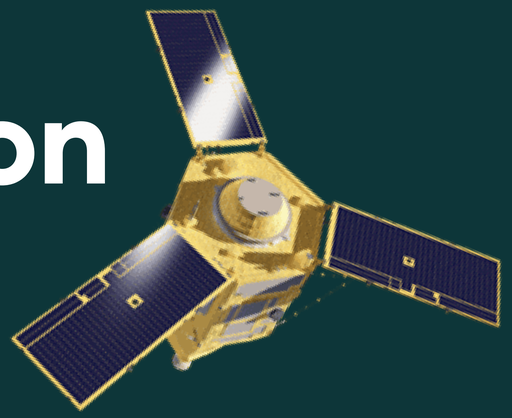
Pléiades Constellation



Pléiades is an environment-focused constellation (consisting of two satellites, referred to as 1A and 1B) from CNES of France, which were launched in 2011 and 2012. They are designed for a range of very-high-resolution (VHR) remote sensing applications in the field of cartography, agriculture, forestry, hydrology, and geological prospecting.

Particularities

The Pléiades satellites have a **very high resolution** (0.5m) and a swath of 20 km. They also offer a **daily revisit** capacity anywhere on the globe. They can also be easily be **reprogrammed** and aquire a new target in less than 24h

Summary of key attributes

- 4 bands: B-G-R-NIR
- Very high resolution
- 2 satellites
- Particularly useful for **object detection**

Sensor Description

- Satellite 1A and 1B are identical
- Orbit Height: **694 km**
- Swath: **20km**
- Revisit time: **1 day**
- Repeat Cycle: **26 Days**

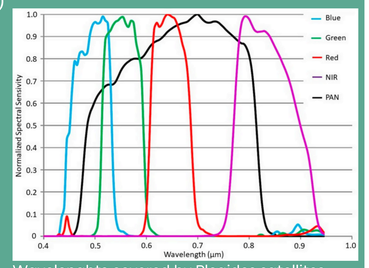
Spatial Resolution

- Resolution for PAN bands = **0.5m**
- Resolution for MS bands = **2m**

Spectral Bands

Panchromatic (Pan):
- 480-820 nm (**Grayscale**)

Multrisprecal (MS) bands:
- B0= 450-530 nm (**blue**)
- B1= 510-590 nm (**green**)
- B2= 620-700 nm (**red**)
- B3= 775-915 nm (**NIR**)



Wavelenghts covered by Pleaides satellites

1. "Pleiades - Earth Online," earth.esa.int. https://earth.esa.int/eogateway/missions/pleiades
2. E. Alcaras, C. Parente, and A. Vallario, "Automation of Pan-Sharpening Methods for Pléiades Images Using GIS Basic Functions," Remote Sensing, vol. 13, no. 8, p. 1550, Jan. 2021, doi: https://doi.org/10.3390/rs13081550.

Application: Object Detection

- Further to all the applications in forestry, oceanography, coastal science and urban planning, one of the key uses of the Pléiades sensor is in **object detection**.
- Thanks to its **high resolution**, Pléiades data can be used for object-based image analysis in urban environments.
- Object detection utilizes **algorithms** to analyze satellite images and automatically identify and count individual objects within the image.
- It is particularly useful in areas like urban development monitoring, traffic analysis, and even defence, where the ability to **detect and classify objects** in detailed satellite imagery is essential for making informed decisions.

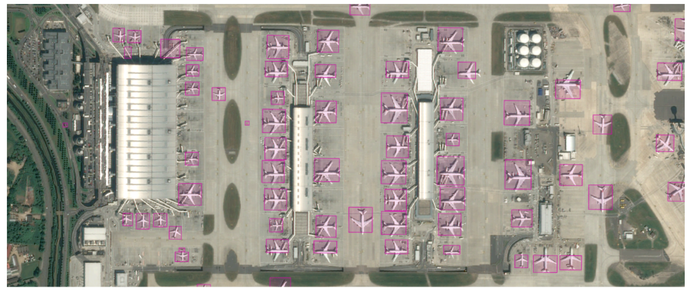
Challenges :

- **Limited number of satellites :** A major challenge with only two satellites is to have good spatial and temporal coverage of the Earth. With Pléaides, space and ground segment have been designed for these sensors to ensure daily revisit capacity anywhere on the globe.
- **Atmospheric conditions :** Cloud cover, atmospheric haze, and other weather conditions can obscure satellite images, reducing the clarity and accuracy of object detection.
- **Sensors and classification :** The effectiveness of object detection in satellite images relies heavily on the capabilities of the sensor, which must handle noise, varied resolutions, and environmental conditions. High-resolution sensors are crucial for capturing detailed images. Robust calibration and adaptability ensure accurate detection and classification, even in challenging terrains.

