

TVT

System for testing long range surveillance VIS-NIR cameras



Fig. 1. Versions of TVT test system: a)TVT300 for testing long range VIS-NIR cameras, b)TVT150 in configuration for testing medium range VIS-NIR cameras, c) TVT150 in configuration for testing short range cameras (CCTV cameras)

1 Basic information

High-end VIS-NIR cameras based on large zoom optics that operate in visible and near infrared range are widely used by military/security agencies in medium/long range surveillance applications. Cheaper VIS-NIR cameras of fixed FOV (fixed focal length) are used in huge numbers in civilian CCTV (close circuit TV) applications.

Majority of VIS-NIR cameras is used for day level applications but an increasing number of these cameras is used to enable surveillance in both night and day conditions. In both cases it is important to verify performance of these cameras under varying illumination conditions from very dark nights to ultra bright days. Important missions can fail due to too low sensitivity of VIS-NIR cameras at night conditions (dark, noisy images) or due to too low dynamic at ultra bright day conditions (saturated, blurred images). In addition, it is important to use VIS-NIR cameras that generate high quality images in order to achieve maximal surveillance ranges.

The TVT station is a variable intensity image projector that projects images of some standard targets into direction of tested VIS-NIR camera. The tested camera generates copies of the projected images. Quality of the images generated by the camera is evaluated and its important characteristics are measured. The TVT station enable simulation of both ultra dark nights (moonless clouded nights) and ultra bright days (bright sand desert at noon) and accurate testing performance of surveillance VIS-NIR cameras working at any illumination conditions. Testing surveillance VIS-NIR cameras with TVT test station generate a series of parameters that give vital information about potential camera surveillance capabilities for camera users. The projection is done by a big reflective collimator when testing medium/long range VIS-NIR cameras, or using small refractive collimator when testing small short range CCTV cameras.

2 Design

Typical TVT test systems are built from the following blocks: LS-DAL calibrated multi-channel light source, CDT reflective collimator, set of exchangeable refractive collimators, MRW-8 rotary wheel, set of targets, PC, set of frame grabbers, and test/control software (DAL Control computer program, SUB-V computer program, TAS-V computer program).

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3 Specifications

Parameter	Value
Test capabilities	Resolution, Minimal Resolvable Contrast, MTF, Distortion, FOV, Sensitivity, SNR, Noise Equivalent Input, Fixed Pattern Noise, Non Uniformity, 1/f noise, 3D Noise, Number of bad pixels and bad pixel localisation, Responsivity function (Responsivity, Linearity, Dynamic, Light Range), Color fidelity.
Collimators	A reflective of-axis collimator (typical aperture 100mm, 150mm; 200mm, 300mm) of narrow simulated FOV and a set of three refractive collimators (max aperture 70 mm) of wider simulated FOV
Light source diameter	40 mm
Modes of work light source:	1) halogen bulb of 2856K color temperature for night and typical day simulation 2) white LED of color temperature over 5000K for simulation of ultra bright days
Total luminance range of light source	10 mcd/m ² - 10 kcd/m ² – D (day version) 10 μ cd/m ² - 10 kcd/m ² – DN (day/night version)
Simulated illuminance ranges (approximate values)	D version: 30 mlx - 30 klx (0.003 fc-3000 fc) DN version: 30 μ lx - 30 klx (0.000003 fc-3000 fc)
Spectral range	Calibrated for testing VIS-NIR imaging sensors of spectral band not wider than 400-1100nm
Spectral modes	a)broadband, b)VIS only, c)NIR only optional different spectral band possible
Targets	Set of six variable contrast USAF 1951 targets, edge target, distortion target, gray scale target
Contrast range of USAF1951 targets	from about 3% to 100%
PC Control	RS 232/USB 2.0 (all functions of DAL light source and MRW-8 rotary wheel)
Accepted electronic image formats	PAL, Camera Link, LVDS, GigE, SDI, DVI, HDMI, USB 2.0/3.0 and other

4 Versions

TVT test systems are modular test systems that can be delivered in form of different versions of different configurations, test capabilities and price. The latter parameter can vary several times depending on version.

The basic division of TVT series system is based on output aperture of the collimator (Table 1).

Table 1. Division of VIS-NIR systems based on the collimator aperture

System aperture code	Collimator output aperture [mm]
TVT60	60
TVT100	100
TVT 150	150
TVT 200	200
TVT 250	250
TVT 300	300
TVT X	>300 (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 TVT system for required applications. We need also to determine:

1. Simulated light conditions
2. Collimators
3. Test capabilities,
4. Acceptable electronic image formats of tested VIS-NIR camera,
5. Boresighting capabilities
6. Simulated distance
7. Optional software.

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Therefore collimator aperture code and additional code composed from seven letters are used to describe precisely parameters of TVT series systems. Definitions of seven letter code are shown in Tab.2. The columns 1-7 present what letters are to be chosen to define precisely required version of TVT test system.

By changing letters from A to E we increase test capabilities of TVT test system but also the cost is increased.

Tab. 2. Definitions of the codes used to describe versions of TVT test system

	1	2	3	4	5	6	7
Code	Light conditions	Collimators	Test capabilities	Image formats of VIS-NIR camera (frame grabber)	Boresight	Simulated distance	Optional software
A	Day (DAL-D light source)	Only reflective, off axis collimator	Basic: resolution	No frame grabber	No boresight capabilities	Only infinity	No
B	Day/Night (DAL-DN light source)	Reflective collimator and a set of refractive collimators	Typical: resolution, MTF, distortion, FOV, sensitivity, SNR, NEI, FPN, non uniformity, responsivity function, linearity	Standard analog video (PAL/NTSC)	Measurement of aligning errors of zoom/step FOV objective	Regulated from 200m to infinity	Movis computer program
C			As for level B but additionally MRC measurement	Additional software accepting USB 2.0/3.0			
D			Ultra expanded: as in level C but additionally 3D Noise model, PVF, NPSD	Additional grabber: CL, GigE, LVDS, CVBS, YpbPr, Coa-XPress, HD-SDI, HD-CVI, HD-TVI, AHD, DVI, HDMI, Fire Wire			

Detail interpretation of the codes is presented below:

1) Simulated light conditions

Different versions of DAL light source are used to simulate different light condition.

