

Method of Rational Choice by Sorting in the Software System “NVGpro”*

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Abstract: *A method of rational choice for the night vision goggles optoelectronic channel elements (objective, image intensifier tube, ocular) choice is proposed. The method is implemented in Web-based software system “NVGpro” for design of the night vision goggles optoelectronic channel. The detection range, recognition range, identification range, the weight and price of the night vision goggles optoelectronic channel are calculated as a result of choice. The sorting algorithm is used to solve decision maker required limits for the calculated results.*

Keywords: *software system, night vision goggles, optoelectronic channel, method of rational choice, sorting algorithm.*

Introduction

The application areas of night vision goggles (NVG) are expanding widely recently [1, 2, 3, 4]. One of the main problems of the NVG developing is the satisfaction of the technical and economical requirements while keeping costs as low as possible. The determination of the requirements satisfaction is possible only after prototype producing and testing which is time and money consuming. That is why the developing of the methods for theoretical estimation of the NVG parameters on the design stage is essential. It is known that NVG optoelectronic channel is critical for the parameters of the NVG device. Nowadays a number of quality elements – objectives, image intensifier tubes (IIT) and oculars for optoelectronic channel are available and the problem of their proper choice exists. In that sense developing of methods for choice of optoelectronic channel elements according to some user requirements and for the purpose of a theoretical calculating of the NVG parameters is needed.

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Method of the iterative choice

The first version of the software program system “NVGpro” was based on the *method of iterative choice* [5]. This method allows the choice of the basic elements of the NVG optoelectronic channel (objective, image intensifier tube – IIT, ocular) and calculating of its working distances, price and weight, but does not allow upper or lower limits setting for the calculated parameters. If the parameters calculated are not what the Decision Maker (DM) expects he/she uses the system to change the choice and to estimate the new results. So, using iterative procedures DM seeks requirements satisfaction. The deterministic or stochastic model is used depending on setting or not of the numerical values for external conditions – ambient light, contrast between the target and the background, atmospheric transmittance and the target area. The stochastic model is based on the mathematical expectations estimates for external conditions.

The graphical representation of the main stages of the *iterative choice method* is shown on Fig. 1.

The first basic stage consists of a survey for needed optoelectronic channel elements and their parameters and a relevant information data base creating.

The second stage includes the user requirements defining – the needed working distances, price, weight, etc.

