



ICCECIP 2023

*Advanced object
recognition using drones*

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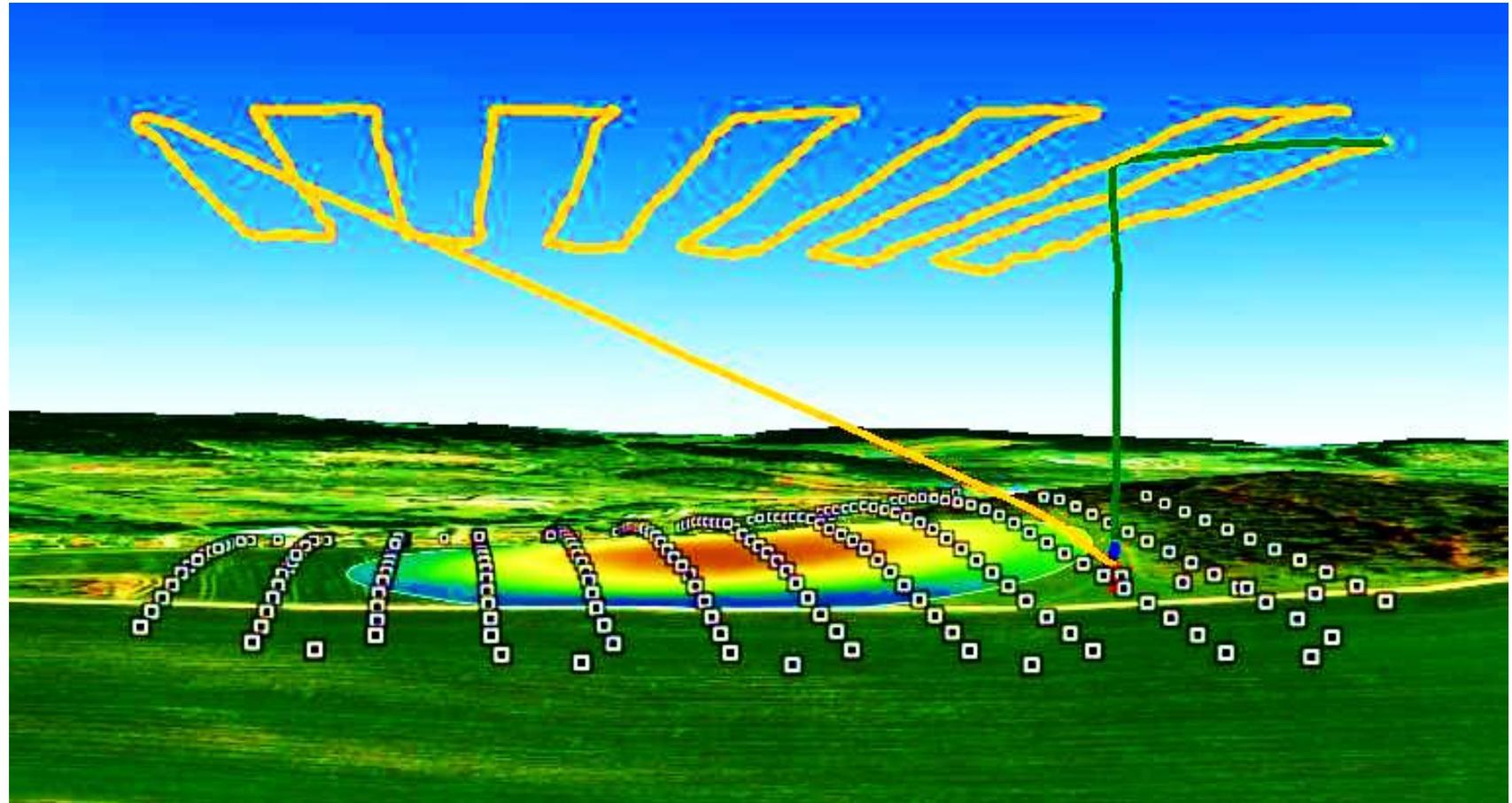
Introduction

What can we use beyond the high-resolution 4K cameras?





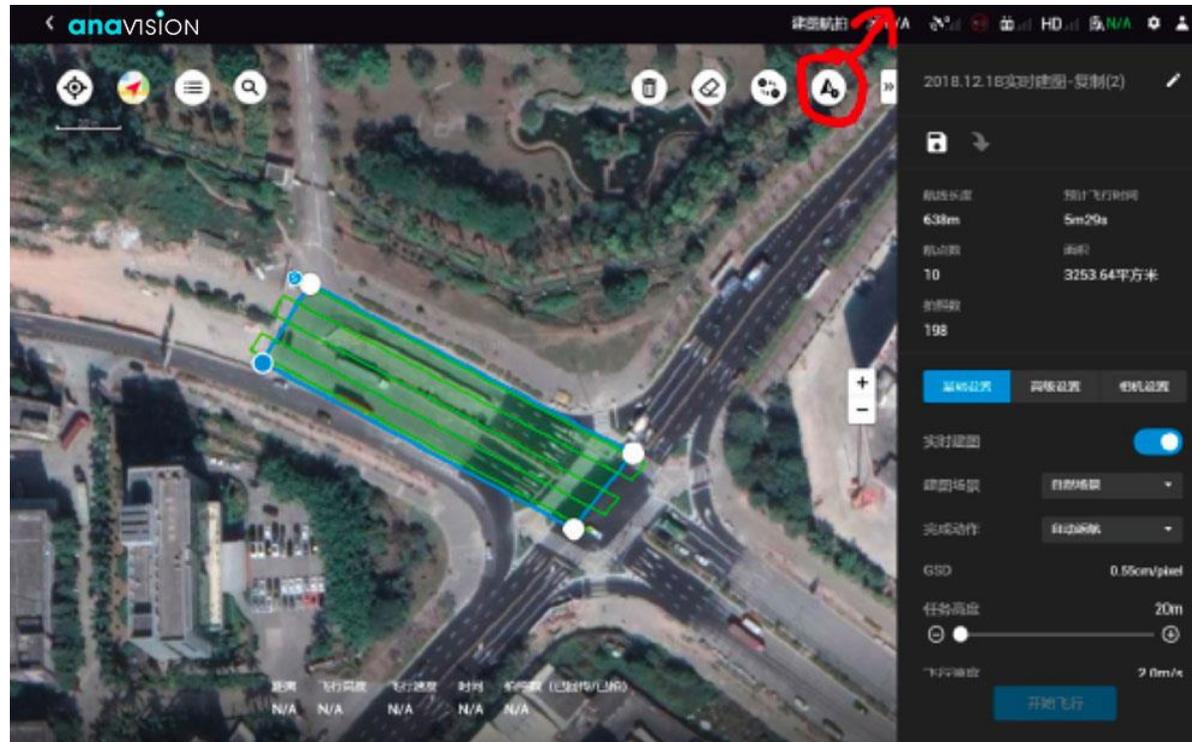
Aerial photography, creating maps





Aerial photography

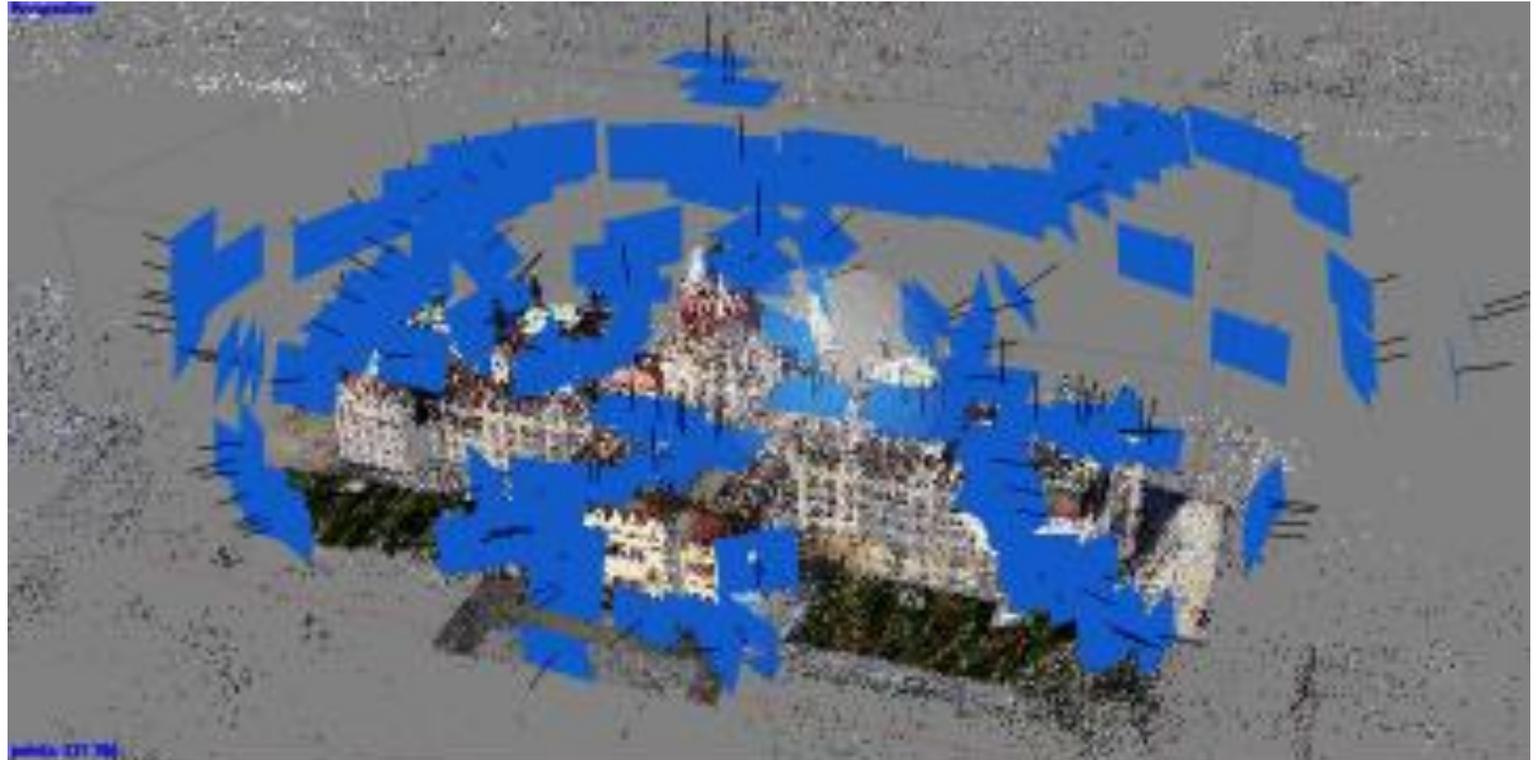
- Field mapping - aerial photo, orthophoto, **3D modeling** - with georeference





Aerial photography

- 750 photos – less than 10cm accuracy
- **10,000 photos – less than 1cm accuracy**





