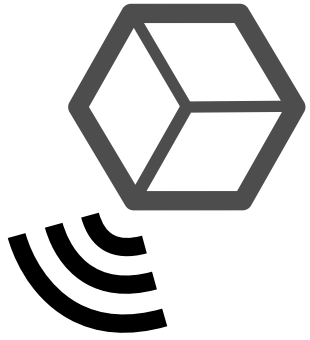
NTNU AMOS

Centre for Autonomous Marine Operations and Systems

HYPESPECTRAL IMAGING

Payload design and UAV flights

SmallSat Seminar - Sept. 6th 2017



João Fortuna

NTNU - AMOS - ITK

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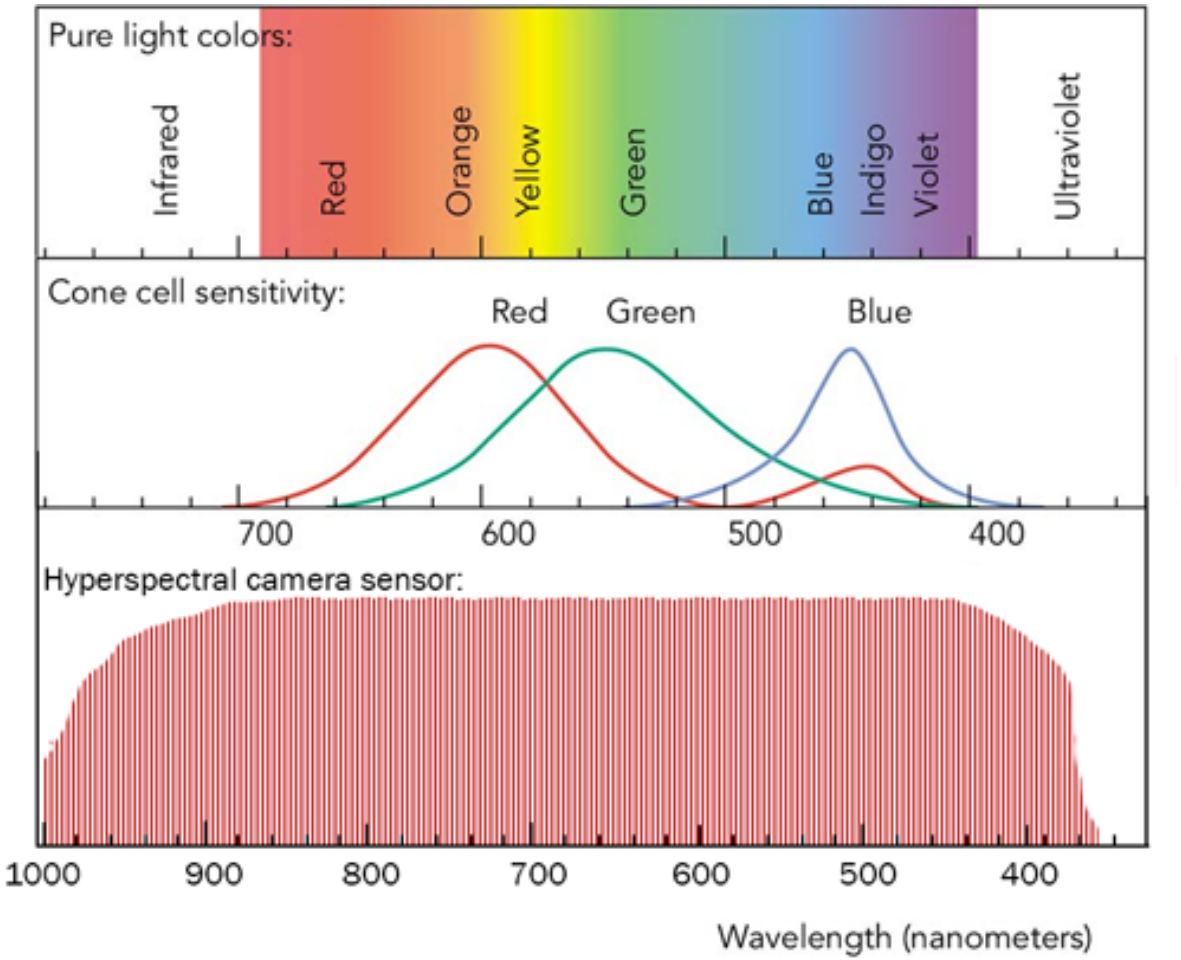
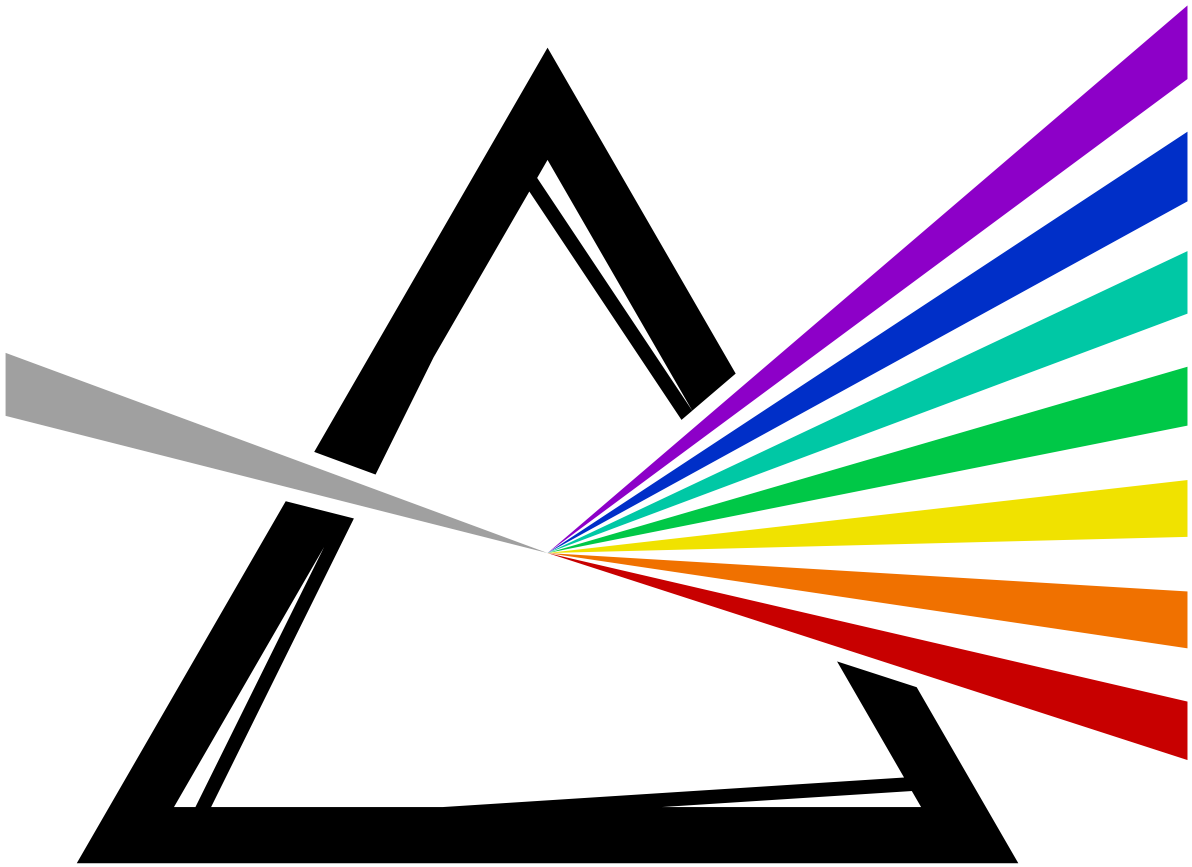
OPTICS BACKGROUND

