# A COMPUTERIZED STATION FOR TESTING NIGHT VISION DEVICES

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**ABSTRACT:**
Due to a set of different reasons manual stations for testing night vision devices are exclusively used to verify performance of these important imaging devices. Technology of stations for testing NVDs has changed little during last several decades in spite of significant progress in night vision technology. This paper present a novel computerized station for testing night vision devices. The station enables expanded testing of great majority of night vision devices with help of modern computer technology, and can potentially significantly increase accuracy, speed and range of testing night vision devices.

## 1 INTRODUCTION

A series of military series MIL standards present recommendations for simple, non-computerized test stations for testing night vision devices [1-5]. Such recommendations are logical because these standards were created decades ago when computers were not available for metrology applications. Next, there have always been pressure from military users for creations of compact, simple test stations.

Simple, compact, non-computerized test stations are an optimal choice for final military users. However, it should be logically expected that manufacturers, scientific institutes, test laboratories should carry out much more advanced testing of NVDs using computerized test stations that enable semi-automatic testing and digital recording of measurement results. The latter scenario has not materialized so far. Simple, non -computerized test stations are recommended by both standards and speclistic literature [1-8].There are no computerized test station for testing NVDs on the market [9-10]. This situation is in sharp contrast with computerized stations for testing image intensifier tubes that are quite popular.
In this paper a novel computerized station for testing night vision devices is presented.

## 2 TEST EQUIPMENT- MARKET SITUATION

Night vision devices generate images that can be seen by humans and it is possible to evaluate a night vision device using human sight. However, it is surprisingly difficult even for an expert to precisely evaluate night vision devices by looking on images of typical scenery. Measurement of a series of parameters is using professional test systems is needed in order to accurately evaluate quality and possible performance of these devices. Market of systems for testing NVDs is dominated by three companies: Hoffman Engineering (ANV16A station), New Noga Light (MTS station), Inframet (NVT, NV14, NVS stations) [9-11]. The most popular is ANV-126A test station from Hoffman Engineering (Fig. 1a).


a)
b)
c)

Fig. 1. Testers of NVDs: a)ANV-126A test station from Hoffman Engineering Ltd. [9], MTS station from New Noga Light [10 ], NVT station from Inframet [11]

So far all these companies have offered only simple non-computerized test stations for both R&D projects, acceptance tests and for maintenace, or for pre-action tests. Such a situation creates significant limitations particularly in R&D projects and acceptance tests.

## 3 LIMITATIONS OF MANUAL TEST STATIONS

There are some design differences between earlier mentioned non-computerized test stations. However, all these stations offer similar test capabilities. In detail these test stations offer measurement the following parameters : resolution, image quality (dark spots), brightness gain, distortion, FOV, collimation errors. All stations can be also used to evaluate operational defects or cosmetic defects. This relatively high number of parameters to be measured using these manual test stations looks impressive. However, in fact there are several significant limitations of this class of test stations.

1. Lack of ability to capture and record images generated by tested NVDs.
2. Important objective parameters like MTF and SNR cannot be measured.
3. MRC (minimal resolvable contrast) needed to determine effective surveillance ranges cannot be measured.

Limitation no 1 means that measurement of resolution and image quality is done fully subjectively and cannot be supported by such techniques like images comparison.

Limtation no 2 means that two important parameters like MTF and SNR commonly used to evaluate TV cameras, image insifier tubes, thermal imagers cannot be used to evaluate NVDs. This is a significant drawback in R&D projects to develop new NVDs. There is also a lack of logic in this situation. MTF and SNR are commonly used to evaluate image intensifier (modules NVDs) but cannot be used to evaluate complete NVDs.

Limitation no 3 means a serious problem when evaluating ranges of effective surveillance (detection, recognition, identification) with tested NVD. Such ranges cannot be determined on basis of resolution measurement. Measurement of MRC is needed to enable calculation of detection, recognition, identification ranges [4,5].

Due to reasons mentioned earlier lack of computerized stations for testing night vision devices can be considered as one of most important reasons for difficulties in effective, accurate evaluation of night vision devices. We must remember that humans can very well compare quality of several images seen at the same time but have big problems to evaluate quality of images seen at different moments of time. Big variablility of indications of team teams during resolution measurement of night vision devices or image intensifier tubes is a result of this situation. Modern computer technology could potentially help to improve accuracy of resolution measurements or even enable measurement of objective parameter of image quality.

