Opinion Modeling in the Context of a Simulation Based Military Training Application

(Poster Abstract)

Linus J. Luotsinen and Fredrik Johansson
Swedish Defence Research Agency (FOI)
SE-164 90, Stockholm, Sweden
linus.luotsinen@foi.se, fredrik.johansson@foi.se

ABSTRACT

In this work we have developed a simulation based training application targeting the training of military staffs within the irregular urban warfare domain. The main purpose of the training tool is to enhance the trainee's ability to trade-off situational awareness vs. risk while considering, in addition to threats from irregulars, intangible human factors such as the civilian population's attitude or opinion towards the military forces. The main contribution of our work, besides the interactive training application itself, is its ability to simulate civilian opinions in the context of military training.

Categories and Subject Descriptors

I.6.3 [**Simulation and Modeling**]: Applications

General Terms

Algorithms, Design, Experimentation

Keywords

Simulation based training, opinion dynamics, serious gaming

1. INTRODUCTION

One important factor to consider by military staffs while planning and conducting military operations in urban terrain (MOUT) is the population's opinion or attitude with respect to, for instance, the regime, the military forces or groups within the population. Opinions may affect the behavior of the population such that, for instance, people that dislike the military forces are less likely to share potentially useful or critical information concerning suspicious activities, demonstrations, etc. Even worse, unsatisfied civilians may start to sympathize with the opposing forces providing them with information, such as the whereabouts of soldiers, patrol routes, check-points, etc., which makes it even harder for the military staff and its forces to protect the population and to safely operate within the city.

In this work we have developed a simulation application where military staffs are able to train their skills in acquiring information to improve situational awareness while at the same time considering the risks of being attacked by irregulars. The application emphasize the importance of winning the hearts and minds of the population by simulating the population's opinion with respect to *the presence of military forces* within the city. In the simulation the opinion is affected by: the plays that are carried out by simulated military forces following the command of the military staff; by the actions of simulated irregulars whose main goals are to recruit civilians and to disturb peace using traditional tactics of terrorism; and finally, by the everyday interactions that occur when civilians are meeting and socializing at home, at work, etc.

2. MODELING OPINIONS

As human beings, we have opinions on nearly anything: politics, sports, literature, and religion to name a few topics. As argued in [2], our opinions are influenced by who we talk to, and whose opinions we respect. There are a lot of social studies showing that opinions tend to become more alike as we interact with each other. This is in social science literature often referred to as social influence, while this kind of behavior often is referred to as herd behavior in economics [6]. No matter what term is used, understanding the process of social influence and the social structures that govern our human interaction is very important in order to understand how opinions change in a population. Such research is central for many social scientists, and the results from such studies have got a large impact on the development of opinion dynamics, i.e., the research field in which mathematical and physical models as well as computational tools are utilized to explore the dynamical process of the diffusion and evolution of opinions in human populations [6].

In our training simulator we have implemented two models capable of simulating opinion dynamics. The first model, the Deffuant model [1], is used in the simulator to update opinions when individuals socialize one-on-one or in smaller groups. The governing equation of the Deffuant model is described in Equation 1:

$$x_i(t+1) = \begin{cases} x_i(t) + \mu[x_j(t) - x_i(t)], & \text{if } |x_i - x_j| \leq \epsilon \\ x_i(t), & \text{otherwise} \end{cases} \quad (1)$$

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, where x_i, x_j represents the opinion of agent i and j respectively, μ is the convergence ratio and ϵ is a threshold value representing the agent's open-mindedness or level of uncertainty.

To complement the Deffuant model we have implemented the Hegselmann-Krause (HK) model [3] which is used to simulate opinion change in situations where individuals meet in larger groups to, for instance, celebrate religious or cultural events. The HK model is described in Equation 2:

$$x_i(t+1) = \frac{1}{|I|} \sum_{j \in I} x_j(t) \quad (2)$$

, where I is the confidence set representing all agents, including i, satisfying the condition $|x_i - x_j| \leq \epsilon$.

3. SCENARIO AND IMPLEMENTATION

The scenario we have used in our training simulator includes the following actors: the *blue* side representing the semi-autonomous agents that are controlled by the military staff; the *red* side representing irregulars; and finally, the *green* side representing the civilian population. In Figure 1 we have graphically summarized the scenario, including the actors, their actions and the main variables of interest, using a causal diagram. Arcs in the causal diagram are annotated with either a plus or a minus sign representing change in same or opposite direction respectively. The main goal of *blue* is to increase the opinion variable by improving its situational awareness which ultimately helps to reduce the strength and influence of the *red* actor. Note that the actions of *blue* may also disturb the everyday behavior of the population which in turn may affect the opinion negatively. The main goal of the *red* actor is to reduce opinion by recruiting civilians and by performing attacks in the city. The *green* actor's main goal is to safely live in the city and to perform its everyday activities.

The scenario described above was implemented using POPSIM which is an agent-based simulation platform that provides tools and models targeting the modeling and simulation of populations in urban environments. POPSIM has been used in the past in applications targeting end-users within the crisis and disaster management community [4, 5].

Examples of how the opinion may be affected in the simulation are provided in Figure 2. The solid line in Figure 2 represents the opinion distribution at the start of the simulation and the dashed lines are the end results after executing two different *blue* strategies. The opinion distribution was estimated using a Gaussian kernel-density estimator. In the first strategy, where the *blue* side was relatively passive, the opinion distribution tended to converge towards the mid-point meaning that the majority of the population could not decide which side to support. The second strategy, which was more aggressive, resulted in a polarized opinion meaning that individuals in the population tended to become extremists either supporting the *red* or the *blue* actor.