WHAT IS HYPERSPECTRAL IMAGING?

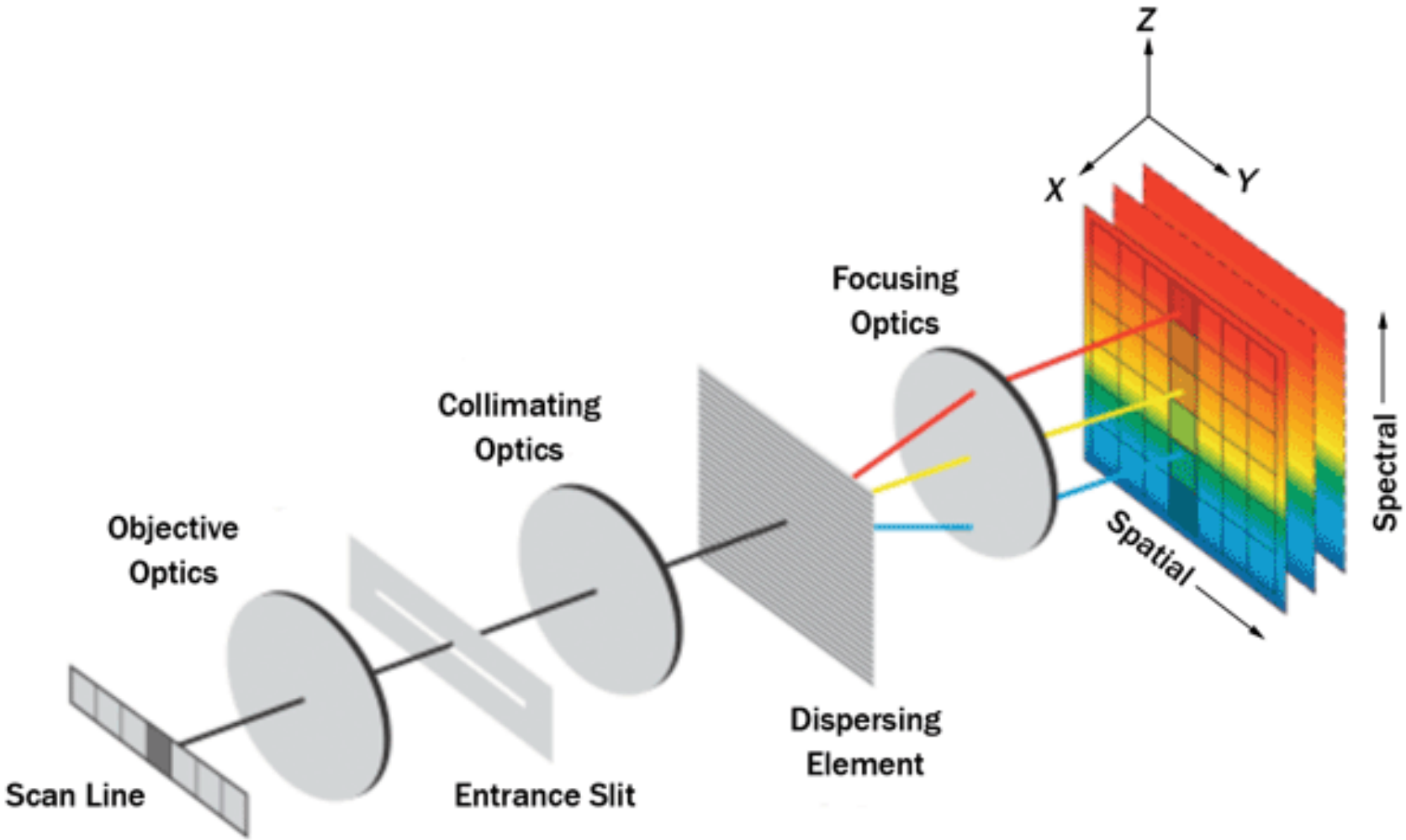


Human eye spectral sensitivity vs. Hyperspectral sensor

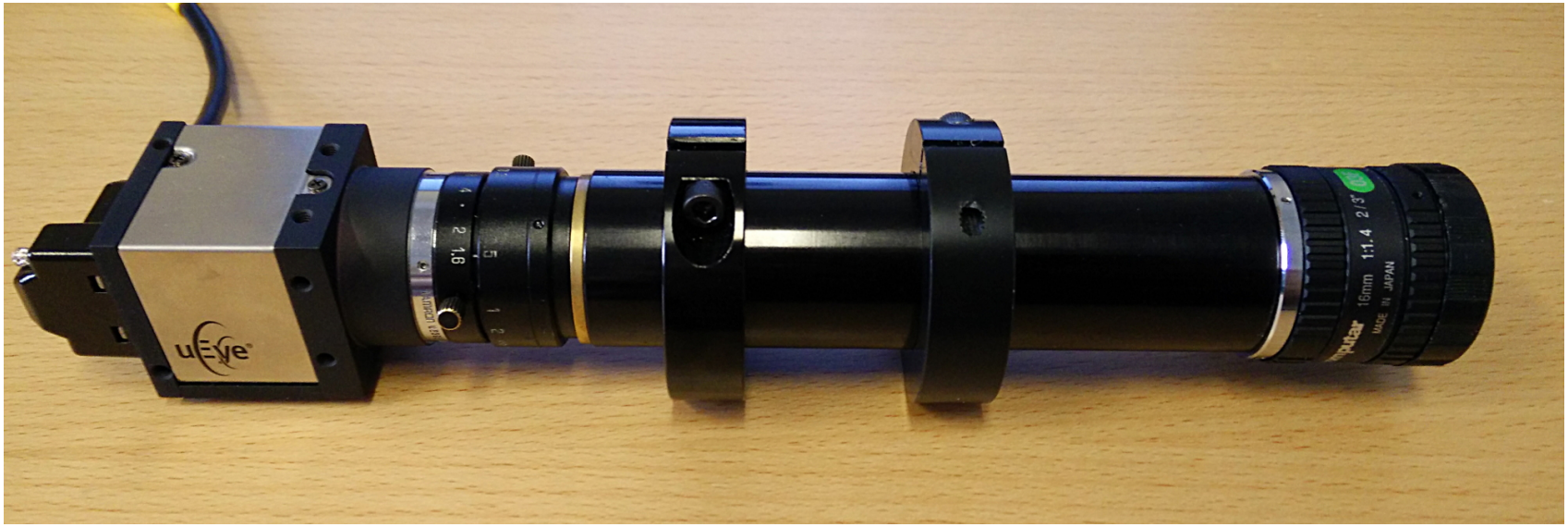
HOW DO WE GO HYPERSPECTRAL?



