ST

Tester of SWIR imagers

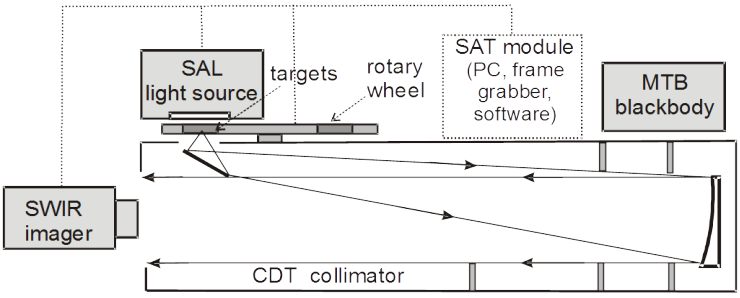

Fig. 1. Block diagram of ST test system

Fig. 2. Photo of the ST200 test system

1 Basic information

SWIR imagers (short wavelength infrared) are an important group of surveillance electro-optical imagers due several reasons. First, advances in InGaAs technology enabled design of relatively low cost SWIR imagers. Second, InGaAs imagers are very sensitive and can generate images of observed scenery even at dark nights. Third, SWIR imagers are less vulnerable to bad atmospheric conditions than VIS-NIR cameras working in visible/near infrared band. Fourth, SWIR imagers can generate hi-res images even if they are built using much smaller optics than used for design of thermal imagers.

Typical SWIR imagers (non cooled InGaAs imaging sensors sensitive up to about 1.7µm use light emitted by natural sources like Sun, moon, stars and reflected by observed targets to create images of these targets in a way similal to VIS-NIR cameras. Extended SWIR imagers (cooled InGaAs imaging sensors sensitive up to about 2.2 µm) can additionally also thermal radiation emitted by observed warm/hot targets to create images of these targets like thermal imagers. Due these features SWIR can be tested using both methodology for testing VIS-NIR cameras or methodology for testing thermal imagers. In addition, parameters of InGaAs imaging sensors can be also used to characterize SWIR imagers.

SWIR is a relatively new technology and testing of SWIR imagers is not standardized. In such a situation Inframet proposes to characterize SWIR imagers by three ways: a)measurement of parameters typical for VIS-NIR cameras (Resolution, Minimal Resolvable Contrast, MTF, Distortion, FOV, Sensitivity, SNR, Noise Equivalent Input, Fixed Pattern Noise, Non Uniformity, distortion, FOV) measured using calibrated polychromatic VIS-SWIR light source, b) measurement of parameters of InGaAs imaging sensors (Mean Detectivity, Noise Equivalent Irradiance, Dynamic range) using calibrated monochromatic light source, c) measurement of parameters typical for thermal imagers (MRT, MDT, MTF, NETD, FPN, non uniformity, distortion, FOV) using medium temperature blackbody.

ST is test system that works as an image projector in VIS-SWIR band that enables measurement of ealier mentioned parameters and expanded characterization of SWIR imagers.

2 List of blocks

ST is a modular test systems built from following blocks (in most exapanded version):

1. CDT collimator (details as in https://www.inframet.com/Data_sheets/CDT.pdf),
2. MRW-8 motorized rotary wheel (details as in https://www.inframet.com/rotary_wheels.htm),
3. SAL light source (details as in https://www.inframet.com/Data_sheets/LS-SAL.pdf),
4. set of spectral filters,
5. set of reflective mode targets (glas substrate targets),
6. MTB-2D blackbody (details as in https://www.inframet.com/Data_sheets/MTB.pdf),
7. set of emissive mode targets (metal sheets with holes of proper shape),
8. PC set,
9. set of frame grabbers,
10. MTB Control program,
11. SAL Control program,
12. TAS-S program.

ST works as image projector that projects image of reference target into direction of tested SWIR imager. Depending on configuration of work different radiation source (LS-SAL light source or MTB blackbody) and set of targes (reflective targets or emissive targets) are used.

3 Configurations of work

ST is a modular system that can be configured to work in two main configurations:

A) Reflected polychromatic radiation configuration (system based on LS-SAL light source),
B) Emitted radiation configuration (system using MTB medium temperature blackbody).

The LS-SAL light source can work both in polychromatic VIS-SWIR light mode and in monochromatic 1550nm light mode. Therefore ST system working in configuration A can measure:

1. polychromatic light mode: Resolution, Minimal Resolvable Contrast, MTF, Distortion, FOV, Sensitivity, SNR, Noise Equivalent Input, Fixed Pattern Noise, Non Uniformity, distortion, FOV.
2. monochromatic light mode: Mean Detectivity, Noise Equivalent Irradiance, Noise, Dynamic range.

ST system working in configuration B can measure following parameters: MRT, MDT, MTF, NETD, FPN, distortion, FOV.

