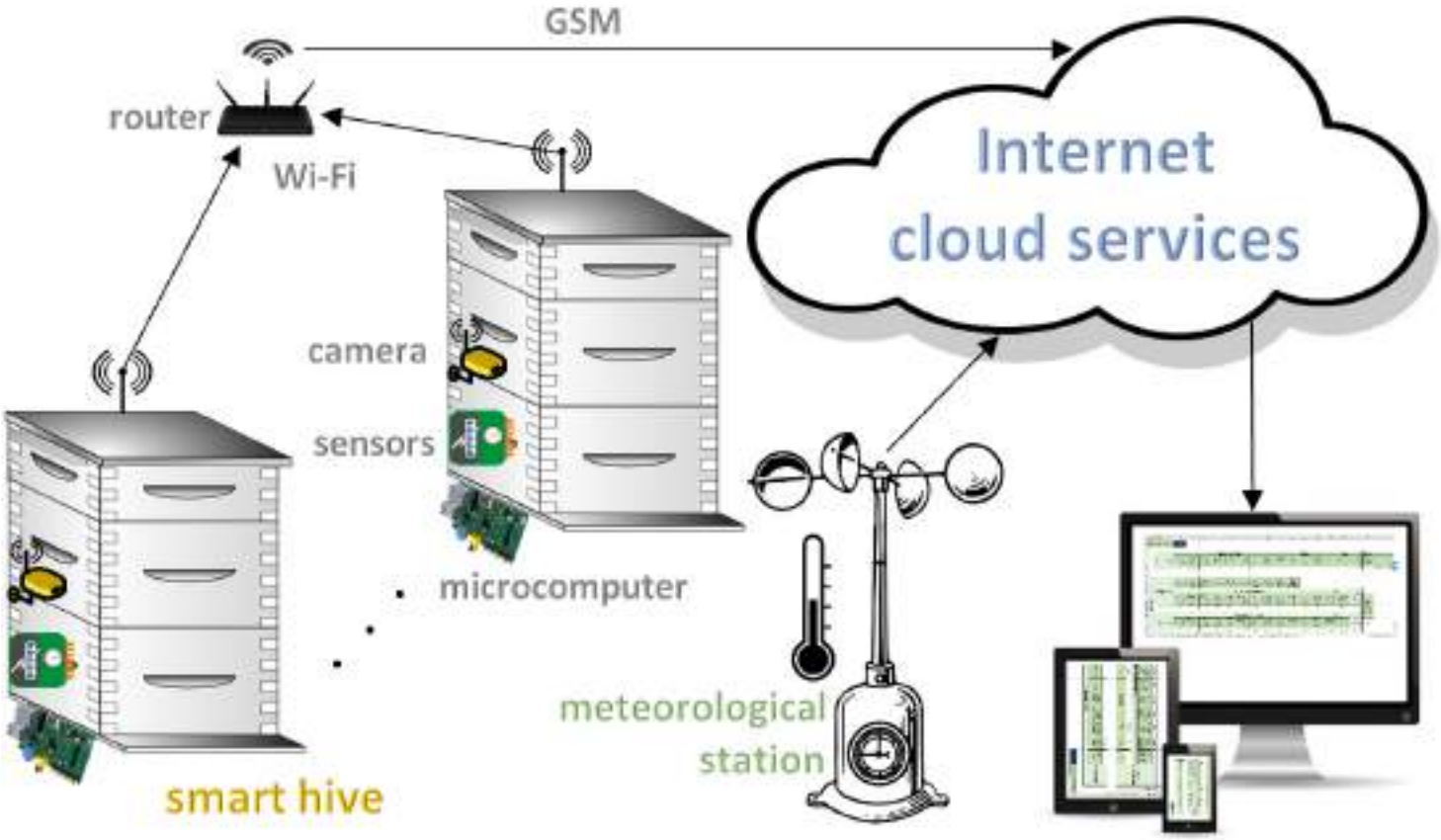
- Cyber Agriculture

✓ **used computer algorithms to determine the optimal growing conditions** (a method identified by researchers at the Open Agriculture Initiative (OpenAg) of Massachusetts Institute of Technology (MIT) Media Lab) "***But that is just the beginning for the new field of cyber agriculture***" (Caleb Harper)

✓ **agriculture exchange mechanism over cyber space**, the imaginary space behind the interconnected computer networks through telecommunication means. It utilizes the power of networks, computer communications and interactive multimedia to facilitate information sharing mechanism