PUSHBROOM

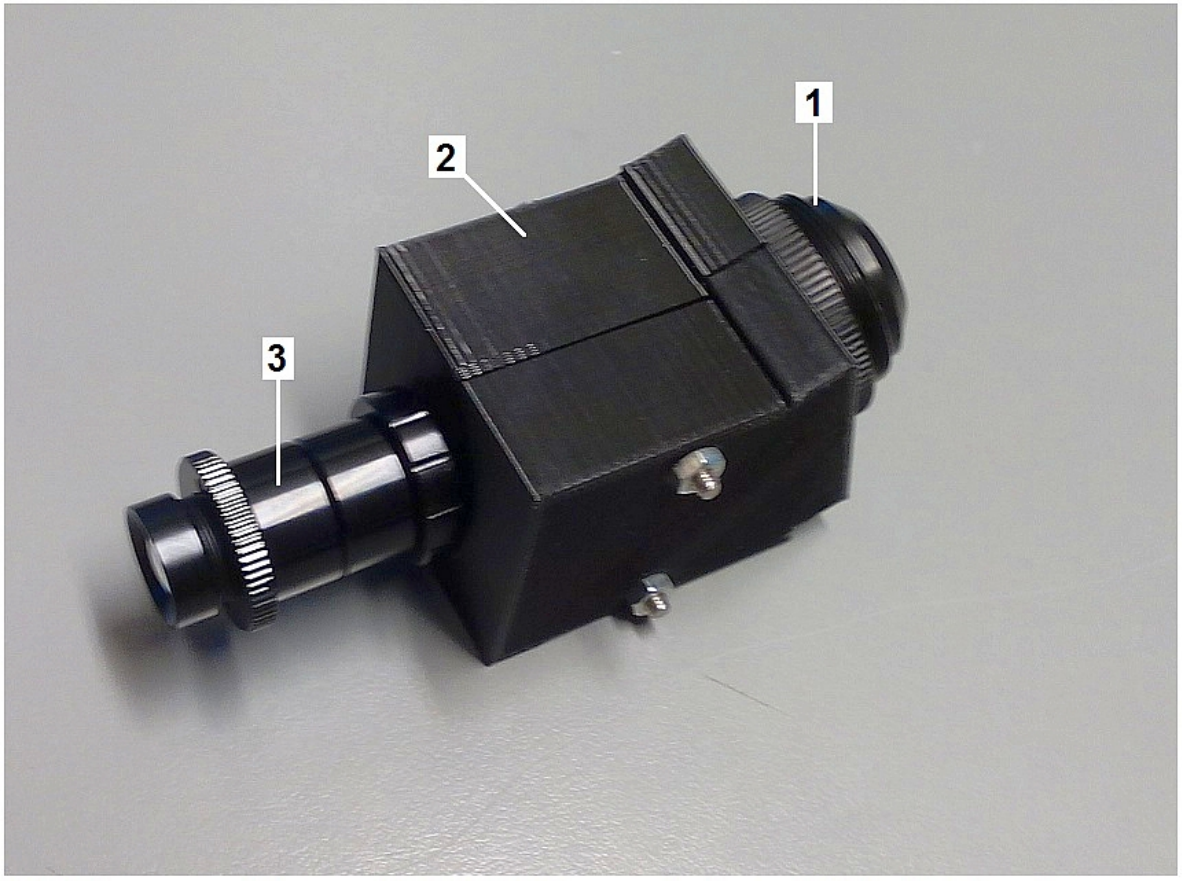

Z
X
Y
Focusing
Optics
Collimating
Optics
Objective
Optics
Spectral
Spatial
Dispersing
Element
Scan Line
Entrance Slit