List of blocks of ST system in configuration A:

1. CDT collimator (details as in https://www.inframet.com/Data_sheets/CDT.pdf),
2. MRW-8 motorized rotary wheel (details as in https://www.inframet.com/rotary_wheels.htm),
3. SAL light source (details as in https://www.inframet.com/Data_sheets/LS-SAL.pdf),
4. set of spectral filters,
5. set of reflective mode targets (glas substrate targets),
6. PC set,
7. set of frame grabbers,
8. SAL Control program,
9. TAS-S program.

List of blocks of ST system in configuration B:

1. CDT collimator (details as in https://www.inframet.com/Data_sheets/CDT.pdf),
2. MRW-8 motorized rotary wheel (details as in https://www.inframet.com/rotary_wheels.htm),
3. MTB-2D blackbody (details as in https://www.inframet.com/Data_sheets/MTB.pdf),
4. set of emissive mode targets (metal sheets with holes of proper shape),
5. PC set,
6. set of frame grabbers,
7. MTB Control program,
8. TAS-S program.

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4 Special features

ST system offers following features:

1. Expanded test capabilities listed in previous section,
2. Ability to simulate both dark night and very bright day conditions
3. Ability to simulate targets of temperature up to 550ºC
4. Computerized test system, semi-automatic measurement of important parameters of SWIR imagers.

5 Specifications

CDT collimator		**SAL light source**	
Collimator type	reflective, off-axis	Aperture	40 mm
Clear aperture	From 100 mm to 200 mm	Light source type	Five: 1) broadband light source from 400nm to 2100nm, 2) visible LED light source, 3) mixed mode: halogen and LED, 4) Halogen bulb – 1550nm filter: monochromatic light source, 5)Halogen bulb – SWIR only filter
WFocal length	Depends on model	Halogen spectral band	400-2200 nm
Spectral range	At least 0.4-15 µm	Halogen color temperature	Approximately 2856K at 450-1300nm band
Spatial resolution	not less than 160 lp/mrad	Halogen Dynamic	0.01 mcd/m^2 - 1000 cd/ m^2
Coating	Aluminum – collimating mirror, gold-flat mirror	Halogen regulation method	Opto-mechanic, continuous
Field of view	Depends on model	LED wavelength	visible
Rotary wheel		LED source dynamic	10000:1
Model	MRW-8	**MTB-2D blackbody**	
Number of holes for targets	8	Aperture	50 mm
Control type	motorized, digital	Absolute temperature range	50ºC to 550ºC
Targets		Temperature uniformity	<0.005xT
Diameter	54 mm (for wheel holes)	Settling time	<30 min
Targets for reflective mode	Set of 5 variable contrast USAF targets, FOV/distortion target, edge target	Regulation resolution/ stability	0.01ºC/ 0.05ºC
Targets for emissive mode	set of eight 4-bar, set of eight pinhole targets, FOV/distortion target, IR edge target	Computer control	RS-232 (USB 2.0)
		Power supply	115-230VAC 50/60Hz

6 Versions

ST test systems are modular test systems that can be delivered in form of different versions of different configurations, test capabilities and price. The basic division of ST series system is based on output aperture of the collimator (Table 1).

Table 1. Division of ST systems based on the collimator aperture

System aperture code	Collimator output aperture
ST110	110 mm
ST150	150 mm
ST200	200 mm
ST 250	250 mm
ST X	>250mm (optional custom designed)

The rule of thumb for choosing proper aperture is following:

- Acceptable situation: the collimator aperture must be bigger than aperture of optics of tested imager
- Recommended situation: the collimator aperture must be bigger by at least 10% than aperture of tested imager

(it is easier to align tested imager).

Collimator aperture is only one of a series of technical parameters that should be determined to optimize ST system for required applications. We need also to determine:

1. Configuration of work (radiation source and set of targets),
2. Acceptable electronic video image formats of tested SWIR imager,
3. Boresighting capabilities.

Therefore collimator aperture code and additional code composed from three letters are used to describe precisely ST systems. Definitions of three letter code are shown in Tab.2. The columns 1-3 present what letters are to be chosen to define precisely required version of ST test system.

As we see in this table by changing letters from A to C we increase test capabilities of ST test system but also the cost is increased.

Tab. 2. Definitions of the code used to describe versions of ST test system

Code	1	2	3
	Work configuration	**Electronic image format**	**Boresight**
A	Only reflected light configuration (only LS-DAL light source)	Standard analog video frame grabber : PAL/NTSC video format	No boresight capabilities
B	Both reflected and emitted light configuration (both LS-SAL light source and MTB blackbody)	Additional digital frame grabber accepting video in one of following formats: CL, GigE, LVDS, HD-SDI/ DVI/HDMI, HD-TVI/HD-CVI, CoaXPress, USB2.0/3.0, Ethernet	Measurement of aligning errors of zoom/step FOV objective
C		Second additional digital frame grabber	As in level B but additionally measurement of aligning errors relative to reference optical axis of thermal imagers or VIS-NIR cameras

Example: ST 100 -AAA test station means the ST test station of the following features:
1)aperture of the collimator =100mm, 2) capable to work only in reflective configuration (only LS-SAL light source and reflective targets), 3)standard analog frame grabber, 4)no boresight capabilities.

Data sheet version 2.1

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