Image Acquisition System for Microsatellite µSAT-3

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1. Introduction

µSAT-3's principal mission will be the observation of the Argentine mainland. For that purpose, this satellite integrates two cameras: one for low, and one for high resolution monochrome images. A special optical focus system is being developed for the high resolution camera, due to small dimensions of the satellite. It consists on a pair of mirrors that reflect the light received from the target lens in order to enlarge the light track.

The Image Acquisition System (IAS)(see diagram on **Figure 1**) includes its own processing unit, controlled by the main On-Board Computer system of the microsatellite, from which it receives commands for image capturing, external storage and for sending images to ground. This system, will be capable of taking images and store them on an external disk. Also, it will generate low resolution images catalogues on demand, that will be sent to Ground Station for picture selection.

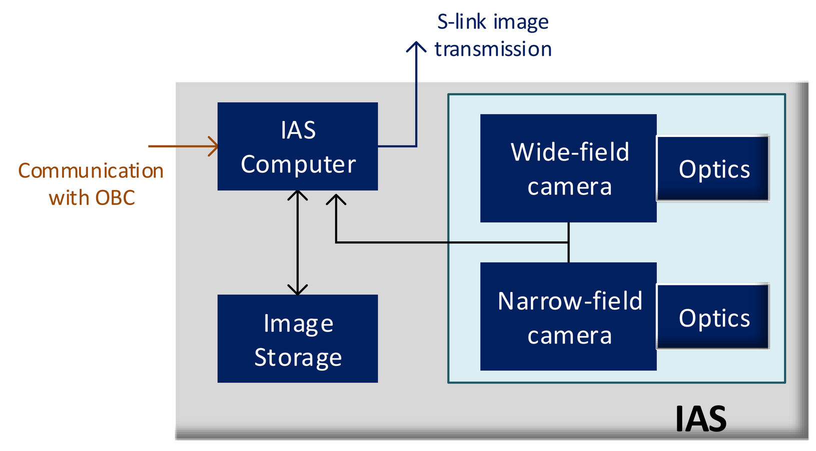

Figure 1: *IAS block diagram.*

2. Cameras

The wide-field camera(**Figure 2**), is intended to cover a 230x200 Km. area, with a 100m/px. resolution.

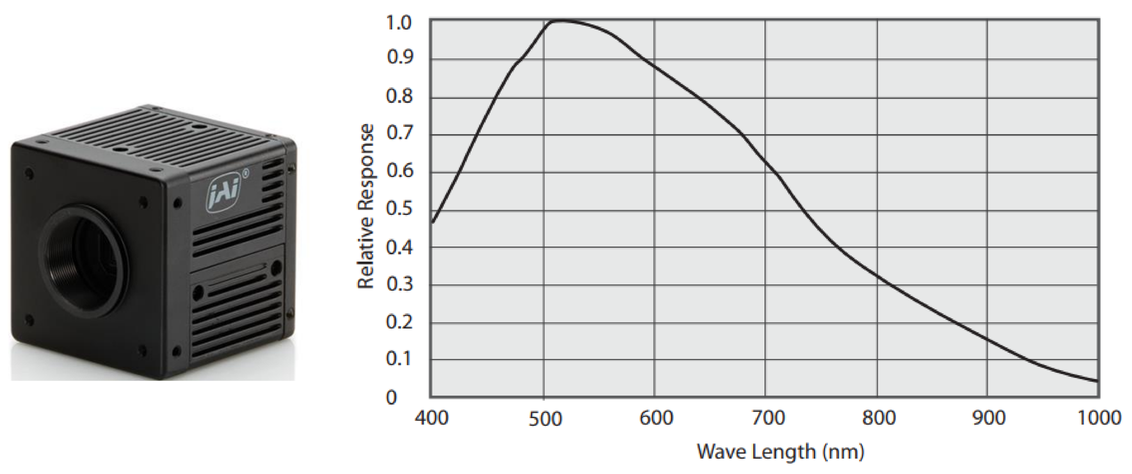

Figure 2: *Low resolution camera.*

For high resolution images, µSAT-3 will incorporate a narrow-field camera (**Figure 3**), targeted to capturing 40x30 Km. pictures, with 10m/px.

