

# CAMERA FOR AGRICULTURAL DRONE

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## A LITTLE BACKGROUND ABOUT AGRICULTURAL DRONES

Drones are increasingly becoming helpful in agricultural operations, to increase crop production in precision agriculture.

- Crop Spraying and Spot Spraying
- Seed planting
- Soil Analysis
- Monitoring crop Growth
- We want to use a camera setup over a drone to help monitor the farm. It may help us in better Crop yields and farm efficiency because of detection of irrigation problem, soil variation, pest and fungal infestation.

## PROBLEM STATEMENT

- We want to use a camera setup over a drone to help monitor the farm. It may help us in better Crop yields and farm efficiency because of detection of irrigation problem, soil variation, pest and fungal infestation

## OBJECTIVE

- Objective of this problem is to use multispectral images captured by drones to measure NDVI and other form of different analysis indexes such as NDRE to provide us with the crop growth analysis so to take corrective measures.

# VARIOUS TYPES OF AGRI MAPPING TECHNIQUE

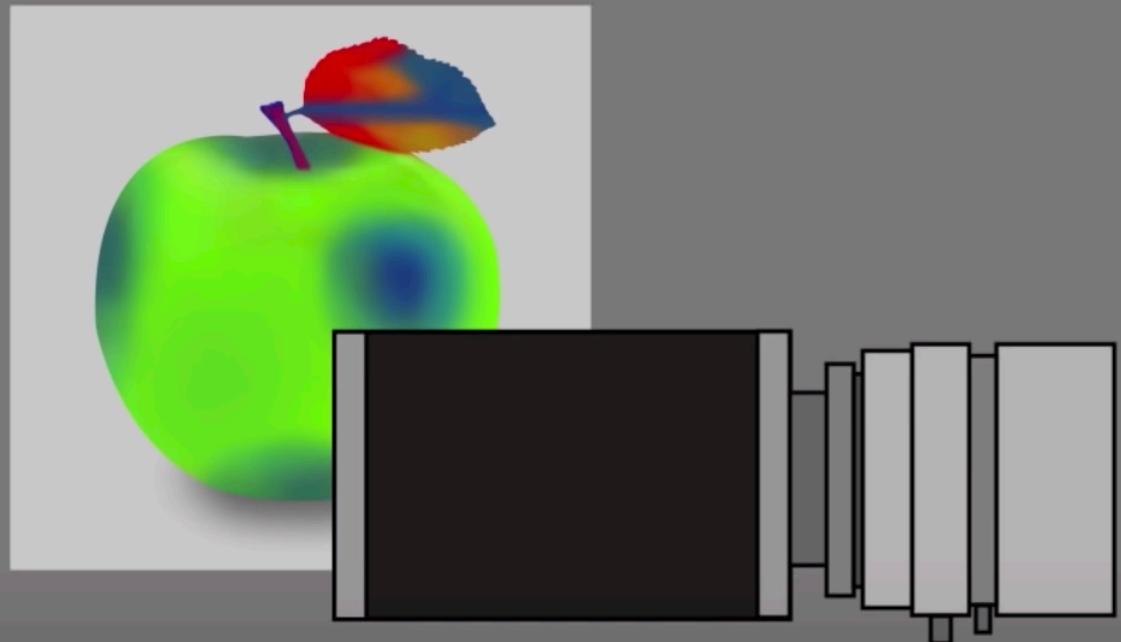
- **1. Chlorophyll Map:** *The red edge spectral band is the star here, working in conjunction with the other bands to provide a more accurate measure of not just plant vigor but plant health.*
- **2. NDVI Layer:** *This commonly known index compares the reflectance of the red band with that of the near-infrared band. However, this index alone provides limited information.*
- **3. Digital Surface Model:** *A DSM is an astonishingly advantageous tool in any agronomist's arsenal, primarily because of its use in evaluating surface properties and water flow.*
- **4. RGB Image:** *RedEdge-MX features global shutters for distortion-free images, including narrowband red, green, and blue bands for RGB color images that when processed are aligned to all visible and non-visible bands and vegetation indices.*

## MULTISPECTRAL IMAGES AND IMAGE SENSORS

- **Multispectral imaging** means methods for spectral **imaging** where one obtains images corresponding to at least a couple of spectral channels. The used spectral regions are often at least partially outside the visible spectral range, covering parts of the infrared and ultraviolet region.