3. A. Mukhopadhyay et al., "High-resolution Pléiades data: an in-depth analysis of applications and future prospects," Spatial Information Research, Jun. 2024, doi: https://doi.org/10.1007/s41324-024-00593-x.
4. "Object Detection," GO, 2024. https://docs.orbitalinsight.com/docs/object-detection.

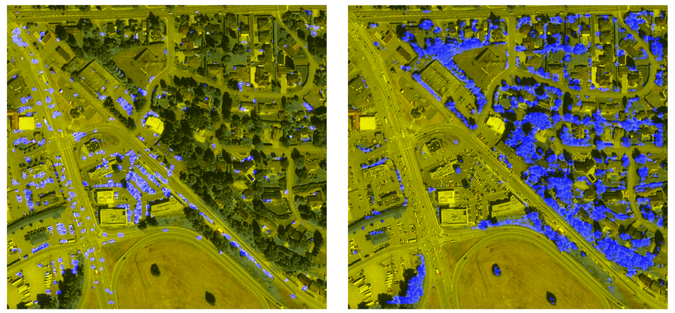
Examples

Earth observation platform UP42 have different algorithms in place to allow multiple scenarios of object detection for analytical solutions. Their algorithms allow aircraft detection & classification (carrier / fighter / helicopter / ...)



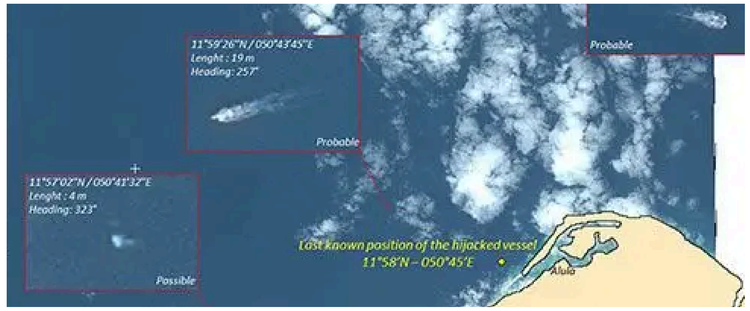
Detected aircrafts from a Pléiades image of Heathrow Airport in London. Source: UP42

Thanks to their high resolution, deep features can be used on Pléiades imagery in order to train a detection algorithm (here using CNN) to detect small objects such as cars dnd trees.

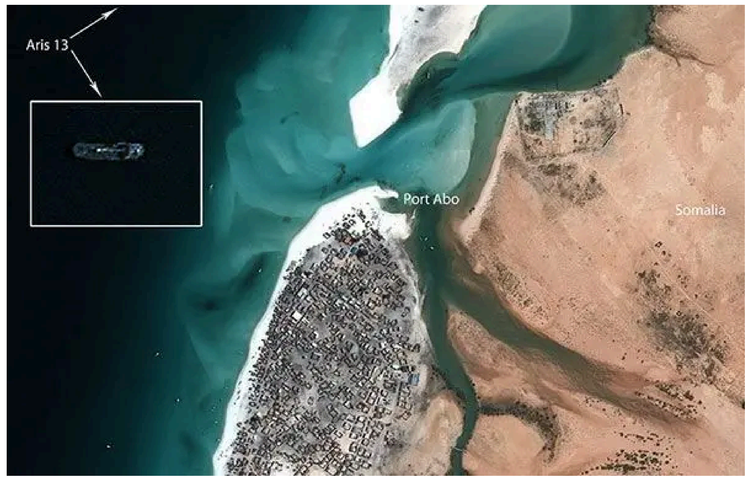


Test image results of detection of cars (left) and trees (right) in a Pléiades image of Quebec

5. M. Dahmane, S. Foucher, M. Beaulieu, F. Riendeau, Y. Bouroubi and M. Benoit, "Object detection in pleiades images using deep features," 2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Beijing, China, 2016, pp. 1552-1555, doi: 10.1109/IGARSS.2016.7729396.



Pléiades' capacity for object detection was also used in order to permit to find the ARIS 13 hijacked tanker vessel when Somali Pirates seized it in 2017. It was located in less than 2 days.



Source: Airbus

> "The Pleiades system is extremely responsive, we can reprogram the satellite very quickly, which means we can respond to emergency situations, including major disasters".
> **- Helène de Boissezon, former Head of Image Analysis and Products at CNES**

6. Aerospatium, "Pléiades et la Charte internationale Espace et catastrophes majeures," YouTube, Oct. 01, 2019. https://www.youtube.com/watch?v=u1yJLhDBjq8.

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