Verifying Unmanned Land Vehicle Vision System Configuration Using Serious Gaming Solution

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Abstract. In this article is described used in Research and Development Center of Mechanical Appliances OBRUM sp. z o.o. method of vehicle R&D cycle support using serious gaming (SG) solution. Implemented in OBRUM sp. z o.o. solution is described on example of Multipurpose Engineering Machine (WMI) with remote control functionality requirement. Short serious gaming introduction with WMI characteristic familiarize reader with study object. Short description of how SG is used in R&D cycle of modernization and concept vehicle R&D. Conclusion summarizes OBRUM sp. z o. o. experience and presents specific application of research results.

1 Introduction

Research and Development Center of Mechanical Appliances "OBRUM" Sp. z o. o. is a part of Bumar Group, and as a main research and development center is conducting a series of programs in support of the national defense. For over 40 years OBRUM realizes modernization, short series manufacture and product implementation in cooperation with reputed universities and defense industry from around the world. Today OBRUM provides full R&D cycle of:

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A. Nawrat and Z. Kuś: *Vision Based Systems for UAV Applications*, SCI 481, pp. 335–342.
DOI: 10.1007/978-3-319-00369-6_22

- Trucked vehicle – PT91, WZT3, MID, MG-20,
- Wheeled vehicle – WMI, MS-20,
- Simulation and Training systems – BESKID-3, SK-1, SK-1 PLATOON

1.1 Serious Gaming – VBS2

Serious gaming is successfully used for training for more than 10 years. SG solutions developed by defence or civil industry are focused in most cases on First Person Perspective or Third Person Perspective simulation of single solider, team, platoon or company level. The main objective of training using serious game is to improve:

- battlefield awareness,
- teamwork inside single squad or team,
- operation tactics,
- communication

Contemporary graphics, easy configurable high fidelity models, enhanced physics and varied available environments opens new possibilities of usage for SG solution. In company like Research and Development Centre of Mechanical Appliances where next to training and simulation system development we run number of analyses and case study at unmanned systems development. Simulation systems development tools is also used in vehicle development, serious game is being use both for simulation and analysis. OBRUM is using Virtual Battlespace 2 (VBS2) as main Serious Gaming solution for S&T system development and prototypes analyses. Virtual Battlespace 2 (http://products.bisimulations.com/development) is a COTS solution used by American, Canadian, Australian and many other army's for tactical training to company level. VBS2 is based on ARMA2 graphic engine, using NVidia PhysX provide sufficient for initial systems analysis fidelity of prepared vehicle 3D models.

At the stage of preliminary analysis OBRUM system designers, software engineers and mechanical designers identified SG used by OBRUM for S&T systems development as a useful for listed above subject analyses:

- HMI interfaces development – testing,
- Vision system configuration prototyping,
- Conceptual vehicles usage verification,
- Controllability analyses,
- Promotion and concept vehicle presentation.

1.2 Object of Study – Base Chassis of Multipurpose Engineering Machine (WMI)

This article discusses conducted analyses for vision system developed for Multipurpose Engineering Machine (WMI) fig. 1 developed and presented by OBRUM in year 2012 on International Defence Industry Exhibition MSPO 2012.

WMI is technology demonstrator of wheeled engineering machine developed in a purpose of direct in convoy engineering support.

The base chassis of WMI is based on 2-axles wheeled drive system, including 4x4 drive. Chassis is equipped with controlled suspension including opportunity to lock and adjust the height, both shock absorbing axles with calibration of twist of the machine (alignment), highly effective brakes at high wheels with ABS systems, clearance about 350 mm, wheels with single terrain tyres of high capacity including pressure control system. Vehicle drive is composed of combustion engine of power about 250 kW. Maximum velocity of the vehicle is about 80 km/h.

WMI vehicle weight including basic equipment of a loader shall equal about 16,500 kg, vehicle width 2.55-3 m, height up to 2.7 m, length up to about 7.5 m.

WMI has a possibilities to lift up to 5,0 tonnes on front work tool, crab drive mode and remote control possibilities.

