Battle Management System as Key Element of Effective Autonomous Ground Robotic System Operation on Battlefield



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Agenda:



- Introduction
- Technical Limitations on the Use of UGS
- Battle Management Systems
- Calculating the Route
- Implementation of MCS CZ into Battle Management Systems
- Conclusion
- Questions



Introduction - The main idea of the article

Integrate autonomous ground robots with C2 information systems

Problem

UGS are limited by terrain, communication range, and the ability to respond to dynamic threats.

Proposed Solution

Use the BMS and the MCS CZ model to plan a route based on the terrain and the tactical situation.

Expected Benefits

The operator enters a task and monitors the sensors; **the robot autonomously follows the route and supports the unit's operations**.

Technical Limitations on the Use of UGS

- Terrain passability: slope, vegetation, surface, water, built-up areas, weather.
- Communication range and reliability of the connection with the operator.
- A changing tactical situation and the ability to respond flexibly.
- UGS are used primarily behind the lines, for resupply or MEDEVAC.
- **Autonomous movement can free up the operator's / commander´s attention to monitor sensors and control the unit.**



The Role of the BMS

A shared situational awareness platform connects people, sensors, vehicles, and command centers



Data Collection and Sharing
Unit positions, terrain, weather, sensors, logistics, and situational information.

Planning and Decision-Making
Digital map, area analysis, task and route planning.

System Integration
Communication between commanders, infantry, vehicles, and autonomous systems.

BMS enhances situational awareness and helps shorten the decision-making cycle.

The benefit arises from the integration of UGS software, the unit's information system, and the operator's equipment.

Battle management systems

USA – JBC-P / Nett Warrior

A tactical map, tracking of friendly forces, reports, navigation, and a soldier's equipment—all integrated into an information network.

Rusko – Andromeda-D / Strelec

Automated command and control, situational awareness sharing, digital communications, and equipment for individual soldiers.

Izrael – TORCH-X

C4ISR, shared battlefield situational awareness, planning, navigation, and integration of sensors and robotic systems.

ČR – IS C2 Land forces

ASVŘ, BVIS/SAMET, and BADIAN support planning, the sharing of tactical information, and the operations of commanders.

Czech army: IS C2 Land forces

ASVŘ

Support for staff, planning, and decision-making; map and geographic analysis; interoperability in accordance with NATO standards.



BVIS / SAMET

Tactical information support ranging from weapon systems to the company level; sharing of positions, messages, and tactical sketches.



BADIAN

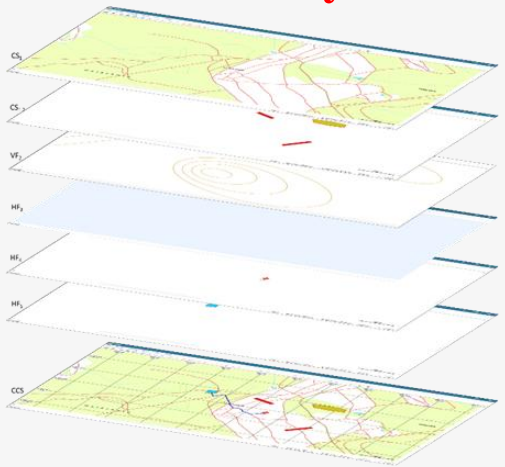
A platform for commanders and soldiers: a shared situational overview on the map, messages, and sharing of tactical markers.



Calculation of the Maneuver Route

MCS CZ – Maneuver Control Systém CZ

The model generates a combined cost surface (CCS) based on several layers of factors.



Surface and vegetation: roads, forests, fields, pastures, built-up areas, and bodies of water.

Terrain and slope: how the terrain affects travel speed.

Weather: the impact of weather conditions on passability.

Tactical situation: threats and the presence of friendly forces.

$$CCS = \frac{CS_1 \cdot CS_{1.2}}{VF_2 \cdot HF_3 \cdot min(1, HF_4 \cdot HF_5)}$$

No-Go (NO GO) areas are bypassed;
Slow Go (SLOW GO) areas slow down transit.



From Map Data to Autonomous Mobility

1 → 2 → 3 → 4 → 5

Input Data

Terrain, weather, passability, and current conditions

CCS Calculation

Combining Effects into a Raster Cost Area

Route Calculation

A Combination of the Floyd–Warshall and Dijkstra Algorithms

Handover of the UGS

The route will be uploaded to the UGS computing unit

Navigation and control

The robot follows the route; the operator monitors the sensors

The calculation takes into account the different mobility levels of pedestrians, wheeled and tracked vehicles.

Integration with BMS

Benefits

- Route planning even at the level of small units
- Passable and safe route
- Focus on sensor data
- Ability to update the plan as the situation changes

Limitations

- Unpredictable changes
- Accuracy depends on data quality and verified speeds
- Full implementation depends on a legal agreement
- Integration has not yet been implemented in the Czech Armed Forces

Conclusion

- UGSs can expand the capabilities for reconnaissance and support of operations.
- The key factor is not only the robotic platform itself, but also its integration with the BMS and C2 systems.
- The MCS CZ model plans its route based on terrain, weather, and the tactical situation - with an emphasis on both speed and safety.
- The the model's validation in experiments with the Taros Furbo UGS and its use in the NATO R2CD2 project.
- **Next step: full integration of the model into existing BMS and practical validation.**

Questions?



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