Multi-Spectral Camera Development

4th Biennial Conference

Presented by Mark Holloway
10 October 2012

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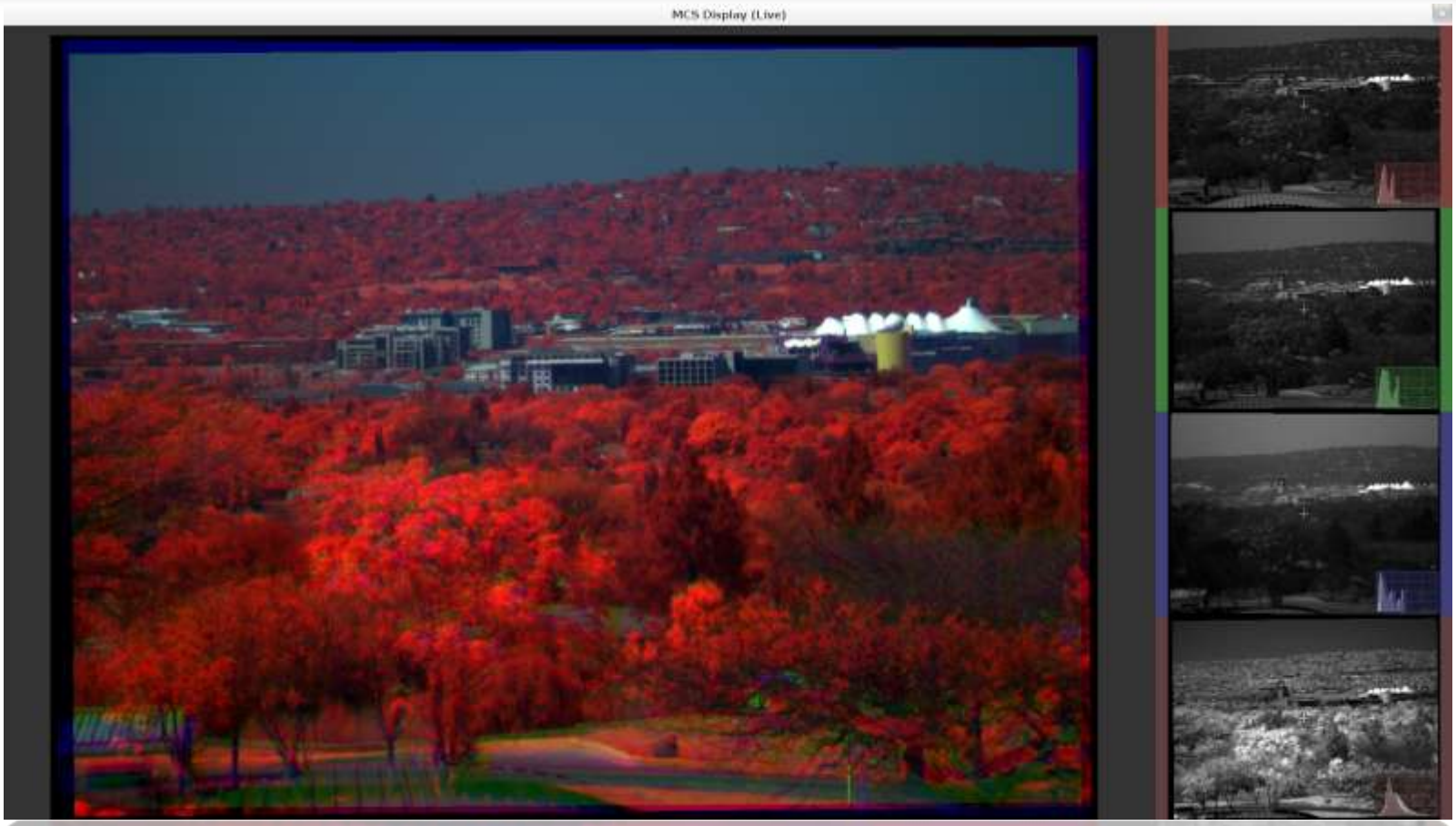
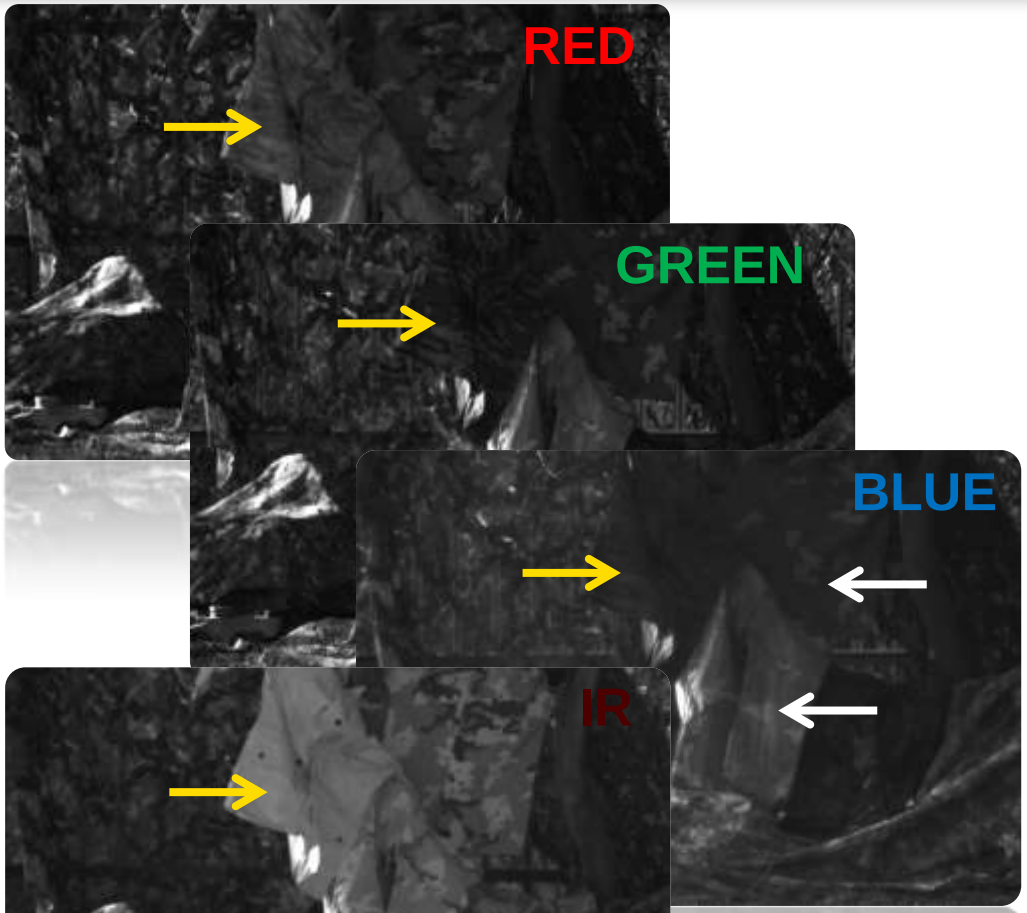
Applications of the Multi-Spectral Camera



