Proceedings of the 2019 Winter Simulation Conference
N. Mustafee, K.-H.G. Bae, S. Lazarova-Molnar, M. Rabe, C. Szabo, P. Haas, and Y.-J. Son, eds.

MODELING COOPERATIVE ENGAGEMENT BEHAVIORS OF MANNED-UNMANNED SYSTEMS

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ABSTRACT

As network-centric operating environments require the interworking of manned-unmanned weapon systems, there is an increasing need to analyze its capabilities and effectiveness in combat simulation. In this paper, we suggest a cooperative engagement behavior model of manned-unmanned systems for engagement-level combat simulation. Using the proposed model, we demonstrate reconnaissance behaviors in various areas under a small unit combat scenario and shows the analytic results of combat effectiveness.

1 INTRODUCTION

Future unmanned ground systems are required to interoperate with manned ground systems through advanced communications so that they conform to the concept of effect-based synchronized operation. Most of ground weapon analysis models are normally limited to simulate the behaviors of unmanned ground systems such as surveillance and remote control. This is because previous models, such as JANUS, calculate MOE (measure of effectiveness) on the assumption that communication is always possible. Therefore, communication drones and robots cannot be simulated, and the calculation of MOE depends only on weapon systems, unit organization, and terrain characteristics. It thus cannot fully support combat effectiveness analysis of ground unmanned systems under network-centric operational environments. In this paper, we design and implement a cooperative engagement behavior model of manned-unmanned ground systems that can be utilized in future ground combat simulation.

2 MODEL

The proposed model is focusing on simulation of reconnaissance behaviors based on manned-unmanned systems. The behavior model defines an action plan from the initial state to the target state under close interaction of ground combat entities represented by interconnecting unmanned systems, *e.g.*, unmanned vehicles, communication drones, and manned systems, e.g., C^2 (command and control) vehicles, combatants and mortars, via automated networks. The behavior model represents situational awareness, decision making and a tactical action process. In detail, this behavior model directs unmanned vehicles to move along a given route and observe the surrounding area. If an enemy target is found, it determines whether the target is detected, recognized, or identified, send an observation report to the commander. This behavior model allows the commander to estimate the situation through the observation reports and then produce an integrated target list. Afterwards this behavior model enables the commander to evaluate the strength of enemy threats based on the threat assessment model and to subdue the enemy using available firepower.

Wireless communication should be modeled to simulate sending observation reports, remote-operating unmanned vehicles and drones, and cooperative tactical actions. Wave propagation model is a key factor to simulate wireless communication as Cloutier et al. (2012) discussed. But prior combat simulation models haven't reflect communication effects, because they have simple simulation algorithms only considering the distance range and the line of sight. The proposed model predicts the success or the failure of data transmission by reflecting terrain profile on the wave propagation route and performance of the communication system. The wave propagation model compares the received signal strength and the minimum detectable signal strength. When the received signal strength falls below the minimum received signal strength, communication disconnection is caused. This occurs when the distance of transceivers is too far or when there are obstacles between the transceivers that prevent transmission of radio signals. In this case, the communication drone could be operated to perform two-hop communication relay.

3 SIMULATION RESULTS

The model is implemented using Java and explored its feasibility by integrating it into OneSAF Int'l 6.0, introduced by Wittman and Harrison (2001). This model could be used to analyze the combat effectiveness depending on communication radius, depending on a communication drone, among many system performance parameters. The authors design an experiment scenario to allow a manned-unmanned reconnaissance unit to search suspicious area and request fire support when an enemy is found. Based on the experiment scenario, we repeat the combat simulation and calculate MOEs: the survival rate of C^2 vehicles defined as the number of surviving C^2 vehicles for total number of C^2 vehicles and the survival rate of defined as the number of surviving entities for total number of entities in the unit.

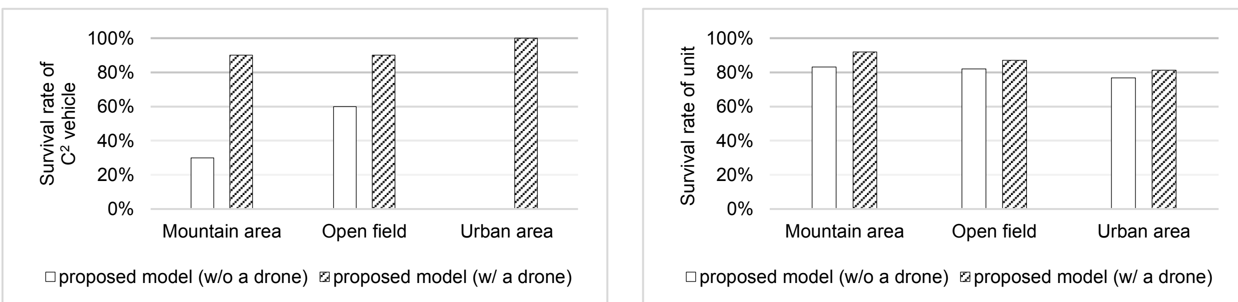

Figure 1: Combat effectiveness considering communication performance.

As depicted in Figure 1, the survival rates are higher when the communication drone is operated. It is expected that using the drone expand the communication radius and provide better outcome. For example, the C^2 vehicle doesn't survive without the drone in urban areas because they are destroyed by anti-tank weapons placed on the roof of buildings. On the other hand, the survival rates of the C^2 vehicle is greatly improved when the drone operates because the C^2 vehicle is outside the effective range of anti-tank weapons. Consequently, the communication drone shows a positive effect on the survival rates, because the C^2 vehicle continues to safely control unmanned vehicles and requests fire support.

4 CONCLUSION

We demonstrated the feasibility of simulating cooperative behaviors based on situational awareness, wireless communication, decision making, and tactical actions of manned-unmanned systems. Using this model, it is expected that combat effectiveness analysis could be conducted for future combat systems.

REFERENCES

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