

Low cost solution to control military command and control system in virtual environment

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Abstract. Military Command and Control system is a principal tool for commander to support its decision making process. The main interface between commander and military Command and Control system is Common Operational Picture (COP). It contains mainly visualized data about friendly and enemy units related to geographical data. The article deals with the output of research activity that brought a new way of controlling COP visualization. Sensor Kinect was employed as low cost devices to manipulate with camera of projected scene. Commander can manipulate with virtual reality by its movement and gestures recognition. Architecture and controlling of low cost solution is introduced. The commanders were able to better understand the most important information coming from command and control system and this solution contributed to the better commander orientation in the real battlefield condition.

Keywords: command and control system, Kinect, visualization

1. Introduction

One of the generally accepted definition of Command and Control (C2) system dates back to 1986. C2 is a system of systems that can be characterized by high degree of complexity, distributed environment focused on distribution of decision making process over the agents, high demand on reliability and inevitable human machine interface implemented to support communication between operator and system (Builder, 1999). C2 system can be seen in many domains such as traffic control, manufacturing system, nuclear system, military system, etc. Military C2 (MC2) system is C2 system that operates in the real time battlefield domain with the main goal to achieve operational and information superiority (Tolk, 2000).

MC2 system research activities began in 1970 and from that moment battlefield information was strictly connected to geographical position information. Thus the main MC2 interface was born as a battlefield real time picture with related geo information. Interface was called common operational picture (COP) and its name is still in use. COP is usually composed of visualized military information (SW solution) and physical interface to control this environment (both HW and SW solution). Visualized military information is divided into:

- Friendly position information (blue forces)
- Enemy position information (red forces)
- Unit tactical data information
- Geo data (raster, vector and satellite imagery)

From the visualization point of view the military information is visualized on the map resources. Physical interface is composed of:

- Projection system (LCD, projector)
- Input devices (keyboard, mouse, trackball)

The most important demands on COP are:

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- Credibility of visualized information
- Accuracy of visualized information
- Visualization in natural and understandable way
- Control by close to human approach
- Control by not disturbing devices (in the sense of operator freedom)
- Control by very fast solution

2. Current State Of MC2 System

First MC2 system has been implemented in 1995 in the US Army. This system was capable to gather all battlefield data from sensors and to visualize it in 2D map resources. The progress of technology and mainly the growth of computer power enabled to develop application that was capable visualizes friendly units in 3D terrain in 2008 (FBCB2, 2008). That was the first attempt to visualize COP in 3D (shown in Figure 1).



Fig. 1: Blue and red forces mapped on the 3D terrain – COP.

FBCB2 3D solution has these shortcomings:

- Friendly and enemy units are visualized as a symbol (not 3D objects)
- Not exactly expresses the area covered by unit (only connected to a point, not to the area of operation)
- Unit tactical data is not visualized (combat efficiency, movement velocity, fuel capacity, ammunition capacity, etc.)
- Human machine interface is slow and old fashioned (keyboards, LCDs)

Two projects followed to overcome these drawbacks in the Czech Armed Forces. Project with code name “Virtual” (2008-2009) implemented a new presentation layer for Czech MC2 system that is capable to visualize friendly units as a 3D object in virtual terrain. The virtual terrain is fully automatically generated from geo data resources without any operator involvement and visualized unit covers by its volume the unit controlled area. Project with code name “Visual”, started in 2010 and ending in 2012, enhances the 3D visualization capability mainly in the field of tactical data visualization in 3D. The 3D visualization methodology of tactical overlays (Tactical Lines, Areas, Directions and Points) has been designed and implemented. Figure 2 shows the tactical overlays visualized in 3D (red – Main Axes of Attack of enemy troops, blue – checkpoint of own troops)

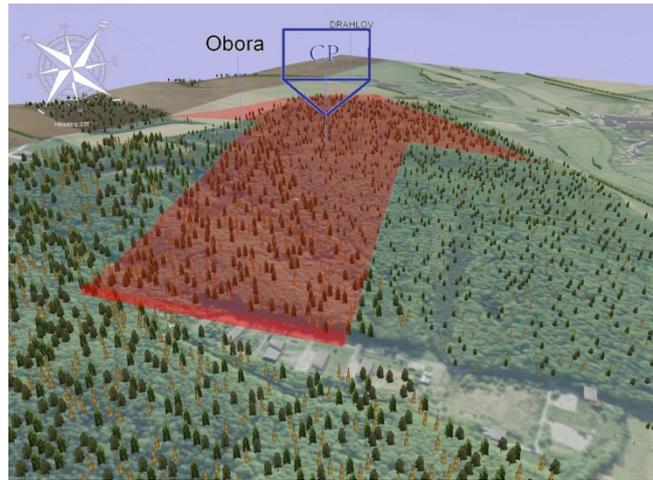


Fig. 2: Units and tactical data visualization in 3D

The last part of the project “Visual” is aimed on a new way of communication between COP and operator (commander). The old fashioned physical interface that is currently used is composed of keyboard (mouse, trackball) and LCD displays. This type of user interface restricts a commander so he cannot be fully concentrated on controlling the operation.