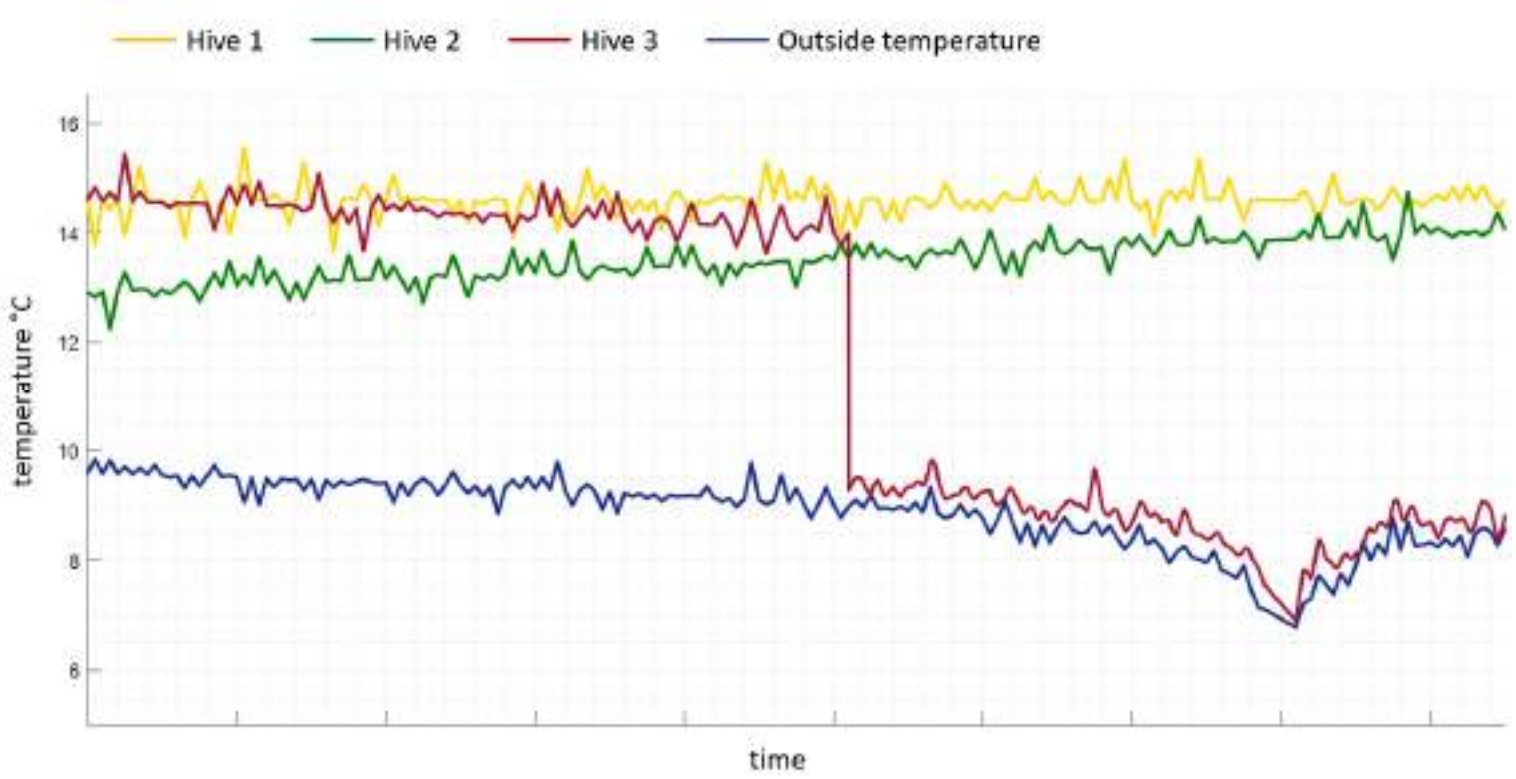
Precise and Cyber Agriculture

Smart Hive



Precise and Cyber Agriculture

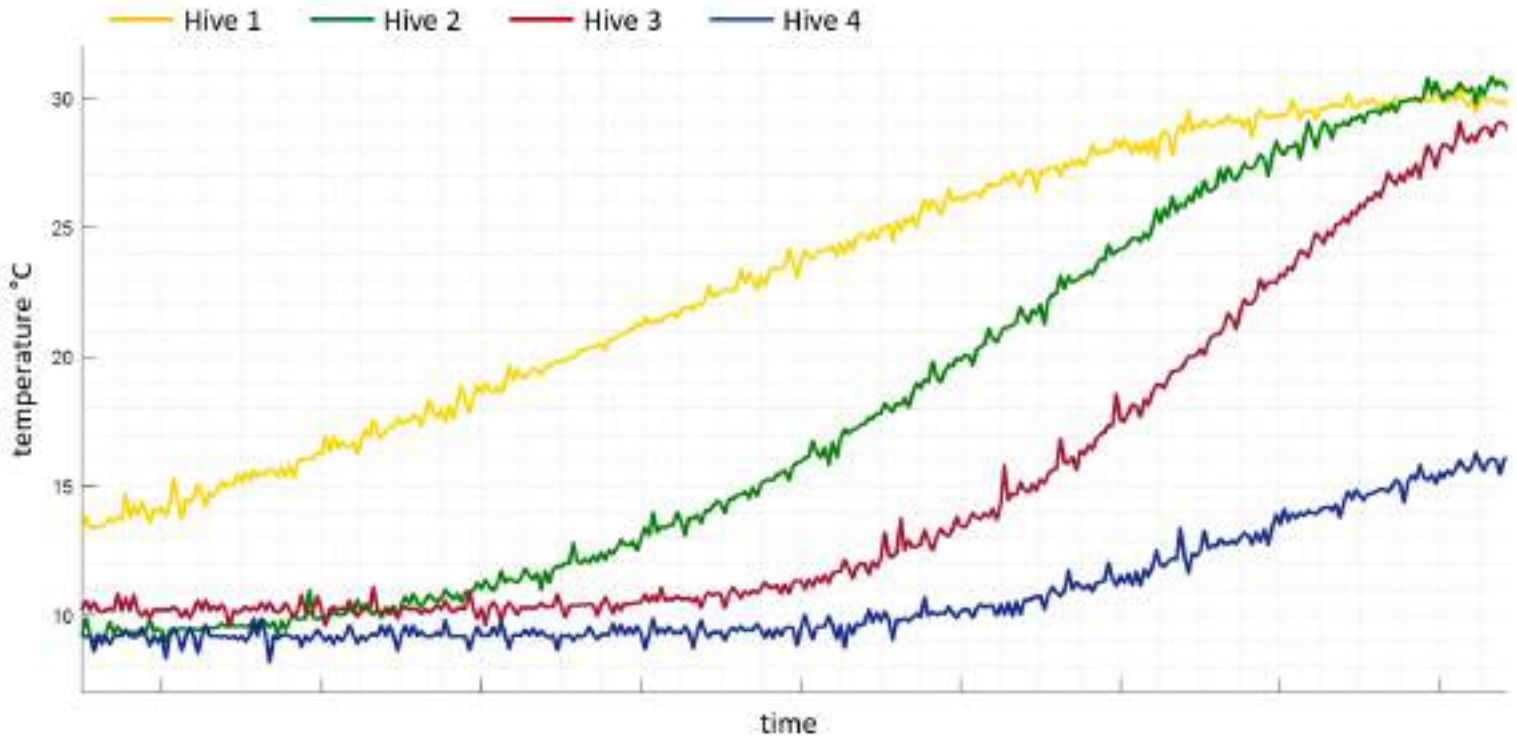
Smart Hive



Detection of bee colony death by temperature measurement

Precise and Cyber Agriculture

Smart Hive

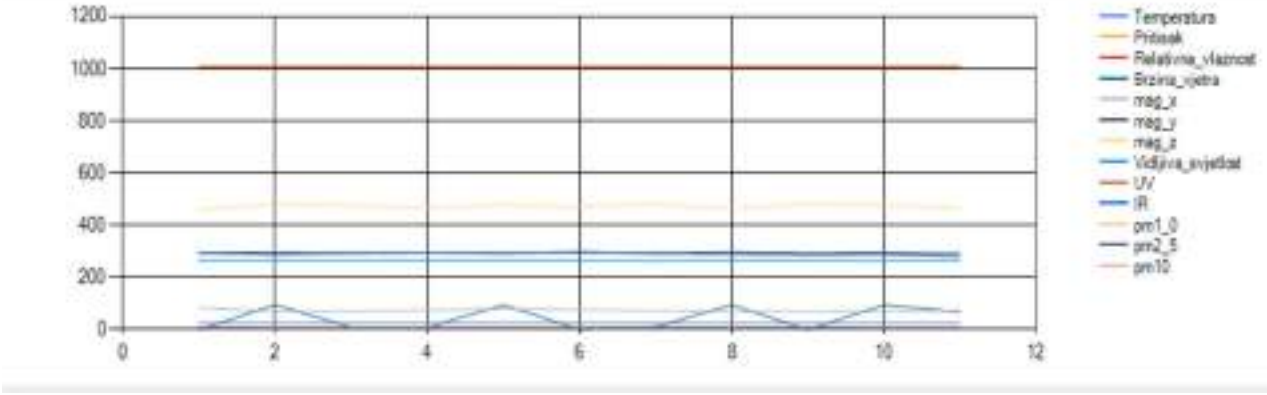


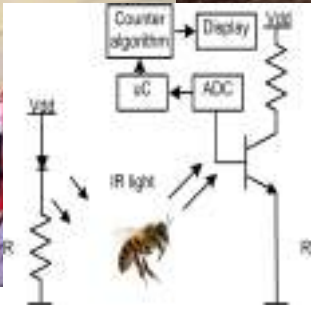
Detecting the formation of bee broad by measuring the temperature

