CoMIC: A Compact Multicolor Imaging Camera

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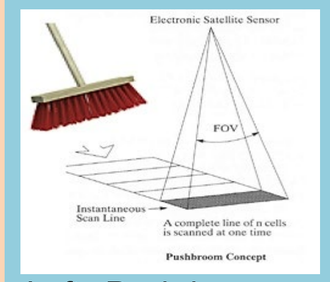
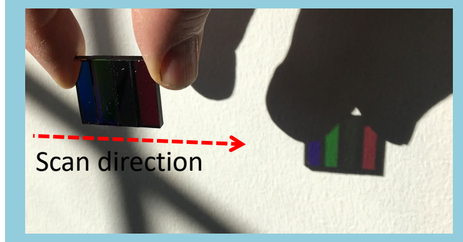
Abstract

We describe the construction and features of a compact multicolor imaging camera (CoMIC) that can be used for remote sensing in 400-900 nm wavelength range. The instrument accommodates a mosaic of optical filters that allow only certain wavelengths of light allowing CoMIC to image different segments of a scene in different wavelengths, then scanned in a push-broom fashion to image a large area in multiple colors. The choice of colors are determined by the chemical species or reaction to be observed: sodium and potassium doublet emission in this prototype.

Push-Broom Scanning

As the name indicates, push-broom scanning (or on-track scanning) uses a line of detectors perpendicular to the direction of scanning. In the case of CoMIC, the field-of-view (FOV) is divided into segments of different colors, and scanning is performed perpendicular to the segments so that one point is imaged under all color segments in the instrument.

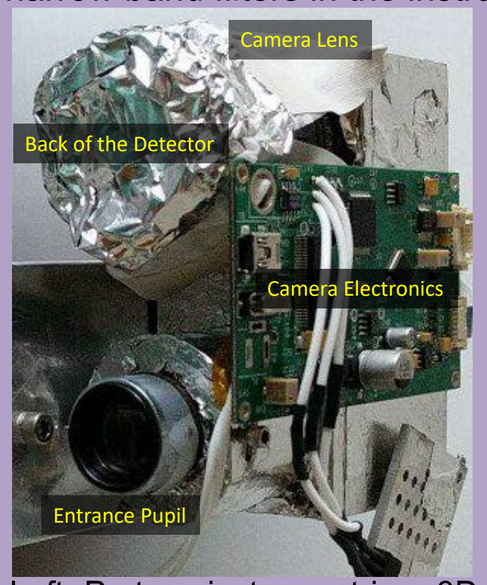


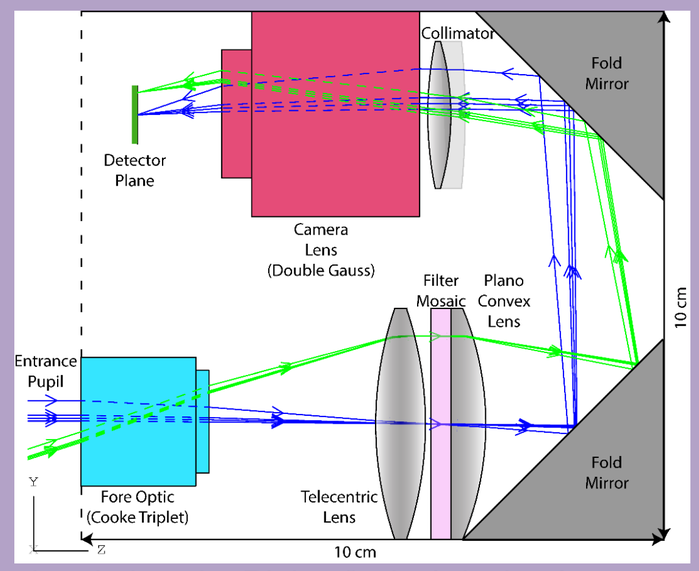


Left: Push-broom scanning concept is described (courtesy: Harris Geospatial); Right: Filter mosaic used in CoMIC, with possible scan direction. The four colors correspond to 500 nm, 589 nm, 770 nm and 700 nm from left to right.

Design Principle

The instrument is designed around the 1U-CubeSat form factor that restricts its mass and volume within a 1.4 kg, 10 cm cube. The filter mosaic that lends CoMIC its ability to image in multiple colors require near-normal incidence of light for optimal operation. This is achieved by placing the filter mosaic at a *telecentric image plane*. The filter plane is then reimaged onto a charge-coupled detector (CCD) array using multiple lenses. The telecentric configuration allows the use of very narrow band filters in the instrument.



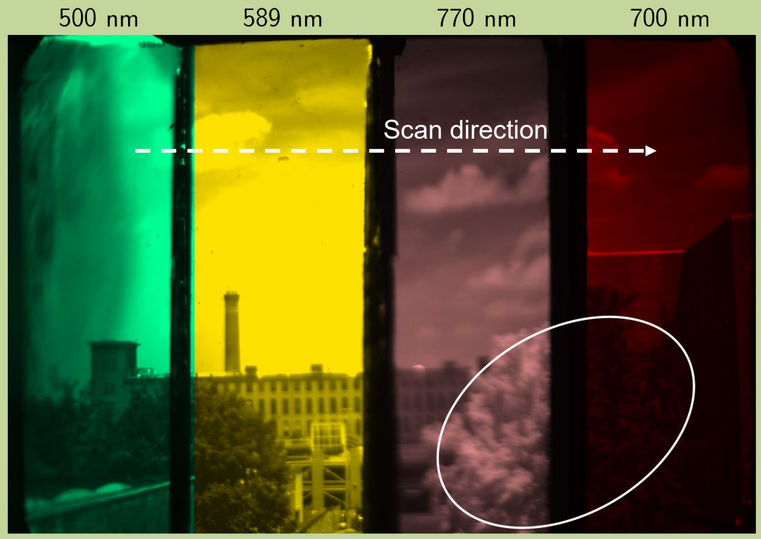


Left: Protype instrument in a 3D-printed chassis; Right: Optical design layout of the instrument.

Data Acquisition

- Obtains optimally bright images through automatic exposure control
- Prototype instrument has four filter panes: 589 nm for sodium, 700 nm for potassium, 500 nm and 700 nm for background continuum

This scene is observed by CoMIC, whose output is displayed on the right.



1 ms exposure taken by CoMIC on a sunny day. The four filter patches are indicated in the figure using false colors. The white ellipse indicates to a tree under the 700 and 770 nm patches; dark trees under all filters but 770nm demonstrates low absorbance by chlorophylls beyond 700 nm.

Design Highlights

- 1U CubeSat compatible
- 8 Watts power usage
- 30° field of view (FOV)
- 0.1° angular resolution
- High optical throughput
- 400 nm-900 nm operating range
- Can be used with very narrow band interference filters
- Exposures as low as 1ms

Future Plans

- Customizable filter mosaic, along with the compact form factor and rugged design makes it ideal for applications such as aeronomy (study of upper atmosphere), to surface remote sensing (agriculture, oil and gas exploration etc) in the visible to near infrared range with a large number of signatures.
- Higher resolution with a smaller FOV or vice-versa with minor modifications to the existing design to extend range of applications.
- Planned weather balloon flight to measure airglow over a 24-hour period to augment existing instruments that measure airglow.

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