Improving crowd behaviour for emergency simulation using game-captured data

Marco Castorina, Eike F. Anderson
Bournemouth University

1 Introduction and Background

Crowd simulation has become an essential asset in many different industries, ranging from games and movies to engineering and construction; while the requirements might vary significantly between these domains, the underlying theory is shared among them. Emergency simulation in particular is a field that has made great use of crowd simulation to validate and improve building design and layouts, allowing architects to determine how a building would cope in case of an evacuation and determine the estimated egress time and survival rate. Existing algorithms and techniques are usually organised in two layers: a high level component determines the actions and goals of each agent that is participating in the simulation while the low level component is responsible for the movement of the agent. Steering behaviours [Reynolds 1987] are usually employed for movement, but they don't take into account more nuanced aspects of agents behaviour like their internal state, priorities and system of beliefs [Pelechano et al. 2007]. This is particularly important for emergency simulations as individuals react in different ways under stressful circumstances and factors like fatigue and caring for others must be taken into account to provide an accurate simulation.

2 Our Approach

In recent years, thanks to advances in computer vision and machine learning, it has been possible to improve the accuracy of existing locomotion models by training them with observed data. Unfortunately visual footage does not give insight into peoples' internal state, emotions and goals. Inspired by [Liu et al. 2014] and similarly set in a game-like environment, we record a player's behaviour during a virtual emergency situation to derive more accurate behaviours and parameters to improve existing models. In particular we are looking at existing frameworks like Soar [Lehman et al. 1996], how these are typically configured to control a crowd during an emergency simulation, how their parameters are defined in those scenarios and how the captured data will influence and inform new parameter values.

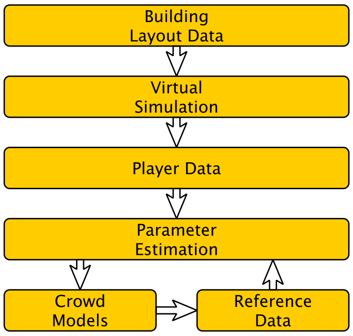

Figure 1: *Flow diagram of our framework.*

Our simulation will provide the player with a top down view of a building populated with synthetic agents driven by the aforementioned frameworks; we are currently investigating two different type of scenarios. In both cases the participant will have to analyse the situation and determine the best course of action by choosing the optimal escape route; the conditions at the start of the two scenarios will be different. In one scenario the emergency will play out from the beginning: agents will be randomly distributed within the environment and the participant has to guide them to safety. Given the stressful nature of the event, not all agents will follow the designated path: some may panic and not move or follow a different path, or the route might become obstructed. We are particularly interested in how the player will deal with this critical event and determine whether they will panic as well, send help in form of other agents or provide a new safe path. In the second scenario there will be only one agent that the participant can control and the emergency simulation will start from a later stage; in this case we are interested in the reactions to situations like clogged exits or presence of smoke to determine whether a different choice will be made from the previous scenario and if the behaviour will be consistent with previous studies (i.e. evacuees will walk through smoke). We are also including other elements like limited visibility and hazards affecting agents (i.e. smoke inducing fatigue or breathing difficulty) to increase the realism of the simulation. The data recorded will then be analysed to derive new parameter values to use in the existing models; an overview of our framework is illustrated in Figure 1. We are aware that the current test setting restricts the validity of the results to situations where people evacuating a building already know its layout, nonetheless there is still a wide range of situations (i.e. factory or office workers) in which such assumptions apply.

3 Conclusion and future work

We have proposed a new framework that will help improving the accuracy of existing emergency simulation models. While the proposed research is still work in progress, we are also evaluating other possible uses for our framework, for instance for training purposes for safety personnel.

Acknowledgements

This work is supported by the EPSRC. The authors would like to thank Yates Buckley and Alberto Venditti of Unit 9 for their feedback.

References

LEHMAN, J. F., LAIRD, J. E., ROSENBLOOM, P., ET AL. 1996. A gentle introduction to soar, an architecture for human cognition. *Invitation to cognitive science 4*, 212–249.

LIU, R., DU, J., AND ISSA, R. R. 2014. Cloud-based deep immersive game for human egress data collection: a framework. *Journal of Information Technology in Construction*, 336–349.

PELECHANO, N., ALLBECK, J. M., AND BADLER, N. I. 2007. Controlling individual agents in high-density crowd simulation. *Proceedings of the 2007 ACM SIGGRAPHEurographics symposium on Computer animation 1*, 108.

REYNOLDS, C. W. 1987. Flocks, herds and schools: A distributed behavioral model. *SIGGRAPH Comput. Graph. 21*, 4, 25–34.