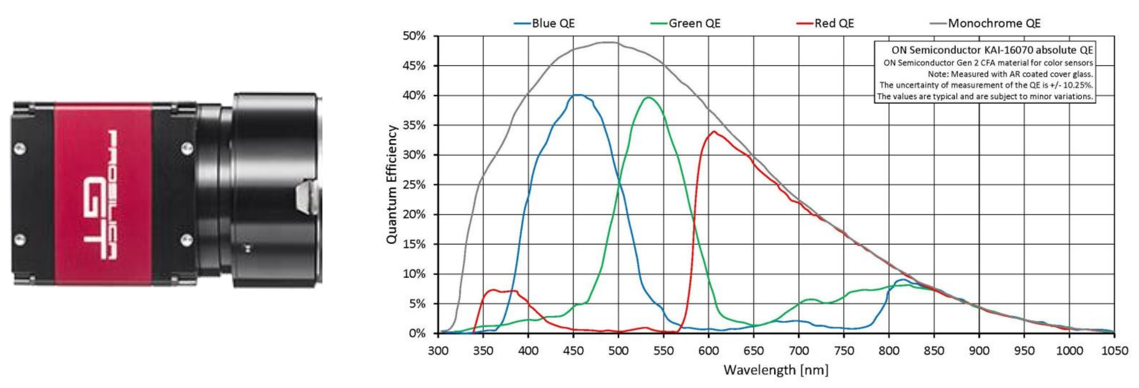

Figure 3: *High resolution camera.*

Both cameras provides monochrome images up to 14-bit depth, and are GigE Vision compliant.

3. Focusing Mechanism

Due to volume restrictions imposed by the launcher interfaces (piggyback mode), there is a maximum static envelope that can not be greater than 350x350x480mm. Also, from the structural dynamics point of view, a large protrusion implies significant take-off loads on deployable components.

Therefore, a special optical focus system (**Figure 4**) is being developed for the high resolution camera. It consists on a pair of mirrors that reflect the light received from the target lens in order to enlarge the light track.

Focus length can be adjusted using a linear servomotor acting over a set of flexible plates, where the camera is mounted.

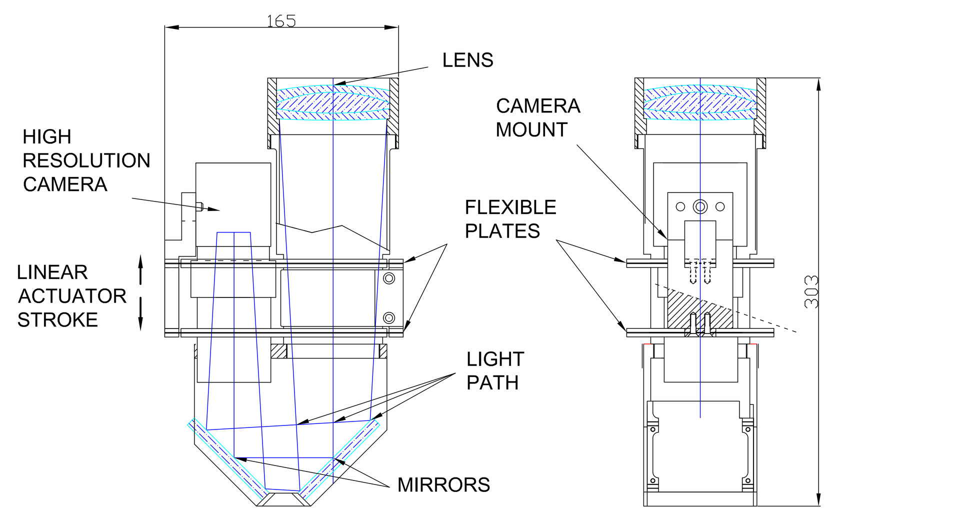

Figure 4: *Focusing mechanism for high resolution camera.*

4. Hardware, Software and Control

The payload control incorporates a processor unit based on an ARM9 CPU, running under Linux OS. For image storage, it includes a SSD external disk connected to a SATA port.

Because a high bandwidth demand, a dedicated connection between payload control and S-band transmitter is required.

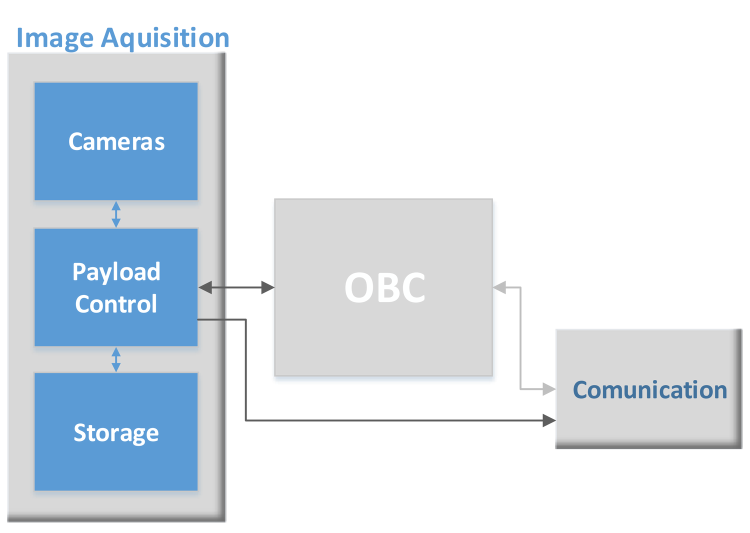

Figure 5: *Interaction between IAS components with the rest of the system.*

The operation of the IAS computer will be controlled by the main OBC system, through an UART communication channel. Also, over this connection a SSH protocol tunneling will be implemented. This would allow full access to IAS computer file system, where the images will be stored.