Aerial photography

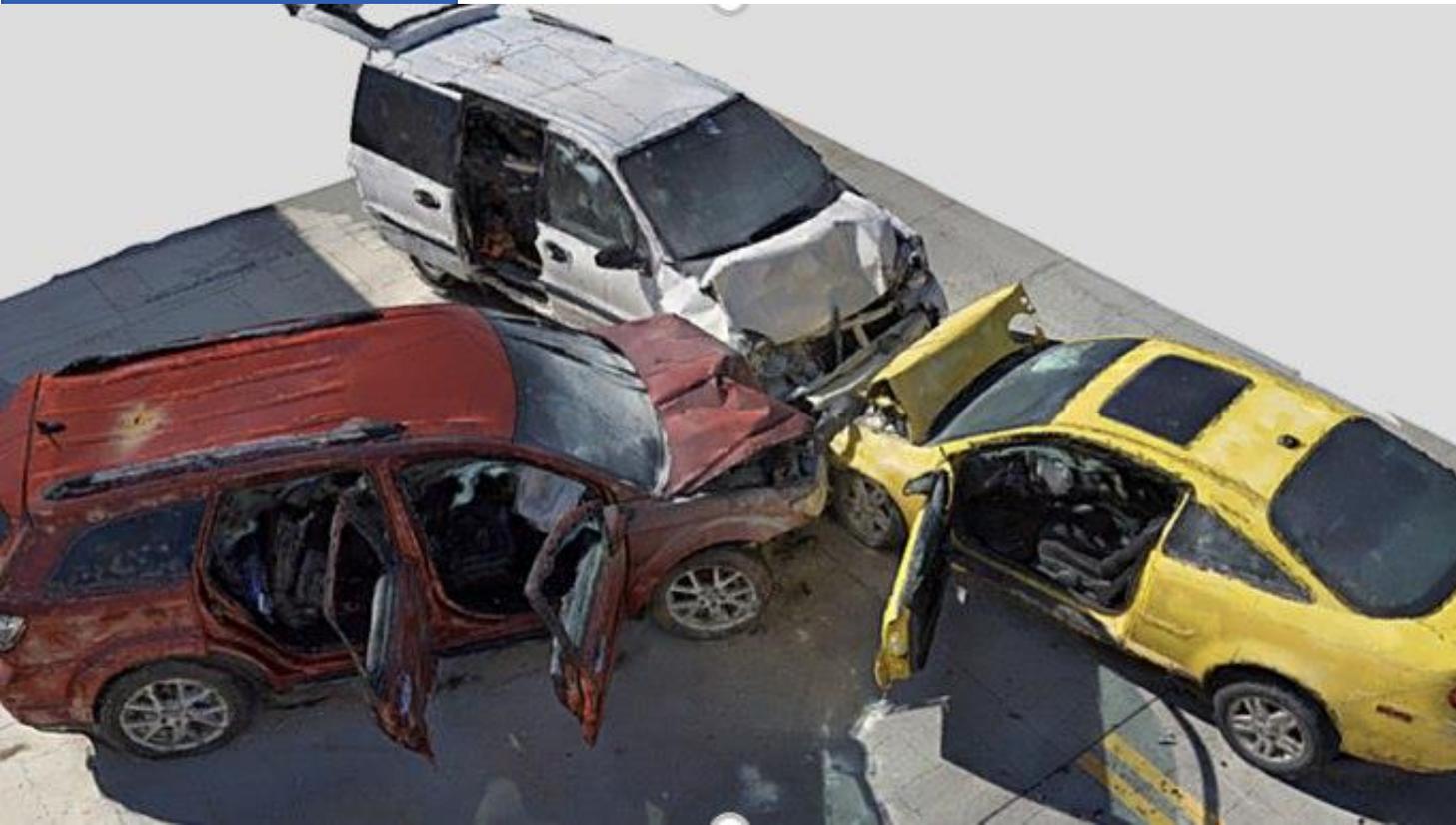
- Small model
- Sparse point mesh
- Dense mesh
- Creating the mesh/surface
- Textures





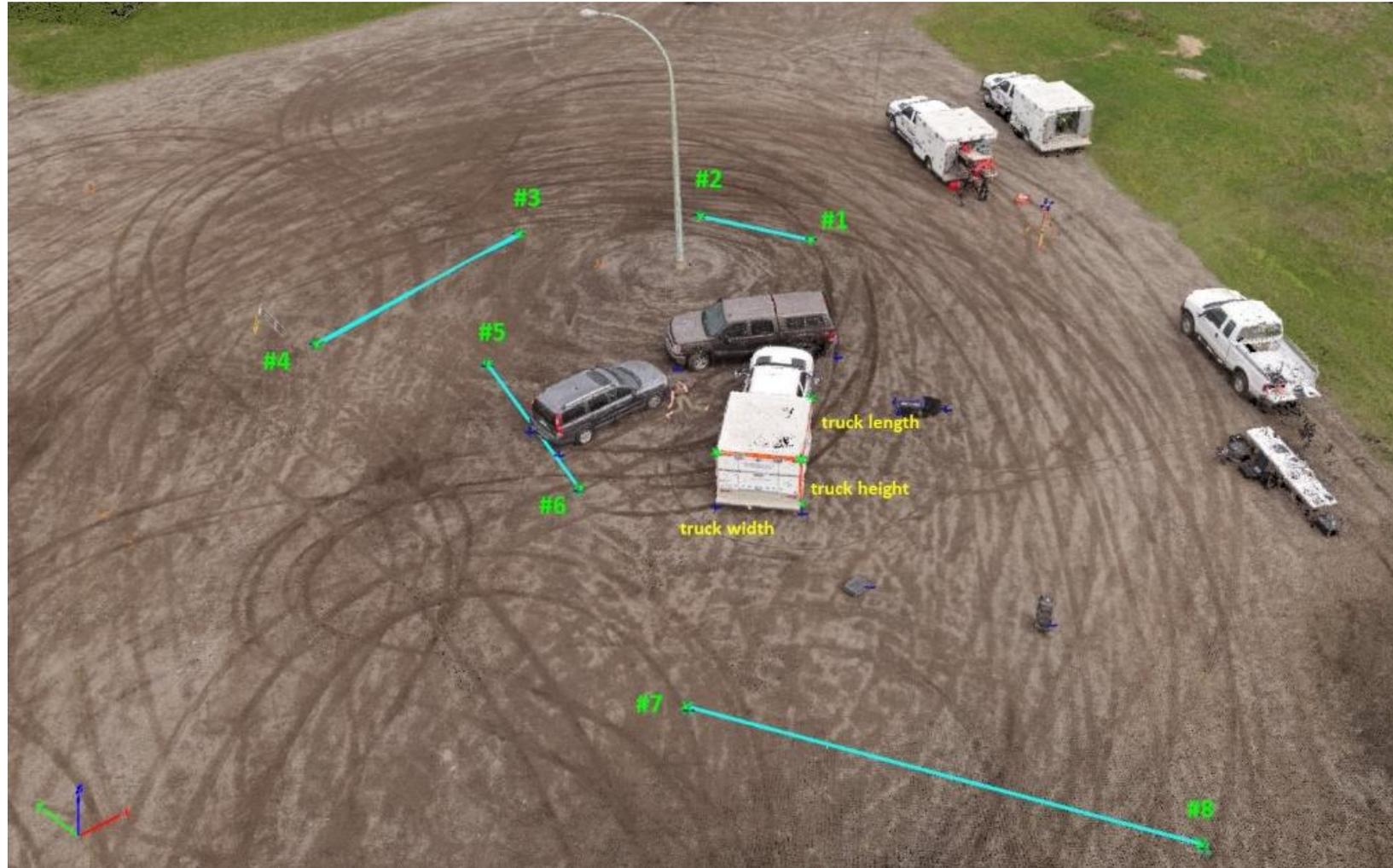
Aerial photography

- Generated with a Skydio 2 and Skydio 3D Scan.
- 0.927 millimeter ground sampling distance.





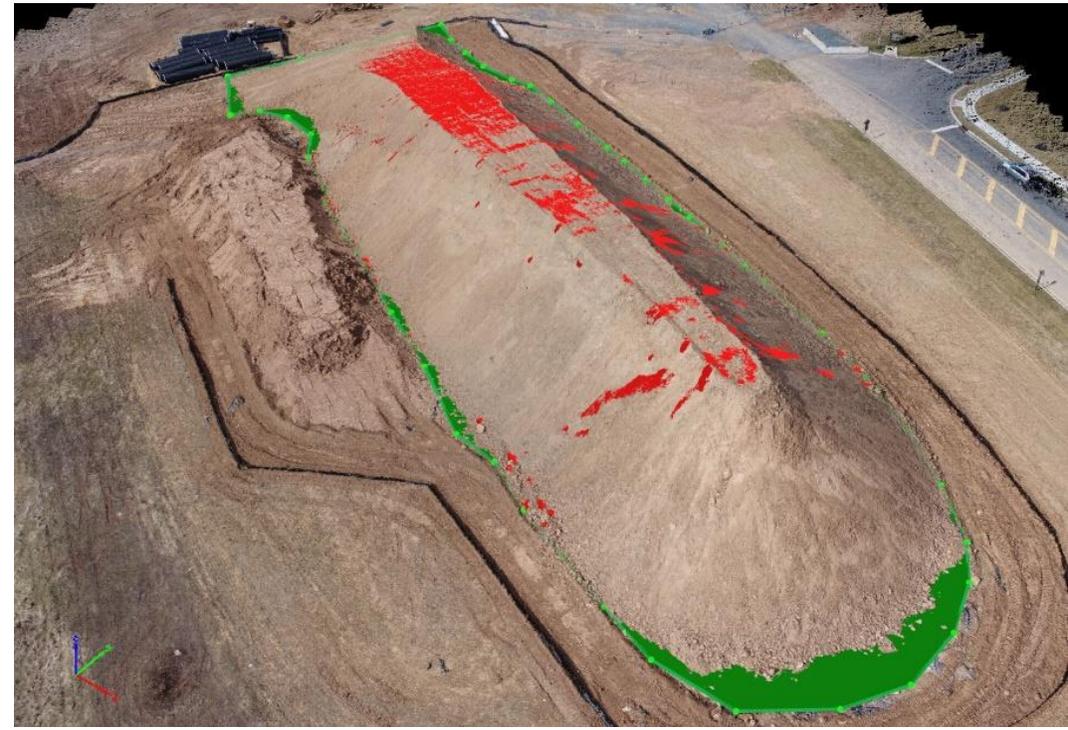
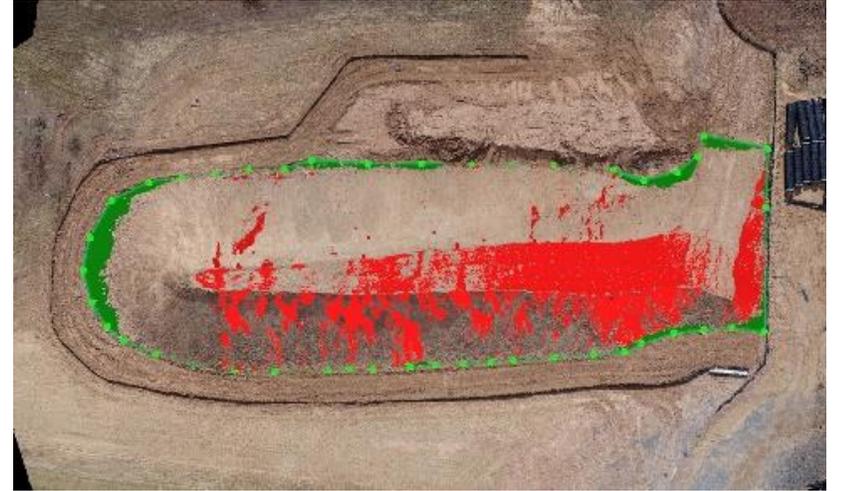
Measuring the distances





Measuring the volume

- Stockpile Volume Measurement
- 350 images of the stockpile from different angles and then created a high-density point cloud using photogrammetry software (Pix4D).
- The same software was used to calculate the total volume from the point cloud.





Measuring the volume

- Drone stockpile surveys use photogrammetry instead, so they are especially useful for
 - very large stockpiles and
 - stockpiles with odd shapes,
- because traditional methods really only calculate volumes assuming simple shapes. The accuracy level is roughly the same as traditional methods.

Annotation & Measurement

Location Distance Area Volume

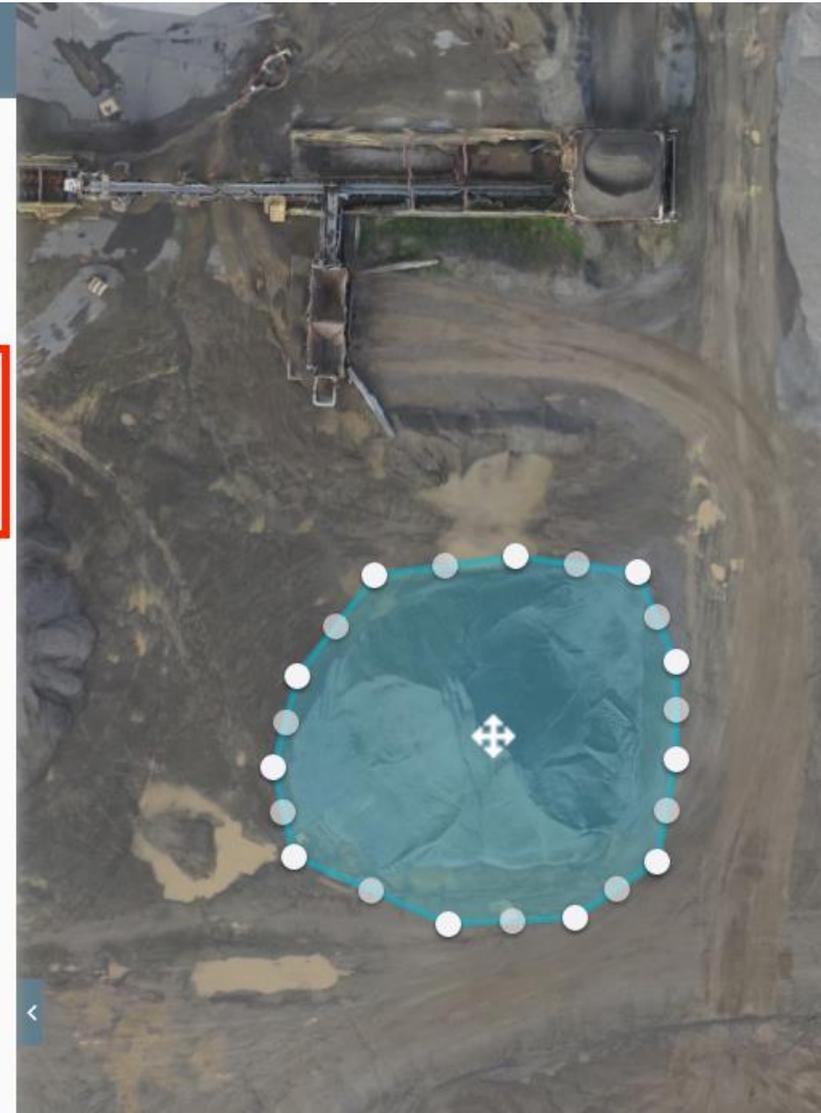
Title

| | |
|--------|----------------------|
| Area | 644 m ² |
| Cut | 507.8 m ³ |
| Fill | -23.1 m ³ |
| Volume | 484.7 m ³ |

Base Plane
Best Fit

Have a conversation about this annotation with DroneDeploy users you share this map with.