Precise and Cyber Agriculture

Bees' Activity Monitoring

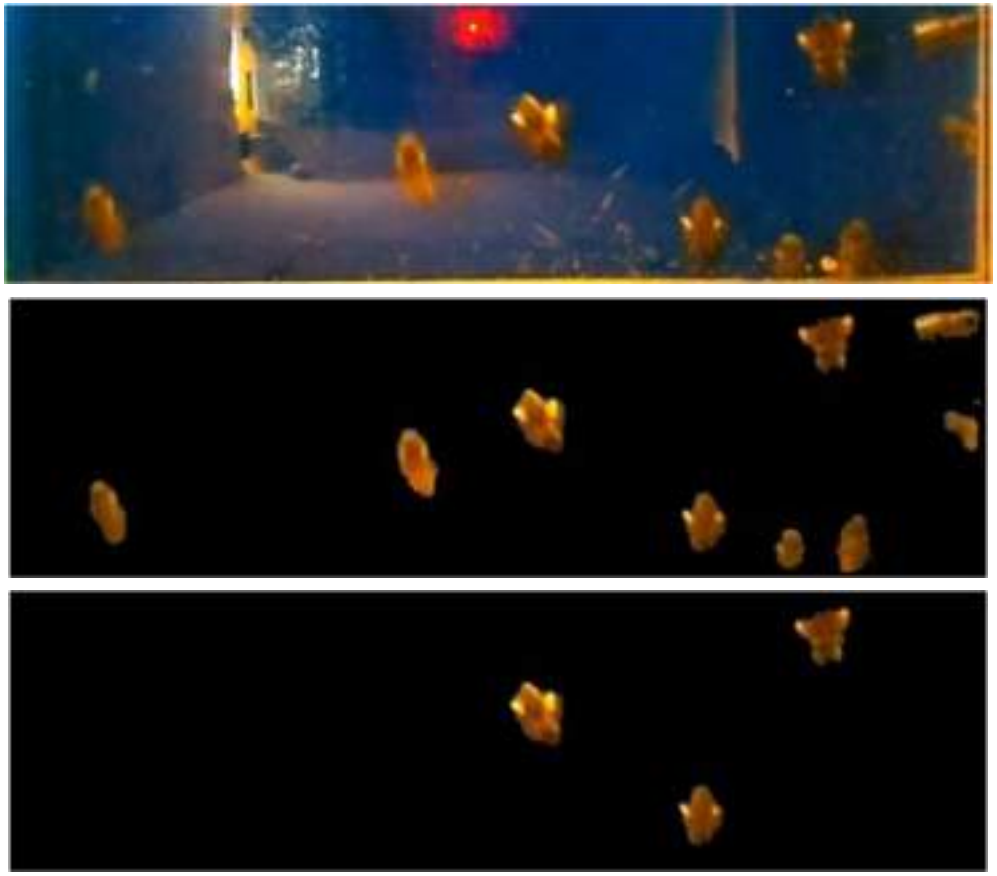
Brzina vjetra [m/s]:	66,92		
Temperatura [°C]:	24,84		
Relativna vlažnost [%]:	31,18		
Pritisak [mbar]:	1.007,01		
UV:	4		
Vidljiva svjetlost:	265		
IR:	293		
Jacina magnetskog polja [uT]:	x: 71,00	y: 280,30	z: 463,63
Prisustvo cestica [ug/m3]:	pm1.0: 6	pm2.5: 9	pm10: 9





