UVIC

Tester of solar blind UV cameras

Fig. 1. Photo of UVIC test station

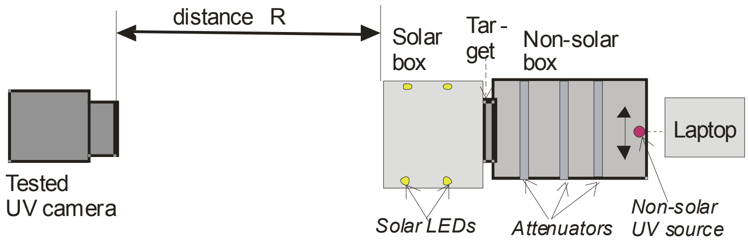

Fig.2. Block diagram of UVIC test station

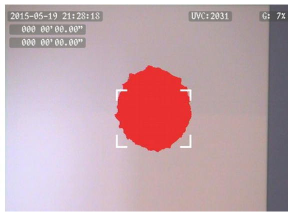

Fig.3. Image of a circular target generated by tested solar blind UV camera

BASIC INFORMATION:

Solar blind UV cameras are imaging devices optimized to detect ultraviolet light of wavelengths below about 280nm. Such cameras are insensitive against sunlight due to negligible sensitivity to visible and long wavelength UV light. From design point of view SBUV cameras are actually bispectral imaging systems built by combining true UV camera with typical visible camera. These bispectral imaging system generate output image as overlay of typical visible image with image of analyzed UV source. Testing performance of SBUV cameras is important because parameters of cameras offered on market vary noticeably and additionally sensitivity of these cameras significantly deteriorate with time.

Manufacturers of SBUV cameras typically present information on camera sensitivity in data sheets. This parameter is typically measured as irradiance at camera optics plane generated by a high temperature blackbody of minimal temperature that makes possible for camera to see incoming UV light. However, such sensitivity data is misleading because it does not does not give information on minimal exitance of the UV source that can be detected but only on minimal irradiance at camera optics plane. Next, test conditions (distance blackbody-camera, blackbody diameter, spectral band of the camera) vary with manufacturer. Such situation makes practically impossible to evaluate SBUV cameras on basis of sensitivity in data sheets, and to use blackbody method to verify camera ability to detect low power UV sources.

UVIC is a tester of solar blind UV cameras built using a special calibrated circular SBUV light source of exitance regulated at very wide range. The station enables precision evaluation of these important and expensive imaging systems. UVIC test station generates images of several standard targets at regulated light intensity in both ultraviolet and visible spectral bands. The tested solar blind camera generates electronic copies of these test images in both two spectral bands. Quality of electronic images generated by tested camera is evaluated by human userver with help of camera software and important performance parameters of solar blind UV cameras are measured.

UVIC station has been developed as the first commercial station for testing SBUV cameras offered on international market. It is especially targeted as station of maintenance of SBUV cameras due to simplicity of operation.

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UVIC

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HOW IT WORKS:

UVIC test station is built from four main blocks: UVIC base block, set of targets, portable laptop, and control software. The UVIC main block can be further divided into three modules: solar box, target pocket, non-solar UV box, and set of attenuators.

Tested SBUV camera is located at a distance about 1-3m from UVIC station and is looking into direction of this station. The UVIC station is equipped with a set of exchangeable targets (3-bar, triangle, circle etc). One of these targets can be in active position between the solar box and non solar box. Both boxes irradiate the test target and create image of this target visible in both SBUV band and visible (solar band). Radiation intensity in both non solar band and in solar band can be regulated in ultra wide band (regulation dynamic over 10^{12} in non solar band). Tested SBUV camera generates electronic copy of original test image generated by UVIC station. This final electronic image generated by tested SBUV camera is analyzed by its user and important parameters of tested camera can be determined.

UVIC is a simple station station that works as image projector that project images of reference targets into direction of of tested SBUV camera that creates copies of projected images. Output camera images are to be analysed visually by human observer or using software of the tested cameras (number of event counts).