# MULTISPECTRAL IMAGING

- Optical elements
- Continuous filter (e.g., filter wheel)
- CMOS sensor with integrated filter



# NDVI: NORMALIZED DIFFERENCE VEGETATION INDEX

- Normalized difference vegetation index
- NDVI** is **calculated** from the red and near-infrared (band 1 and band 2) reflectances as

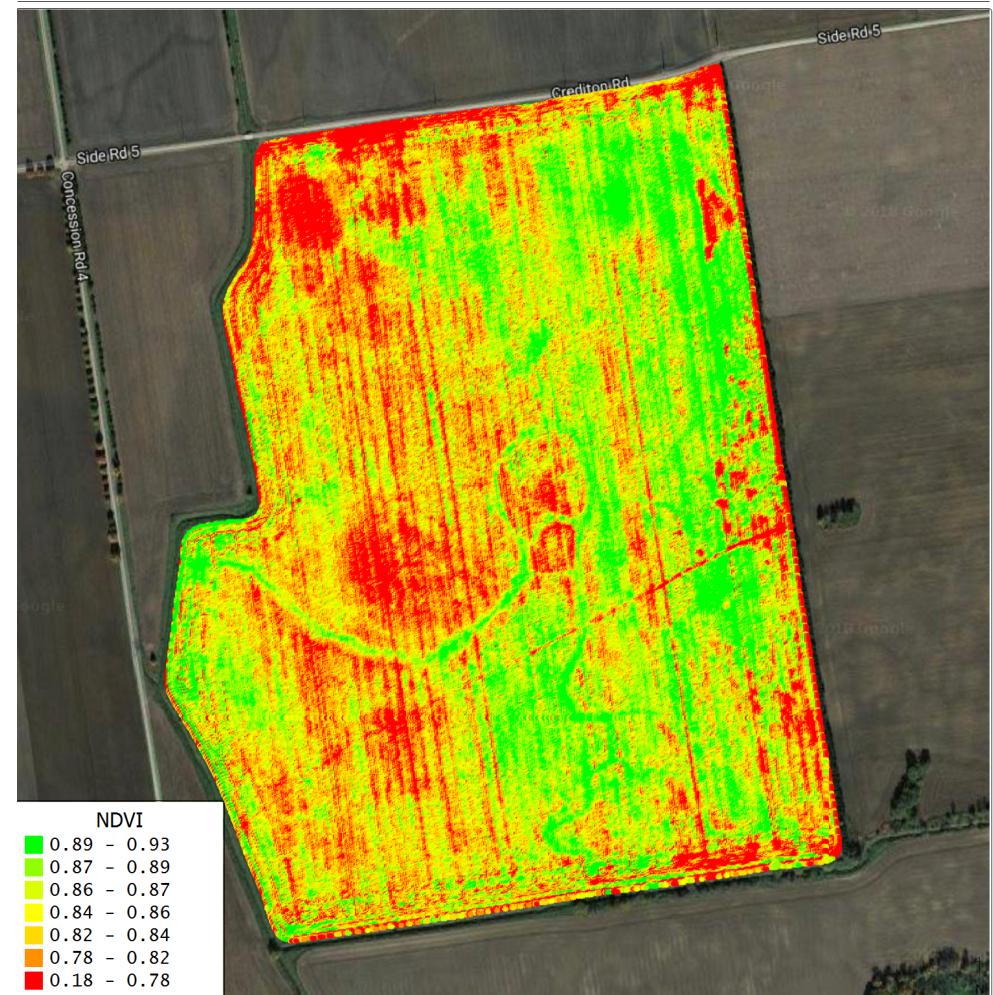
NDVI Value Range -1.0 to +1.0