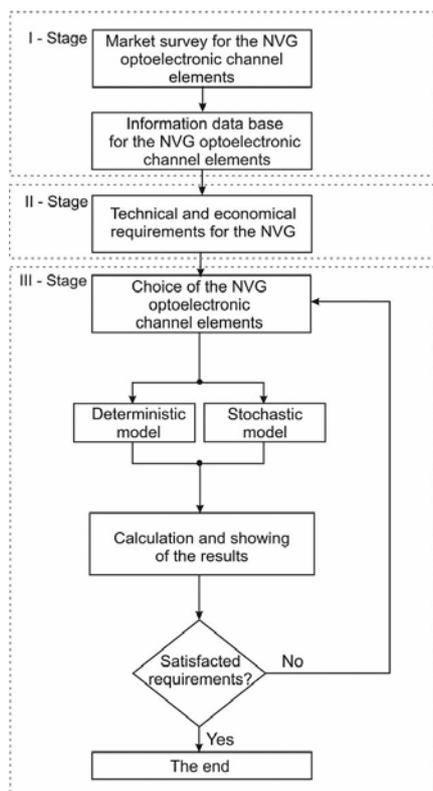


Fig. 1. The basic stages of the iterative choice method

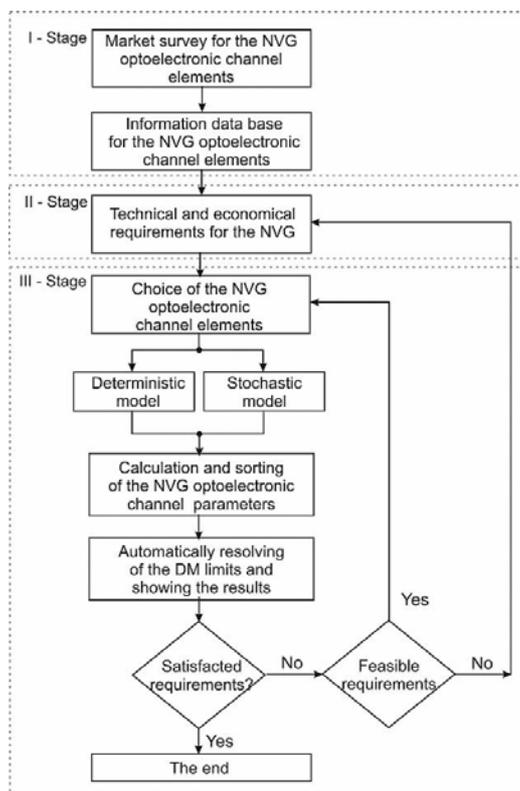


Fig. 2. The basic stages of the rational choice method

The third stage implements the iterative choice itself. The choice of the optoelectronic channel elements is done by the decision maker (DM). He/she chooses objective, ocular and image intensifier tube (IIT) and decides to use deterministic external conditions with proper numerical values or stochastic ones – with implemented in the system mathematical expectations estimates for them. The system calculates the NVG working distances, weight and price for the optoelectronic channel for the chosen elements. The working distances (detection, recognition, identification) are calculated using the proposed formula [5, 13] which takes into account parameters of optoelectronic channel elements (objective focal length, diameter of the inlet pupil, objective transmittance, IIT limiting resolution, IIT luminous sensitivity, IIT signal/noise ratio, IIT photocathode limiting light flow) and ambient light illumination, atmosphere transmittance, contrast and the target area. The calculated results are compared by the DM with the requirements set. If the results did not meet the preliminary requirements the DM changes some of the optoelectronic elements and repeats the process of calculation. By using iterative procedures the DM gets to a set of optoelectronic elements satisfying the preliminary requirements.

Method of rational choice

Using of the software system “NVGpro” in company “ЕлкоЕ” practice shows some needed useful additions to the system. As a result the *method of iterative choice* was modified and extended as a *method of rational choice* [5] (Fig. 2) which is implemented in the 2nd version of the software system “NVGpro”.

The first two basic stages of the new *method of rational choice* are the same as in the *method of iterative choice* i.e. – a survey for the optoelectronic channel elements availability, a information data base creating and user requirements defining.

The differences and additions for the *method of rational choice* are implemented in the third method stage. The first addition is a check for feasibility of the chosen set optoelectronic channel elements. If a infeasibility is found a proper information (through “pop-up” window) is shown to the DM and he/she should make a new choice. If a choice is feasible the DM compares the calculated by the system results with the preliminary requirements and repeats the process until their satisfaction.

Another important addition of the *rational choice method* is the included possibility for the dynamically setting of the boundaries for the calculated results – low limits for the working distances and upper limits for the price and the weight of the optoelectronic channel. There is no optimization algorithms used in the *method of rational choice* and other algorithms are used instead to minimize the repeating process to satisfying the user requirements. The main idea is based on using the sorting algorithm for ordering the results for the all of the possible combinations for the parameter to be considered. Then starting from the beginning of the increasingly sorted array of the results, a proper value (1st above lower limit or below upper limit) is chosen and the relevant combination of optoelectronic channel elements is shown to the DM. In that way a dynamically entered requirements of the DM are satisfied or checked against their infeasibility. The disadvantage of the proposed rational choice by using of the sorting algorithm is the need to consider and calculate all of the possible combinations of the optoelectronic channel elements. The practical usage of the system “NVGpro” shows that disadvantage is not essential for modern personal computer functionalities.

