# Gesture and Body Movement Recognition in the Military Decision Support System

Jan Hodicky and Petr Frantis
*Communication and Information System Department, University of Defense, 65 Kounicova str., Brno, Czech Republic*

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Abstract: The paper deals with the result of the research activity in the field of military decision support system. It brings a new way of communication between system and commander. Kinect - the low cost gesture and body movement recognition device was employed to control 3D visualization of real-time battlefield situation. Experiments confirmed the correctness of Kinect using to support all phases of decision making process. The quality of operation planning and control was increased.

## 1 INTRODUCTION

In the military field the decision support systems play a major role in modern operations. To define the military decision support system the non-military definition must be declared. One of the generally accepted definitions claims that decision support system (DSS) is a computer technology that can be used to support complex decision making and problem solving (Shim, 2002).

In that context DSS is an information system or system of systems that must:

- Help to decision makers (individuals or group);
- Use information and communication technology (ICT) to deal with data, information and knowledge gathering, processing and presentation;
- Help to solve non-documented or non-structured problem;
- Support realization of all parts of decision making process;
- Help to identify the best problem solution.

The military decision support system (MDSS) definition corresponds to previously defined DSS but is aimed to the real time battlefield domain. MDSS helps the warfighter to gain and maintain information superiority in order to achieve command superiority in war and peace time (Tolk, 2000).

The massive research activity in the MDSS area is dated back to the 1970. From that moment many concepts were introduced but the most important milestone is 1995 when the first command and control (C2) system was implemented in the US Army (FBCB2, 2008). C2 system is DSS based on the geographic information system that provides sets of capabilities to deal with geo-referenced input, storage analysis and output. C2 has high demand on real time visualization of all objects in the battlefield. The main interface between fighter and C2 is common operational picture (COP) (Johansen, 2005). Common operational picture is mainly composed of friendly and enemy forces position and other tactical data real-time visualization. These days' research activities are focused on improvement of COP reading, presenting and understanding.

## 2 SHORTAGE OF CURRENT C2 SYSTEM

The best way how the COP can be understood is its real time visualization. The latest research revealed that 3D visualization can significantly improve battlefield understanding. The new presentation layer of C2 system with 3D visualization capabilities has been already presented (Prenosil, 2008).

The Figures 1 and 2 demonstrates the COP visualized in two and three dimensions. The unit symbols and crucial tactical data are presented in relation with 3D terrain. COP can be projected by 2D or 3D stereoscopic projection. Thus the commanders (decision makers) must wear

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appropriate glasses that are synchronized with stereo projection to get 3D environment feeling. The 3D environment is controlled by commander by well-known devices such as a mouse and keyboard. This way of controlling is very disturbing in the mission planning and controlling phase of decision making process.

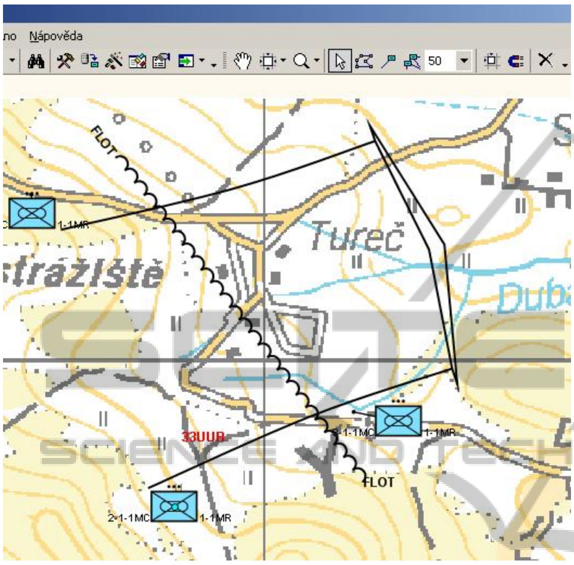


Figure 1: COP - visualized units and tactical data in 2D.