Precise and Cyber Agriculture

Pollination Monitoring

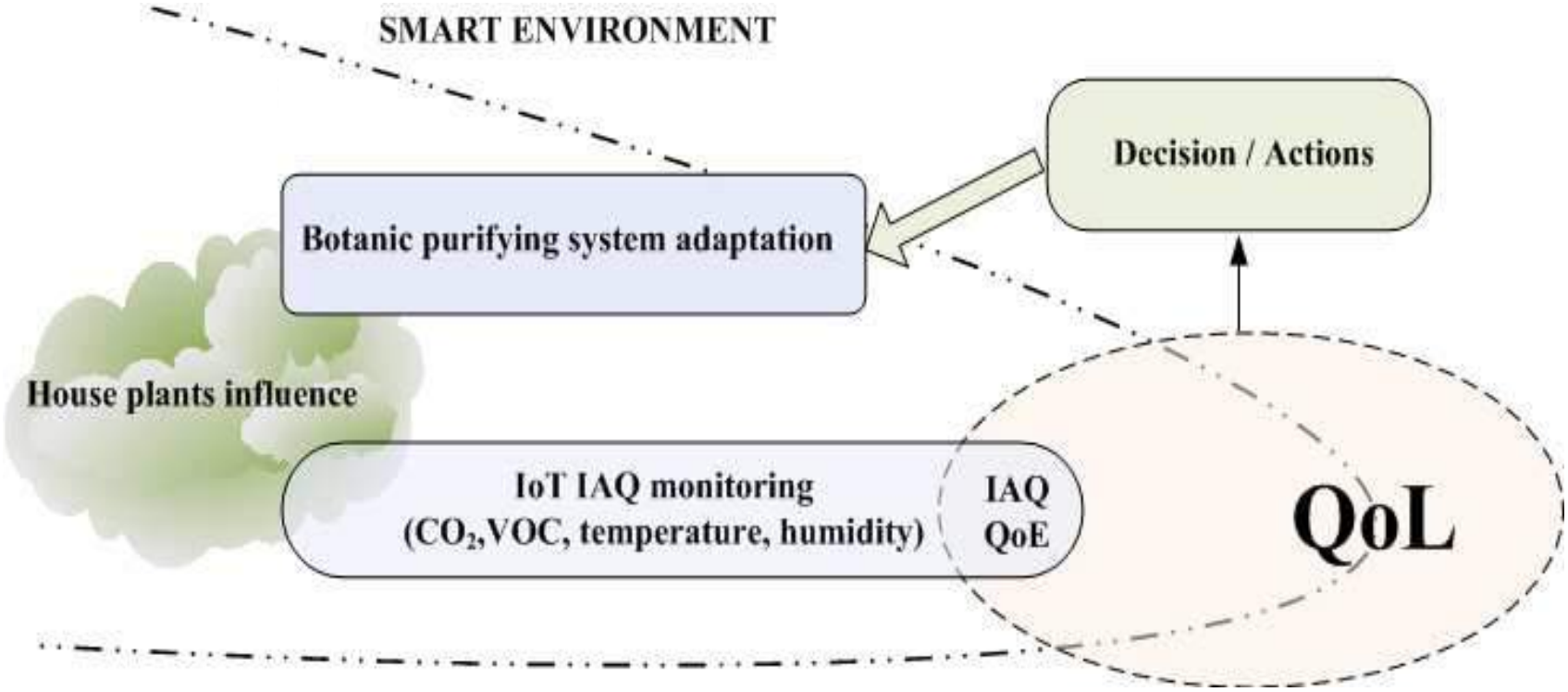


Between $235 and $577 billion (U.S.) worth of annual global food production relies on the direct contribution of pollinators.

