ASIR

System for testing active gated SWIR imagers

Fig. 1. Photo of the ASIR200 test system

1 What are active gated SWIR imager?

Active imagers are a type of EO imaging systems that generate image of scenery of interest when the scenery is illuminated by an artificial light source (typically internal but rarely external light source). Historically first night vision devices built using Gen 0/Gen 1 imager intensifier tubes used up to 1980s have been active imagers that needed some artificial illumination of targets of interest in order to generate useful image of such targets. Therefore such active night vision devices included illuminator in form of optical system having a tungsten lamp at its focus and emitting light beam into wide projection angle.

Humans operating such old active imagerss could be easily detected. Therefore active NVDs have been gradually replaced by passive passive EO imagers (NVD built using Gen 2/3 tubes, thermal imagers, VIS-NIR cameras, SWIR imagers) in 1980s. Therefore passive EO imagers totally dominate present day international market. However, modern active imagers built by replacing old tungsten illuminators by pulse lasers as illuminators represent an interesting novel direction and their number is growing due to three main desing changes.

First, main drawback of classical active imagers has been eliminated by use of lasers emitting highly directional light beam that cannot be easily detected.

Second, the laser illuminators emit pulsed light in contrast to old illuminators that emitted temporally constant intensity light beam.

Third, special gated cameras of regulated time delayed gating period synchronized with laser emitter enables the camera to be sensitive only to light reflected by targets at specified distance.

Therefore, comparing to classical passive imagers, modern active laser imagers offer such features: 1)conceal use (only target of interest is illuminated), 3)ability to estimate distance to visualized targets, 3)better performance at low visibility conditions (smoke, fog, rain, snow), 4)some active imagers of narrow gating period enable to estimate 3D shape of targets of interest.

Range of active imagers depends mostly on ratio of pulse peak power/pulse energy to emission angle of laser illuminator. Higher power of laser illuminators means longer range of active imager. However, at the same time in many applications laser illuminator should not be dangerous for humans illuminated by laser light. For this reason lasers operated at wavelenghts over 1400nm (laser safe range) are preferred in long range applications. In detail, commonly available pulse lasers emitting laser light at 1550nm window (from about 1530nm to 1570nm) cooperating with gated InGaAs cameras are typically used in long range active imagers. The additional advantage of such technical solution is fact that such imagers cannot be detected by most common EO imagers: night vision devices and VIS-NIR cameras.

2 What is ASIR test system?

Testing active SWIR imagers is not standardized (testing passive SWIR imagers is actually also not standardized). In such a situation, Inframet has developed its own test methodology of testing active SWIR imagers based on vision of test system capable to simulate real work conditions and capable to measure all important parameters needed for evaluation of active SWIR imagers. In detail, Inframet has developed modular ASIR test system that can be configured to carry out expanded multi level tests of active SWIR imagers:

1. tests of classical passive SWIR imagers (measurement of resolution, MRC, MTF, NEI, FOV)

2. tests of pulsed laser illuminator (measurement of pulse energy, pulse time width, PRF, illumination angle (divergence angle), illumination uniformity),
3. boresight tests (measurement of boresight angle between optical axis of transmitter (laser illuminator) and receiver (gated SWIR camera)),
4. system for tests of time delay electronics (checking if gate of SWIR FPA sensor opens at proper time delay comparing to pulse of laser emitter – checking ability to capture image of targets located at any distance within specified imager distance range),
5. system performance tests against simulated target located at regulated distance/illumination level (checking ability to generate high quality image of scenery of interest located at any distance at specified distance range and of different light intensity due to variable distance)
6. system performance tests against simulated 3D targets to determine ability to determine 3D shape of scenery of interest built in form of four targets located at different distance. This configuration enables to simulate up to four different targets located at different distances. Distance to each target can be individually regulated.

3 How ASIR is built and works?

ASIR is a modular test system composed from two groups of blocks:

1. collimator image projector (CDT off axis reflective collimator, MRW rotary wheel),
2. support blocks (SAL calibrated light source-different versions possible, set of targets, frame grabber, PC set, TAS-SW software, internal modules for collimator for testing high power lasers, COE energy meter, SLA set of large attenuators, laser reflective cards LRC, CEB collimator expander block, L0AS pulse generator, O0AS optical module, L1AS pulse generator, O1AS optical module, L4AS pulse generator, O4AS optical module).