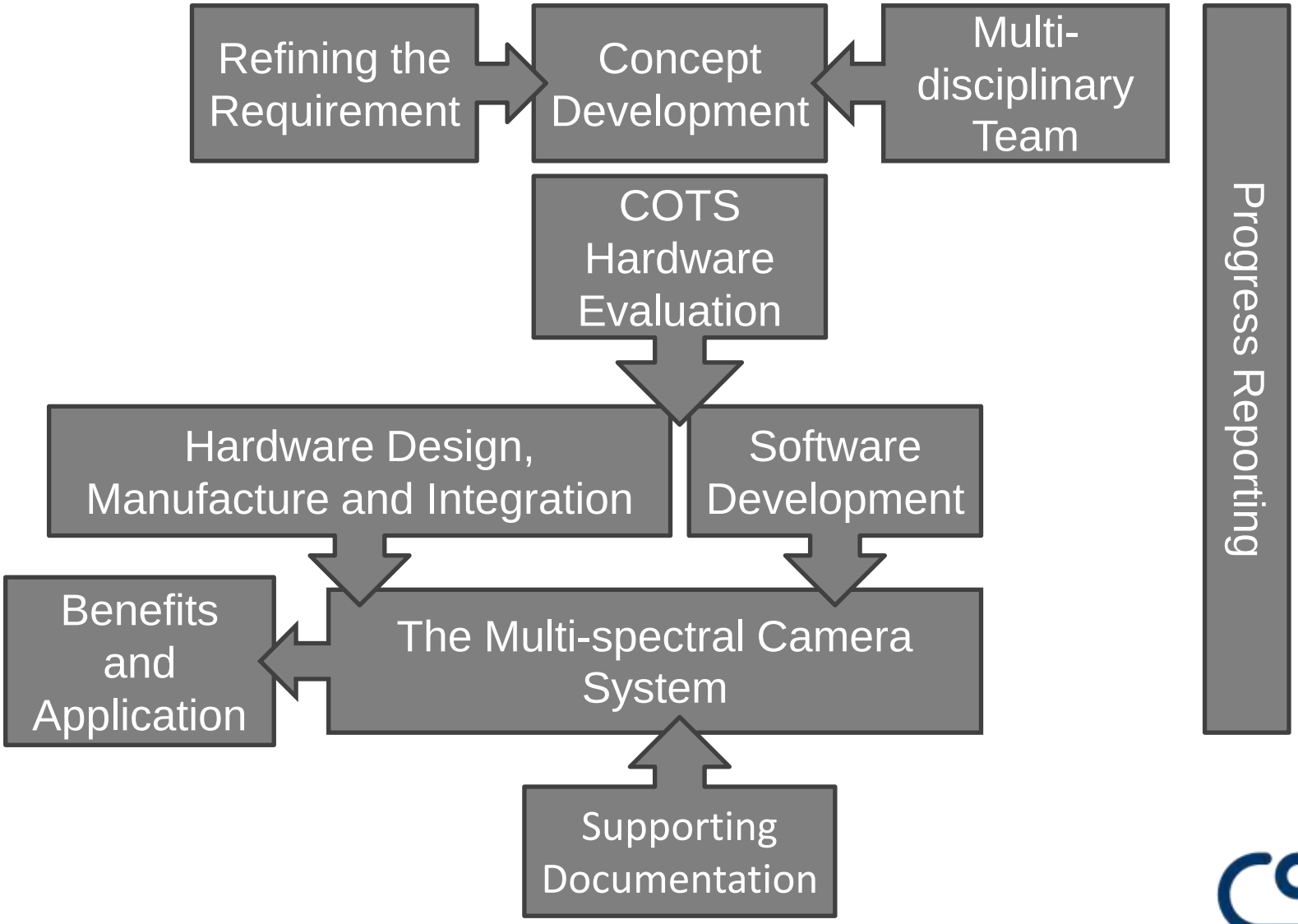
Fused image

- Red, Green, Blue, Near Infrared (IR)

Applications of the Multi-Spectral Camera



Engineering the Concept Demonstrator

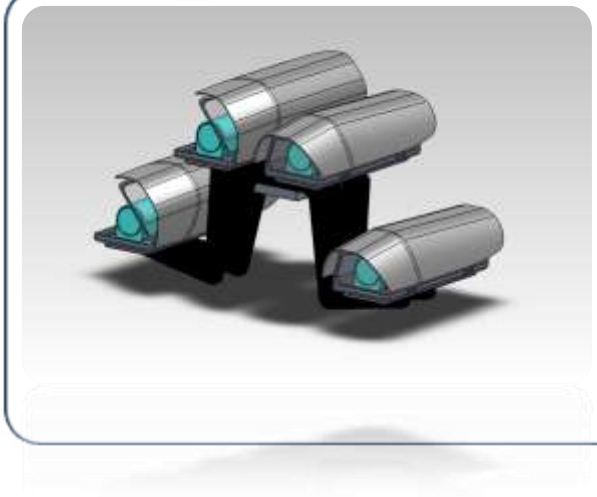


Refining the requirement

Original requirement (selected examples)

- 6 Spectral bands plus laser range finder
- High Definition (HD) video format
- Synchronised image capture
- Configurable mounts – positioner and laboratory
- Radiometric and geometric calibration
- Fiber optic data transmission