HYPERSPECTRAL CAMERA



Prototype by Fred Sigernes (University of Svalbard)

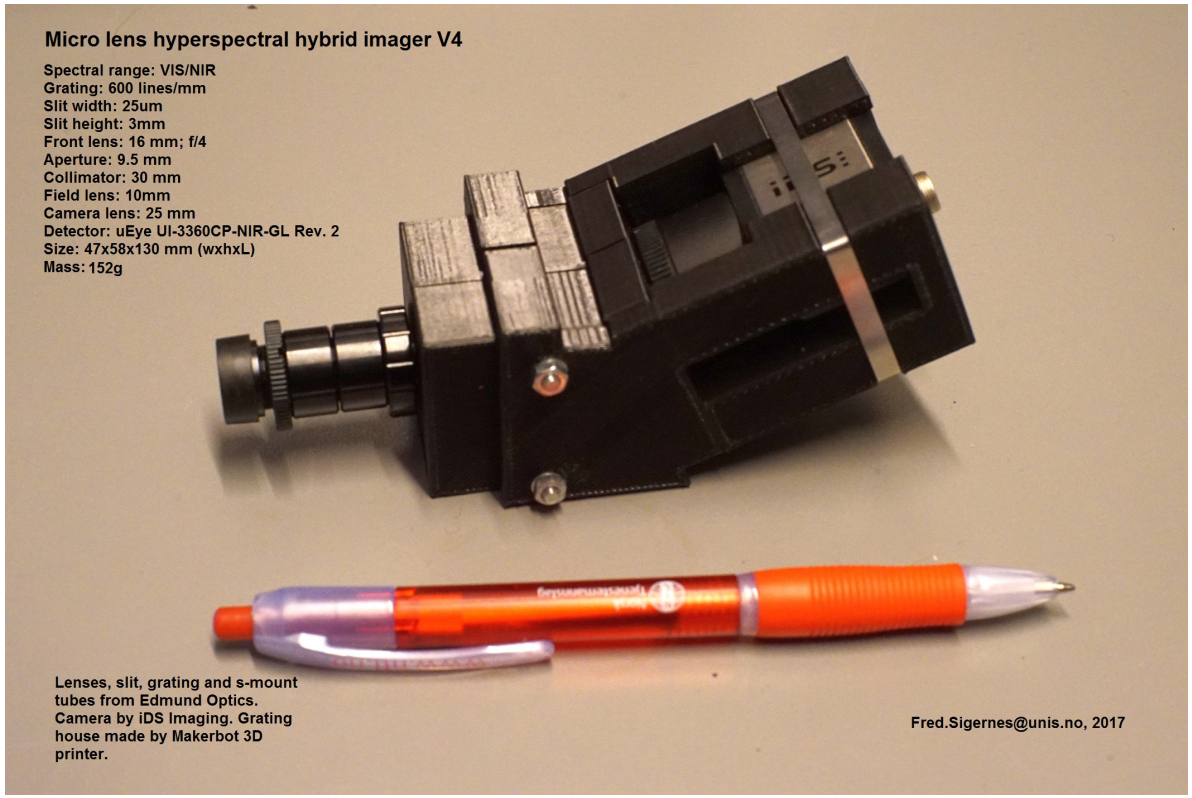
HYPERSPECTRAL CAMERA V2



Mini Hyperspectral Imager V2. (1) S TO C-mount adapter, (2) 3D printed optics holder and (3) Front optics w/ slit.

Prototype by Fred Sigernes (University of Svalbard)

HYPERSPECTRAL CAMERA V4



Prototype by Fred Sigernes (University of Svalbard)

REGARDING RESOLUTION

Spacial resolution is defined as the pixel size of an image representing the size of the surface area being measured on the ground.

Ground Sample Distance(GSD) is the distance between pixel centers measured on the ground.

