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SIMULATOR FOR THE RS OPERATOR USING VISUAL DEPICTION

ABSTRACT

The high operational cost of exploitation of armaments in near-battle conditions and numerous restrictions in use of the battle equipment in places of permanent deployment have contributed to seek new training methods. In recent years, there has been a rapid development of simulators used in the process of education and in-service training associated with the technological advancement and the modernization of the armed forces of the Republic of Poland.

In this article, an experimental model of the simulator was introduced for the operator of manual tracking (RS) using a visual system. This model was built by the authors as part of their master's thesis. It allows either manual or automatic tracking of targets against the simulated background and gives a grade to the operator based on the accuracy achieved while tracking the target. The solution suggested by the authors may raise the effectiveness of training of operators using television-optical systems, as well as reduce the associated operating costs of the weaponry.

Key words:
the RS operator simulator, visual depiction, automatic tracking.

INTRODUCTION

The process of education and in-service training of staff of the military forces of the Republic of Poland is foundation for the operation of a modern army. Their combat capabilities depend on military hardware (SpW), weaponry, and the abilities of soldiers. In the Mid-1990s, the need for the use more modern and cheaper

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methods of the training was noticed. This was caused, among other things, by exploitation limits, SpW service lives and the high costs of use in battle-like conditions (trips to field centres, costs of fuel, quartering and the like). It is thus essential under conditions of the limited budget to maintain keep SpW in a state of combat--readiness and ensure the highest level of military education.

Along with the technical modernization of the Polish military forces, a rapid development of simulators for training purposes took place [7]. Simulating the real action of the weaponry and SpW, they make the performance of activities possible following a combat scenario. Moreover, the application of multimedia allow a real depiction of the battlefield in virtual reality. Thanks to this, effective training of soldiers is possible without incurring heavy costs and excessive use of SpW or of the weaponry [1].

This article presents the model of the simulator for the RS operator using visual depiction. This simulator can be used in the initial stages of training soldiers for the position of RS operator of devices working under television-optical channels. In the extended version for additional functions, it can also serve in the next stages of training as the basis for RS operators in radio and anti-aircraft units.

Simulators using visual depiction are based on solutions that have arisen over the past few years [8]. One type of these simulators shows an animated video on the display screen or a previously prepared animation (tactical situation). In most cases, the image is generated dynamically and is changing depending on the activities performed by the user of the system. However, according to assumptions set by the authors, the simulator built for the RS operator at the present stage of development is not interactive; it has only to enable to track moving objects relating to the tactical situation similar to real combat action.

In the next section of the article, preliminary assumptions on which the functioning of the simulator is based are described. In the next sections, the principles of its operation and the findings of the research are presented. Conclusions are included in the final part of the article, as well as the possibilities for developmental follow-up works about the simulator are indicated.

PRELIMINARY ASSUMPTIONS ABOUT THE OPERATION OF THE SIMULATOR

As part of the research work, the authors set out to prepare the RS operator station, which would make possible:

- manual and automatic target tracking in a selected tactical situation;
- preparing three combat scenarios in 3ds Max software allowing tracking of targets;

- setting exact coordinates of the tracked object by calculating the coordinates of the object in space 3D space in 3ds Max software to coordinates in 2D space of this object shown on the projection screen or the monitor;
- preparation of an external application exporting the coordinates of the moving object to a file;
- preparation of an the application for the automatic and manual tracking of the shown object;
- saving the coordinates of a moving target in real time;
- noting tracking errors on the basis of the difference between the coordinates from the program Max Script and the coordinates of the centre of the tracked object.