During machine development, mechanical, electrical designers with OBRUM research department conducted series of analyses to fulfil vehicle technical and tactical requirements.

Remote control capabilities, for unmanned mode was achieved by developed in OBRUM control system that give us the same steering capabilities inside and outside of control cab.

Fig. 1. WMI photography without front work tool, showing front working tool adapter (source: OBRUM)

2 Analysis

Analyzing requirements and SG possibilities, defined following analyses to be conducted to determinate:

1. Vision system configuration:
    a. Number of cameras,
    b. Cameras placement,
    c. Minimal image resolution of transferred to control panel vision signal.
2. Controllability using designed vision system.

In this article we discuss developed in OBRUM development department method on a example of defining vision system camera placement.

2.1 WMI for VBS2 Model Construction

First step of preparation for system analyses using VBS2 is 3D model development.

For purposes of WMI analyses we used CAD/CAM model built in used by OBRUM R&D department SolidWorks. Model prepared for production of technology demonstrator is a source of surface 3D model for VBS2 model development tool – OXYGEN. After preparation of model skeleton and textures config file is prepared. Config file in VBS2 contains all information about model used in VBS2 simulation. One of many configuration parameters is PhysX parameters that describes model physic such as weight, mass centre, materials and others. After finishing configuration of VBS2 model we can use it in VBS2 scenario and control it with keyboard, HID devices such as steering wheel, pedals or other earlier implemented HMI interfaces.

In the phase of development machine specification and 3D models of chassis designer establish proposed vision system configuration, which are a base point for camera placement. During 3D model preparation for VBS2, as many camera points on model is set as construction of the machine allows. After game model is prepared we develop simplified HMI interface or implement existing solution for operator to control the machine in virtual environment.

2.2 Scenario Preparation

To determinate proper camera placement for remote control of engineering machine we have to build a set of test scenarios. Trial scenarios will be used as a test ground and let chose optimal configuration to achieve point 1b of virtual machine tests.

To fulfil requirement of safe remote control of Multifunctional Engineering Machine (WMI) was prepared 4 scenarios. Every scenario was played by the same operator using the same HMI interface. For full credibility of conducted test for every configuration 3 set of test were conducted in slightly different configuration (to avoid user remember obstacles configuration).

For vision system configuration was prepared the fallowing scenarios:

1. Maneuvering in urban areas,
2. Road clearing – obstacles remove,
3. Precise working tool operation,
4. Tow and winch operating.

2.3 Trials Examples

Showed above example of 3D scenario configurator in VBS2. Precise objects placement is possible thanks to available measure tools fig. 2 and 3.

Fig. 2. Scenario screen 3D camera view

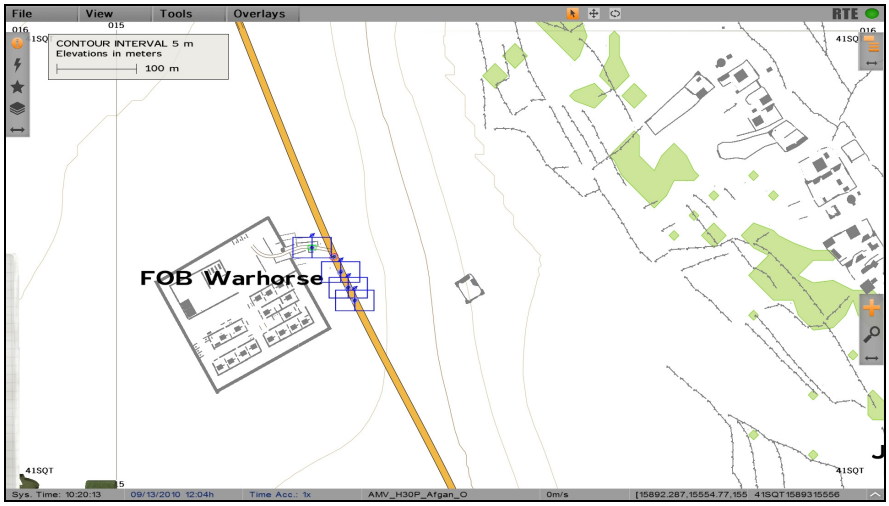

Fig. 3. Scenario screen tactical view

Tactical scenario view allows operator to see full scenario and like at battlefield plan its actions.