Colony Collapse Disorder (CCD) syndrome

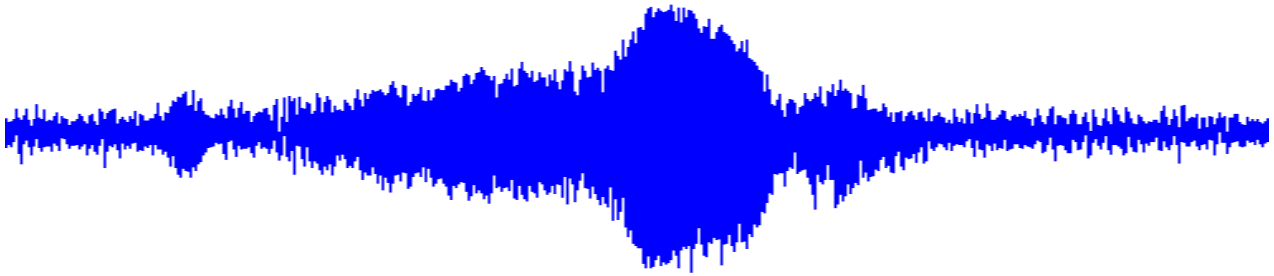
Precise and Cyber Agriculture

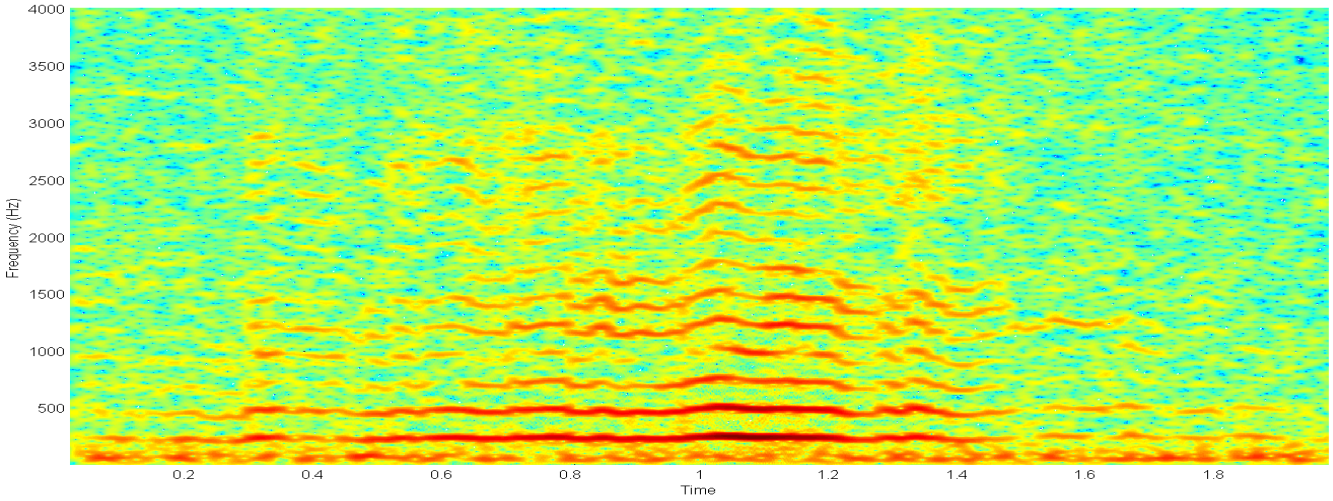
Indoor Air Quality Monitoring



Bioacoustics Signal Processing

Buzzing Bees





background noise:
100-150Hz
wing movements:
180-250 Hz

Swarming

whistles: 100-200 Hz to 200-250 Hz, contact with bees: 200-500 Hz, short sounds 4 -5 MHz

Bioacoustics Signal Processing

Voice Processing

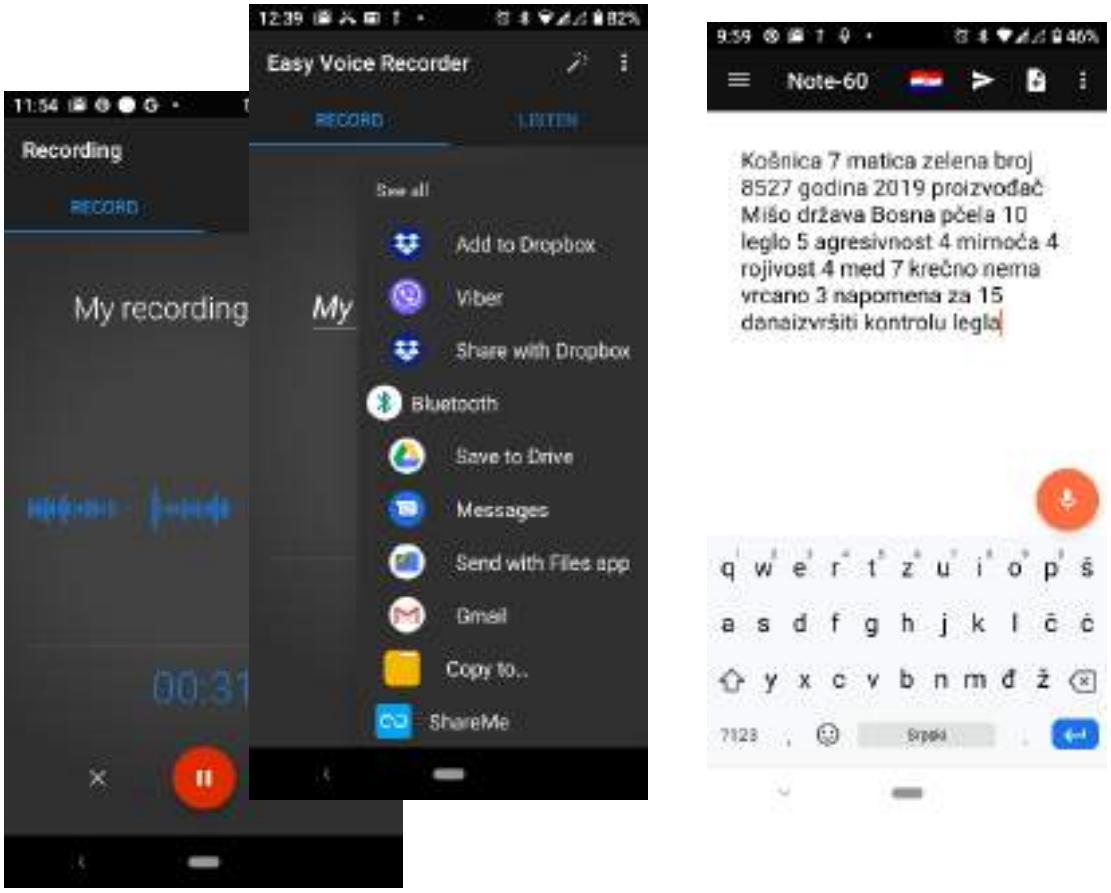
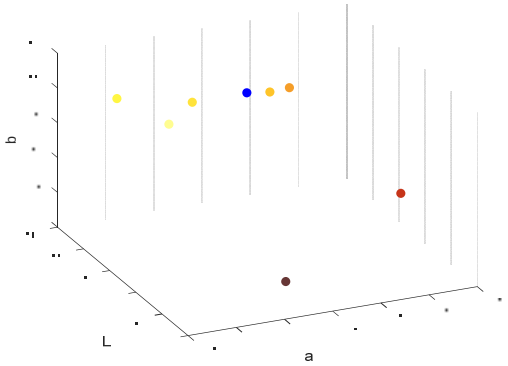
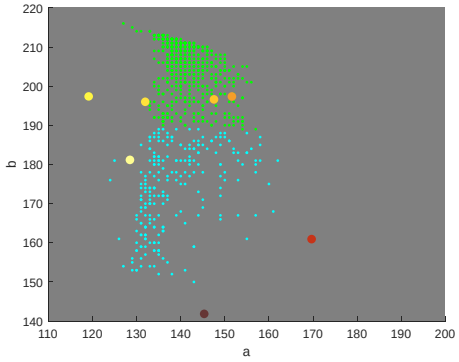