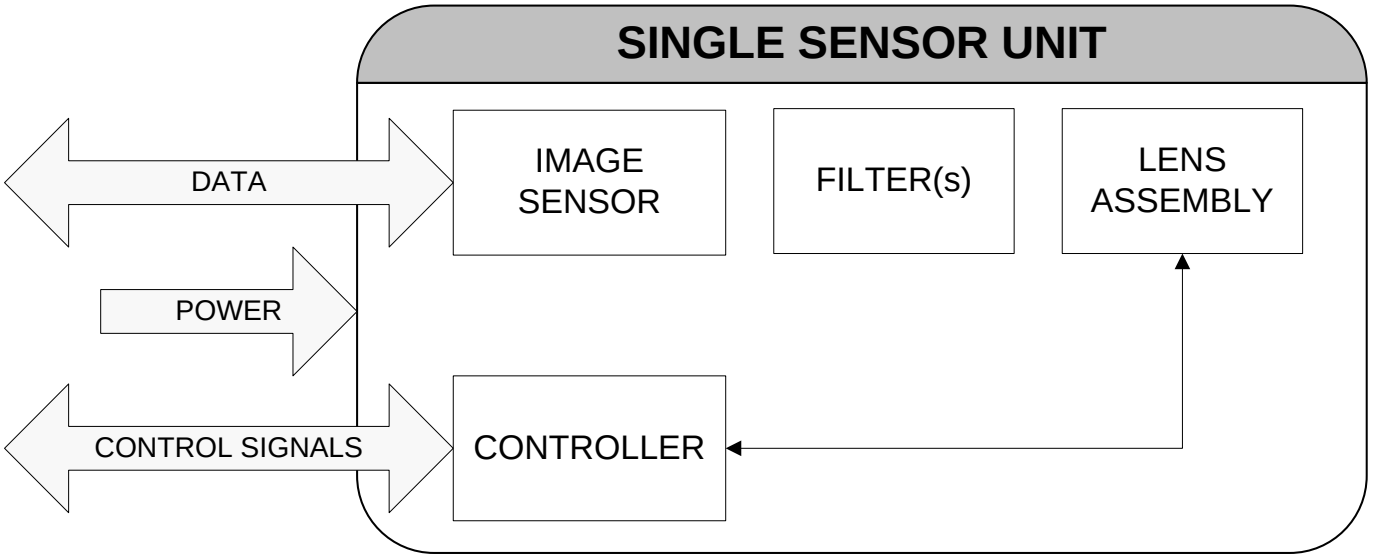
BUDGET



Proposed system (selected examples)

- 4 Spectral bands
- 1.4 Megapixel sensor, HD capable optics
- Synchronised image capture
- General purpose mount
- Rigid transform for image registration
- Standard Gigabit Ethernet data transmission

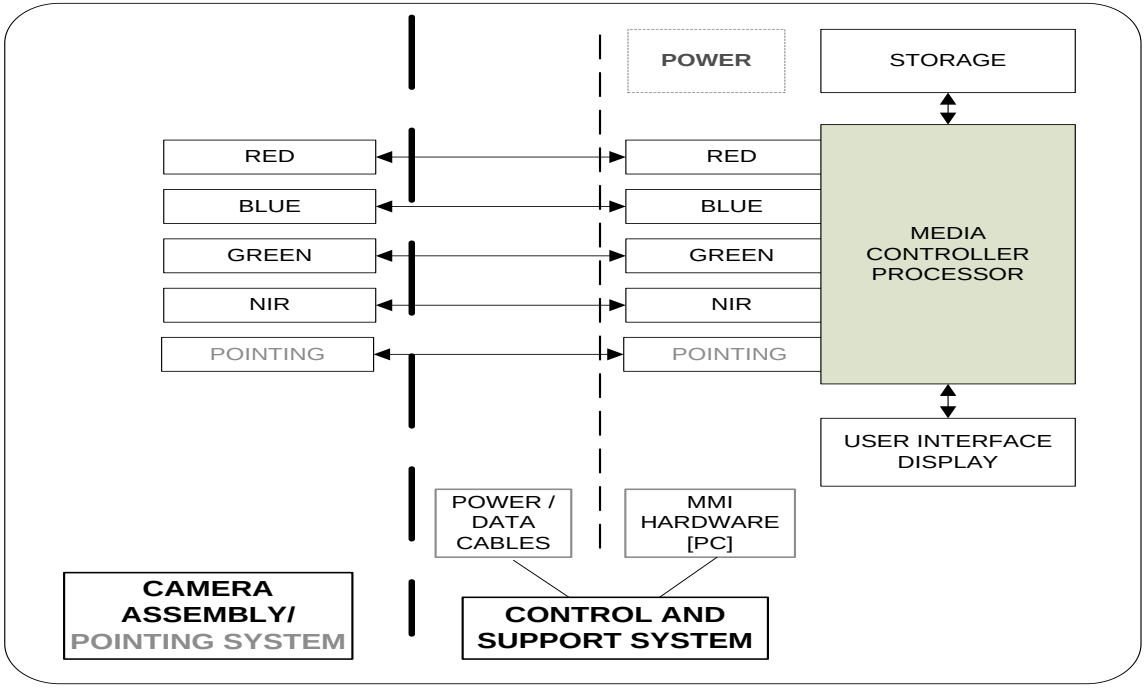
Concept Development – Sensor units



System architecture

- Consists of 4 similar sensor units
- Mounted on a single mechanical mount
- 12x Optical zoom with 1.4 Megapixel industrial GigE camera
- 4 spectral bands – Red, Green, Blue and Near Infrared
- Filter cartridge of optical filters

Concept Development – Control and Support



System architecture

- Operates on GNU/Linux operating system
- 8 Tb of data storage
- Dual monitor display, one for GUI and one for images
- Sensor unit power supply and signal distribution enclosure

Multi-Disciplinary Team

Documentation and Acceptance Test Procedure (ATP)

Gladys Sonko

Electronics and Embedded software

Deán Aucamp, Marietjie Blignaut, Herman Visagie

GUI and Image Processing

Bernardt Duvenhage, Nelia Lombard

Opto-Mechanics and Packaging

Warren Cowley, Mark Holloway, Ipeleng Mathebula

Test and Evaluation

Bertus Theron

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Hardware evaluation - COTS lens