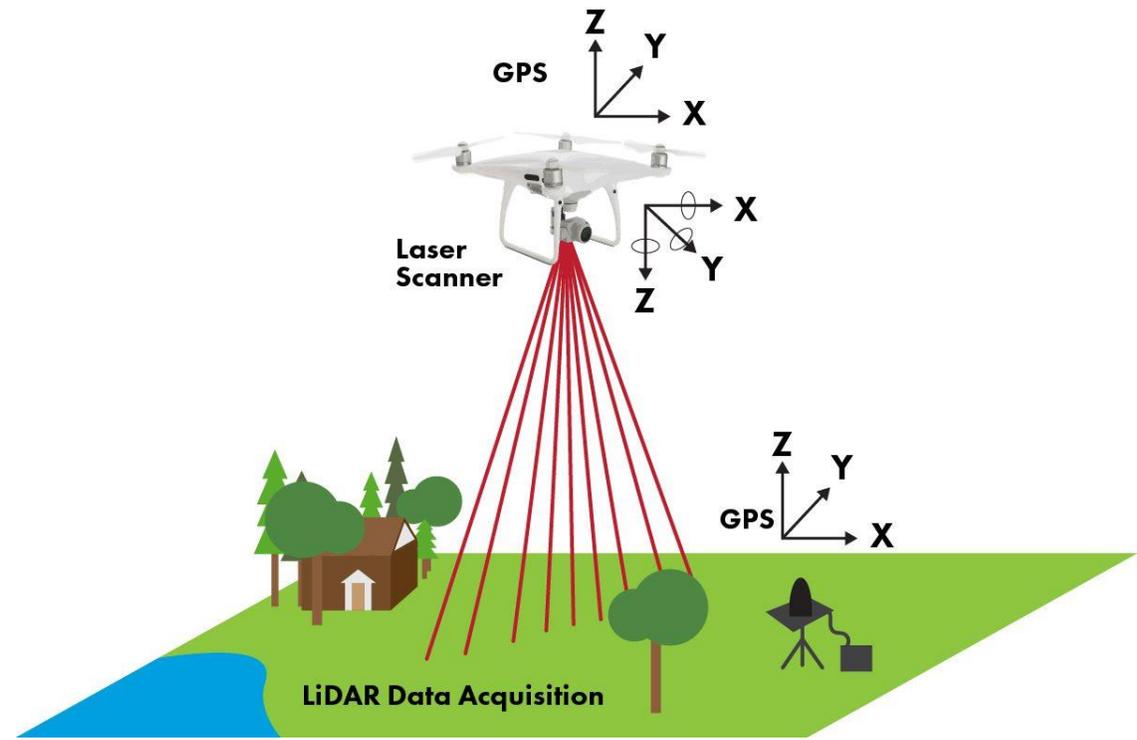
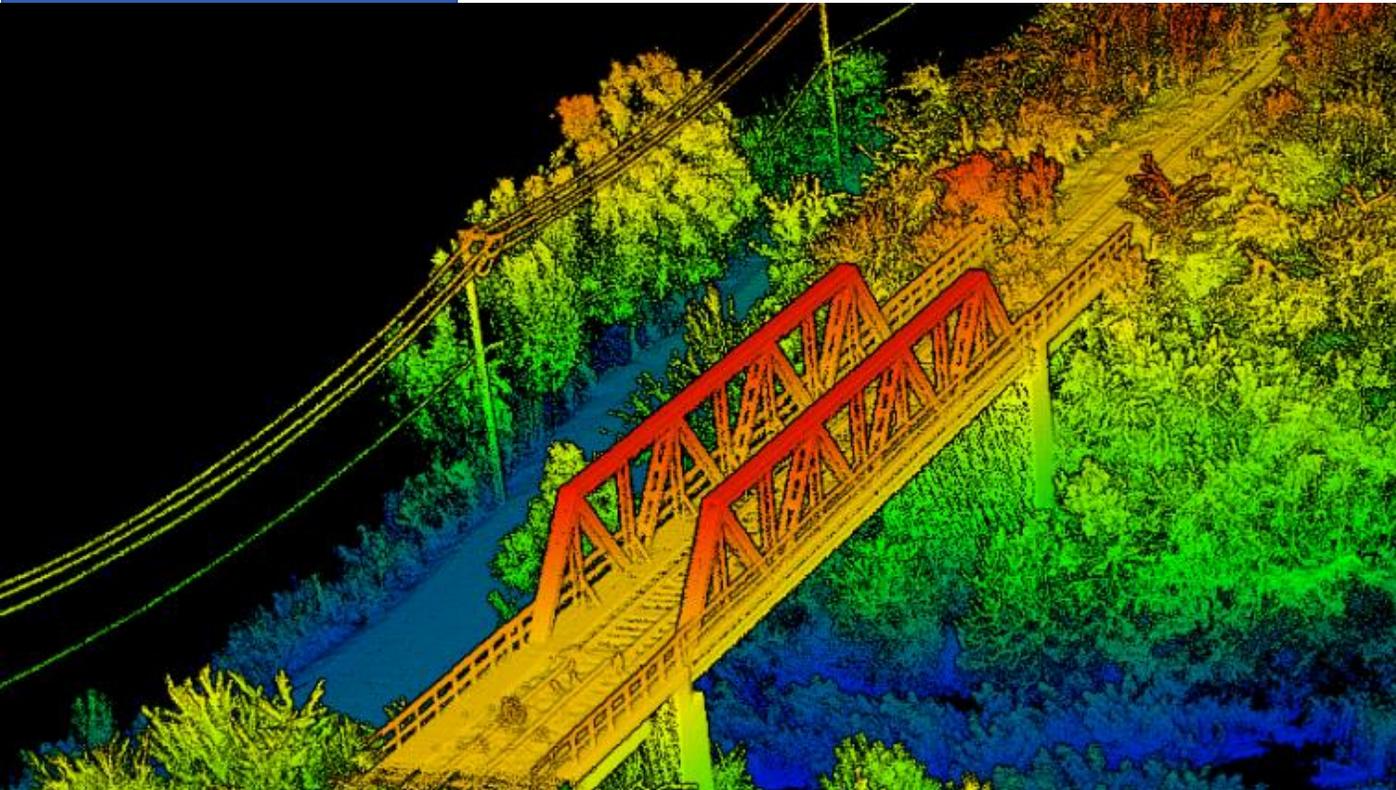
Add a comment





LIDAR

- No texture, but high resolution 3D data





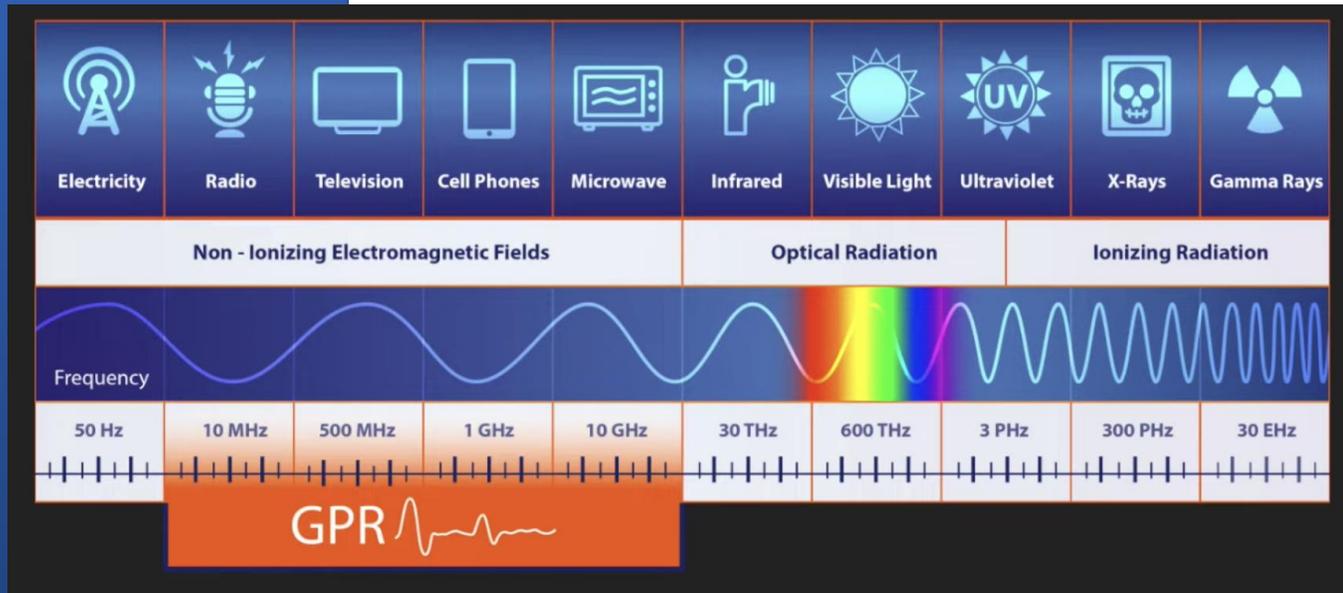
Below the surface





Below the surface

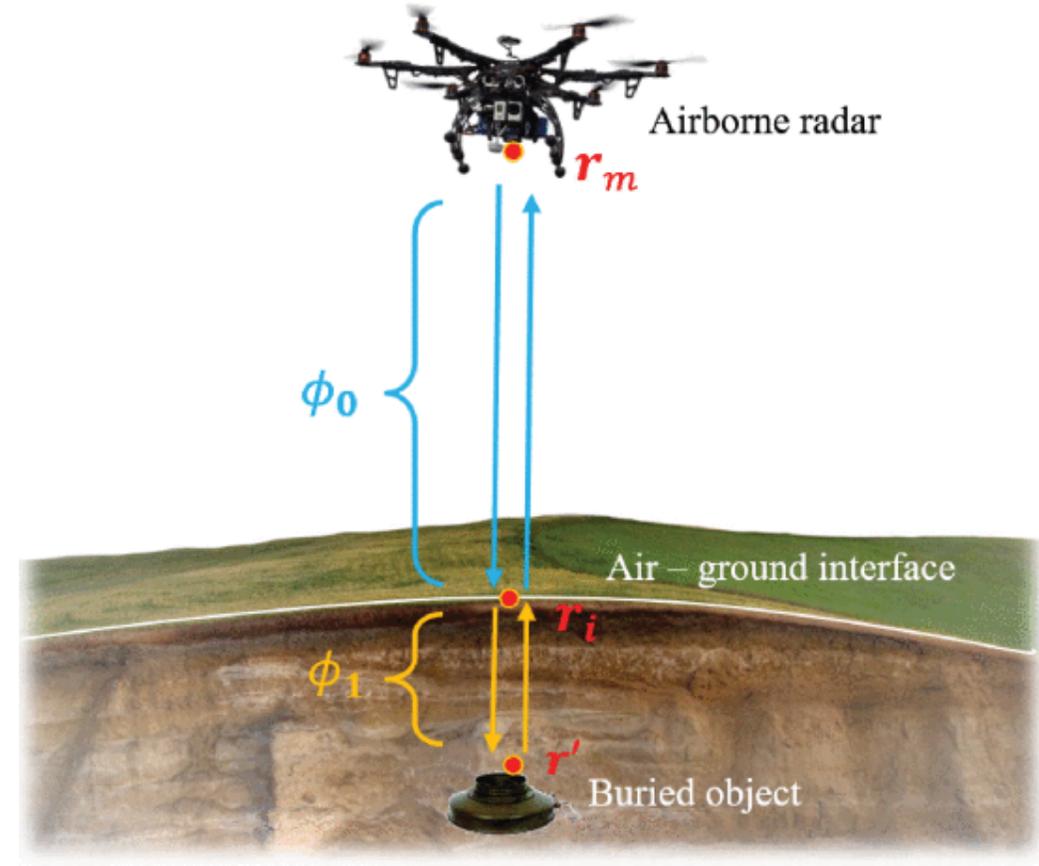
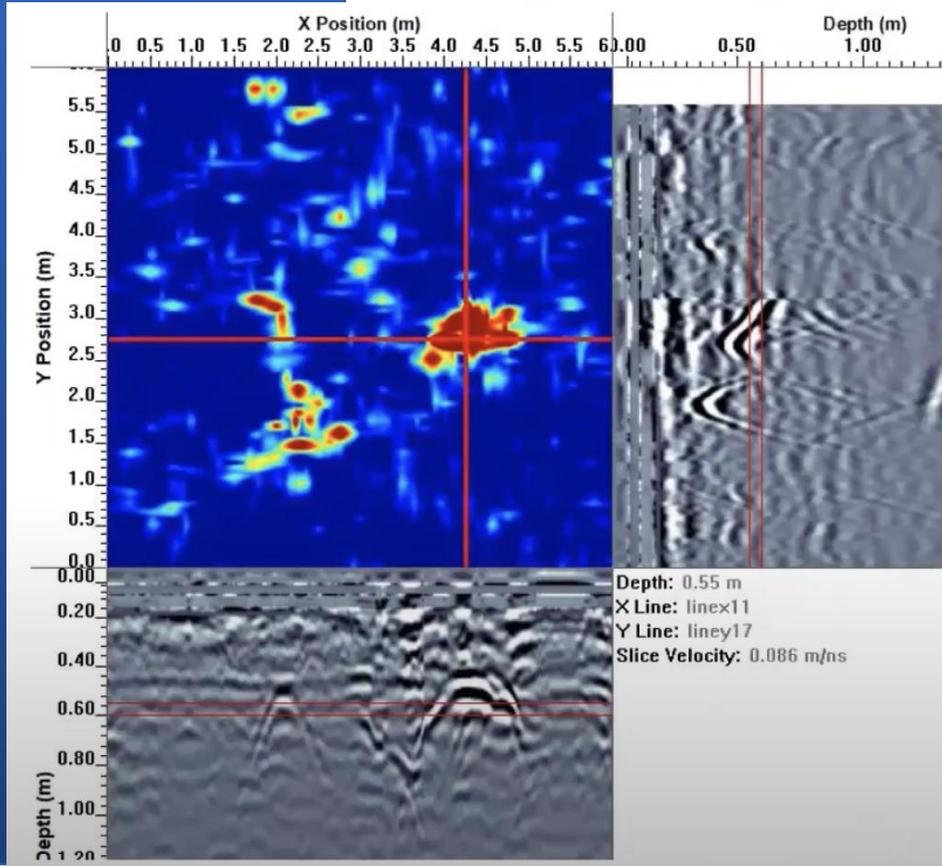
- Ground-penetrating radar