Further on, use of computer technology in testing NVDs can potentially reduce differences between methodology of testing NVDs and methodology of testing electronic imagers like thermal imagers, and visible/NIR cameras. Nowadays, there is basically no major technical obstacles to use well matured methodology of testing visible/NIR cameras also for testing NVDs. This scenario would potentially enable easy comparison of performance of NVDs and low light TV cameras.

## 4 DESIGN OF COMPUTERIZED TEST STATION

A new computerized test station (coded later as NICOM) has been developed and is presented here. The station is based on a concept to keep test methods recommended by MIL standards but implemented using modern computer technology.

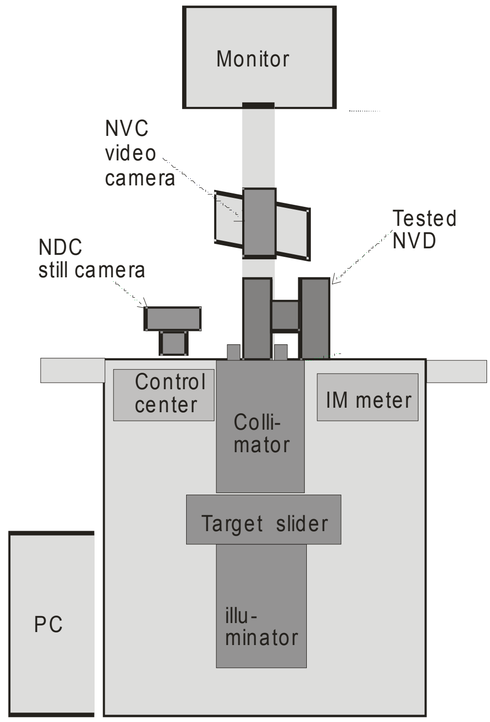


Fig. 2. Block diagram of NICOM computerized test station

As we can see in Fig. 2 this new test station is built as an vertically configured test system composed from two main blocks. The first is an image projector that project image of a series of standard targets into direction of tested night vision device. The tested NVD generates distorted image of these targets. This distorted image is analysed using the second main block: a set of tools for image analysis. The latter set is composed from a high-res video camera, digital still camera, small spyglass, and two luminance meters. The station can be also optionally equipped with a set of optical bridges needed to measure binocular parameters of NVDs.

Fig. 3. Photo of NICOM computerized test station

NICOM test station enables measurement (or checking) of a long list of parameters that can be divided into six main groups:

1. Typical tests: resolution (center, peripheral, high level), screen quality (dark spots), brightness gain, field of view,
2. Maintenance checks: Operational defects (shading, edge glow, flashing/flickering/ intermittent operation, emission points); Cosmetic defects (Dark Spots, Bright Spots, Fixed-Pattern Noise, Chicken Wire, Image Disparity, Output Brightness Variation, Image Distortion),
3. Binocular tests: collimation errors, gain disparity,
4. Expanded tests: Minimal Resolvable Contrast (Fig.4), EBI, magnification,
5. Electrical tests: power consumption, current,
6. Advanced tests: MTF (Fig.5), SNR.

Next, the station enables not only expanded testing of night vision devices but also recording images generated by tested devices and measurement results.

This new test station significantly increases ability for accurate testing and evaluation of modern NVDs.

Results of expanded tests (measurements of MRC, EBI) enables accurate evaluation of ranges of effective surveillance. Ability to use MRC to determine surveillance ranges is particularly important because calculation of these ranges on basis of measured resolution using classical Johnson criteria generates typically too optimistic, non-realistic results.

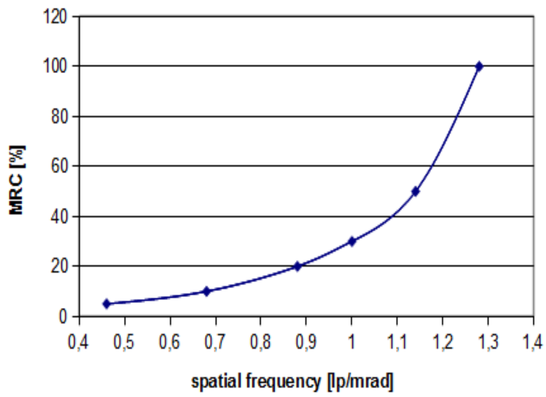


Fig. 4. MRC measurement of exemplary night vision goggle

Results of advanced tests enables to carry out effective design optimization of NVDs. Now, designers of NVDs can compare MTFs built using different modules (II tube, optical objective, optical ocular), and carry out performance-cost analysis.