Evaluation rational

- Data-sheets for COTS optical systems have been used, of the lens was compared to the manufacturer's data-sheet
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  benchmark and verify
- Bench-marking the C
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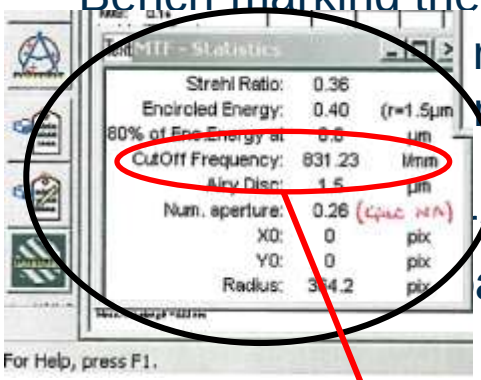
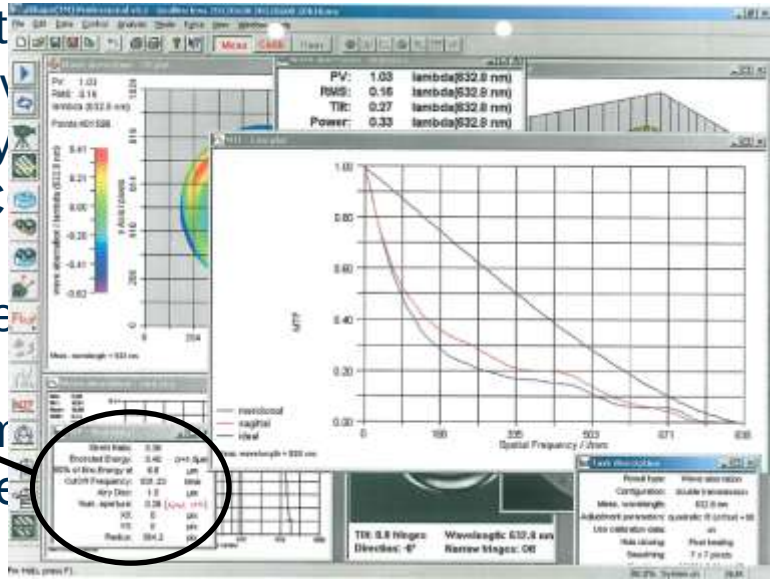
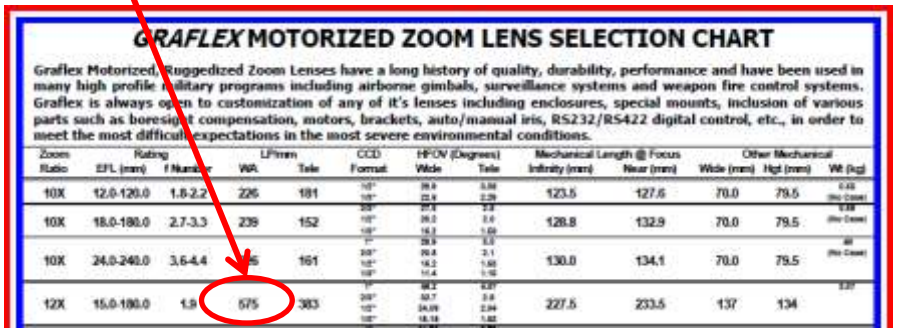




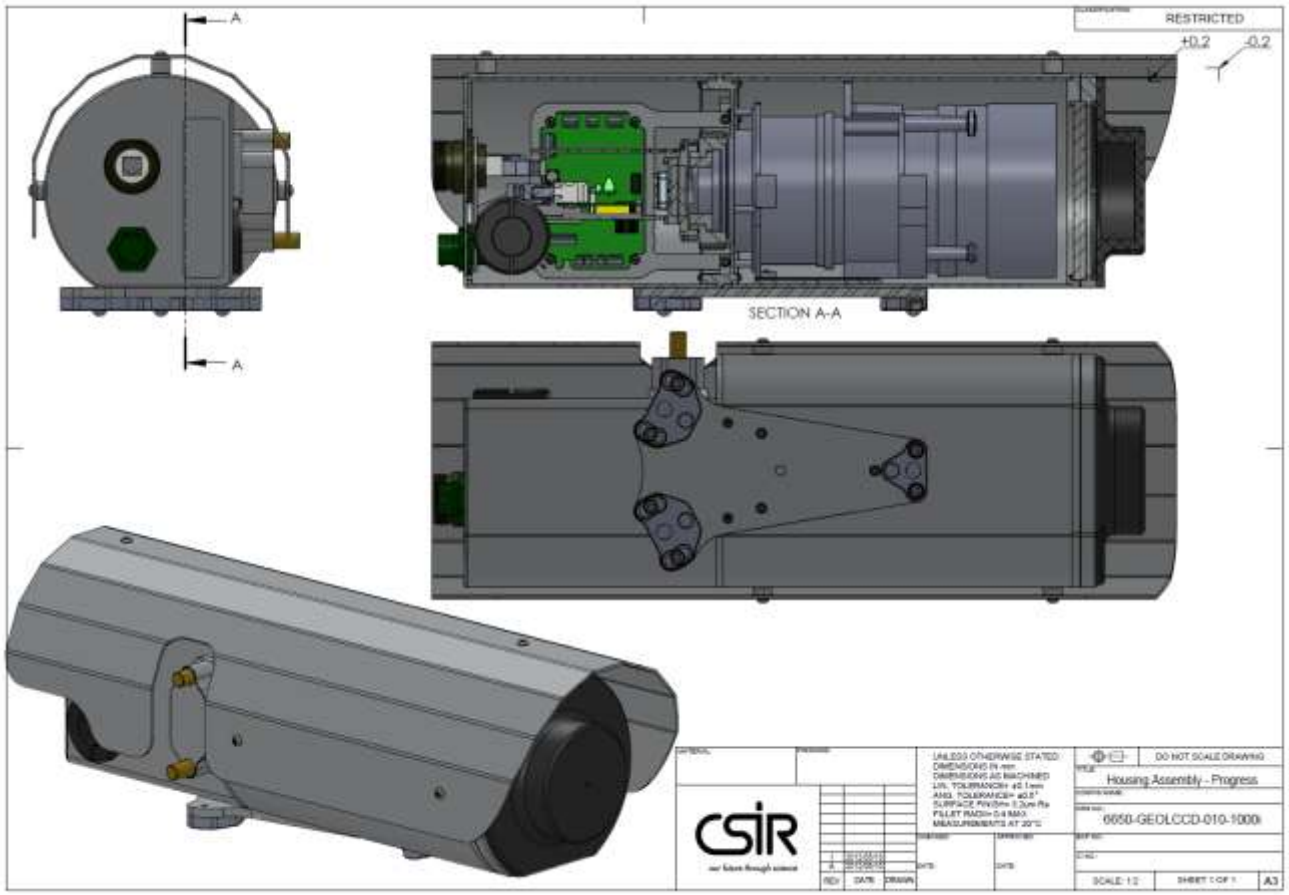


GRAFLEX MOTORIZED ZOOM LENS SELECTION CHART

Graflex Motorized, Ruggedized Zoom Lenses have a long history of quality, durability, performance and have been used in many high profile military programs including airborne gimbals, surveillance systems and weapon fire control systems. Graflex is always open to customization of any of it's lenses including enclosures, special mounts, inclusion of various parts such as boresight compensation, motors, brackets, auto/manual iris, RS232/RS422 digital control, etc., in order to meet the most difficult expectations in the most severe environmental conditions.