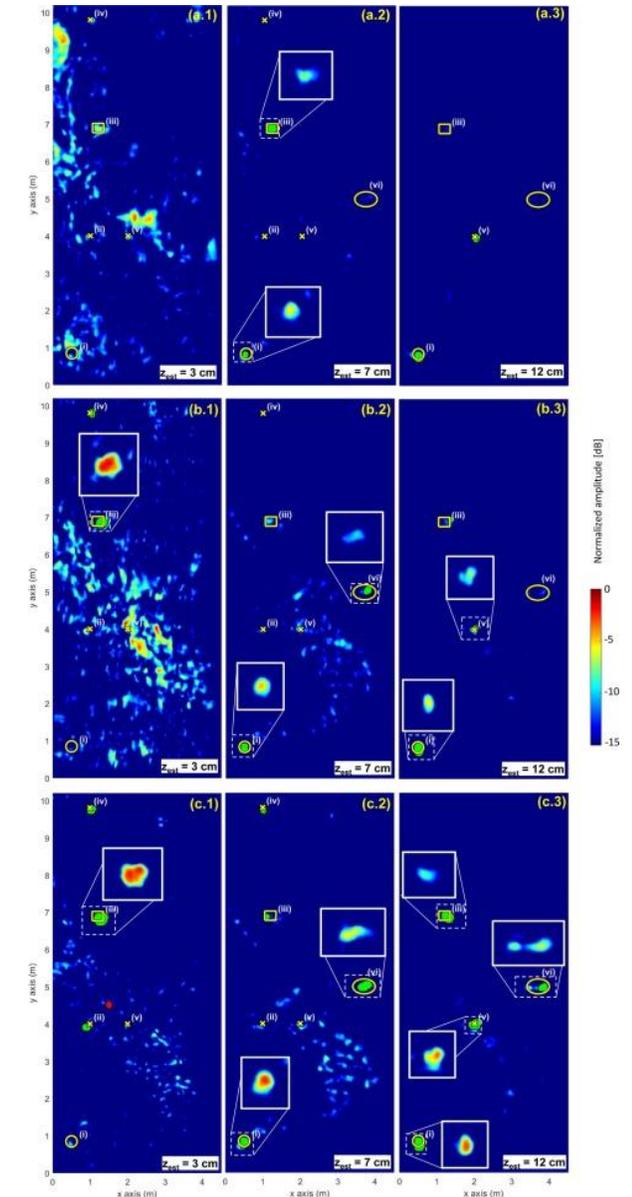
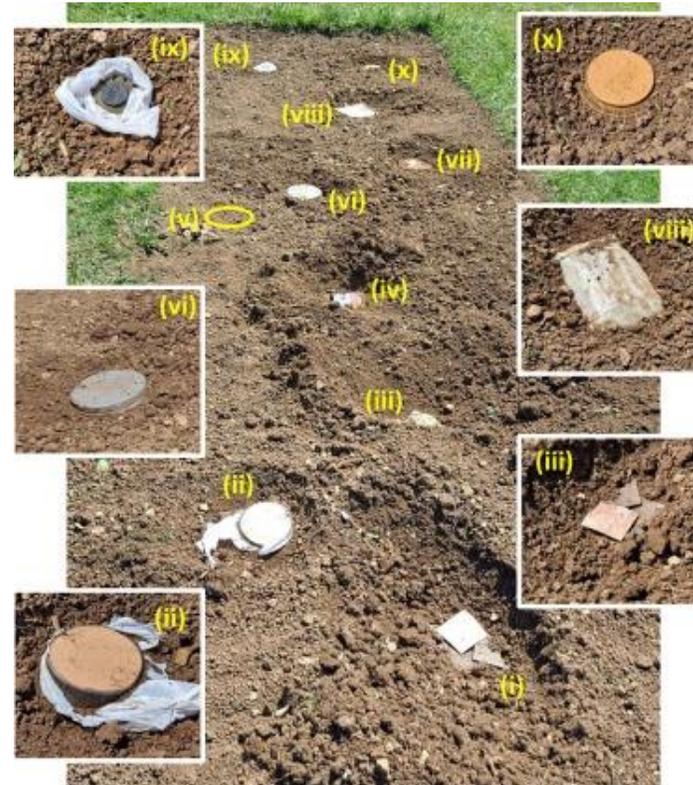
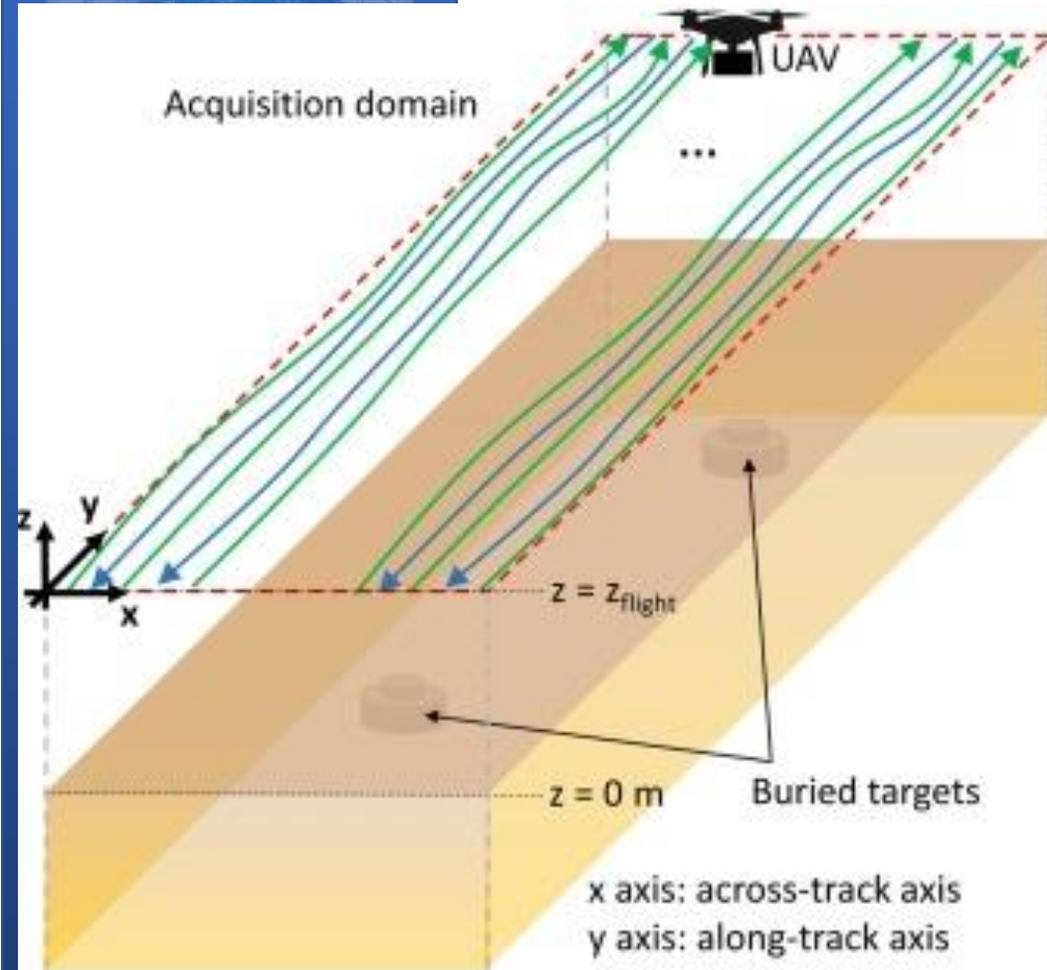
Underground SAR imaging technique using an airborne GPR