-0.1 - +0.1 for mountains and barren land

+0.6-+0.8 for dense vegetation

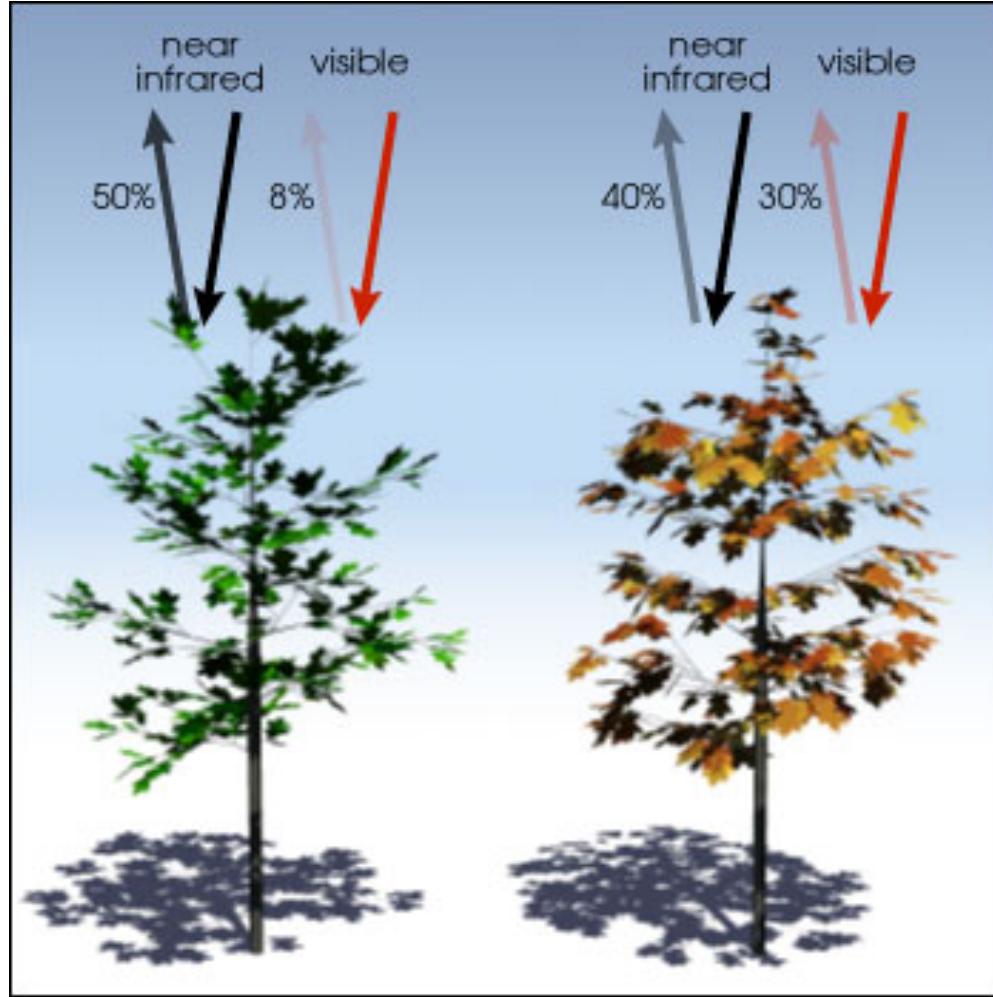
-1.0 corresponds to Water

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



## NDVI

- Healthy vegetation (chlorophyll) reflects more near-infrared (NIR) and green light compared to other wavelengths. But it absorbs more red and blue light.