4. CONCLUSIONS AND FUTURE WORK

In this work we have introduced an interactive simulation based training application where military forces, which are controlled by military staff, and irregulars are fighting each other to win the hearts and minds of the civilian population.

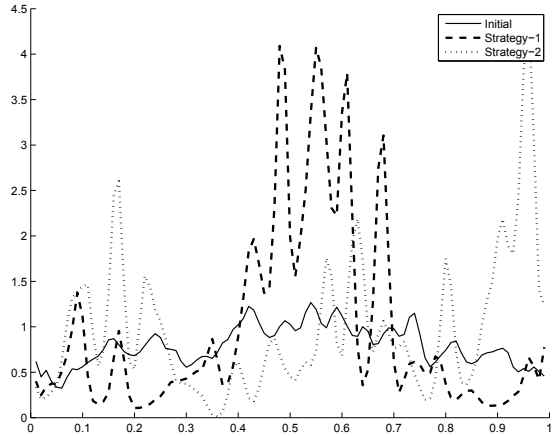

Figure 2: Experimental results.

The training application is currently a prototype and lots of work still remains before the tool is mature enough to be used in practice. Future work includes improving the behavior models of the main actors; improving the city infrastructure models that represent roads, buildings, water/sewage, cell-phone communication, electricity, etc.; allowing the actors to sabotage and repair city infrastructure ultimately affecting the population's everyday behavior and opinion.

Even though the results presented in Figure 2 are not too surprising, considering the initial opinion distribution and the nature of the governing opinion dynamics equations, they highlight that our tool is able to generate different outputs depending on the plays of the military staff. Whether or not the opinion distributions at the end of the experiments are realistic or not is an open research question that we plan to address in future works by gathering both quantitative and qualitative feedback from our experts and end-users.

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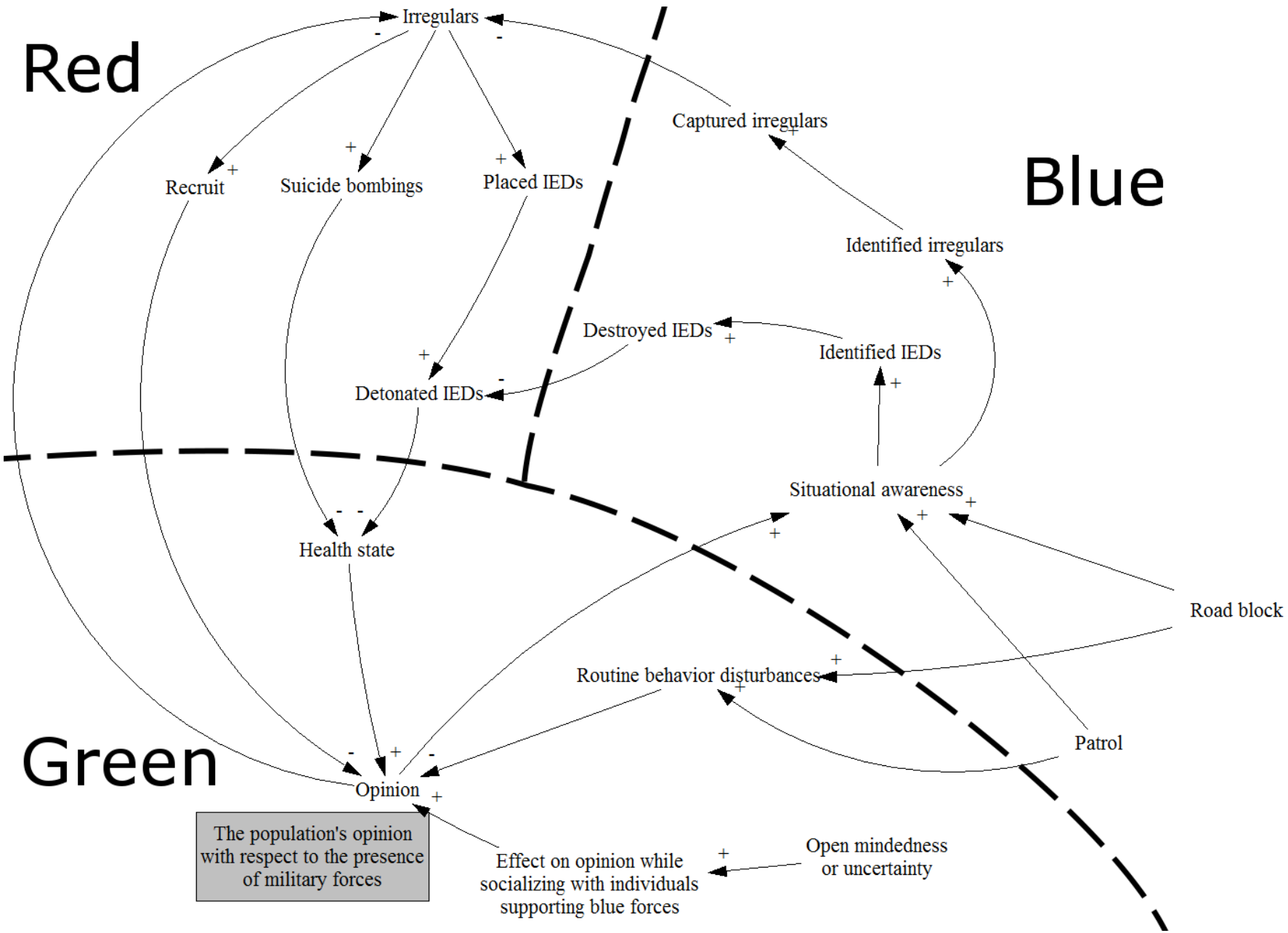

Figure 1: Causal diagram describing the scenario including the actors, their actions and the main variables of interest.