Two different concepts that can have very different values!!

REGARDING RESOLUTION

Swath width (SW):
$SW = Z\frac{h}{f_0}$

Ground Instantaneous Field of View (GIFOV), along-track:
$\Delta_x = Z\frac{w}{f_0}$

For a sun synchronous orbit of 96min:
$Z = 574Km, f_0 = 50mm, w = 75\mu m, h = 3mm$
$SW = 34.4Km; \Delta_x = 861m$

If $w = 25\mu m$, then $\Delta_x = 287m$, but we get less light in sensor.

REGARDING GSD

Ground Sample Distance(GSD):
$GSD = \frac{v_{gnd}}{fps}$

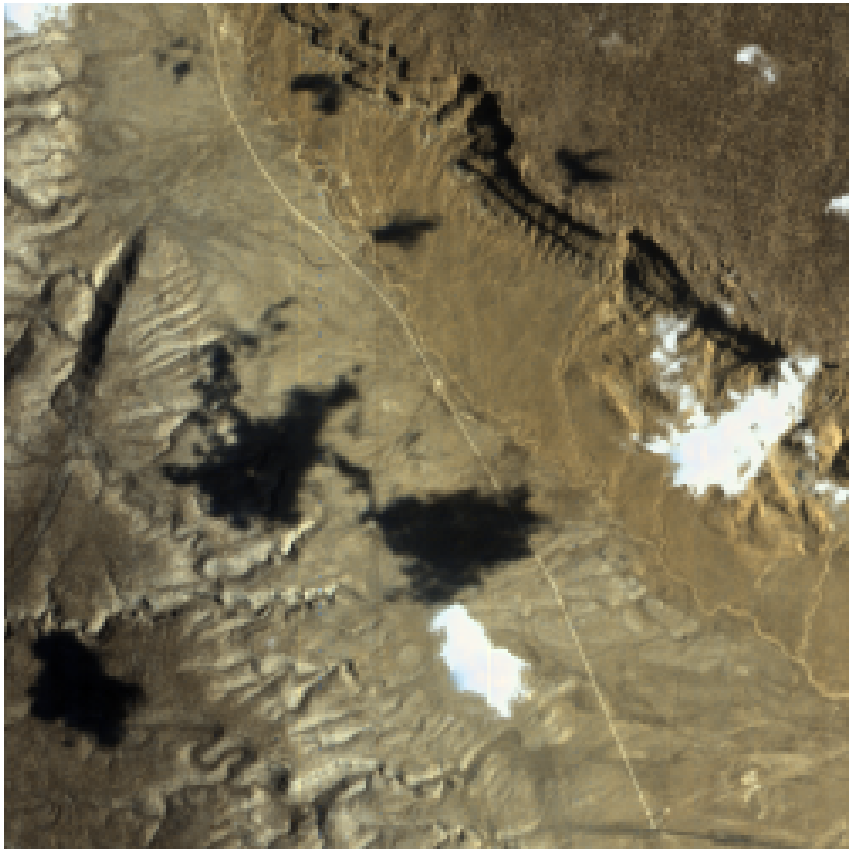
If we have a $5min$ window of observation and want to observe $50Km$:
$v_{gnd} \approx 167m/s$ and consider $fps = 15$
$GSD \approx 11m$!

If exposure time is $50ms$ then motion blur is caused by displacemente of $\approx 8m$ on the ground.