WHY TO TEST:

Performance of SBUV cameras offered on market vary significantly. Two cameras having almost the same data sheet can perform in much different way in real application. Next, performance of SBUV cameras vary with time due to deterioration of parameters of the crucial block: solar blind UV image internsifier.
Due to these reasons testing SBUV cameras is critically important at any stage of life of SBUV cameras.

WHAT CAN BE MEASURED:

At present testing SBUV cameras is totally non regulated. There are no standards, no scientific papers on testing SBUV cameras. Manufacturers present in catalogs a parameter called sensitivity but measured using a method suitable for infrared technology that generates over optimistic results and vary depending on test conditions. Practically users of solar blind UV cameras have no chance for proper evaluation of these measuring tools. Situation is particularly annoying at companies/institutes that implemented so called quality systems and are required to calibrate these measuring tools to international metrological system.

In this situation Inframet proposes test methodology based on its experience on testing electro-optical imaging systems. In detail following parameters are to be measured:

1. Sensitivity (Noise Equivalent Radiant Exitance at 260nm)
2. Event count response function
3. Variable target detectivity
4. UV resolution
5. Visible resolution
6. Center boresight error.

Parameters definitions are as below:

Sensitivity

Sensitivity of SBUV cameras is defined as noise equivalent radiant exitance (NERE). In detail, NERE is equal to radiant exitance of a large target at peak sensitivity wavelength (typically 260nm) that can generate the same output signal as signal generated by dark noise of the tested camera. It should be noted that NERE depends on camera gain and integration time. NERE unit is W/cm^2.

It is also possible to measure sensitivity as minimal detectable radiant exitance of the SBUV light source. User is expected to measure output signal (number of event counts) using camera software.

Event Count Response Function

Event Count Response function ECRF is a ratio between spatio-temporal density of event counts in analysed image area and input radiant exitance of a large target. In detail, ECRF is calculated as ratio of average number of event counts recorded in time unit and input radiant exitance of a large target. EFRF unit is s^{-1} W^{-1} cm^2. Attention: ECRF depends on size of analyzed area.

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Variable target detectivity

Variable target detectivity (VTD) is function of minimal detectable exitance of target of interest versus angular size of this target. Measurement is to be done in UV only mode by visual observation of the image generated by tested camera by a human observer.

UV resolution

UV resolution is a maximal angular spatial frequency of 3-bar 100% contrast target irradiated by SBUV light that can be resolved by human observer looking on image of this target generated by UV channel of SBUV camera on its display.

Visible resolution

Visible resolution is a maximal angular spatial frequency of 3-bar target 100% contrast irradiated by visible light that can be resolved by human observer looking on image of this target generated by visible channel of SBUV camera on its display.

Center boresight error

Center boresight error (CBE) is an angular image shift between UV image and visible image of the same target located in approximate center of FOV of both channels. Unit of CBE is mrad.

SPECIFICATIONS

Parameter	**Value**
Modules	UVIC base station, set of targets, laptop, UVIC Control program
Solar box aperture	160x120 mm
Non-solar source aperture	36 mm
Spectral band of non solar source	From 250nm to 270nm
Spectral band of solar source	360nm to 730nm
Exitance range of non-solar UV source	10^{-18} to 10^{-6} W/cm^2
Luminance range of solar box	0.1 -300 cd/m^2 (simulated approximate illumination 0.3-1000 lx)
Targets	UV targets: set of six circular targets (diameter: 1.6; 3.2; 6.4; 12.8; 25.6; 34 mm), set of six 3-bar resolution targets of bar width: 5; 3; 2; 1.41; 1mm Visible targets: USAF 1951 resolution target (spatial frequency from 1 lp/mm to 7.13 lp/mm)
PC Control	RS 232/USB 2.0
Mass	12 kg
Dimensions	390x380x310mm (without laptop)
Operating temperature range	5°C to 40°C
Storage temperature range	-5°C to 55°C
Humidity	Up to 95% (non-condensing)
Power	AC230/110 V (option DC12V)

*specifications are subject to change without prior notice

SUMMARY

UVIC station is the first commercially available station for testing solar blind UV cameras. The station can be a very valuable tool to evaluate true performance of these expensive cameras available on the market and to monitor performance during their life time.

Version 3.3

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