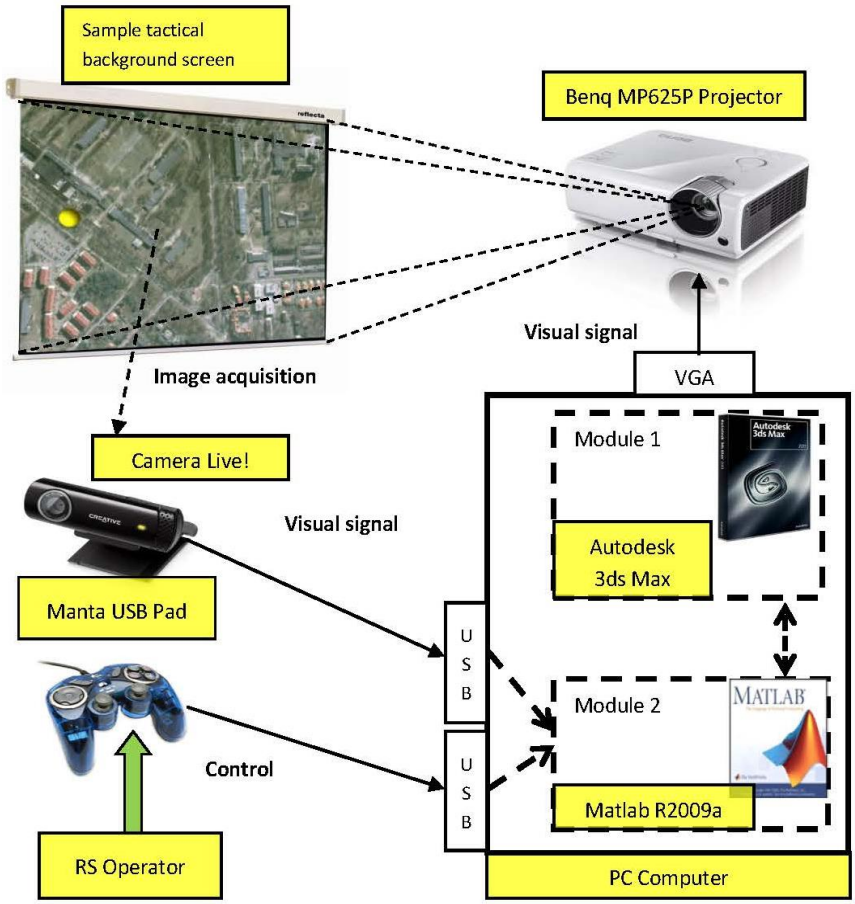

Fig. 1. Model of the simulator for the RS operator [own study]

The model of the RS operator simulator, used to verify the assumptions made, consists of the following elements (fig. 1) [2]:

- a PC computer with installed Matlab, Autodesk 3 ds Max software and with applications enabling to track selected objects;
- a projection screen for displaying the image;
- a projector for generating scenes of appropriate quality on the screen;
- a camera placed at a determined distance and at an appropriate angle to the screen used for canvassing the image;
- a control device (joystick/pad) for guidance with a crosshairs, with which the operator is carries out manual tracking or is selects the object for automatic tracking.

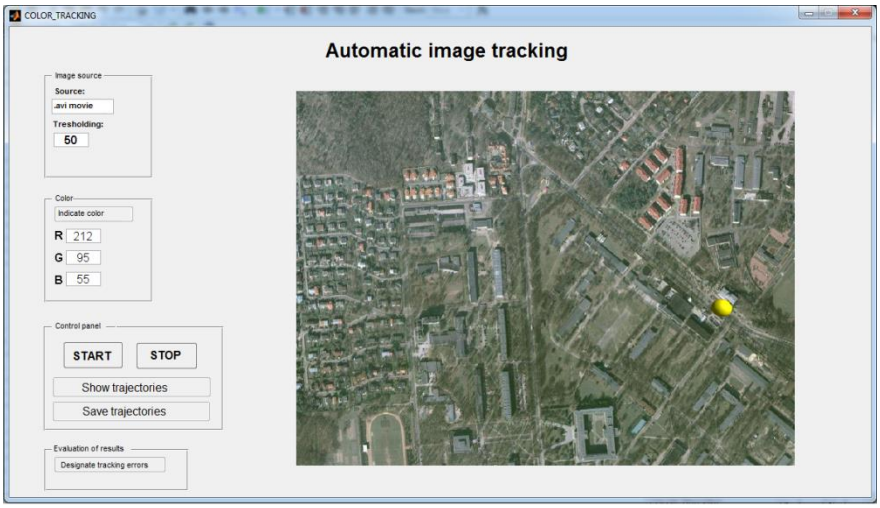

Fig. 2. Interface of the application of module 2 with a loaded file during the completion of automatic tracking [own study]