$$\frac{(0.50 - 0.08)}{(0.50 + 0.08)} = 0.72$$

$$\frac{(0.4 - 0.30)}{(0.4 + 0.30)} = 0.14$$

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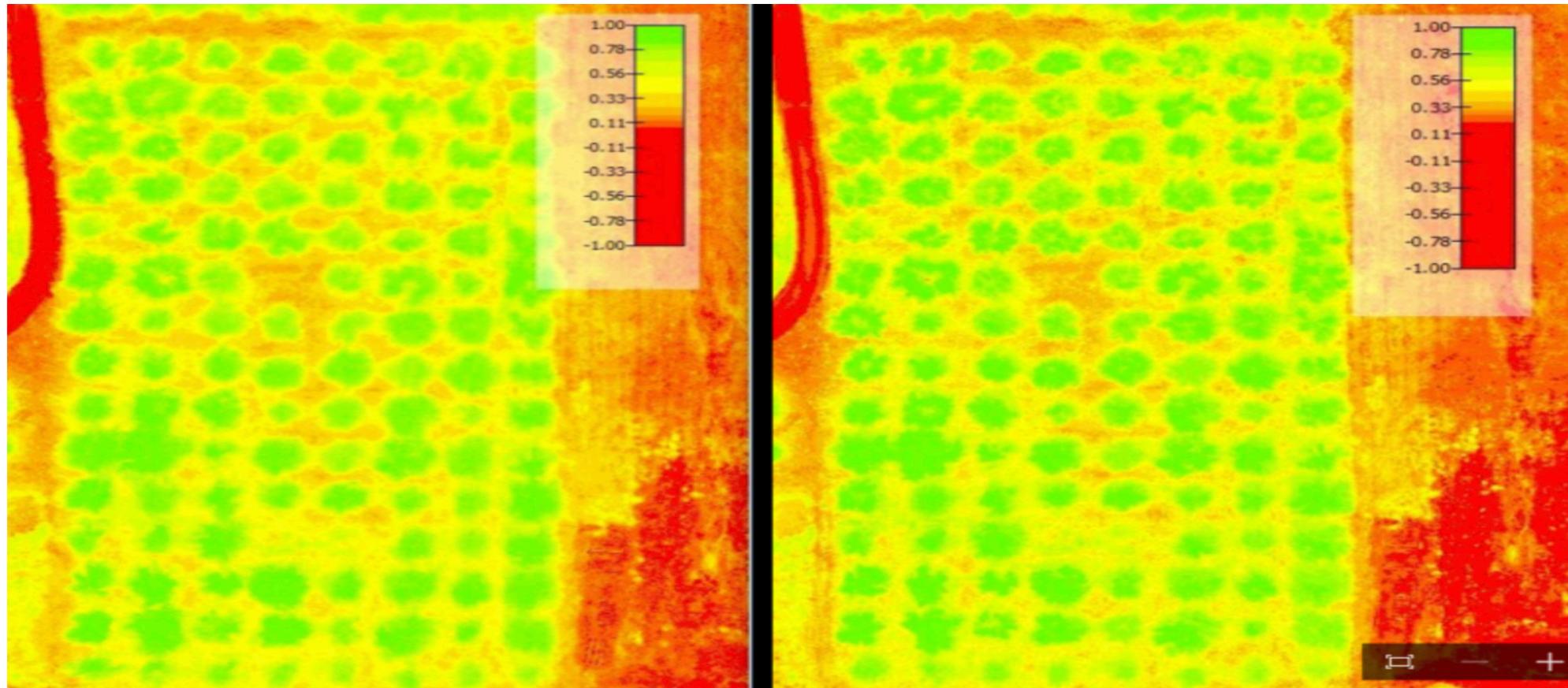
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# SETUP



MOTIVATION: DIFFERENCE BETWEEN MICASENSE REDEDGE 3  
(7000 USD)(8 CM PER PIXEL (PER BAND) AT 120 M (~400 FT) AGL)  
47.2 HOV VS **CANON S100 + MIDOPT FILTER (200 USD)**



# MAIN CAMERA REQUIREMENT

Our typical camera would look like:

- Light weight.
- Should consume low power.
- Should have good resolution and should work in far range.
- Ideal operation height is 60 meters. (Maximum allowed height is 400 ft/120 meters by DoT)
- Should have around 1 cm or 2 cm / pixel resolution on ideal operational height.
- Should be able to capture multispectral images.
- High FPS.

# MAIN CAMERA DESIGN

Sensor Spec:

SONY Exmor IMX377: [https://www.sony-semicon.co.jp/products/common/pdf/IMX377CQT\\_Flyer.pdf](https://www.sony-semicon.co.jp/products/common/pdf/IMX377CQT_Flyer.pdf)

4152\*3062 pixels == 12.71 M pixels [Diagonal : 7.81 mm type 1/ 2.3" ]

**Top level lens spec for our application:**

Focal length= 5.5 mm

**Camera spec:**

Pixel pitch= 1.55 microns

Number of detectors: 4152 \*3062 (W\*L) Dimension of detectors: 6.435 mm x 4.746 mm