Zoom Ratio	Rating EFL (mm)	Rating f Number	LP/mm WA	LP/mm Tele	CCD Format	HFOV (Degrees) Wide	HFOV (Degrees) Tele	Mechanical Length @ Focus Infinity (mm)	Mechanical Length @ Focus Near (mm)	Other Mechanical Wide (mm)	Other Mechanical Hgt (mm)	Wt (kg)
10X	12.0-120.0	1.8-2.2	226	181				123.5	127.6	70.0	79.5	
10X	18.0-180.0	2.7-3.3	239	152				128.8	132.9	70.0	79.5	
10X	24.0-240.0	3.6-4.4	95	161				130.0	134.1	70.0	79.5	
12X	15.0-180.0	1.9	575	383				227.5	233.5	137	134	

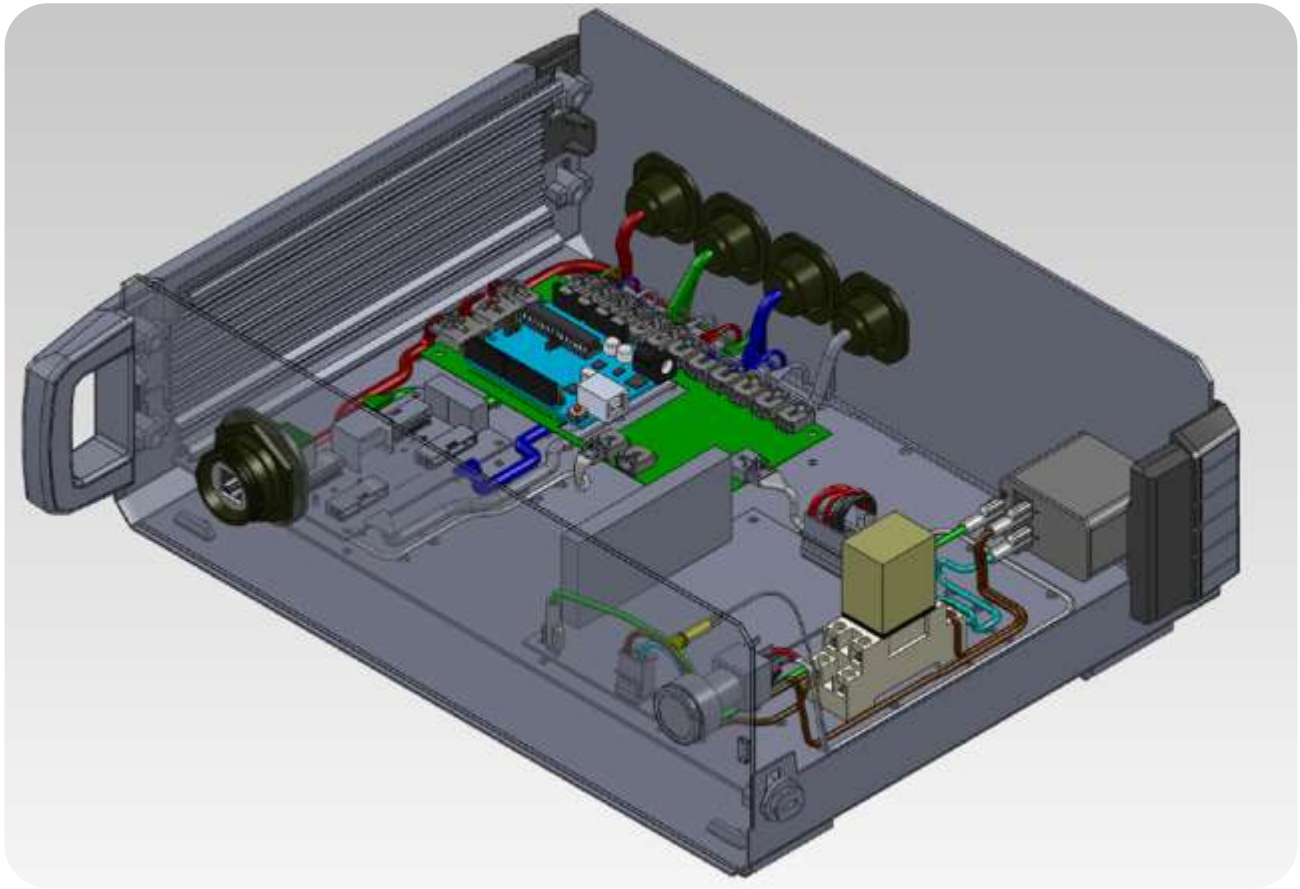
Hardware Design – Sensor Unit



Key design elements

- Integration of COTS hardware
- Environmental protection
  - Dust
  - Water splash
  - Sun exposure
- Spectral filter cartridge
- Cable looms and routing
- Kinematic mount
- Designed for upgrade path

Hardware Design – Power Supply and Control signals



Key design elements

- Ethernet to 4 channel RS422 serial comms
- External video frame synchronisation
- System power supply

Progress Reporting

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Problem Areas

1. Optical Window

The optical windows have been ordered, but will require wave-front measurement when received.

Possible Solutions to Problem Area

1. Optical Window

Possible re-work, final sizing and if required, Anti-Reflection (AR) coating may be required.

3rd Progress Report dated 22 June 2012

Project Highlights

1. **Mechanical Design**

Design of the lens to tripod/Pan and Tilt Unit (PTU), hereafter referred to as the MCS base assembly, shown in Figure 4, has been completed. Figure 5 shows the MCS assembly, consisting of the camera housings and MCS base assembly as a unit.

Suitable transport cases for the imaging components and computer hardware have been selected. The foam profiles for the transport cases have modelled in concept and will be finalised once the power supply enclosure design is complete.

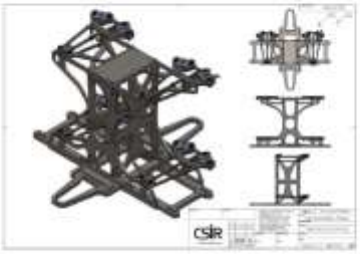

Figure 4: MCS Base Assembly

Project No: GEOLCCD

Project Name: Multi-spectral Camera System Concept Demonstrator

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Page 4 of 9

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Figure 5: MCS Assembly

2. **Mechanical Manufacture**

Manufacture of the lens interface components is complete. Conformance of the parts to the manufactur drawings has been verified. A test fitting of the lens interface assembly has confirmed fit and function Figure 6 shows the manufacture batch of lens interface components and a set of components required fo the assembly. The surface treatment of these components will commence once all of the parts for the MCS assembly have been received.