The software of the RS operator simulator consists of two main modules:

1. Using software 3ds of Max for the preparation of three-dimensional animations also MAX Script language to calculate the coordinates of a moving object in 3D space on flat coordinates their exports to file.
2. Executed in the Matlab environment, that allows hand and automatic tracking of a moving object, a record of coordinates also determination of tracking errors. This module has many possibilities that were not considered in the outline of the project (fig. 2). Above all, it allows:
   - loading the image in .avi format;
   - loading the image from the camera in RGB colours and in any chosen resolution (the resolution depends on the camera parameters);

- display of the object for tracking;
- automatic tracking of its trajectory;
- showing coordinates of the moving object in close to real time;
- analysis and recording of the flight trajectory;
- comparison of coordinate trajectories with real coordinates of the tracked object (provided these are available);
- designation of tracking errors;
- manual tracking of the object.

PRINCIPLES OF OPERATION OF THE SIMULATOR

The principles of operation of the simulator reflect real activities on radar stations by the RS operator which in the passive type of work is responsible for detection, tracking, and in special cases for guiding anti-aircraft rockets to destination target. These tasks are performed through guidance with a platform, on which the television-optical camera and the radar were installed. Based on the depiction from the camera, the operator steers the platform with a joystick so that the tracked object remains in the targeting crosshairs.

The principles of operation of the simulator consist in showing animations on the screen previously prepared in.avi format. The operator's task is to grabbing hold of and tracking of a target appearing in the animation with the use of a control device (joystick). This is used for manual tracking, in which the operator is to keep the crosshairs on the tracked object. In automatic tracking, however, the operator indicates the target to be tracked, after which the RGB matrix of the colur of the selected target is read and a tracking algorithm ensures automatic observation.

The image of the target in the animation recorded by the camera, is processed in close to real time with the acquisition and tracking algorithm, implemented with computer software (module 2). The software allows coordinates to be recorded and on this basis to project the trajectory of the tracked object, as well as sending this data for further processing.

For the scenario carried out in the 3ds Max software, one of four tactical backgrounds is assigned, depending on the platform on which the television-optical camera is mounted (fig. 3). This solution allows use of the simulator by all branches of the armed forces. In simulated scenes, it is possible to raise the degree of difficulty by increasing the speed of the target, maneuvering it violently, as well as hiding it behind natural obstacles. The instructor can choose the target and change its movement parameters only before generating the animation.

Fig. 3. Tactical scene projected by 3ds Max software [4]

The software components of module 1 carried out in the internal script Max Script language of the 3ds Max software allow a choice one or of a few targets for display in the 3D animation space, the coordinates of which will be the reference point for the calculation tracking errors. The program automatically converts the 3D coordinates of the object to perspective coordinates, and then to coordinates of the target shown on-screen [4]. Later, they are exported to a text file what allows to their processing and use for calculations with various parameters. It is possible to compare this data with the coordinates to which the operator guided the crosshairs. In this way, the module 2 software calculates tracking errors (fig. 4), thanks to which the accuracy of the actions taken by the RS operator can be assessed.

The simulator can be adapted to training of drones, radiolocation stations with mounted television cameras working passively in radio-engineering and anti-aircraft units.

EXPERIMENTAL STUDIES

The authors conducted the experimental study in two stages. In the first, tracking of moving objects with using scenarios prepared in the 3ds Max environment

was carried out. Because of the tracking algorithm used, the weak colour contrast between the moving target and the animation background as well as the lighting in the room, it was not possible to maintain steady gracking of the moving target. This may have been affected by the quality of colour reproduction of the camera and projector used.