**FOV:**

Horizontal fov=  $6.435/5.5\text{mm} = \mathbf{50 \text{ degree}}$

Vertical fov=  $4.746/5.5 = \mathbf{40 \text{ degree}}$

Angular per pixel =  $1.55/5.5 = 0.28 \text{ mRad}$

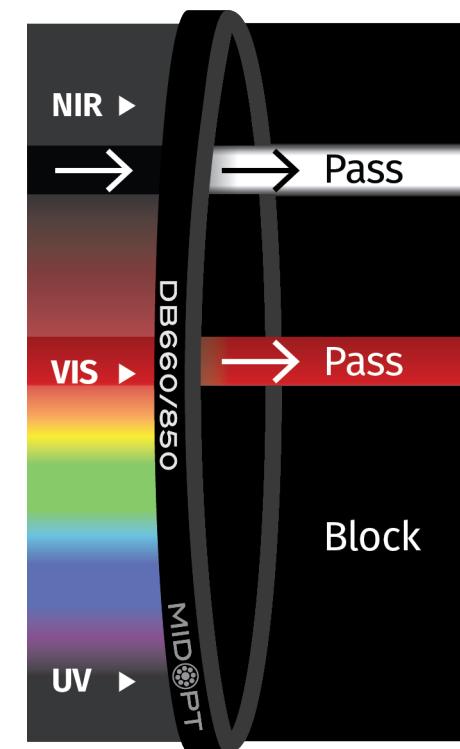
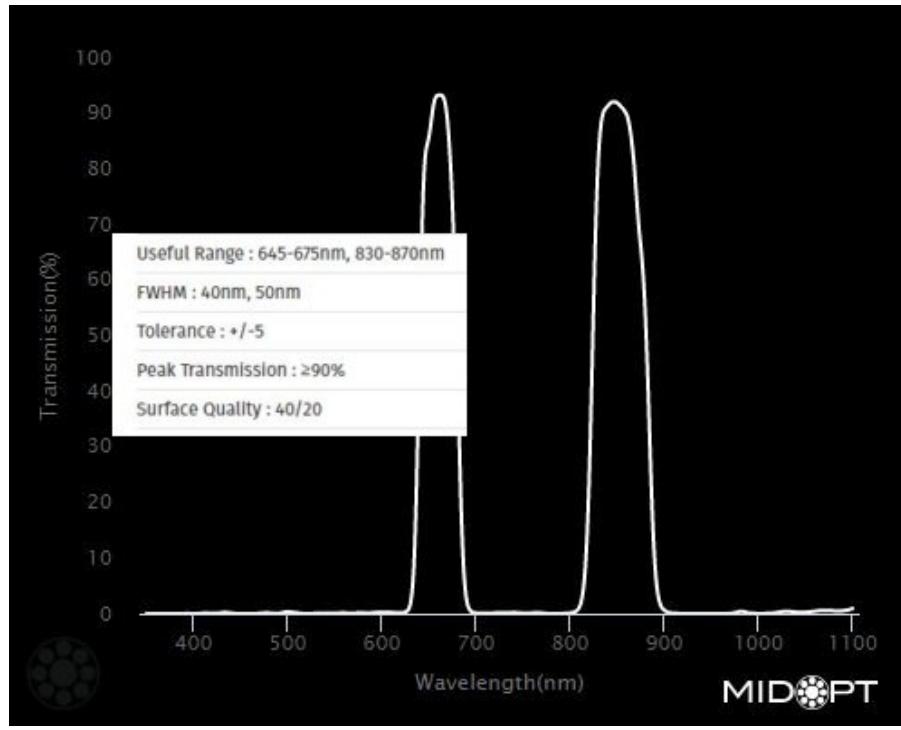
Pixel size over 60 m=  $((1.55 * e-6)*60)/5.5 \text{ mm} = \mathbf{1.69 \text{ cm/pixel}}$

# MIDOPT DB 660/850 FILTER

(USEFUL RANGE : 645-675NM, 830-870NM)

REFLECTED RED LIGHT (660NM)

INFRARED LIGHT (850NM)



## COMMERCIAL OPTIONS

- Sentera Double 4k
- Sensors 12.3MP BSI CMOS • Sony Exmor R™ IMX377
- Sensor Spectral bands
- NDVI • Red: 625nm x 100nm width • NIR: 850nm x 40nm width
- NDRE • Red Edge: 720nm x 40nm width • NIR 840nm x 20nm width
- Data capture 12.3MP Stills 4K Ultra HD video @ 30fps 1080p/720p Video • H.264 encoding
- Field of view: 60° HFOV (4K Stills / Video) 1080p ranges 30° - 60° HFOV



# CONCLUSION

- As we have seen above, we wanted to have a camera for our agricultural analysis setup, and we tried to set our specification and have found reliable sensor and lens for the application.

## REFERENCE

- <https://www.micasense.com/rededge-mx>
- [https://www.sony-semicon.co.jp/products/common/pdf/IMX377CQT\\_Flyer.pdf](https://www.sony-semicon.co.jp/products/common/pdf/IMX377CQT_Flyer.pdf)
- <https://publiclab.org/notes/Claytonb/07-09-2016/plant-health-ndvi-consumer-camera-vs-professional-multispectral-camera>