Figure 6: Lens Interface Components

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Page 5 of 9

Client feedback

- Managing potential risks and offering solutions
- Status of task progress

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Hardware Manufacture

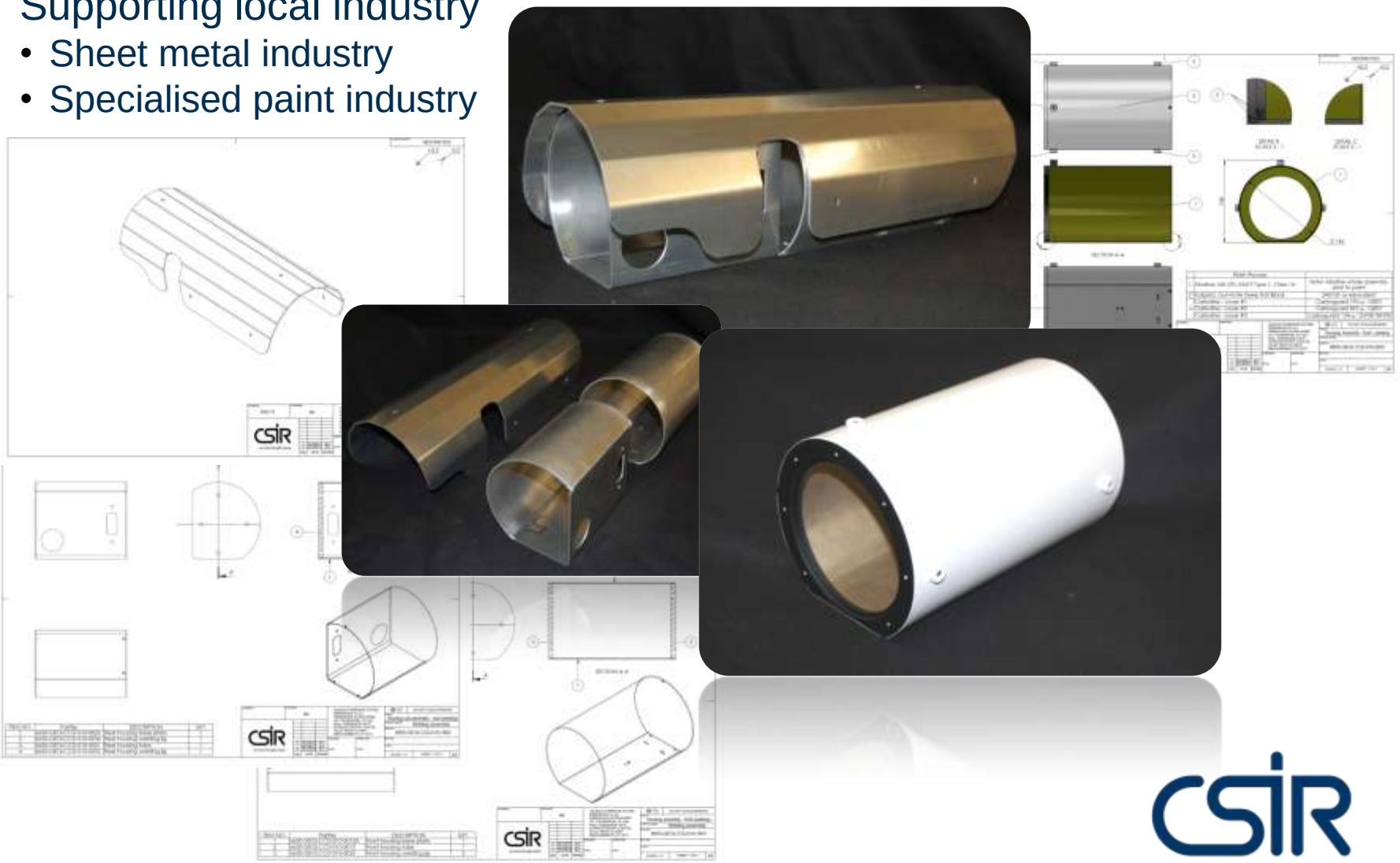
Supporting local industry

- Precision Engineering shops
- Surface treatment industry

Hardware Manufacture

Supporting local industry

- Sheet metal industry
- Specialised paint industry



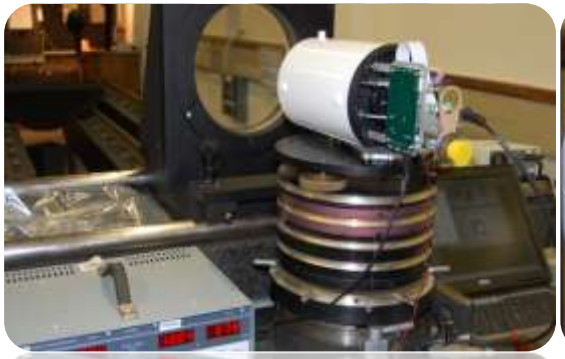
System Integration – Sensor Unit

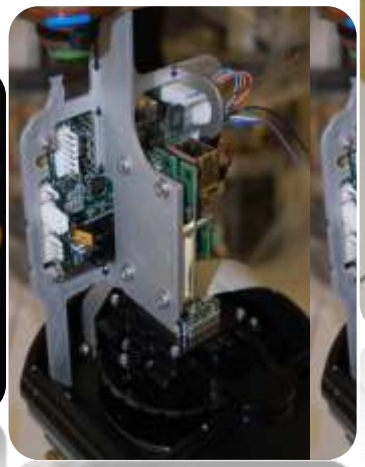




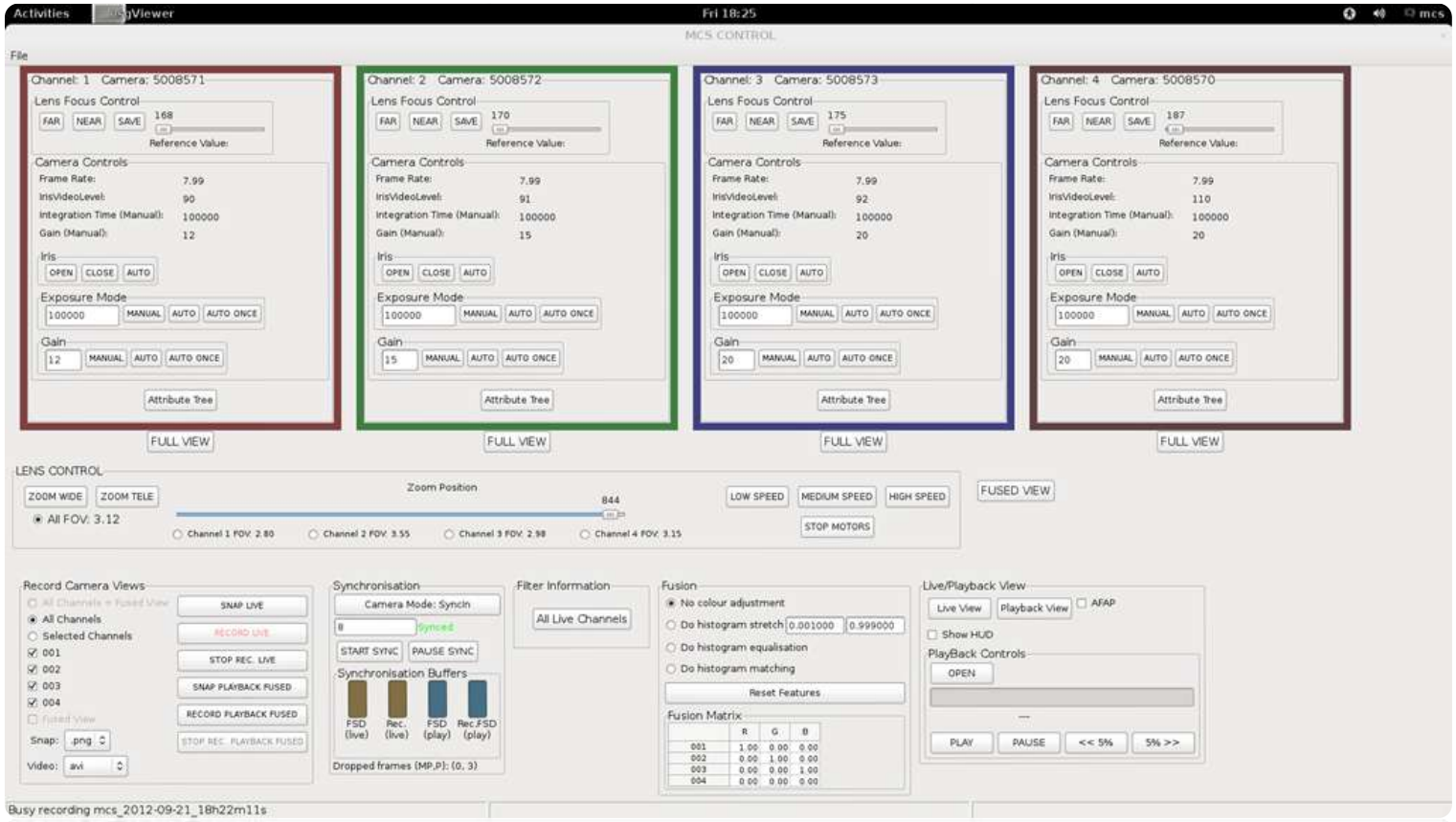
Integration process