- SAR: Synthetic-aperture radar



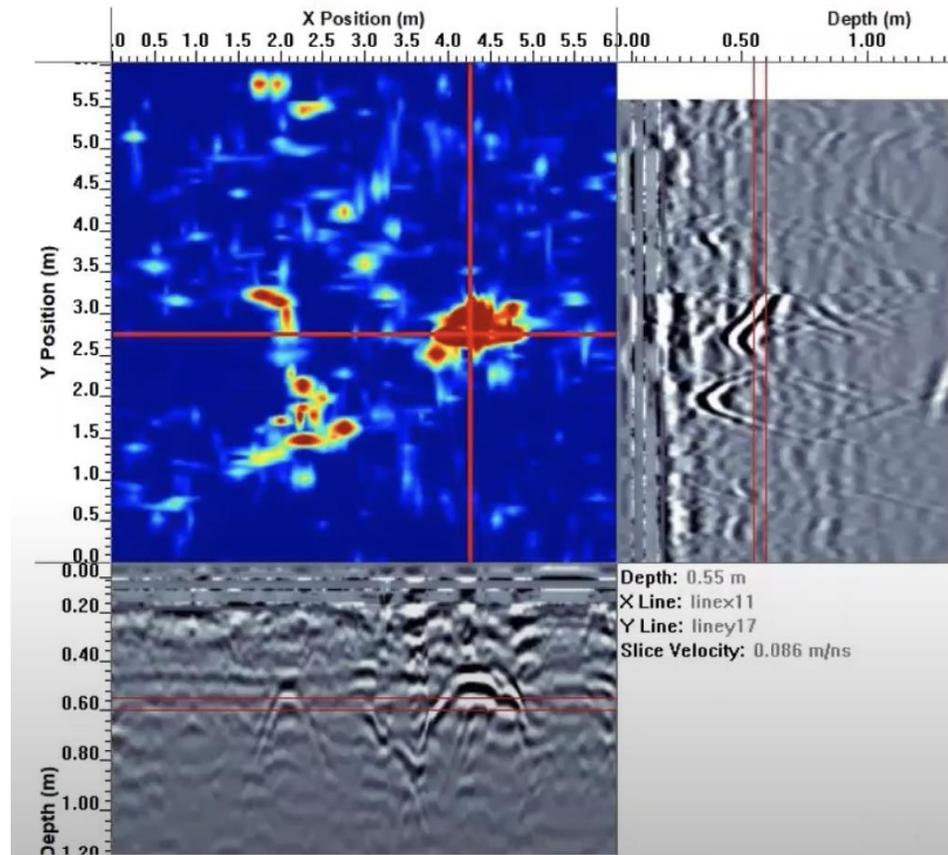


Underground SAR imaging technique using an airborne GPR





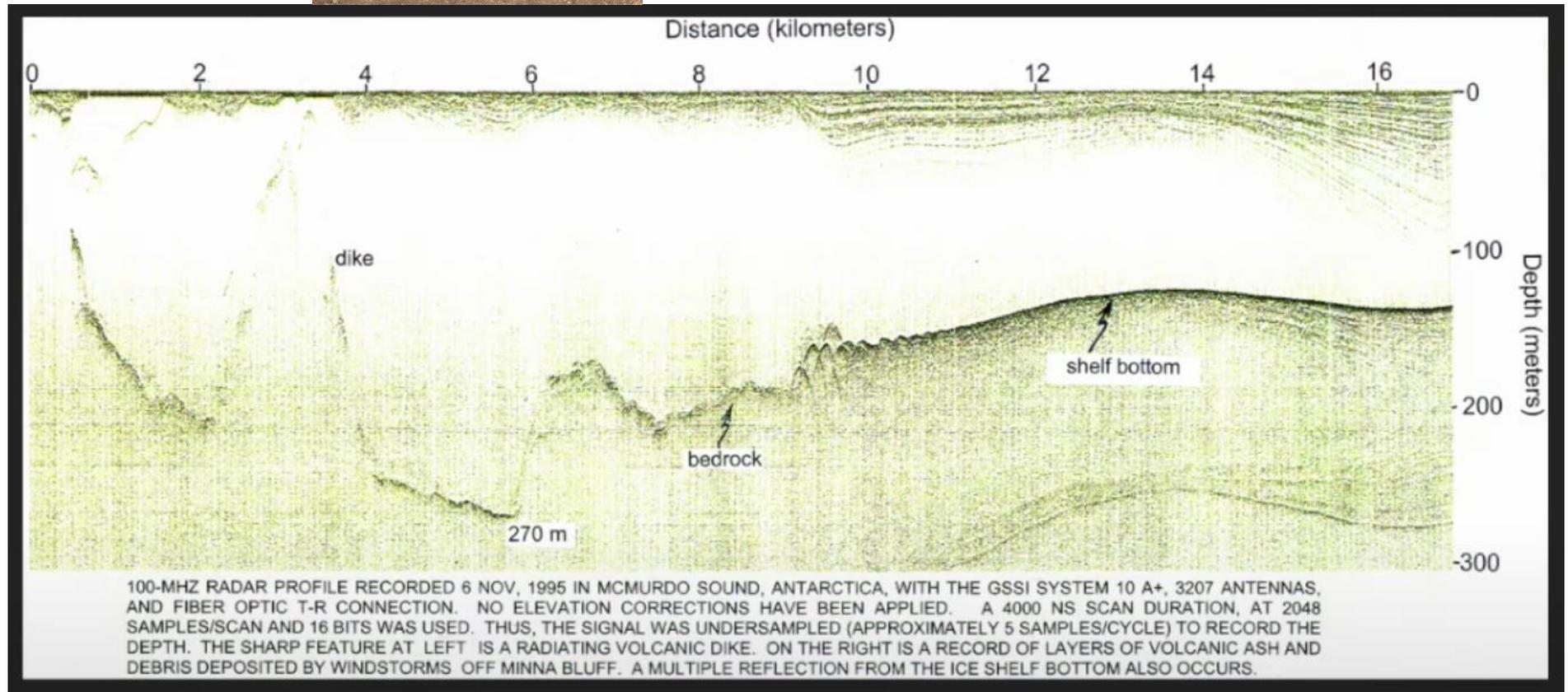
What can we detect? - Objects, water, caves.
In case of high contrast,
the reflectivity is high



| Material | K |
|-----------|----------|
| Air | 1 |
| Ice | 3 |
| Dry Sand | 5 |
| Granite | 6 |
| Dry Salt | 6 |
| Limestone | 8 |
| Shale | 15 |
| Wet Sand | 25 |
| Silts | 30 |
| Clays | 40 |
| Water | 80 |
| Metal | ∞ |

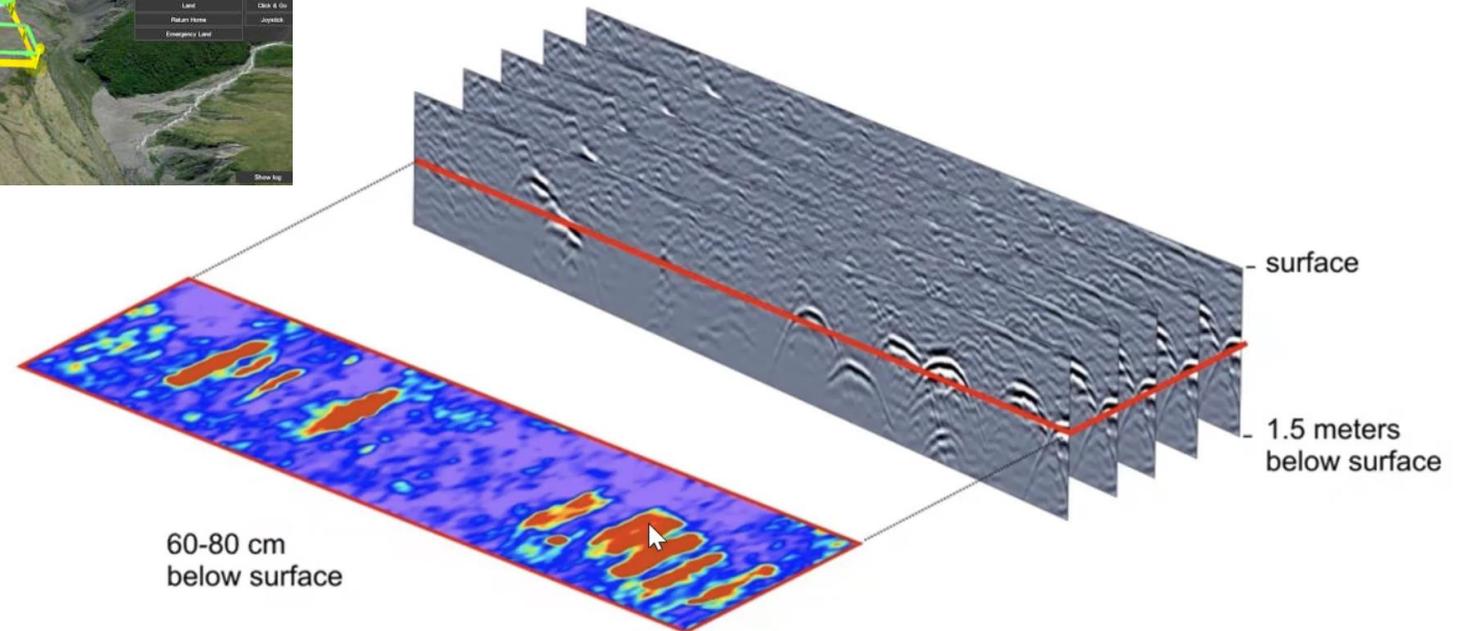
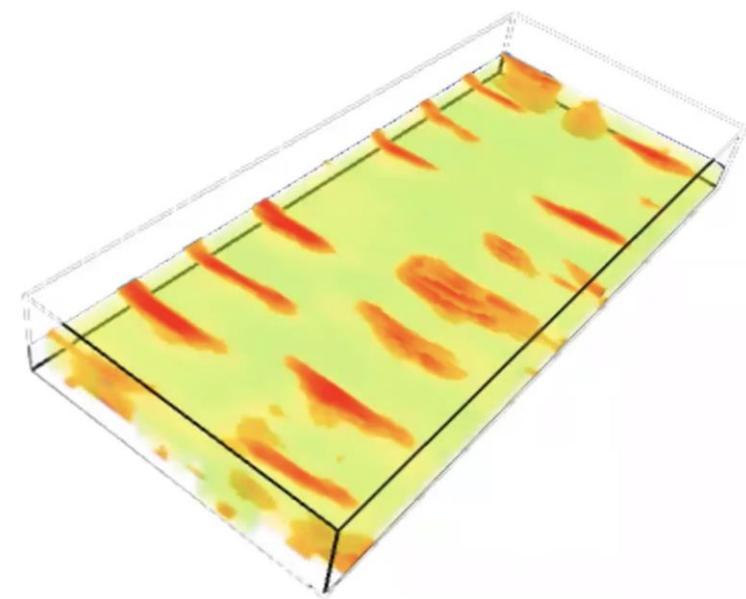
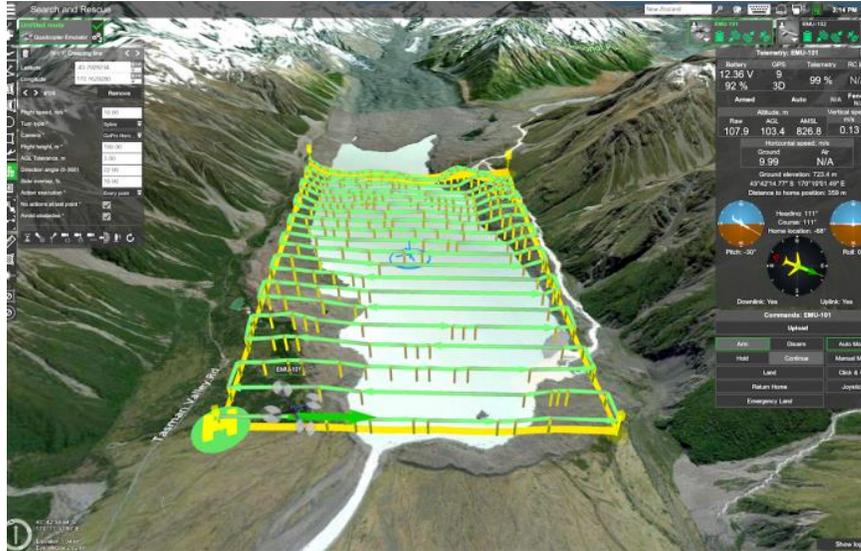


