Creating Realistic Human Behavior in Physical Security Systems Simulation

Volkan Ustun
School of Industrial and Systems Engineering
Georgia Institute of Technology
Atlanta, GA, 30332, USA
ustunvolkan@gmail.com

Jeffrey S. Smith
Department of Industrial and Systems Engineering
Auburn University
Auburn, AL, 36832, USA
jsmith@auburn.edu

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1. Introduction

Physical security systems (PSS) are designed to prevent access to a facility by *intruders*, detect the presence of intruders, or facilitate the capture or neutralization of intruders once they are detected, without negatively impacting the intended users of the facility, or *neutrals*. The application domains for PSS include banks, retail stores, schools, airports, subway stations and military installations, where the intention of the intruder can range from simple theft, to kidnap or mayhem to total facility destruction, and intruder mitigation can range from discouraging (in the case of shoplifting, e.g.) to alerting (in the case of burglary, e.g.), to capture and confinement or neutralization (in the case of facility destruction). These systems generally include a combination of physical barriers, human guards, and sensor-based detection systems such as video surveillance systems. Furthermore, the tactics and policies for the security personnel are also integral to the overall PSS. The primary goal here is to assess the effectiveness of a PSS (both the sensor placement and the security policy of the personnel) for detecting intruders and mitigating their impact in compliance with the organization's goals (e.g. deterrence, detection etc.). Other questions of interest that contribute to the primary goal include but are not limited to:

- Is the PSS robust and effective against different tactics used by intruders (e.g. stealth, deceit, and force)?
- What will be the effect of a change in physical security design on intruder behavior?
- What should be the rules of engagement for security personnel to best mitigate the risks imposed by intruders?

The complex interactions among guards, intruders, and neutral entities as well as the interactions between these entities and the environment, complicate analysis of these systems (for instance, a fundamental problem in PSS is to distinguish an intruder from a neutral based on behavior) which is often limited to static "line of sight" and "field of view" models designed to help with camera placement and guard patrol path determination. Existing simulation-based analysis methodologies include only crude and often hard-coded implementations of behavioral responses to predetermined situations for the guards, intruders, and neutrals. This limits the analysis capabilities of these models and makes creating them very time consuming and expensive.

Models for PSS analysis are intended to estimate the system performance in settings which resemble real life situations. A realistic model of human reasoning should incorporate the shortcomings and fallacies of human reasoning as well as its ability to generate quick solutions that are "good enough". Subsequently, realistic and credible simulations of PSS require incorporation of human behavior models that involve situation awareness, cooperative team behavior, planning, and deliberative decision making processes of human agents.

We have demonstrated a proof-of-concept for a novel approach to simulating PSS, comprised of three principle components:

- A spatial model which formally represents the static features of the environment in a simulation-friendly structure;

- An agent-based behavioral framework which realistically represents the decision making activities of the agents using models of perception and heuristics to represent human intuition and decision making; and
- A formal representation of the application domain; for example, which behaviors constitute an intrusion and how an intrusion is detected vary between different domains.

The success of the proposed approach results from the realism and the variety of behaviors generated by the behavioral framework. The behavioral framework is extendable since it uses heuristics to model human intuition. Introduction of different heuristics directly relates to the emergent behavior. In addition, applying these heuristics on the perceived environment (the mental representation of the environment as the agent perceives it) creates interactions and behaviors that are difficult to anticipate in advance. Therefore, even with a limited number of heuristics, it is possible to observe a wide variety of potential activity sequences and interactions between agents that cannot be easily foreseen.

We have discussed the conceptual models for this application in various publications. Ustun (2009) provides the details for the whole computational framework. Ustun et al. (2005) introduces the spatial model. Ustun and Smith (2008) discuss a novel aspect in the agent based behavioral framework. Ustun et al. (2006) has a conceptual introduction to a sample application domain: retail store security systems. Marechal et al. (2009) uses a part of the proposed computational simulation framework in an optimization application.

In this interactive demo, we will demonstrate the several aspects of the proposed computational framework using a poster and a partially live demonstration of the developed computer application. The poster will be primarily used to present the conceptual features and several animations from the sample retail store application will be shown to provide insights on the interesting interactions between the virtual participants of the simulation experiments.

2. References

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Author Biographies

VOLKAN USTUN is a postdoctoral research fellow in the H. Milton Stewart School of Industrial and Systems Engineering at the Georgia Institute of Technology. He has received the B.S. and M.S. degrees in Industrial Engineering from Middle East Technical University (METU) in 1997 and 2000, respectively and the Ph.D. degree in Industrial and Systems Engineering from Auburn University in 2009. Prior to the Ph.D. degree, he has also worked as a research engineer at The Scientific and Technical Research Council of Turkey (TUBITAK). His research interests mainly include discrete-event and agent-based simulation models and frameworks for complex systems.

JEFFREY S. SMITH is a professor in the Industrial &Systems Engineering department at Auburn University.Prior to joining Auburn, Dr. Smith was an associate professor in the Industrial Engineering Department at Texas A&M University. He received the B.S. in Industrial Engineering from Auburn University in 1986 and the M.S. and Ph.D. degrees in Industrial Engineering from Penn State University in 1990 and 1992, respectively. In addition to his academic positions, Dr. Smith has held industrial positions at Electronic Data Systems and Philip Morris U.S.A. Dr. Smith is an active member of IIE and INFORMS.