Fig. 4. HMI interface example used for machine control (developed for MS-20 – 20m bridge layer) control panel

HMI interface fig. 4 used for VBS2 model control was MS-20 control panel (20m bridge layer MS-20) and PC with 24' LCD screen for camera view.

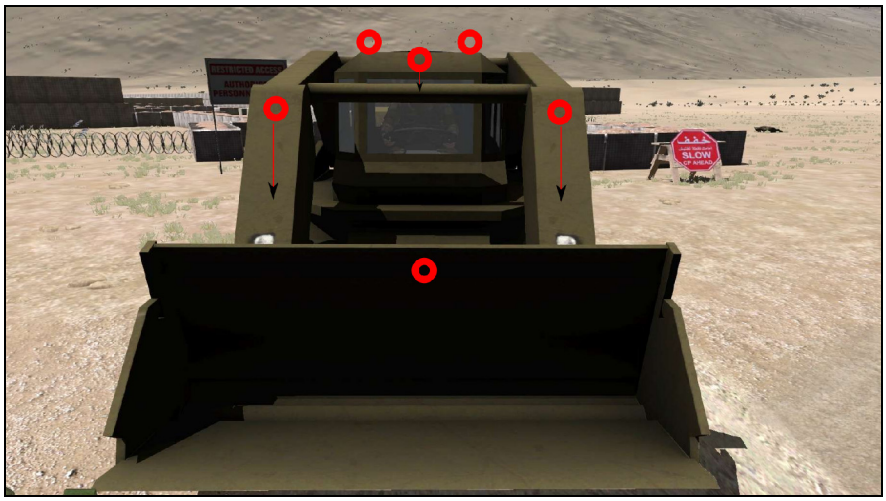

Fig. 5. Verified camera position at working tool and cabin

Verified camera position fig. 5 at working tool and cabin. Camera position verification during trials was prepared in several different configuration taken into account machine construction, operator proposal and hardiness of used cameras. Camera view change required VBS2 model config file edition and change.

Fig. 6. Camera at work tool view point example

Showed above camera views fig. 6 were displayed at 22" LCD screen in configuration:

- 1 view per screen – using two 22" LCD screen,
- 2 per screen – using one 22" LCD screen,
- Switchable configuration.

2.4 Implementation of Test Result

During conducted trials OBRUM engineers specified vision system configuration for next phase of WMI project, 3 axis PINIA. Developed solution contains:

- Optimal camera configuration, divided into specific operation usage modes of machine,
- Optimal camera placement,
- Requirement for communication link,
- Requirement for camera resolution and view angle,
- Proposed HMI configuration,
- Controllability analyse.

3 Conclusions

During test and trials of developed in OBRUM modernization and concept vehicles, ware defined fallowing conclusion of using Serious Gaming in R&D cycle of vehicle:

1. Serious gaming can by successfully used in manned and unmanned vehicle research and development cycle, for:
    a. Conception verification,
    b. Subsystem configuration analyses, such as:,
        i. Vision systems,
        ii. Interior HMI configuration,
        iii. Remote control panel configuration,

   c. Controllability analysis,
   d. Tactical usage verification,
   e. Controllability when towing,
   f. Promotion (advert) and concept vehicle usage demonstration.
2. Proposed solution can help engineers running analyses, concept works or vehicle modernization to solve the problems of:
   a. Controllability analyses,
   b. Inside and outside cabin visibility,
   c. Vision systems configuration,
   d. HMI interface configuration,

However serious game that using only simplified physic models or inaccurate data about model can issues difficulties with simulation fidelity. Conducting tests and trials at VBS2 models of concept machines there is a problem of building high fidelity physic and construction model for under construction vehicles – that translate to only indicative controllable test results.

Developed in OBRUM solution for concept testing in most affordable, fastest and giving best results method of concept vehicle verification and development.

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