GPR





Airborne GPR



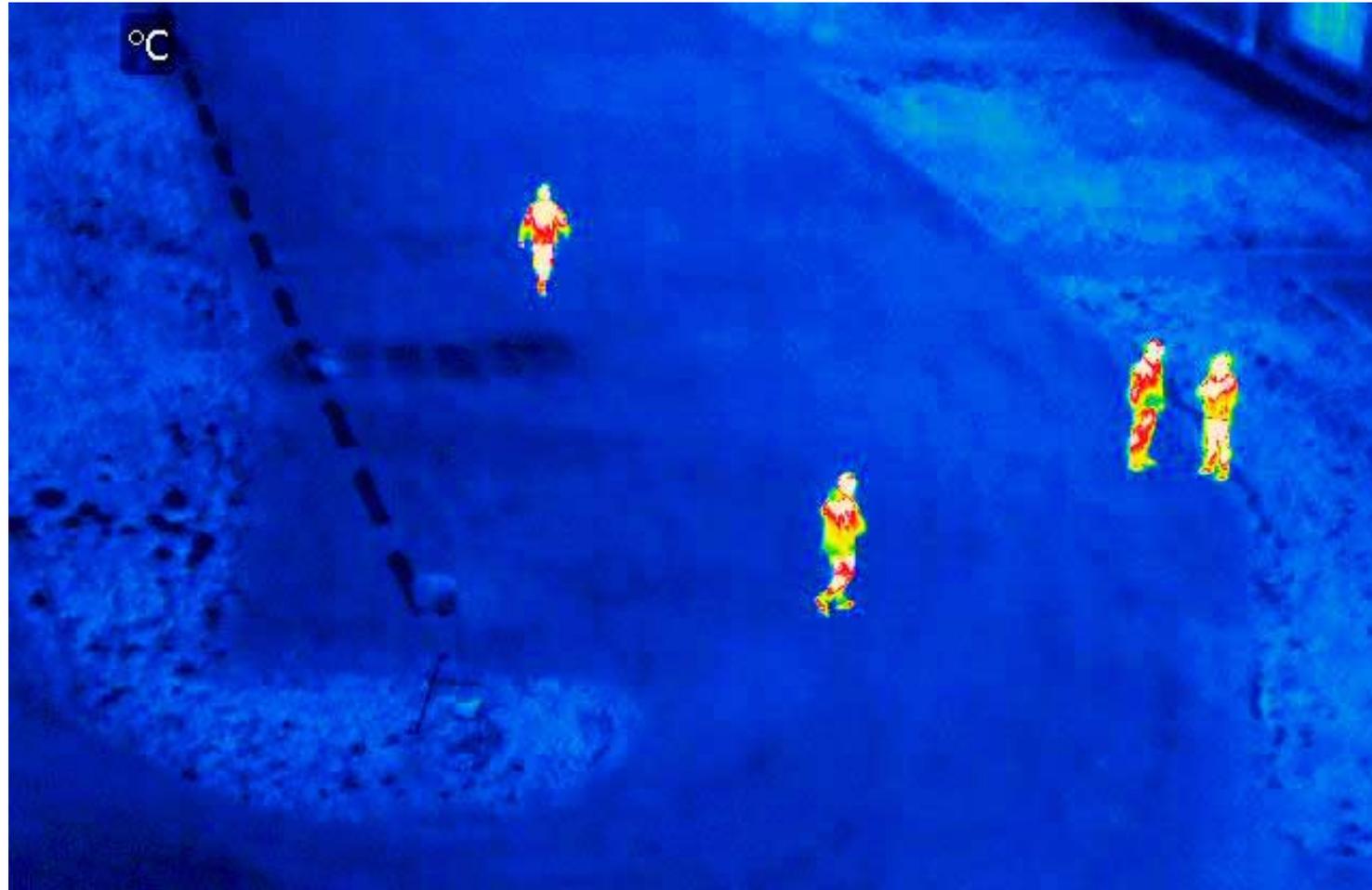


Thermal imaging





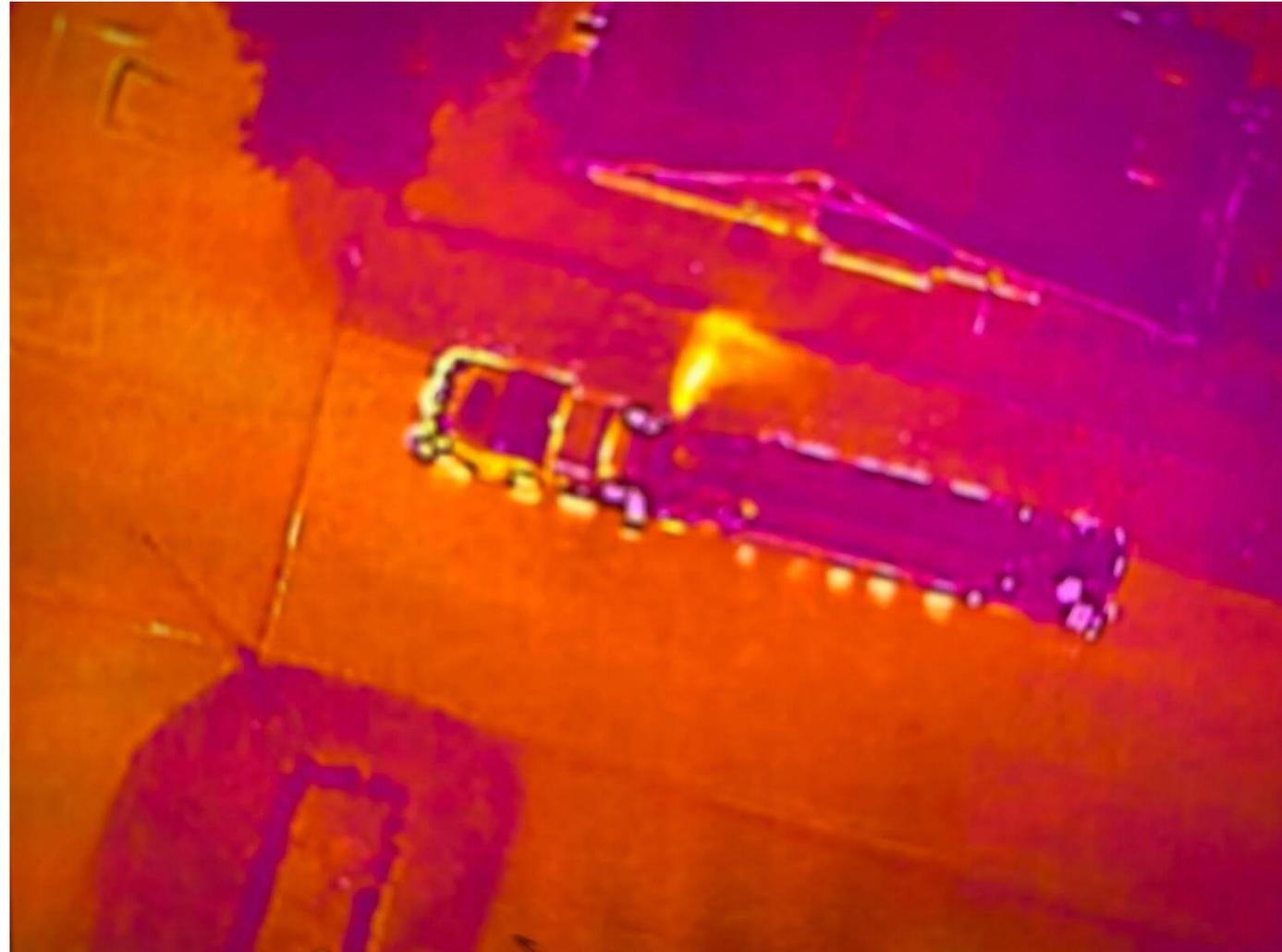
Thermal imaging





Thermal imaging

- Leak detection





Thermal imaging

- Dark conditions





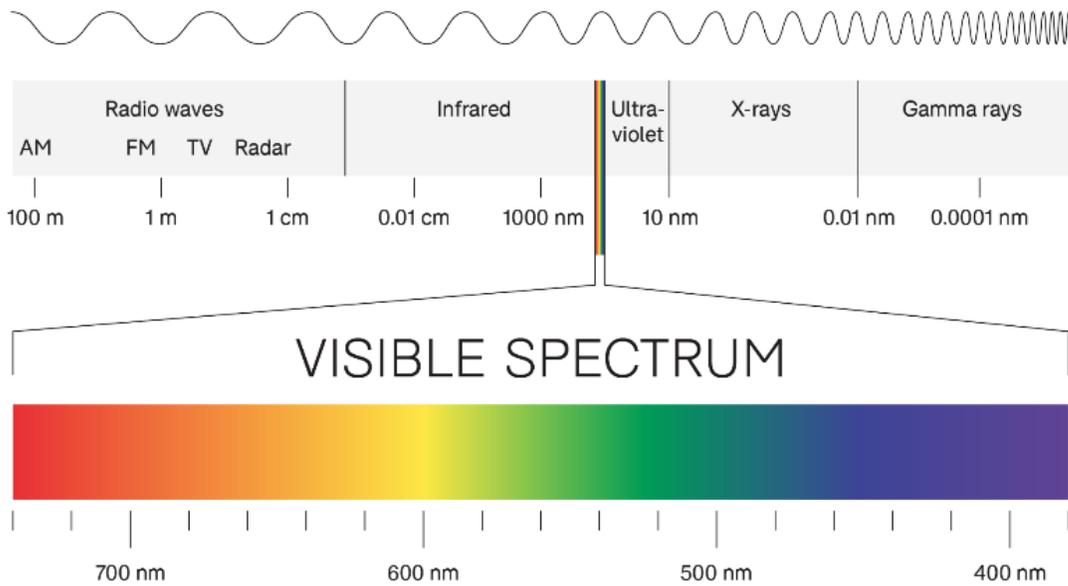
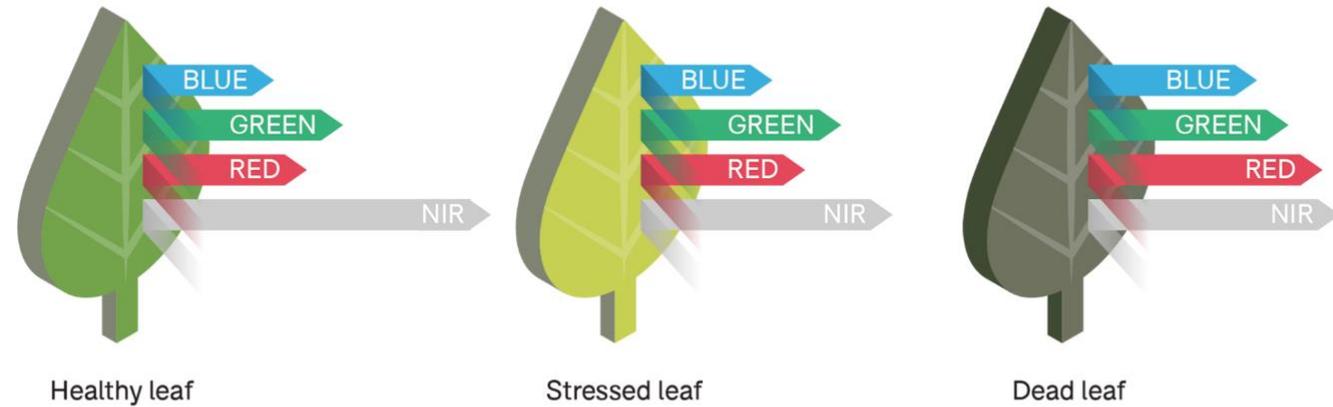
Thermal imaging

