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TopSat: low cost high-resolution imagery from space

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Abstract

TopSat is a mission to demonstrate the use of small low-cost platforms for high-resolution imaging and direct data dissemination to local users via the use of a fully mobile ground station. The main elements of the TopSat system are described including the high-performance imaging system, microsatellite platform, data-handling/downlink and ground station that will be used. Finally, the current status of the programme as of January 2003 is summarised.

1. Introduction

TopSat is a low cost-microsatellite (~120 kg) which is being developed by a consortium of UK industrial partners. It will produce high-resolution imagery from low Earth orbit and demonstrate rapid dissemination of imagery to local users. The TopSat project will provide a complete end to end mission encompassing development, build, launch and operations.

The TopSat mission is sponsored jointly by the UK Ministry of Defence (UK MoD) and the British National Space Centre (BNSC, who provided funded through the MOSAIC small satellite initiative). The TopSat consortium consists of:

- Surrey Satellite Technology Ltd are building the microsatellite platform,
- Rutherford Appleton Laboratory are providing the high-resolution imaging system,
- QinetiQ are leading the consortium, providing the data-handling unit (DHU), downlink equipment, payload operations and the mobile/fixed ground stations,
- Infoterra are responsible for commercial exploitation of TopSat image data to show the commercial utility of low-cost systems.

TopSat is designed to provide 2.5 m resolution panchromatic (and 5 m multispectral) imagery of a 15×15 km area from a 600 km sun synchronous orbit. The satellite will be capable of imaging up to 30° off nadir and will be able to revisit any location on the globe within 6 days. In addition, TopSat will provide a demonstration of small satellite capability within the UK and the use of low-cost satellites to provide timely information direct to local users.

In order to balance these requirements against the significant technical and financial constraints on the

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mission, a low-cost philosophy has been adopted. This consists of:

- Tight constraint on requirements and no "nice to haves",
- Use of contractor standards rather than imposition of industry standards,
- Reduce the scope of the mission rather than increase the cost,
- Use of existing COTS/heritage equipment/solutions wherever possible. (i.e., use of proven SSTL bus systems, QinetiQ CrenLok joint and flight spare S-band transponder from STRV-1c/d mission.)

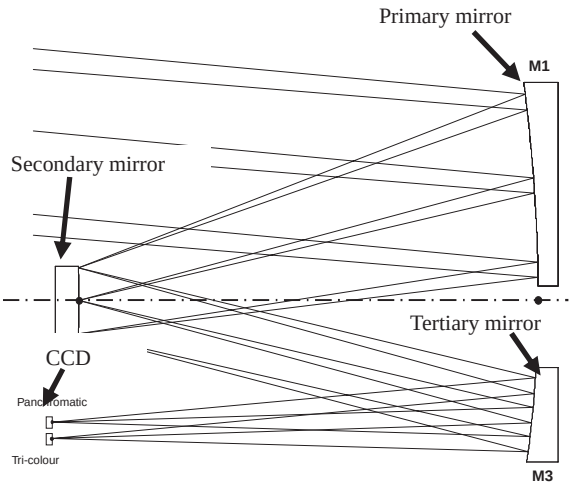

Fig. 1. Camera optical.

2. System description

2.1. Camera

The TopSat camera being developed by RAL is designed to meet the requirements of high resolution and optical quality, wide field of view and good radiometric performance whilst being accommodated on a small satellite bus. These requirements have led to an all reflective, 3 mirror off axis system with a 1.68 m focal length and a 20 cm aperture accommodated within a volume of $75 \times 52 \times 35\,\mathrm{cm}^3$. The optical system consists of off axis hyperbolic primary and tertiary mirrors and an on axis secondary mirror, giving a field of view of 1.4° across track (Fig. 1).

The combination of high resolution and small aperture size means that to obtain an acceptable signal to noise performance it is necessary to increase the exposure time of the detectors beyond that available for a simple pushroom imager. This is achieved using a form of time delay integration (TDI) in which the TopSat platform is slewed so that the apparent motion of the camera field of view over the ground is slowed down.

The camera focal plane accommodates 2 commercial linear CCDs, a 7 μm pitch panchromatic array and a 14 μm pitch tri colour (red, green and blue) array. These occupy about half of the optical field of view to give an image swath of 15 km (10 km for colour channels).

The optical components and focal plane electronics are mounted on an optical bench of monocoque

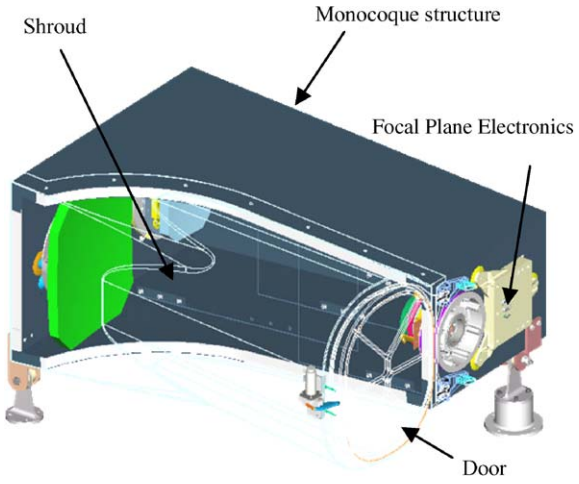

Fig. 2. Camera.

design (Fig. 2). This consists of panels of aluminium honeycomb core with CFRP faceskins joined using the "CrenLok" corrugated joint developed at QinetiQ. The camera structure is mounted onto the spacecraft by 3 Titanium blade mounts, which are designed to remove any effects of thermal stresses between the camera and spacecraft. This structural arrangement provides low CTE and high strength allowing the optical system to maintain alignment during thermal cycling and launch vibration.