IAS subsystem will be able to generate catalogues on demand, sending low resolution images for selection. The IAS will provide, through this catalogue, the ability of selecting which images of interest (or a part of them) will be sent to the ground station.

5. Imaging

What we would expect to see...

Figure 6: *10 meters per pixel - Campo de Mayo, Argentina.* Source: Google Earth

6. Improvements Over the Years

µSAT-3 will be the third of a generation of microsatellites, developed by Argentinian Air Force. Through the years its imaging capacity has been improved, as shown below:

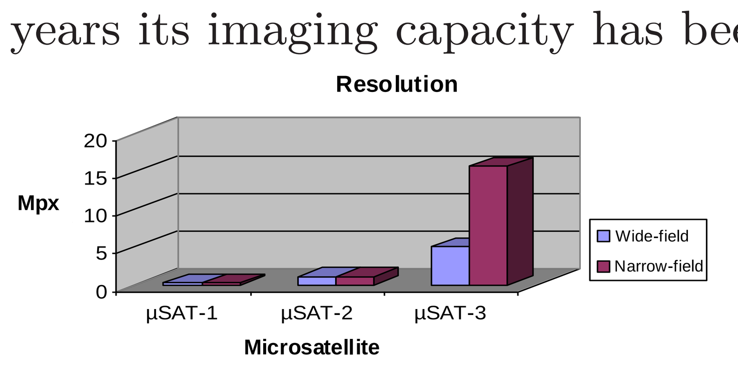

Figure 7: *Improvements in resolution.*

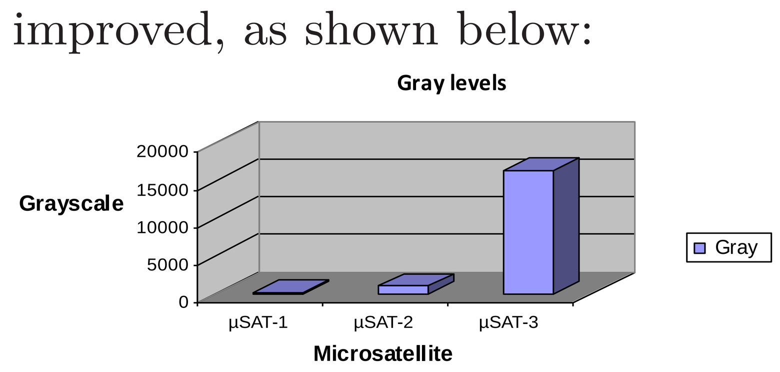

Figure 8: *Image pixels quantification with up to 14 bits.*

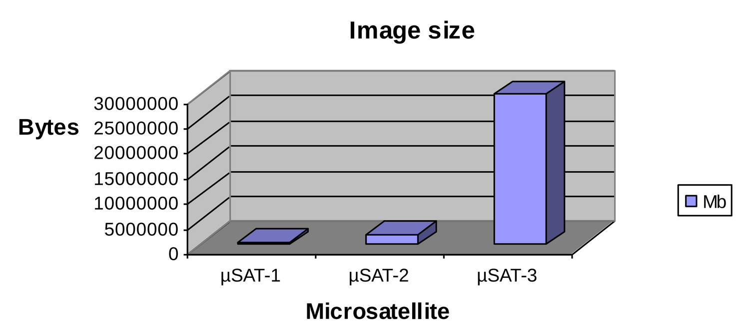

Figure 9: *Impact of more detailed images in file size (in bytes).*

7. Conclusions

As most of the IAS components are COTS (not radiation hardened), they must pass Q&A tests in order to overcome the launch and space environment phases. For the focusing optical mechanism, there are some other alternatives under consideration instead of the linear servomotor: heated bimetallic strip, an electromagnetic system or a HOP (High Output Paraffin) actuator.

8. References

[1] Palacios, Gastón et Al. Memoria Técnica S/N:"Proyecto MuSAT-3: Fases C y D – Desarrollo y Calificación", September 2015.