- Other advantages





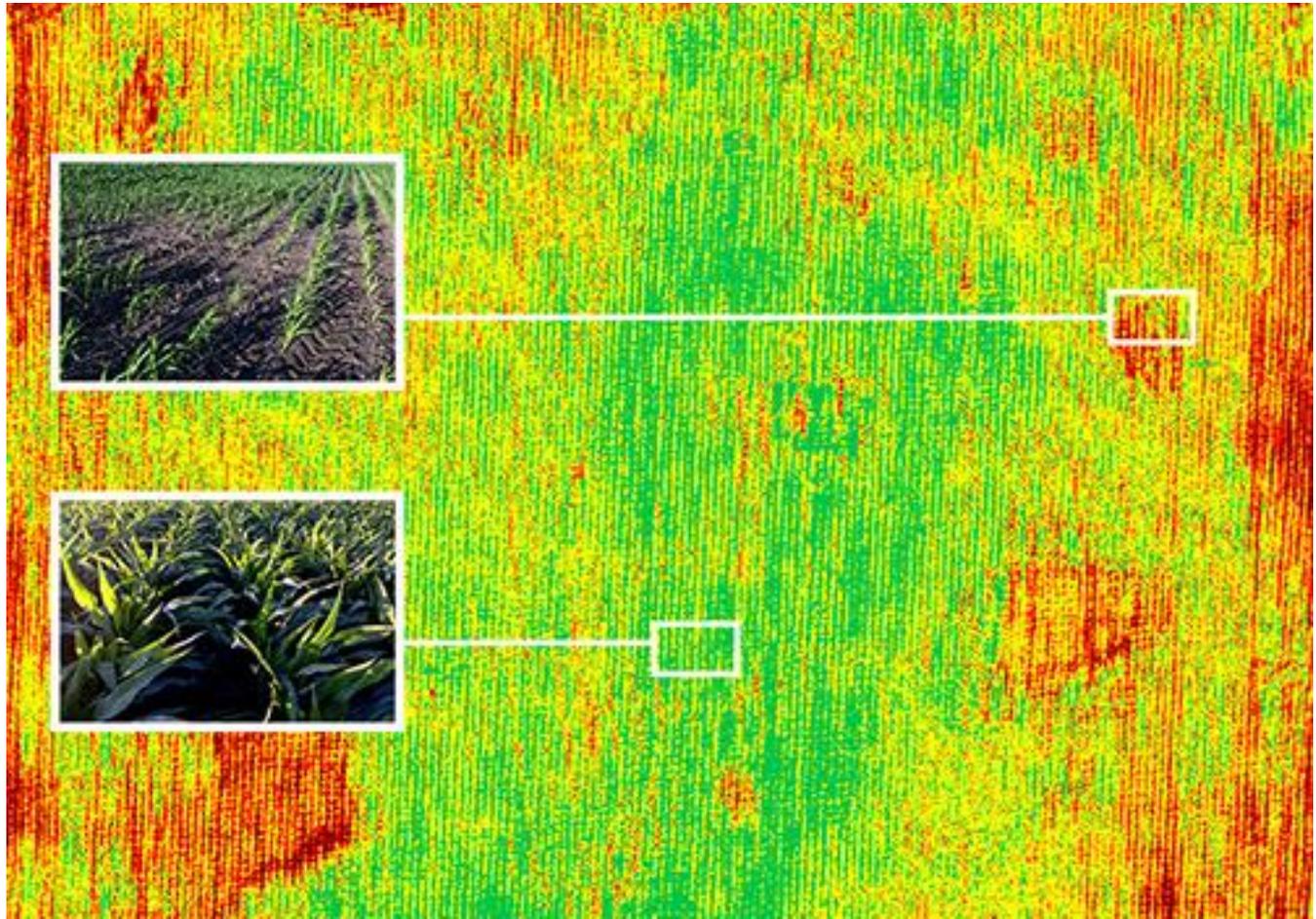
Multispectral imaging





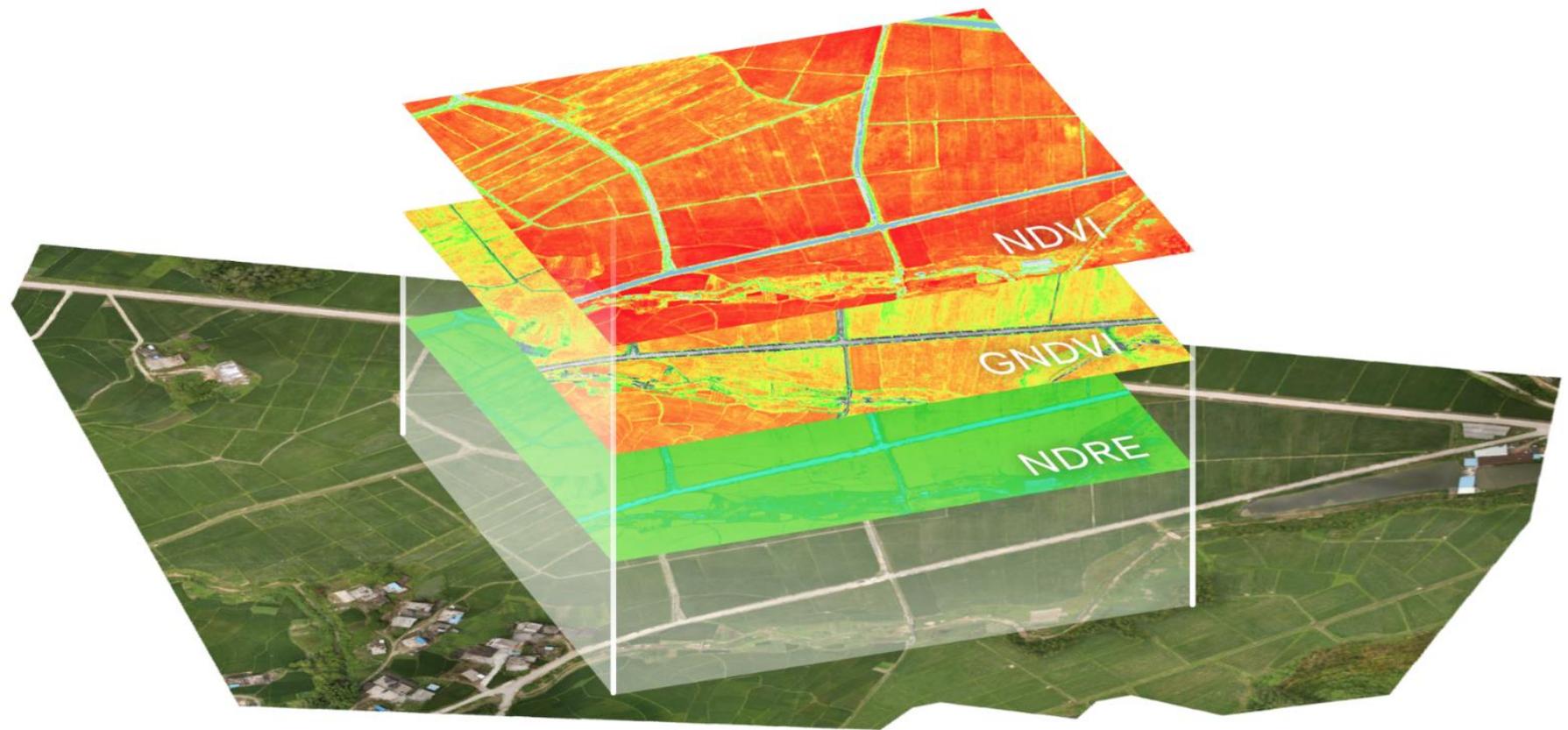
Locating the goods

- Agriculture started to use it to detect the condition of the plants.





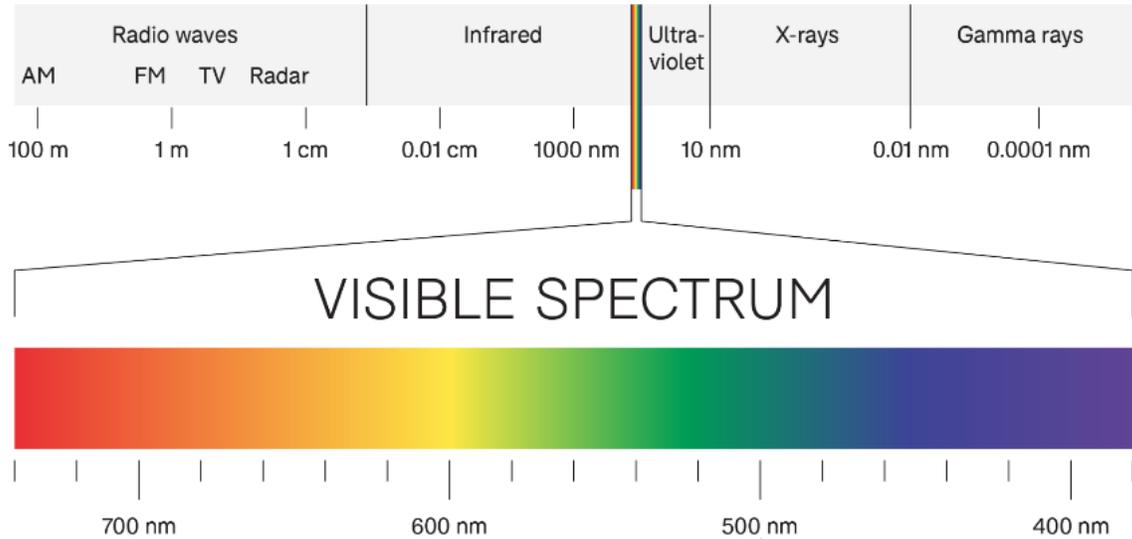
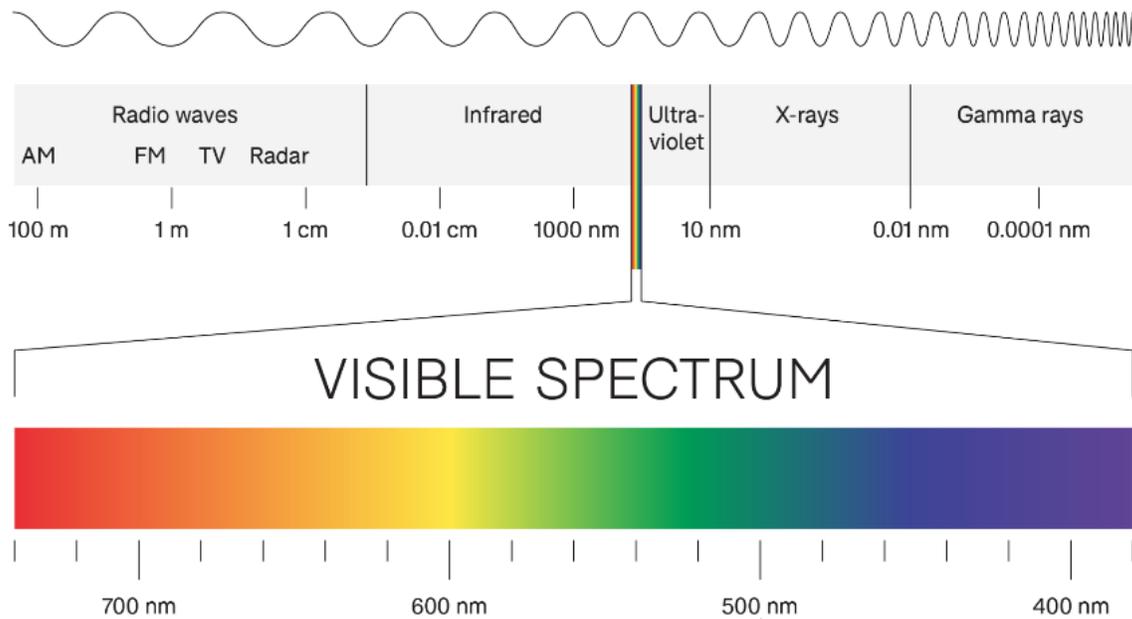
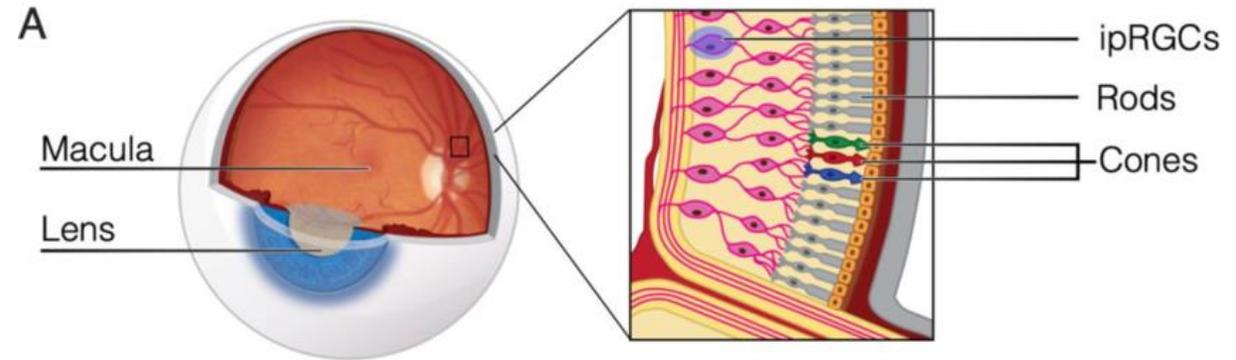
Multispectral imaging