Collimator image projector is built as a set of two blocks. This projector is the core of ASIR system and is used in all work configurations of ASIR system. Support blocks are optional. Depending on what support blocks are used six different test capabilities are achieved:

A) System that projects temporally static images of reference targets, analyze such images and calculate parameters of typical passive SWIR cameras, Blocks: CDT collimator, MRW wheel, SAL calibrated light source-different versions possible, set of targets, frame grabber, PC set, TAS-SW software. Typical ST system for testing passive SWIR imagers.

B) System that creates image of laser spot created by laser illuminator and analyze the image and calculated parameters of laser illuminator. It is assumed that customer SWIR camera can be used for visualization of laser spot. ASIR task is attenuate and collimate incoming laser beam on laser screen located at collimator focal plane. Blocks: CDT collimator, MRW wheel, COE energy meter, SLA set of large attenuators, laser reflective cards LRC, frame grabber, PC set, BOR software,

C) System for boresight tests of laser transmitter relative to receiver camera. Task of ASIR is the same as in previous configuration but additionally CEB block is used to apparently increase collimator aperture – case when distance between centers of receiver and transmitter is over 100mm. Additional block: CEB expander.

D) System that projects pulse image of a pulsed light source at regulated distance between tested active imager and simulated source. Blocks: CDT off axis reflective collimator, MRW rotary wheel, set of pulse targets, frame grabber, PC set, TAS-SW software, L0AS pulse generator, O0AS optical module. Size/light intensity of simulated light source cannot be changed.

E) System that projects pulse image of a pulsed target at regulated distance between tested active imager and simulated source and of regulated light intensity. Blocks: CDT off axis reflective collimator, MRW rotary wheel, set of pulse targets, frame grabber, PC set, TAS-SW software, L1AS pulse generator, O1AS optical module. Size/light intensity of simulated light source can be changed.

F) System that projects pulse image of four pulsed targets at regulated distance between tested active imager and simulated source. Blocks: CDT off axis reflective collimator, MRW rotary wheel, set of pulse targets, frame grabber, PC set, TAS-SW software, L4AS pulse generator, O4AS optical module. Size of targets can be regulated. Light intensity of simulated light source cannot be changed.

4 Test capabilities

Test capability/system feature	Value
active gated SWIR imager	
Maximal aperture of receiver camera (limited by collimator aperture)	200mm
Maximal aperture of combined receiver and transmitter	300mm
Receiver spectral band	In range about 900nm to about 1700nm
Laser wavelength	In range about 900nm to about 1700nm
Illuminator angle	Non higher 5mrad (option 18 mrad)
Illuminator mode of work	pulse
Test capabilities	
Configuration A	resolution, MRC, MTF, NEI, FOV
Configuration B	pulse energy, pulse time width, PRF, illumination angle (divergence angle), illumination uniformity
Configuration C	Angle between laser beam of transmitter and LOS of receiver camera
Configuration D	Simulation of pulse light source at distance in range from 100m to 40km. Light source in form of circle of size about 5 mrad.
Configuration E	Simulation of pulse light target of regulated size, distance and light intensity. Target: any shape of size below 5mrad. Distance: from 100m to 40km. Pulse energy density: from about 0.2nJ/cm2 to about 20nJ/cm2 Wavelength of pulse source: 1064nm. Option about 1550nm.
Configuration F	Simulation of four pulse light targets of regulated size and distance. Targets must be of shape of square that combined together form a new bigger square. Size of this combined square must be below 5mrad. Simulated distance for each target: from 100m to 40km. Pulse energy density: non regulated (option: step regulation)

5 Versions

ASIR system can be delivered in form of different version of different test capabilities. Simple code is used.
Example: ASIR200A1B0C0D0E1F0.
200 means collimator aperture.
A1-configuration A is included (additional needed blocks are delivered)
B0-configuration B is included (additional needed blocks are not delivered).

Version 1.2

CONTACT:

Tel: +48 22 6668780 *Fax: +48 22 3987244* *Email:* info@inframet.com