Image Processing

Color Analysis and Classification





UPOV1	UPOV2	UPOV3	UPOV4	UPOV5	UPOV6	UPOV7
0.21	13.37	37.32	20.94	12.51	1.60	14.06

Image Processing

Counting Bees in Infrared Images

Image processing

Remote Sensing and Classification

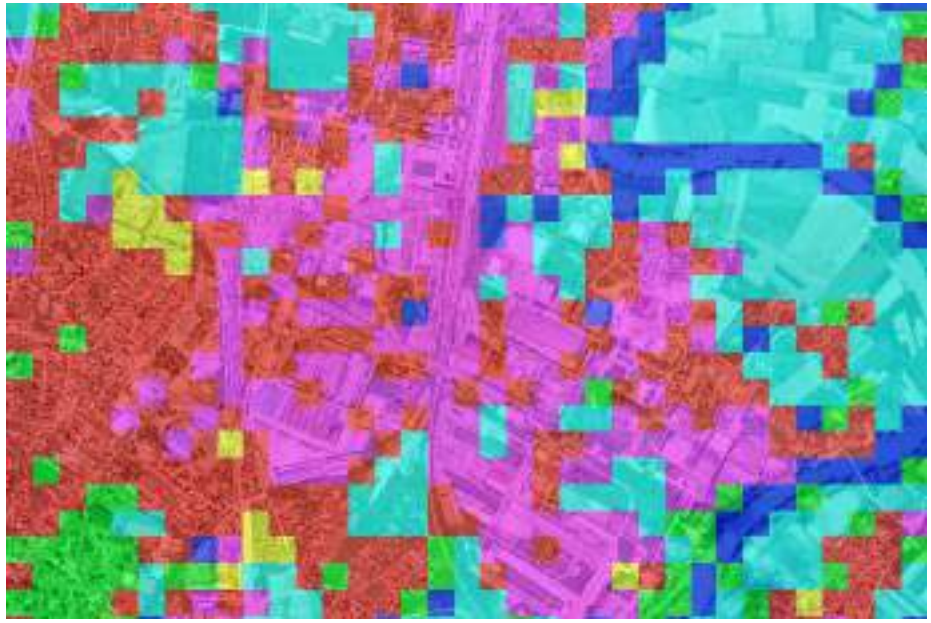
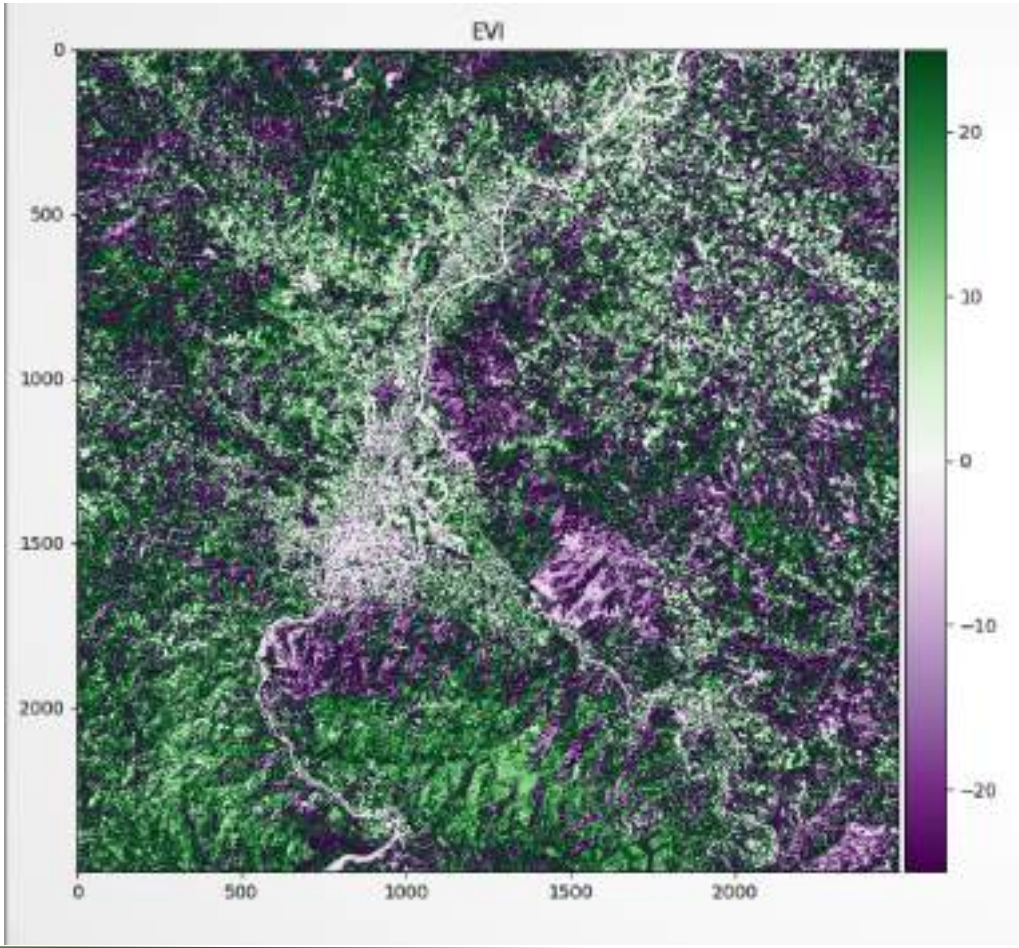