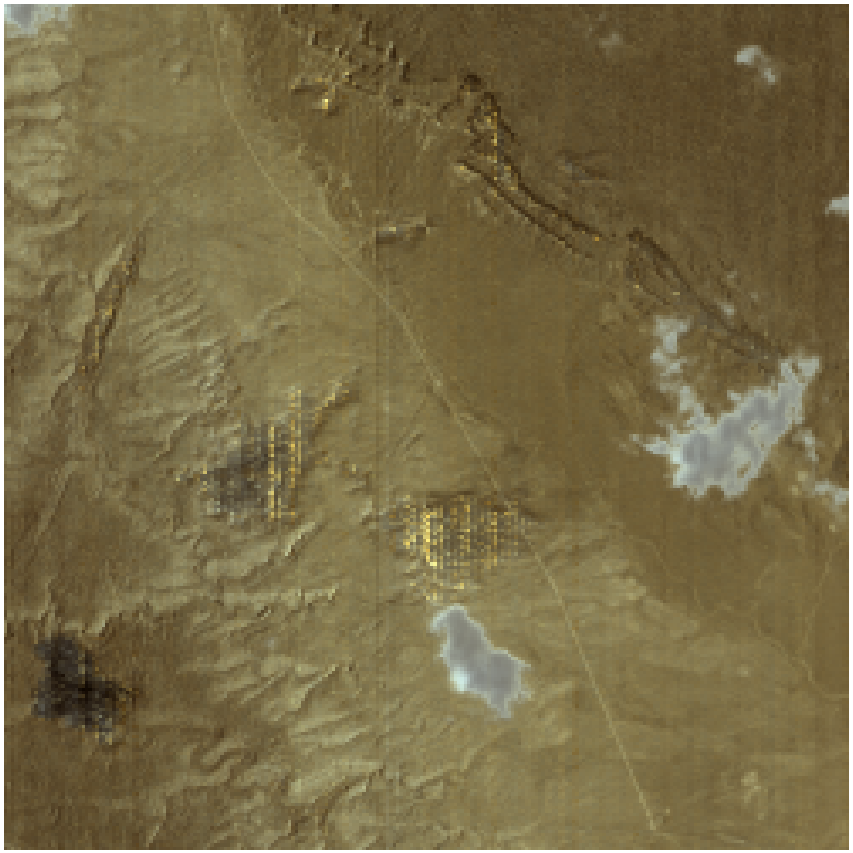
DE-SHADOWING

SATELLITE IMAGE DATA

Original



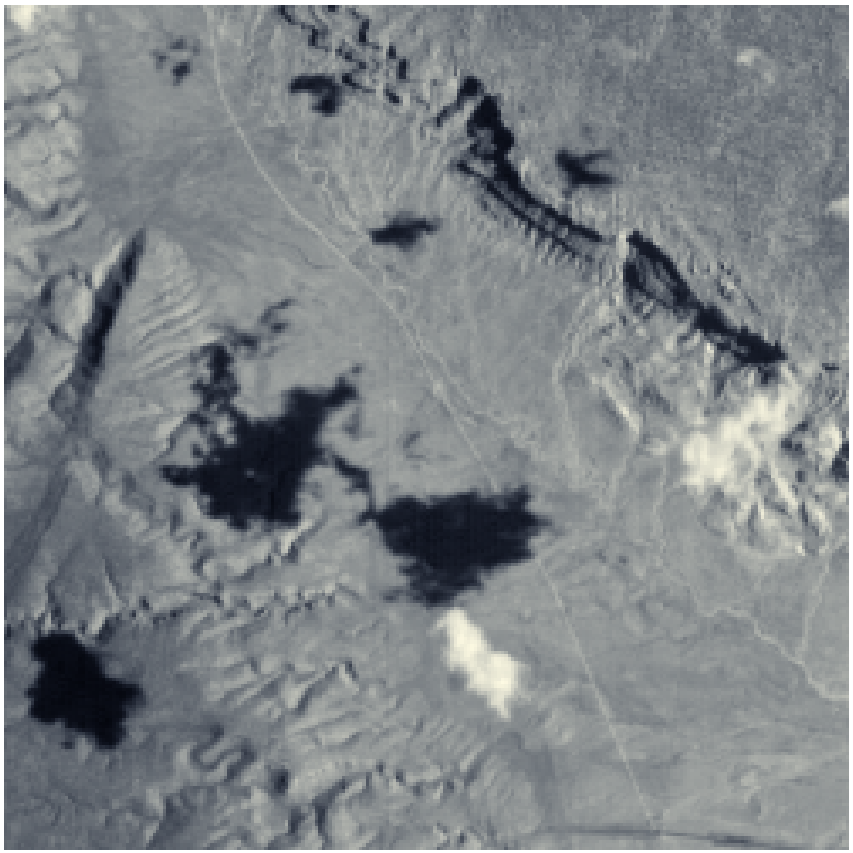
De-shadowed



Data from EO-1 Satellite, available at the USGS portal

SATELLITE IMAGE DATA

Shadow



TEST FLIGHTS

TESTS IN PORTUGAL

LESSONS LEARNED

- Settings for imaging ocean/water bodies with optimal dynamic range, do not work for land targets (saturated).
- Observing the ocean makes image reconstruction simpler, since we can assume a ”flat” surface, with constant altitude.
- Sun glint/glare will be an issue. If data is saturated, might be impossible to recover any information.