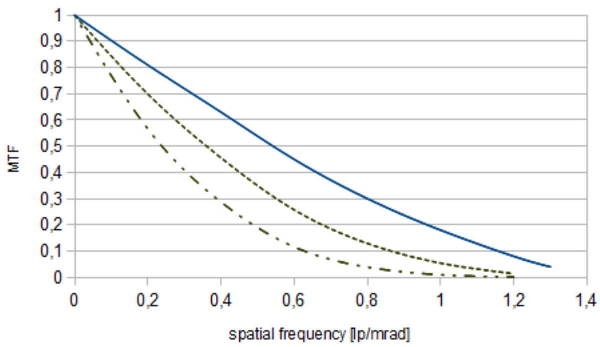


Fig. 5. MTF graphs: a)continuous line - II tube of 64 lp/mm resolution , b)fine dashed line- NVD built using high-res optics, c) dashed-dotted line – NVD built using typical commercial optics

Next, SNR of complete NVD can be compared with SNR of II tube to evaluate influnece of optical objective.

To finish this presentation it can be said that NICOM test station enables testing two types of NVDs:

1. All goggles and monoculars ( typical NVDs of FOV about 40º)
2. Sights/binoculars of FOV > 10º.

These two types of NVDs represent at least 98% of all NVDs offered on international market.

## 5 LIGHT SOURCE

MIL standards recommend to use a calibrated tungsten filament lamp of 2856K color temperature as a radiation source. It is technically difficult to develop a reliable, long life, 2856K color temperature tungsten filament light source that enables regulation of light intensity in wide range. Therefore majority of commercial test stations for testing night vision devices offered on market are built using a single LED light source [9,10]. Such test stations are calibrated to simulate 2856K color temperature light source for one specific type of night vision device (typically built using Gen 3 tubes and Class A filter). Measurement accuracy significantly deteriorate when night vision devices of different type are tested.

NICOM test station is built using a more advanced concept. The station is built using two switchable light sources: halogen bulb of 2856K color temperature source and a monochromatic LED light source. Halogen source is used during measurement of photometric parameters (brightness gain, EBI); monochromatic LED source during measurement of imaging parameters (resolution, dark spots, MTF etc).

Therefore NICOM station enables accurate measurement of photometric parameters (like brightness gain) of all types of night vision devices. Next, NICOM station can be checked and re-calibrated by advanced photometric laboratory because the station use classical photometric light source. At the same time, life time of the test station was significantly extended because halogen source is used only for measurement of photometric parameters.

## 6 COLLIMATOR

Collimator of NICOM test station is designed using a broadband refractive four lens objective. Task of the collimator is project high resolution images in spectral band from 400 nm to 1000nm at field of view up to 40º. Resolution at level 40 lp/mrad was achieved. Projected image is practically distortion free in sharp contrast to collimators used in typical test station.

## 7 IMGAGE EVALUATION TOOLS

A set of image evaluation tools is used by NICOM test station: video camera, digital still camera, and two luminance meters.

Video camera is used to support measurement of resolution, MRC, MTF and SNR. The camera is characterized by ultra high sensitivity (close to 1 mlx) combined with high resolution (600TVL for PAL format). Image processing electronics was linearized in order to enable its use as a measuring tool in MTF, SNR measurement. The camera is combined with high resolution, diffraction limited objective optimized to cooperate with oculars of tested NVDs.

Body of the digital still camera is the same as in commercial models. The main difference is an ultra compact optical objective of wide FOV capable to capture full image generated by tested NVDs.

Luminance meters are used to measure brightness of screens of II tubes seen via oculars of tested NVDs. The first unit of sensitivity at level about 0.01 cd/m$^2$ is used to enable measurement of brightness gain. The second unit of sensitivity at level about 0.0001 cd/m$^2$ is used to enable measurement of EBI of tested NVDs.

## 8 CONCLUSIONS

The computerized station presented in this paper can potentially significantly improve situation in night vision metrology due to several reasons.

First, the station can improve accuracy of resolution measurement due to ability to use image comparison technique during resolution measurement.

Second, computerization of measurement can improve test speed.

Third, the station enables measurement of MRC characteristic and therefor make possible more accurate evaluation of effective surveillance ranges with tested NVDs.

Fourth, the station enables enable measurement of objective parameters of NVDs parameters like MTF or SNR.

Finally, use of computer technology in testing NVDs proposed in this paper can potentially reduce differences between methodology of testing NVDs and methodology of testing electronic imagers like thermal imagers, and visible/NIR cameras.

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