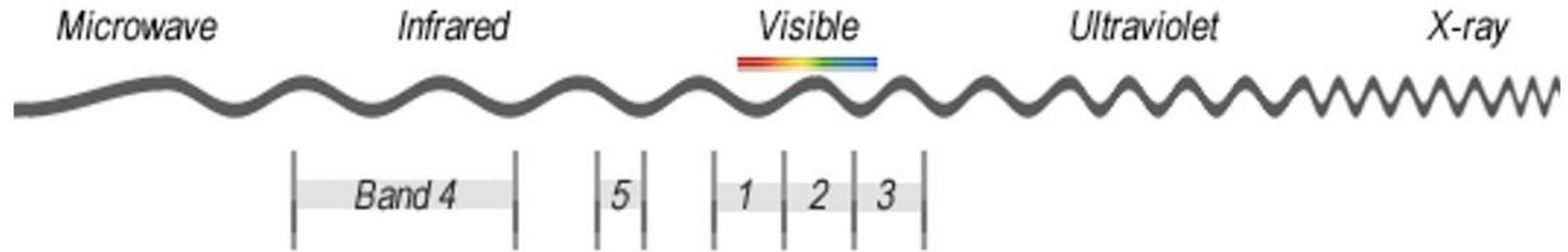
Multispectral imaging

- Human eye:
- Only 3 colors
- Wide spectrum

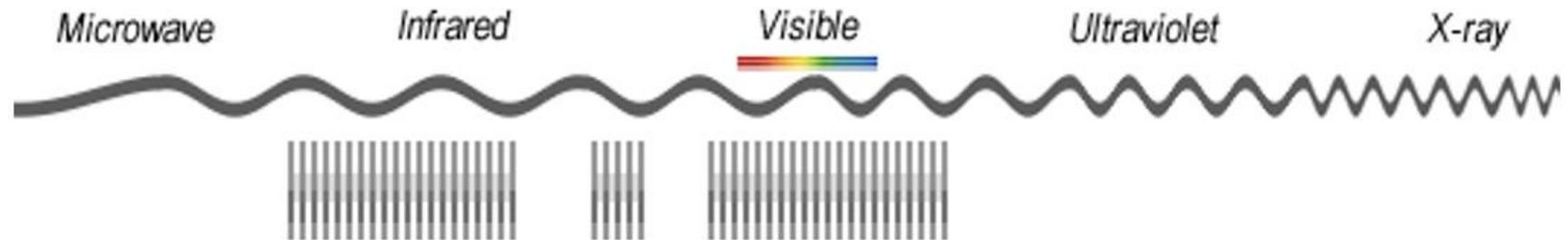




Multispectral imaging



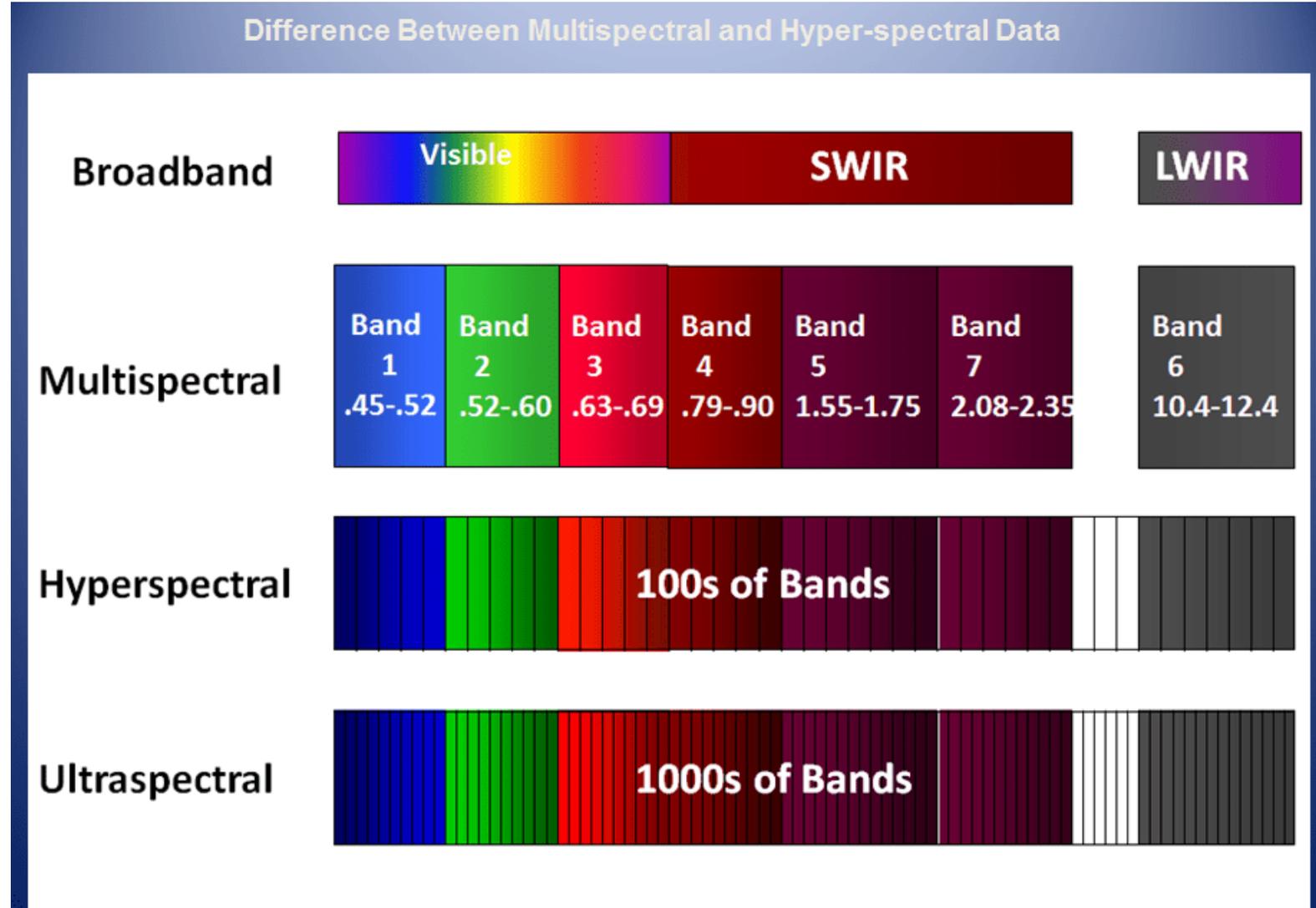
- Multispectral Example: 5 wide bands



- Hyperspectral Example: Imagine hundreds of narrow bands

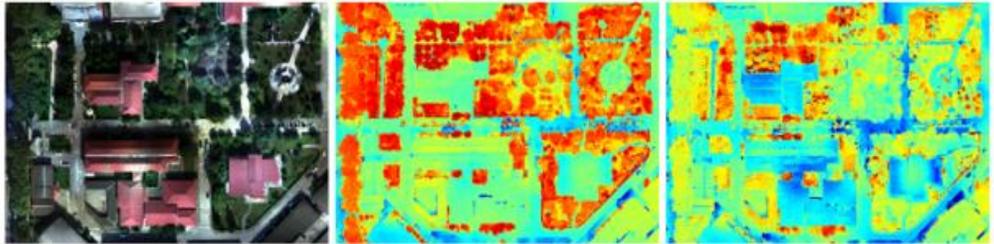


Multispectral imaging





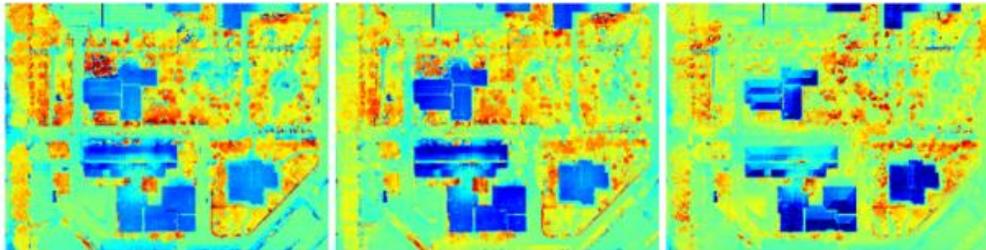
Multispectral imaging for object recognition



RGB

NDVI

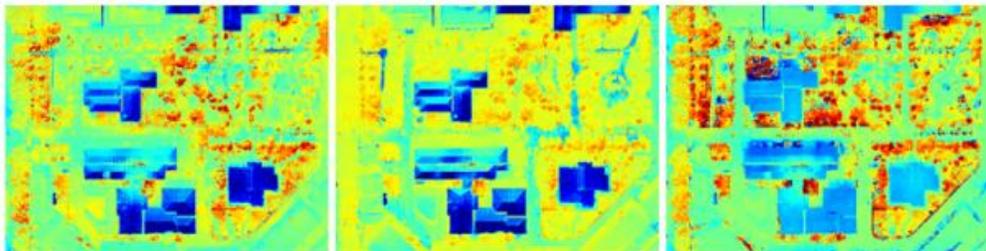
NRDE



NDI

VDI

CIVE

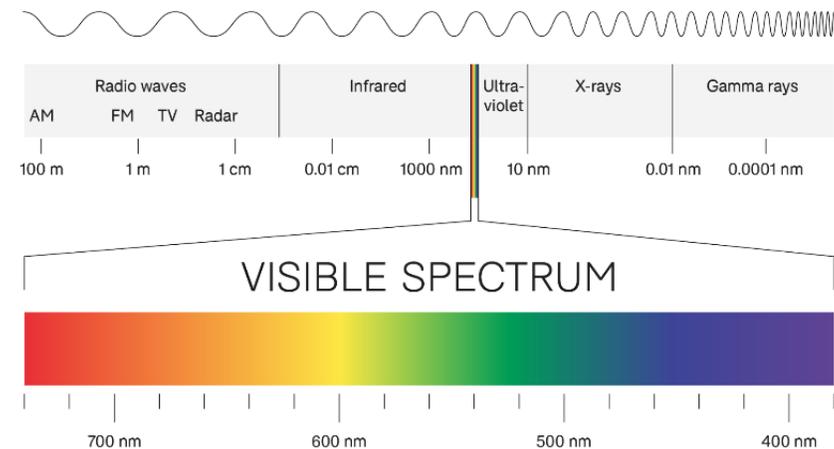


ExG

ExR

VEG

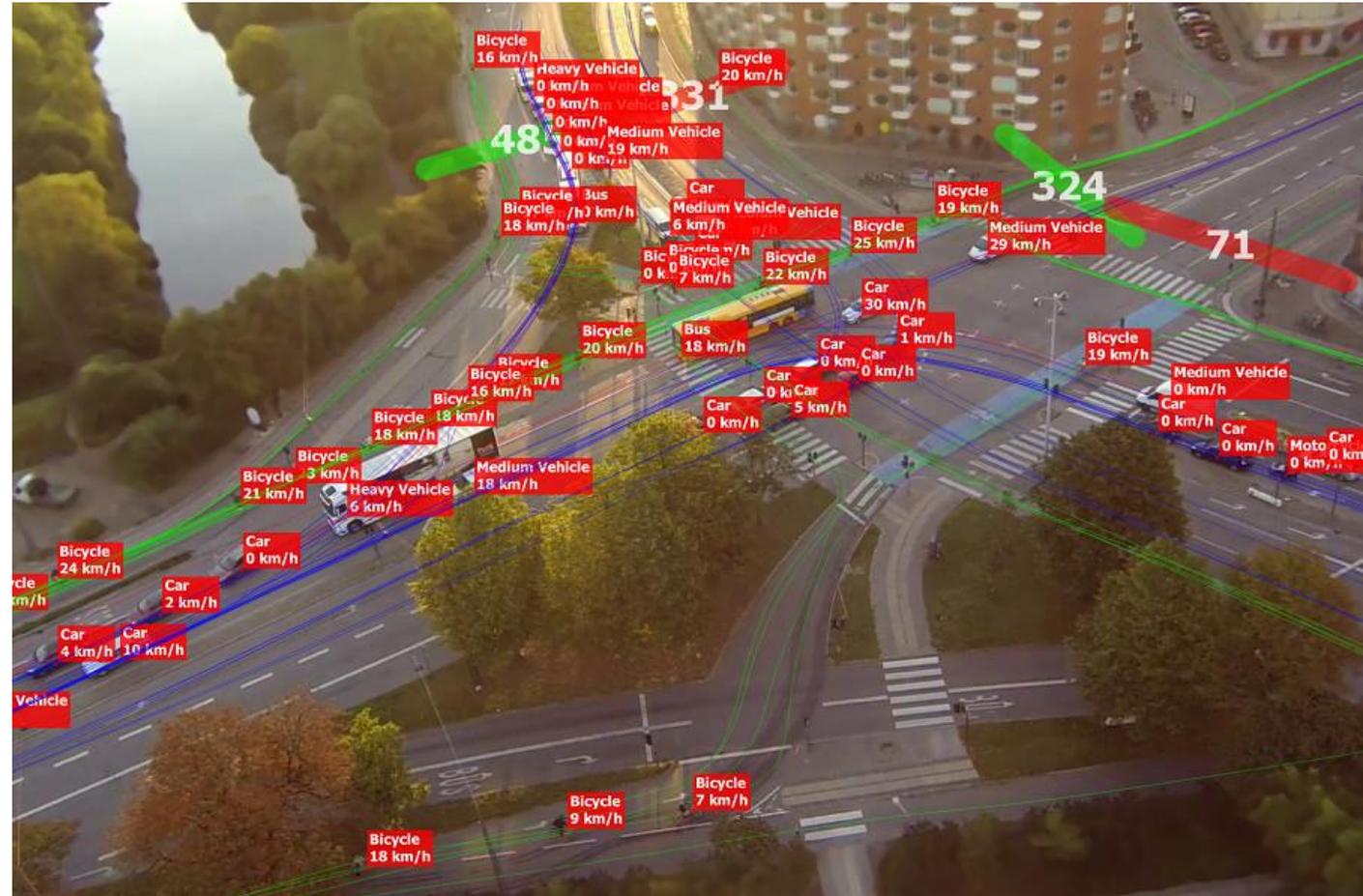
| Index | | Equation |
|-------|--|--------------------------------|
| NDVI | Normalized Difference Vegetation Index | $(NIR-R)/(NIR+R)$ |
| NDRE | Normalized Difference Red Edge Index | $(NIR-RE)/(NIR+RE)$ |
| NGRDI | Normalized Green-Red Difference Index | $(G-R)/(G+R)$ |
| VIDVI | Visible-band Difference Vegetation Index | $(2G-R-B)/(2G+R+B)$ |
| CIVE | Colour Index Vegetation Extraction | $0.441R-0.81G+0.385B+18.7874$ |
| ExG | Excess Green VI | $2G-R-B$ |
| ExR | Excess Red VI | $1.3R-G$ |
| VEG | Vegetation | $G/R^a B^{1-a}$ with $a=0.667$ |





Traffic recognition using a UAV

- Bicycle
- Motorbike
- Car
- Medium vehicle
- Heavy Vehicle
- Bus





Traffic recognition using a UAV

- Speed
- Acceleration





AI

- Object recognition
- Person recognition





Ultrasonic thickness measurement

- **Contact measurements** with ultrasonic sensors
- Non-Destructive Testing
- The high versatility and mobility of a drone is unmatched
- The costs of the inspections lowered by 25-50% because fewer man-hours are needed
- eliminating the need for human access to dangerous, hazardous areas
- **Results are 0.1 mm accurate**
- Wall structure
- Roof structure





Results/Conclusion

- Aerial photography: color 4K photos
- Aerial photography: 3D model reconstruction
- Measuring distances
- Measuring the volume
- LIDAR: 3D model by using laser distance measurement
- GPR: Ground Penetration Radar: to see the structures underground
- Thermal imaging
- Multispectral imaging
- Traffic monitoring using a UAV
- AI
- Ultrasonic thickness measurement



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Thank you for the kind
attention!

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