Testing with sets of 12 IITs, 5 objectives and 5 oculars shows completing of the calculations well under one second time – i.e. almost immediately. Although not very elegant compared to the optimization methods [14], the rational choice algorithm by using of sorting is quite satisfying for the real life practice and is implemented in the 2nd version of the system “NVGpro”.

Structure of the “NVGpro”

Due the advantages of the Web-based technologies [6, 7] the developed software system “NVGpro” is designed as a Web-based system. The basic modules of the system are shown in Fig. 3.

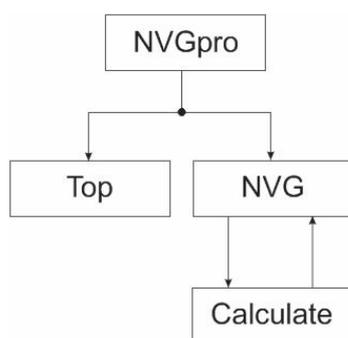


Fig. 3. The basic modules of the software system “NVGpro”

The main module “NVGpro” loads and activates the rest of the modules. It defines the location and dimensions of the program windows where the modules “Top” and “NVG” are to be loaded and executed. The “NVGpro” open design allows extending of the program system with other modules if necessary.

The module “Top” shows the system title and the buttons for activating of the “pop-up” windows with the information about the system and some help information.

The “NVG” module implements the basic system functions – choosing of elements for the NVG optoelectronic channel (image intensifier tube, objective with corresponding ocular, target type and ambient conditions), editing of the basic parameters of the chosen elements (needed when the data of the specific element exemplars differ from the catalogue ones in the internal information data base) and showing the calculated parameters of the NVG optoelectronic channel as a result of this choice.

The calculations of the parameters of the NVG optoelectronic channel are done by the module “Calculation”. It takes parameters of the chosen elements from the “NVG” module and after calculation passes back the results to the “NVG” module. The modules “NVGpro”, “Top” and “NVG” are realised using the well known Web-technology for the Internet applications – HTML, XML [7-10] and JavaScript [11, 12].

Main functions of “NVGpro”

The first function of the software system “NVGpro” is to give the DM a tool for the choice of the NVG optoelectronic channel elements, of the target type and of the external conditions. This choice is done by the means of the “drop-down” menus with elements from the relevant internal information data bases included into the system. The corresponding positions are “IIT”, “Objective and ocular”, “Target type”, “Ambient light condition”, “Contrast”, “Atmosphere transmittance”. The choice of the objective automatically chooses and corresponding ocular [14]. If the DM knows the values to be chosen for some of the parameters “Ambient light condition”, “Contrast”, “Atmosphere transmittance” the deterministic mathematical model of the NVG optoelectronic channel is used. If some of these values are unknown by the DM he/she could use the “mathematical expectation estimate” position on the corresponding “drop-down” menu which activates the stochastic model. In that way the DM does not need to be aware of the details of the implemented mathematical models of the NVG optoelectronic channel.

The second function is to show the chosen elements parameters: “IIT limiting resolution”, “IIT luminous sensitivity”, “IIT signal to noise ratio”, “IIT weight”, “IIT price”, “Objective focal length”, “Objective F-number”, “Objective transmittance”, “Field of view”, “Distortion”, “Objective focus range”, “Weight of the objective and the ocular”, “Price of the objective and the ocular”, “Diopter adjustment”, “Eye relief”.

The third function is to allow editing of some parameters data: “IIT limiting resolution”, “IIT luminous sensitivity”, “IIT signal to noise ratio”, “IIT weight”, “IIT price”, “Objective focal length”, “Objective F-number”, “Objective transmittance”, “Weight of the objective and the ocular”, “Price of the objective and the ocular”, if there exist difference from the data used and real data of the elements – sometimes catalogue data differs from the real data of the elements to be used by the user.

The fourth function is to calculate and show the working distances (detection, recognition and identification ranges), weight and price of the NVG optoelectronic channel for the chosen elements [5, 13].