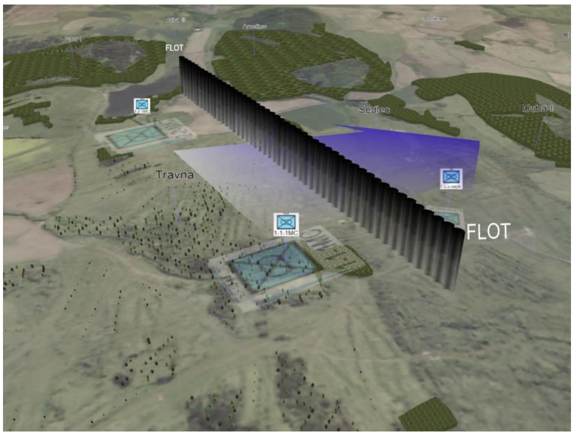


Figure 2: COP - visualized units and tactical data in 3D.

The most important issues in current C2 solution from the human machine interface and commanders point of view are:

- 3D visualization solution should be implemented at low costs;
- 3D visualization solution must be easily and quickly configurable and reconfigurable;
- 3D solution must be deployable as fast as possible;
- COP controlling must be as fast as possible;
- COP controlling must be natural and very fast to learn;
- COP controlling must not disturb commander in its decision making process in command place.

These facts leaded to a new research activity focused on implementation of a new way of communication between commanders and COP.

# 3 NEW ARCHITECTURE OF C2 SYSTEM

Our team used the Microsoft Kinect motion tracking device to enhance 3D visualization solution in 2011. This enabled to the commander to control COP by gesture and body movement. Microsoft Kinect is a low-cost gesture and body motion tracking device that can be connected not only to XBOX 360 console but to PC via USB cable as well. New C2 architecture is shown on the Figure 3. Agents (units, vehicles, individuals) collect information about battlefield and sending them to the core of C2 system. In the core of C2 system are the incoming data analyzed and COP is created. COP is visualized in 2D or in 3D in the new presentation layer. This presentation layer contains Kinect application programing interface (API) that enables commander to interact with the system in 3D environment.

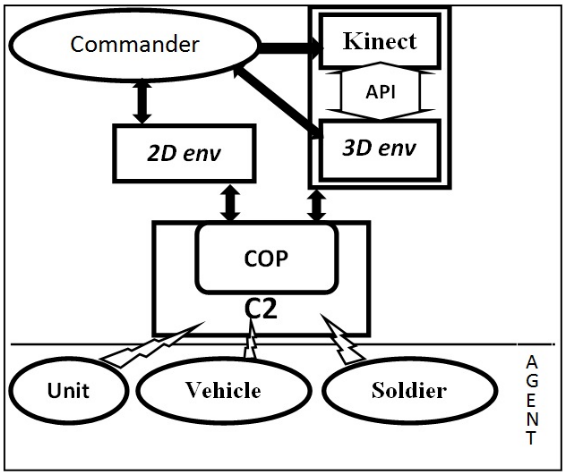


Figure 3: New architecture of C2 system with Kinect.

The 3D commander workstation is composed of:

- 3D stereoscopic projector;
- 5 synchronized glasses (for commander and its staff);
- Projection screen;
- Kinetic sensor placed under the projection

screen;
- Standard PC.

The commander is capable to control the 3D environment by the body movements. Before first use the system should be calibrated according to his physique and its initial position (IP). Then he can immediately control the 3D environment. Movements from the IP means that camera in 3D environment is moving in the corresponding direction. The commander's right hand controls camera viewing direction (it replaces computer mouse operation in 3D environment). The commander's left hand controls levels of details in the scene. When the commander points the left hand down, 3D environment immediately increase the level of details in the scene and camera moves closer to the terrain. If the commander points the left hand up, 3D environment decreases the level of details and the distance between camera and terrain increases. Commander 3D workstation with Kinect is shown on the Figure 4.

Figure 4: Commander 3D workstation with Kinect.

## 4 COMMANDER DECISION MAKING PROCES

Commander decision making process is divided into two main parts:

- Operation planning;
- Operation control.

During operation planning the commander and its staff is dealing with possible variations of task, maneuver, activity, etc. In the briefing time the commander and his staff use the COP to clarify their intention in accordance to geographical 3D data. The time interval in which the consensus must be done can be essential. The result of planning process is a complete documentation for operation (for example operation order- OPORD).

During the operation control the commander commands and controls the inferior units to achieve the created plan. It is a real time process and COP must correspond with the real situation on the battlefield. During the battle operation the COP changes so the commander must correlate the plan based on the discussion with its staff. Time interval in which the consensus must be done is crucial.