In order to eliminate the adverse impact of the equipment and external conditions, in the second stage a simplified scene, in which a field map was used with a target, prepared with higher contrast, moving on it. This made stable tracking of the target possible as well as checking the functionality of all the elements prepared in the Matlab software. The results of the accuracy of automatic tracking are presented in figure 4.

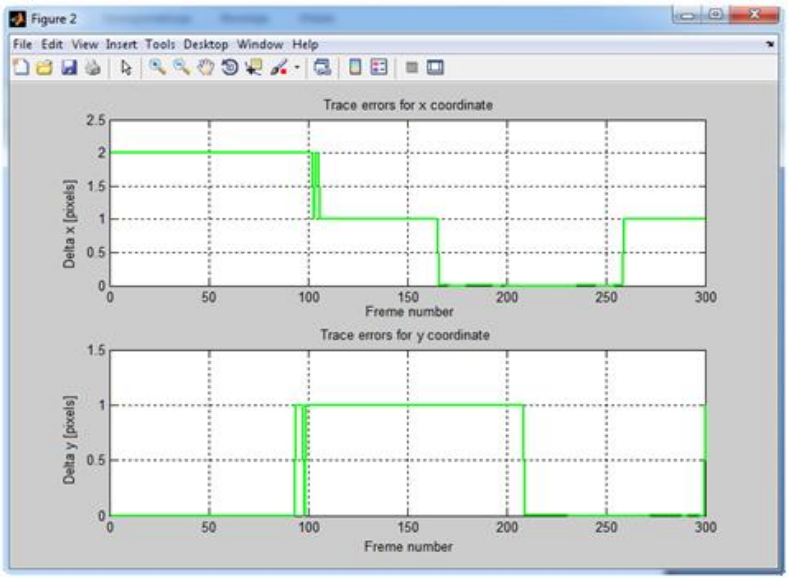

Fig. 4. Tracing errors for the 'x coordinate' and 'y' at using automatic tracking [own study]

The authors of this work successfully executed manual tracking in the first and in the second stage of the experimental research. The tracking errors in both cases were considerably greater than with the use of automatic tracking.

CONCLUSIONS

The model of the simulator for the RS operator meets the fundamental assumptions of the project, such as tracking a target automatically or manually, determining

coordinates of the target and the crosshairs, and calculating tracking errors. Defining allowable margins of error allows assessment of the operator and determining his progress in the training.

As part of the research work, the authors drew up a model of a simple and cheap simulator. However, they are aware that it needs to be updated in terms of interactivity between the operator and the displayed scenario, imitation of the inertia of engines of the platform, on which the television-optical camera is mounted as well as the possibility of generating scenarios in real time.

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SYMULATOR DLA OPERATORA RS WYKORZYSTUJĄCY ZOBRAZOWANIE WIZYJNE

STRESZCZENIE

Wysokie koszty eksploatacji uzbrojenia w warunkach zbliżonych do bojowych i liczne ograniczenia w użyciu sprzętu bojowego w miejscach stałej dyslokacji przyczyniły się do poszukiwania nowych metod szkolenia. W ostatnich latach nastąpił dynamiczny rozwój symulatorów wykorzystywanych w procesie kształcenia i doskonalenia zawodowego związany z postępem technologicznym oraz modernizacją Sił Zbrojnych RP.

W artykule przedstawiono model doświadczalny symulatora dla operatora ręcznego śledzenia (RS) wykorzystujący system wizyjny. Model ten został zbudowany przez autorów w ramach ich prac magisterskich. Umożliwia on ręczne lub automatyczne śledzenie celów na pozorowanym tle oraz wystawienie oceny operatorowi na podstawie osiągniętej dokładności podczas śledzenia celu. Zaproponowane rozwiązanie może podnieść efektywność szkolenia operatorów korzystających z systemów telewizyjno-optycznych oraz obniżyć związane z tym koszty eksploatacji uzbrojenia.

Słowa kluczowe:

symulator operatora RS, zobrazowanie wizyjne, automatyczne śledzenie.