The fifth function is the possibility for setting by the DM of lower limits for the calculated working distances or upper limits for the weight or price of the NVG optoelectronic channel.

Main screen and interface of the system “NVGpro”

The main screen of the system “NVGpro” with an example for choice by means of a “drop-down” menu is shown on Fig. 4. The calculation of the working distances, weight and price of the NVG optoelectronic channel is activated by the button

. The button  clears all of the fields for the next step of choice and calculation. If some of the chosen elements is changed the fields of the calculated results are cleared and the activation of the button  is needed to show the new results for this choice.

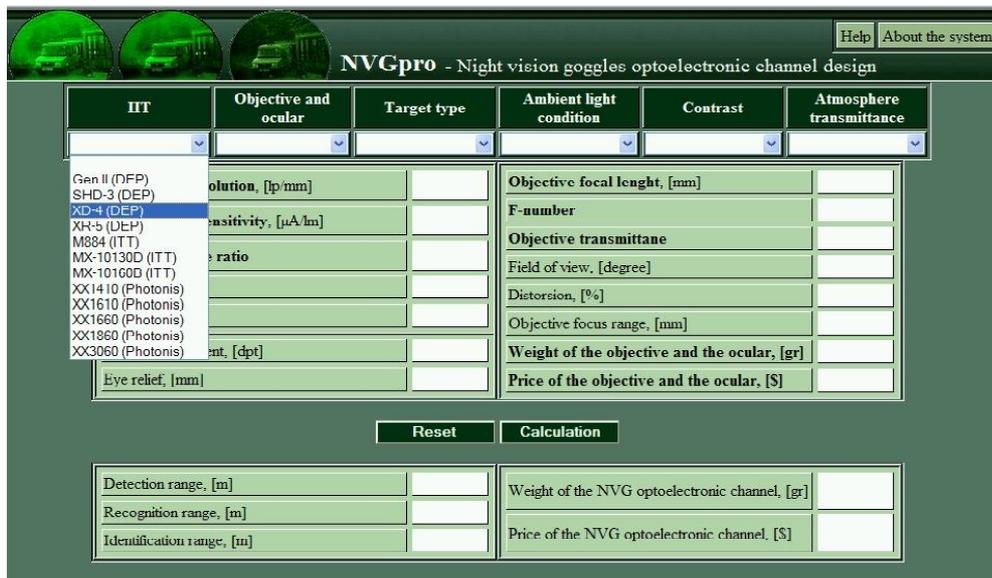


Fig. 4. A choice form drop-down menu

If not all of the elements are chosen the system shows “pop-up” message that some of the data needed is missing as shown in Fig. 5.



Fig. 5. The message for the missing data

When DM sets some limits for the calculated working distances, weight or price of the NVG optoelectronic channel the implemented in the system “*rational choice method*” gives the closest to that limit result and the corresponding combination of the automatically chosen elements. If there is not a feasible combination satisfying that limits a proper “pop-up” message is shown and the DM should change the unfeasible

limit. In this way the DM can operate with the system until he/she gets to the rational choice satisfying the requirements to the NVG optoelectronic channel.

The software system “NVGpro” is Web-based application with internal information data base on the server side and the system is accessible by Internet and some JavaScript based browser. The choice and calculation results stay locked on the client side and are not accessible for other users of the system.

Conclusion

Web-based software system “NVGpro” is a “Decision Maker” tool for the optoelectronic channel elements choice and calculating as a result of the NVG working distances and the price and the weight of the NVG optoelectronic channel. Using the system gives a preliminary theoretical estimation of the designed NVG optoelectronic channel parameters and helps reducing costs for producing of the prototype and laboratory or field testing it against the user requirements. Although Web-based, the system guaranties the confidentiality of using it and the results calculated are kept on the client side only. The software system “NVGpro” is implemented and used in the practice of the company “ЕлкоЕ” for designing and producing of night vision devices.

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