In both cases decreasing the time interval to get the consensus is one of the main goals with respect not to decrease the quality of the decision making process.

## 5 EXPERIMENT

In our experiment we wanted to reveal if Kinect sensor implementation, it means gesture and body movement recognition of commander that is controlling the 3D environment (COP), can decrease the time for making the consensus.

Our experiment was divided into two parts according to two parts of decision making process where the COP is used: operation planning and operation control. In both parts two groups of 5 military students were employed. The one of the student in each group (G1, G2) was the commander and the rest was its staff.

In planning operation experiment two groups got the same task to generate operation order for attack of a company into defense position of one enemy platoon in two scenarios. In the first scenario –S1 first group- G1 could use Kinect to control 3D COP, the other one – G2 couldn't. Second scenario –S2 was conducted in the opposite way and in a different terrain. G1 couldn't use Kinect and G2 could use Kinect to generate the operation order. The Table 1 shows results of overall time needed to generate OPORD.

Table 1: Planning operation experiment results.

| Scenario | S1 | | S2 | |
|---|---|---|---|---|
| Group | G1 | G2 | G1 | G2 |
| Kinect | X | | | X |
| time[s] | 1750 | 1920 | 1720 | 1640 |

In the operation control experiment the interconnection between constructive simulator (VR Forces) and the Czech Army C2 system was implemented. The VR Forces was set up by scenarios – S1 a S2 from the operation planning. VR Forces fed C2 system with scenario and the "real – time" operation was modeled in VR Forces and COP was directly visualized in 3D environment. Figure 5 shows architecture of the experiment in the operation control phase with Kinect solution.

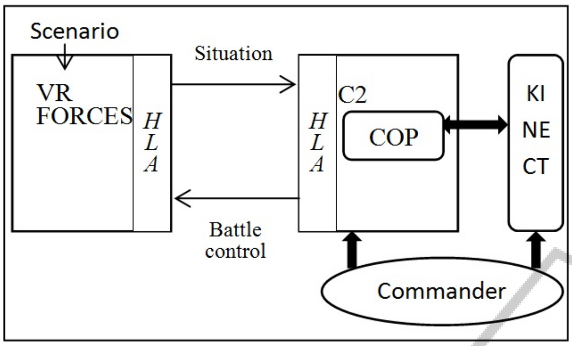


Figure 5: Operation control experiment architecture with Kinect.

The aim of the exercise was to destroy the enemy platoon based on the previously generated OPORDs. In the first scenario- S1 commander of the G1 group could use the Kinect for controlling the 3D environment during communication with it staff (G2 couldn't use Kinect). During the second scenario– the S2 commander of G1 couldn't use Kinect and vice versa. The following table shows results of the overall time needed to destroy all enemy vehicles.

Table 2: Operation control experiment results.

| Scenario | S1 | | S2 | |
|---|---|---|---|---|
| Group | G1 | G2 | G1 | G2 |
| Kinect | X | | | X |
| time[s] | 185 | 220 | 410 | 320 |

## 6 RESULTS

Results from the first part of the experiment that focuses on operation planning, reveals that the commander using Kinect to control the 3D environment (COP) was able to construct the operation order in a shorter time interval. The second part of the experiment identically found out in that in the simulated environment the time interval needed to successfully executed operation order is shorter in case of Kinect using.

After discussion with group of testers the main benefits of the Kinect solution are:

- Easier orientation in the terrain based on the natural way of controlling the 3D environment;
- Faster way of communication with COP;
- Easier explanation of potential maneuvers;
- Better understanding of distances between objects;
- Better remembering of the orientation points in the battlefield;
- Better immersion into the virtual battlefield.

## 7 CONCLUSIONS

The new research activity in the field of military decision support system brought a new way of communication between the C2 system and the commander. Experiments with Kinect confirm the correctness of idea using the virtual reality devices to support decision making process in almost all phases of command and control process. After getting used to control the 3D environment with gestures and body movements the overall quality of operation planning and control increases. This solution is not limited to military domain, but can be easily adopted in civilian sphere, for example in crisis management system solutions. Future research activity will be aimed on implementation of voice control of the C2 systems.

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