- Each sub-assembly is integrated and the build data recorded for configuration purposes
- Each fully assembled system is set-up and verified on the OTEL Day / Night resolution test bench






Software - Graphical User Interface (GUI)



GUI functionality

- Single and global lens control
- Camera setting controls
- Image view selection
- External sync control and system status
- Selectable recording and snap
- Image fusion selection
- Live / playback view controls

Software - Image Processing - Computational Alignment

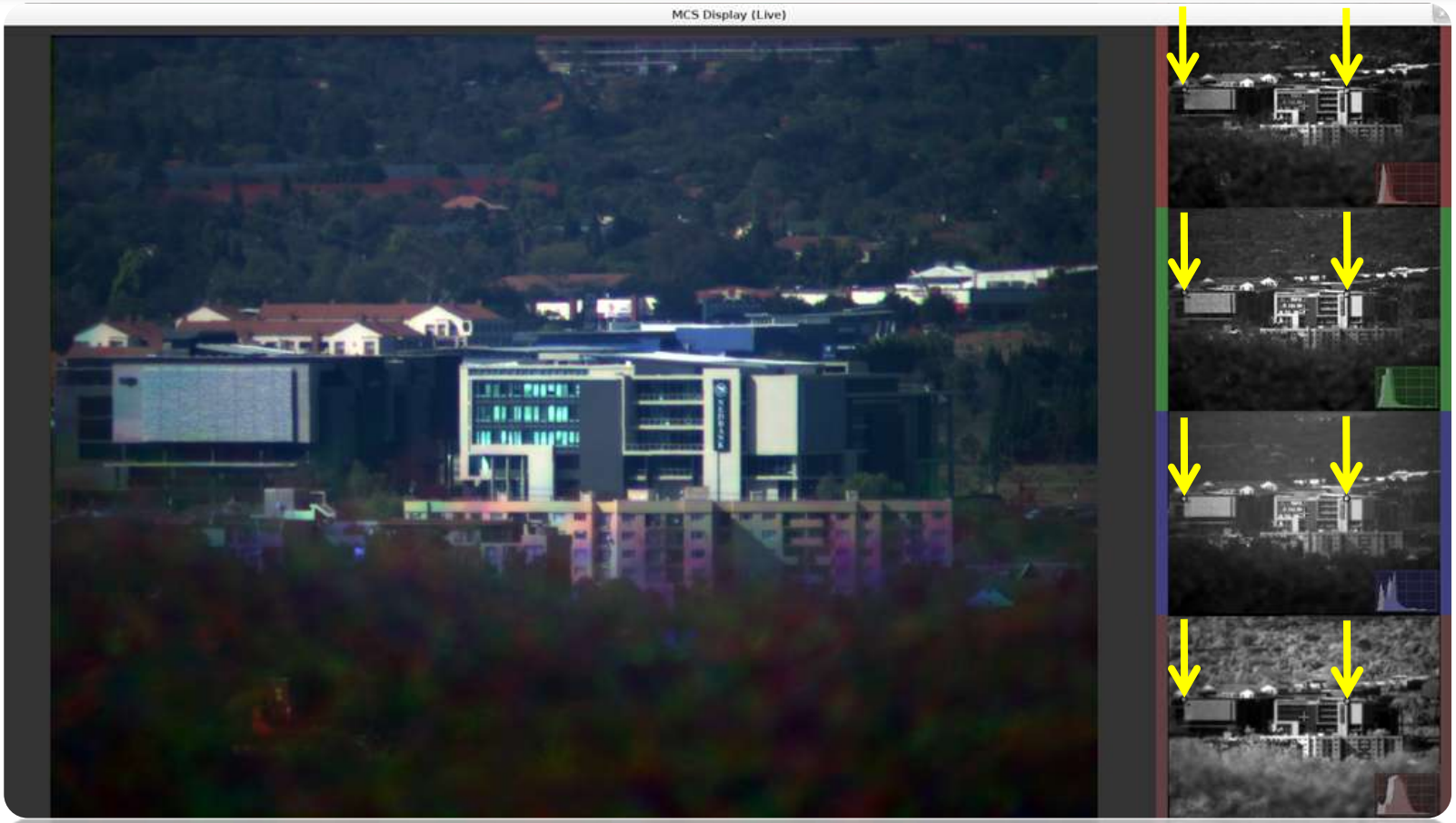


Image registration

- Basic 2 point homography
- Manual feature selection for alignment
- No lens distortion, near field or perspective correction