Image processing

Multispectral Image Processing



Normalized Difference Vegetation Index

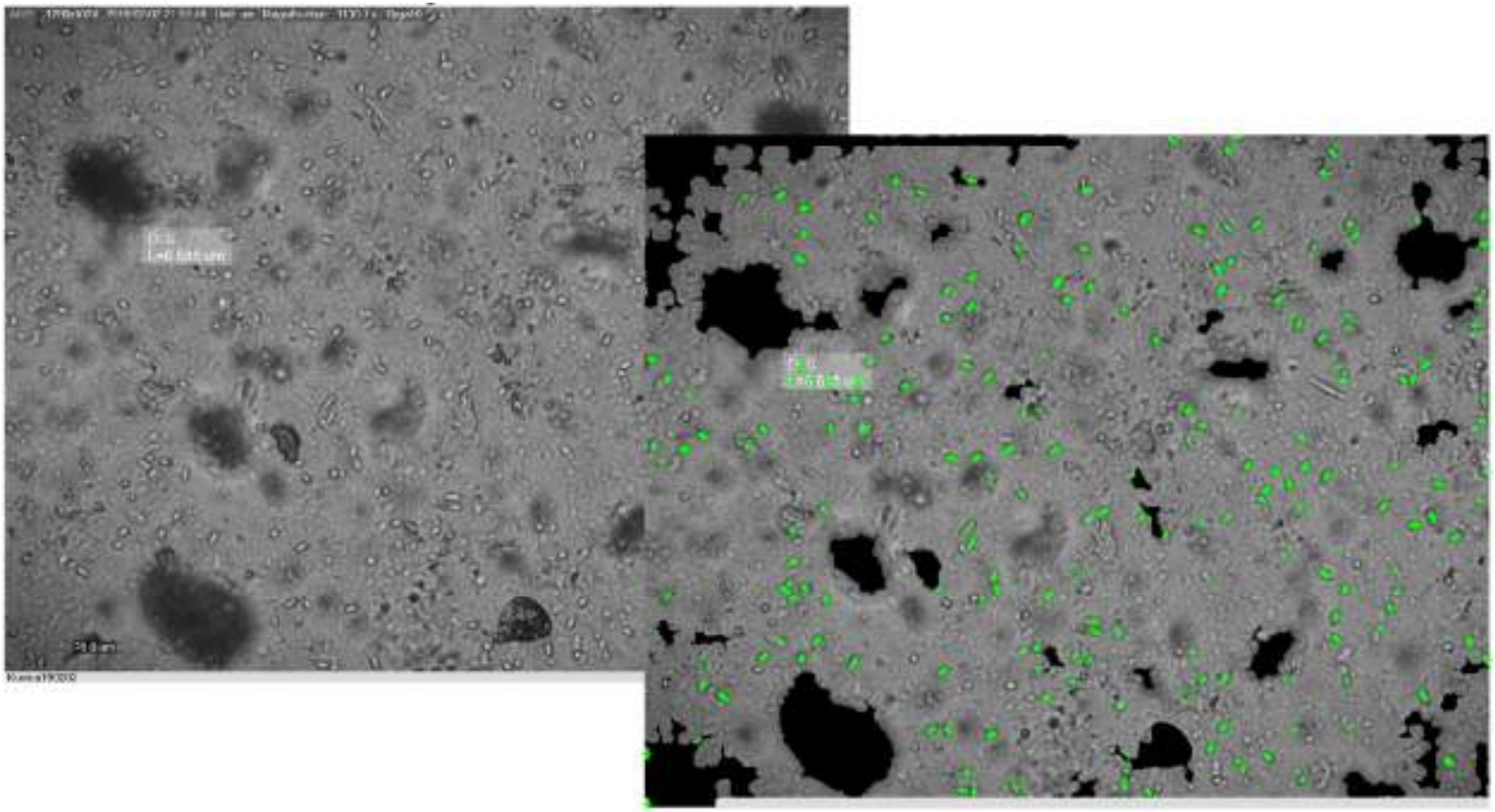
$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{Red})}{(\mathrm{NIR} + \mathrm{Red})}$$

Enhanced Vegetation Index

$$EVI = G \times \frac{(NIR - RED)}{(NIR + C1 \times RED - C2 \times Blue + L)}$$