Due to these facts a new solution should be implemented to allow the commander to be fully concentrated to fast decision making process.

3. Kinect Gesture And Voice Recognition Devices

Microsoft Kinect sensor was chosen to control COP as a low cost device. Originally it was developed only for Xbox game console, but currently Kinect can be used on the PC platform. This devices is composed of two infra cameras and one standard camera that enables the drivers to measure distance between important points in the tracked area. The exact position of appropriate joints of user (or two users) standing in front of it can be solved by Kinect API and customized SW application.

The Kinect device was implemented into MC2 solution. The commander can stand in front of sensor and his movements are tracked by the Kinect device. The tracked body movements and gestures are used to control the COP visualization process. The Kinect is a wireless device so the commander does not need any other attached motion tracking sensors.

4. Low Cost HW Solution Architecture

Not only was the Kinect device employed into overall architecture. The Figure 3 shows the complete COP visualization architecture solution. Commander and his staff (usually 5 persons) wear glasses that are synchronized with 3D stereoscopic projector projecting the visualized imagine on a standard projection screen (active stereoscopic projection is used). The Kinect device is placed under the projection screen. The projector can placed either on the floor or mounted on the ceiling. The ceiling projection mounting allows more room for the commander but floor projector placement is easier for fast deployment. This configuration was designed and tested for easy deployment in standard military field tents. The active stereoscopic projection enables better depth sensing of the visualized terrain and is very appreciated by the commanders and staff.

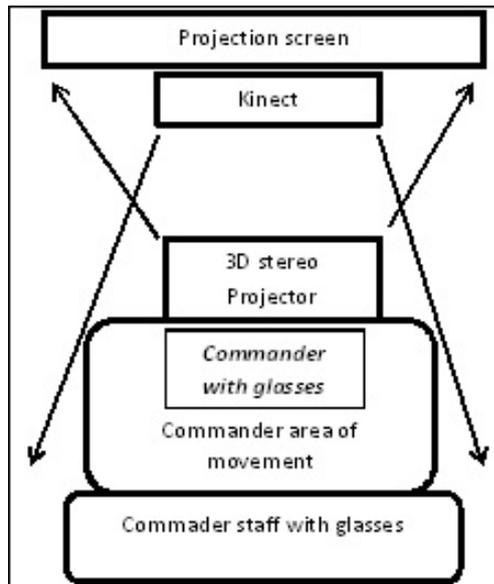


Fig. 3: COP Visualization HW solution.

5. Command And Control Process In Virtual Environment

The military command and control process is composed of two main activities:

- Understanding of current situation in the battlefield
- Command of inferior units.

Better understanding of current situation is done by a new natural way of controlling the visualization. In the beginning the commander must calibrate the sensor system by standing with arms raising forward. The application saves his position, body height and length of his arms. Thus the gestures can be recognized. Movements in the virtual environment are controlled by the commander movements in his working area. Step forward means the virtual camera movement in the same directions proportionally. It works similar with movements in other directions. Distance between the commander and the saved calibrated position controls the velocity of the virtual camera movements. The Left hand controls the altitude of the camera over the terrain. If the commander raises his left hand the altitude is increased and the level of details decreases and vice versa. Right hand movements replace the mouse operation in 3D environment (shown in Figure 4).



Fig. 4: Commander workstation with low cost visualization solution.

6. Conclusion

We have already done couple of experiments with our low cost visualization solution. We have tested the Kinect sensor and the way of COP controlling by the commander in the simulated battlefield conditions. We revealed that:

- Kinect solution works perfectly in dark environment (battlefield tents).
- Commander staff must be located in the specified areas (usually on the sides) to not cross the line of sight from the Kinect device to the tracked commander.
- Commanders were able to better understand the vital information from the battlefield.
- Commanders were capable of better orientation in the virtual environment if they were using the Kinect device.
- Control of visualization was more intuitive and thus faster.
- The overall solution was easy to deploy and ready to use in very short interval – less than 10 minutes.

The future aim of our research is focused on merging two stereoscopic projection systems and more Kinect sensors to be able to track more staff personals simultaneously.

7. References

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