Software - Image Processing - GUI

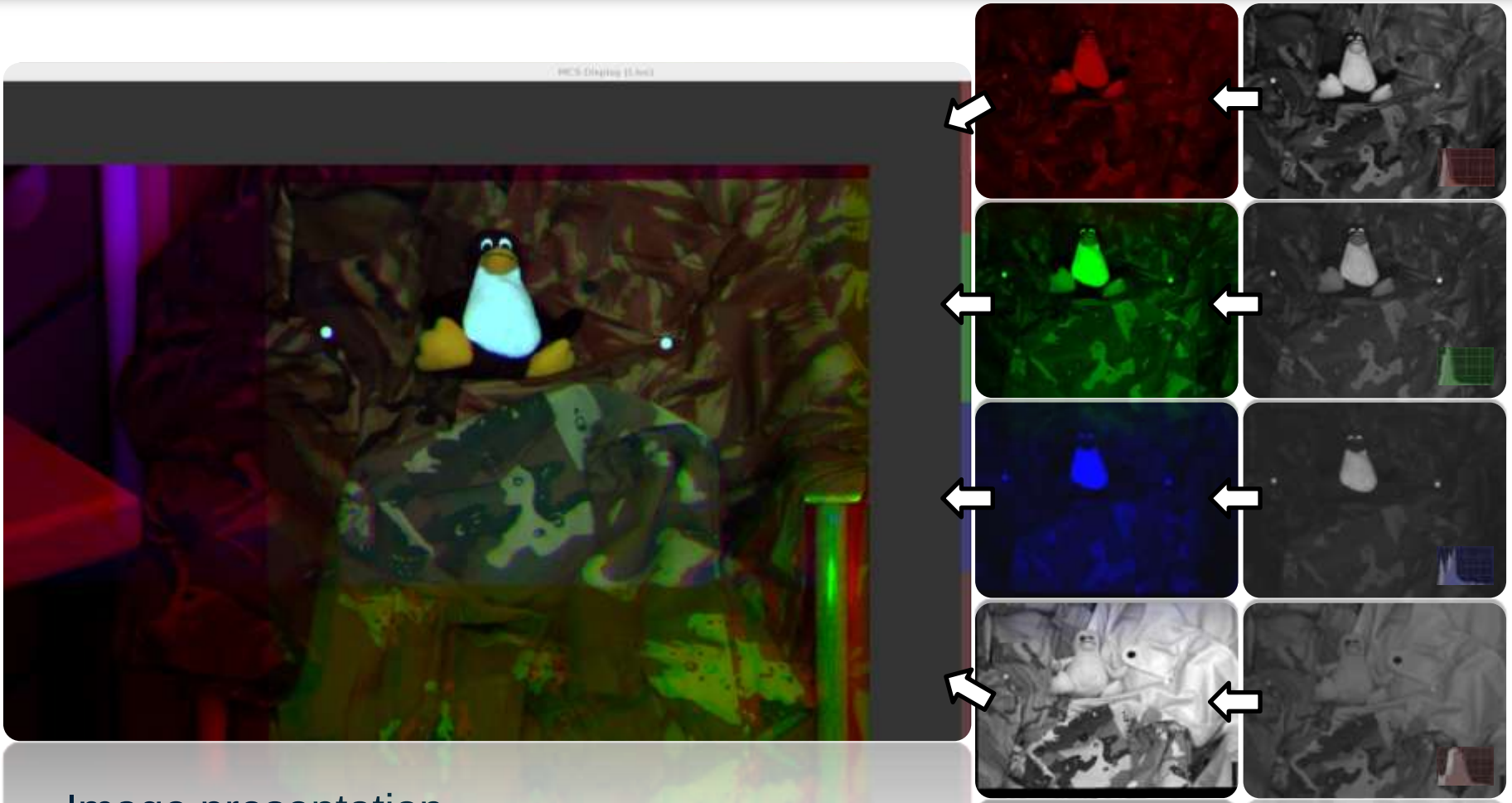


Image presentation

- Pixel brightness map based bandpass shader (filter dependent)
- Histogram stretching for optimal fused image exposure

The Multi-Spectral Camera System

Support Documentation

Configuration Control

- System design booked into eB
  - Documents
  - Software version control and source code
  - Electronics design
  - Opto-Mechanical and mechanical design

- Acceptance Test Procedure (ATP) for system conformance verification, performed both as a factory and customer procedure

REQ.1.7.2	There is evidence that the Sensor Unit enclosure meets the IP54 protection rating (enclosure design methodology)	• Inspect design drawings and enclosures for evidence that enclosures meet IP54 rating.		
REQ.1.7.3	The Sensor Unit [illegible]	• [illegible] enclosure by opening (and closing) the filter cap.		
[illegible]	Each Sensor Unit enclosure has a label with an appropriate unique identifier	• Inspect each Sensor Unit for an identifier/label.		
		Sensor Unit		Identifier\Label
		1	SU 1	
		2	SU 2	
		3	SU 3	
		4	SU 4	

Requirement ID	Req.1 [illegible]				
Compliance Status:	All units comply				
Test Operator(s)	1. MH	Signature:	5. MB	Signature:	
	2. BD	Signature:	6. GS	Signature:	
	3. NL	Signature:	7.	Signature:	
	4. DA	Signature:	8.	Signature:	
Date of Test:	07 September 2012				

Impact in the client environment

Providing capability and skills not available in-house to the client

- Image processing framework
- Design and integration of the Multi-Spectral Camera technology demonstrator
- Provide a purpose built, versatile solution through intelligent integration of Commercial Of The Shelf (COTS) and custom hardware according to the client requirement
- Providing the value for money system which the client could not find internationally

Applications

- Ground target interogation
- Camouflage – uniforms / vehicles
- Background characterisation
- Aircraft / decoys

Thank you

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