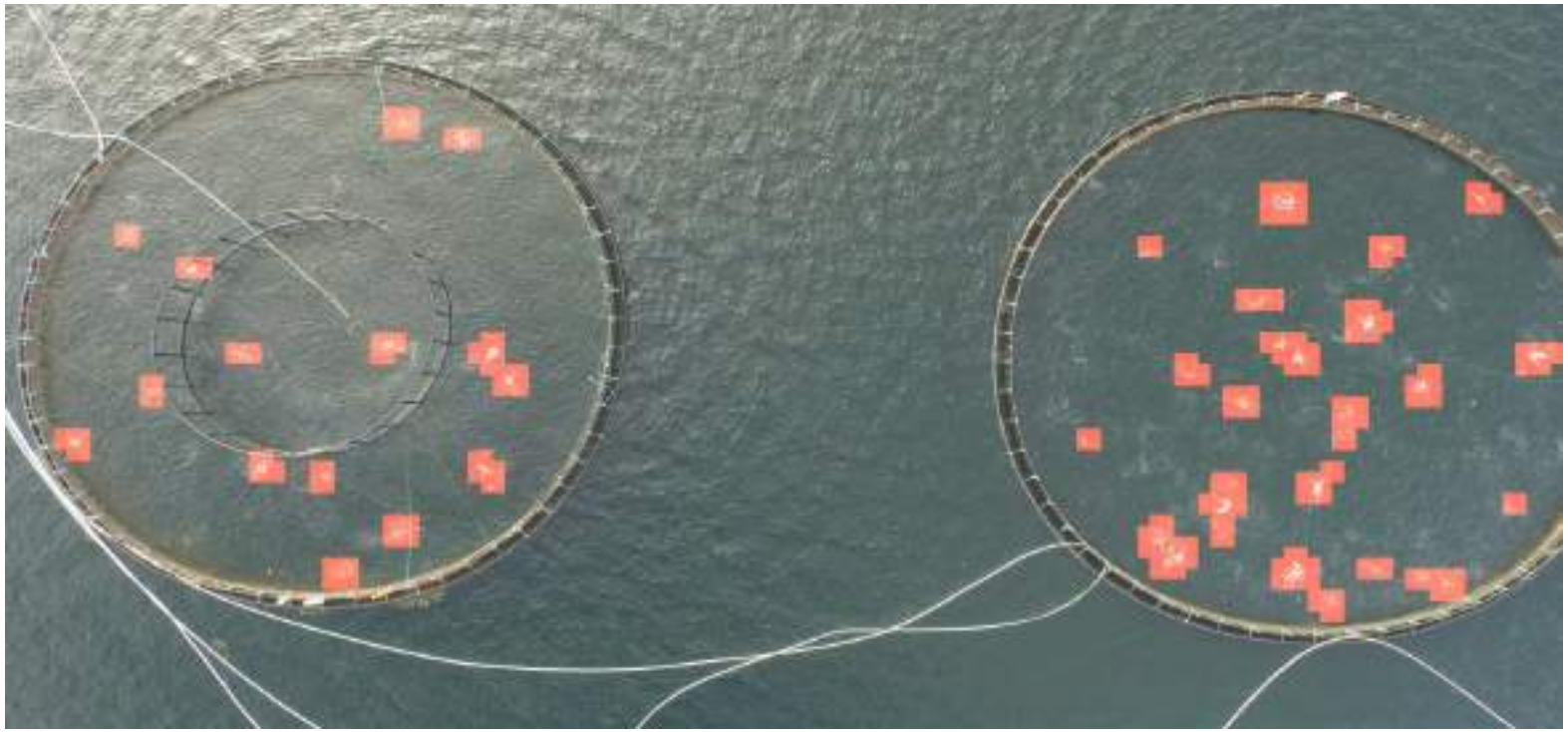
Image Processing

Shape Recognition



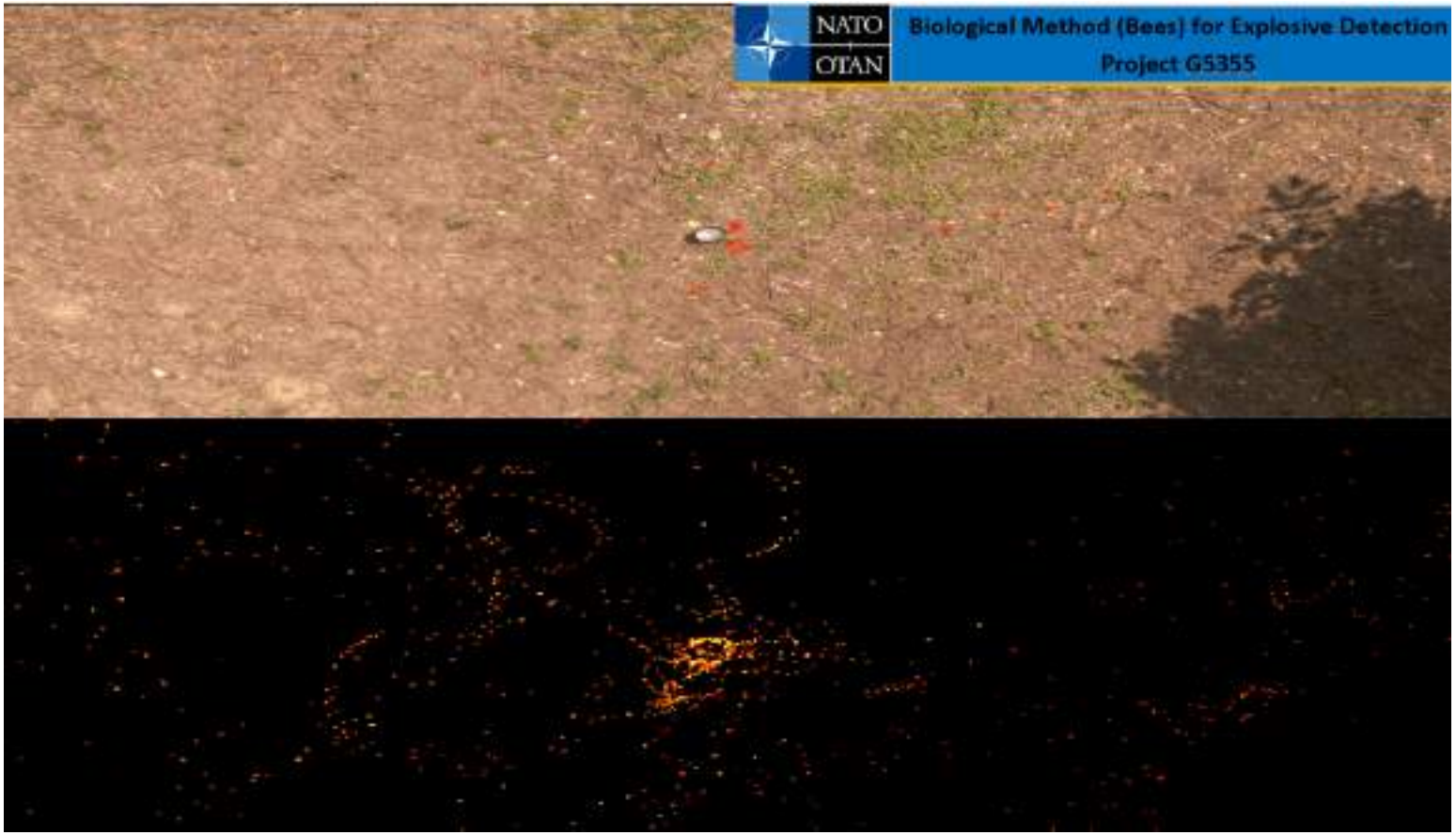
Video Processing

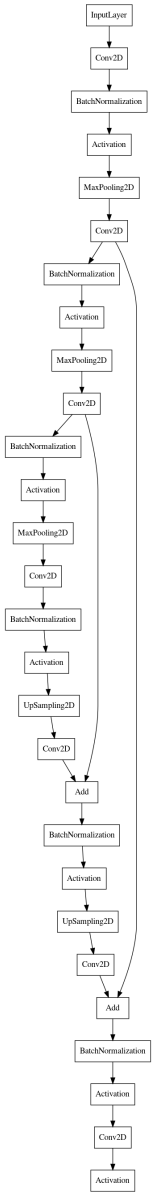
Splash Detection in Fish Plants



Video Processing

Bees Counting





Thank you!

Questions?

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VIRAL

VITALISING ICT RELEVANCE IN AGRICULTURAL LEARNING