A) D version: 30 mlx - 30 klx (0.003 fc-3000 fc)

B) DN version: 30 μ lx - 30 klx (0.000003 fc-3000 fc) where fc is foot candela

2) Collimators (optimal projector configuration for VIS-NIR cameras of different FOV):

A) Only a single off axis reflective collimator. This is a situation suitable for testing typical VIS-NIR cameras optimized for long range surveillance.

B) Additional set of refractive collimators is delivered. This set is useful for testing VIS-NIR cameras optimized for short range surveillance (wide FOV).

3) Test capabilities

List of test capabilities is presented in Tab.2 column no 3.

4) Acceptable image formats of VIS-NIR camera

4a - no frame grabber is delivered

4b - Frame grabber accepting images in standard analog video format (PAL/NTSC) is delivered.

4c - TAS software is modified to accept video in USB 2.0/3.0 format. Attention: Camera should be compatible with MS DirectX.

4d - Second frame grabber is delivered: Customer can choose from a long series of frame grabbers: analog HD/SD TV (CVBS, RGB, YpbPr), LVDS or RS-422, Camera Link, CoaXPress, GigE, IEEE 1394 (Fire Wire), SDI, DVI, HDMI. It is expected that customers know parameters of tested camera needed to configure earlier mentioned frame grabbers.

Attention: More frame grabbers can be optionally delivered. Please contact Inframet with your specific requirements.

5) Boresighting

A) No boresight capabilities

B) Measurement of aligning errors of zoom/step FOV objective

6) Simulated distance

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- A) The targets are located at focus plane of the reflective collimator. The position is not regulated. The collimator simulate targets at so called optical infinity.
- B) Position of the wheel with targets can be regulated. Additional platform to move the rotary wheel. PC control. The collimator simulate targets at regulated distance. Useful for checking boresight errors of focusing mechanism of the optical objective.
- 7) Optional software
 - A) No optional software
 - B) Additional MOVIS software that enables easy calculation of detection, recognition and identification ranges of several targets with tested VIS-NIR camera

Example: TVT 150 -BABB-AAA test station means the TVT test station of the following features:

1) simulated light conditions: day/night, 2) image projector built using a single reflective off axis collimator, 3) typical measurement capabilities, 4) image format: analog video, 5) no boresighting capabilities; 6) non-regulated simulated distance, 7) no optional software.

5 Why TVT test system?

There are on market other systems for testing VIS-NIR cameras. However, there is a series of reasons to consider TVT station as the best solution for testing long range VIS-NIR cameras.

1. Universal modular test system that enable extended tests of all commercially available surveillance VIS-NIR cameras
2. Ultra expanded measurement capabilities. The system enables measurement of following parameters: Resolution, Minimal Resolvable Contrast, MTF, Distortion, FOV, Sensitivity, SNR, Noise Equivalent Input, Fixed Pattern Noise, Non Uniformity, 1/f noise, 3D Noise, Number of bad pixels and bad pixel localisation, Responsivity function (Responsivity, Linearity, Dynamic, Light Range), Color fidelity. *Typical test systems offer typically measurement of lower number of parameters.*
3. TVT systems offer for testing VIS-NIR cameras (MRC tests) using a set of at least six USAF 1951 targets of contrast from about 3% to 100%. This test is extremely important because most of targets of interest are low contrast targets. It is easy to manufacture high contrast targets but very difficult to manufacture low contrast targets. Inframet mastered technology to produce targets of contrast as low as 3%. *Typical competitor test stations offer usually only one USAF 1951 target of fixed 100% contrast.*
4. Ability to simulate both day conditions and night conditions due to extremely wide range of illumination regulation in range from about 30 $\mu\text{l}\text{x}$ to over 30 klx. In other words it can be said that TVT system can simulate both ultra dark nights in Afganistan mountains and very bright day conditions on Arabia desert. *There is on the market no test system that could simulate illumination condition in so wide range.*
5. Unique light source (triple work mode (halogen 2856K color temperature for simulation of night&typical day conditions, white multi LED of 5000K color temperature for simulation of bright day conditions, and mixed mode) enables simulation of realistic light spectrum that can be met at real work conditions. Typical light sources can work only at halogen mode of 2856K color temperature that is poor fit to simulate day conditions.
6. Ability to simulate harmful effect of UV light on output image. This is important effect especially for high altitude application. *None of systems offered by competitors can do it.*
7. A set of exchangeable refractive/reflective collimators (enable regulation of angular size of the simulated scenery depending on FOV of the tested imager). *Typical test systems are equipped with only one collimator and there is no possibility to optimise collimator field of view depending on VIS-NIR camera field of view.*
8. Advanced software for image capturing and analysis that enable measurement of all important parameters of all types of surveillance VIS-NIR cameras.
9. Movis computer program (part of TVT system) offers calculation of detection, recognition and identification range of target of interest on basis of measured MRC.
10. TVT system offers measurement of aligning errors of zoom/step FOV objective.
11. A set of different versions of TVT stations of different test capabilities and different price is offered. It is possible to optimize TVT station depending on local requirements.
12. TVT test system has been experimentally verified by a long series of manufacturers of VIS-NIR imager, space test centers or scientific institutes that do research in field of VIS-NIR imaging who have purchased this test system.

Data sheet version 5.2

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