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Bush Fire Simulation through Emotion-based BDI Methodology

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***Abstract*— This paper introduces an emotion-based BDI (Belief, desire, intention) methodology to model decision-making during fire evacuation simulations while considering human emotions. The methodology is designed to represent human decision-making processes in graphical representations, which can be simply translated for the implementation phase to simulate various case studies. The methodology utilizes the Belief, Desire, and Intention architecture and the OCEAN Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism) personality behavior to represent decision-making processes graphically, making it easy to translate into a simulation. The methodology aims to create a more realistic simulation closer to real human behavior by incorporating emotions that affect decision-making. In this paper, we validate the emotion-based BDI methodology by replicating the bushfire Australia case study and benchmarking with the previous work on BDI fire evacuation. From the comparison, we found that both results share almost similar patterns. The results show "dead while still unaware" (0% vs. 0%), "dead while deciding what to do" (69% vs. 48%), "dead while defending" (6% vs. 8%), and "dead while preparing to defend" (6% vs 28%), "dead while preparing to escape" (4% vs 0%) and "dead while escaping" (15% vs 20%). The results show that in our Simulation, there is a death related to preparing to escape (4% vs 0%). However, the other causes of death have an almost similar percentage of death causes. Hence, based on the comparison, supporting and validating our emotion-oriented simulation model is considered adequate. Therefore, this emotion-based BDI methodology can systematically reproduce human cognition and emotion.**

***Keywords*—Emotion based modelling; BDI; multi-agent.**

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I. INTRODUCTION

Emotion-based BDI methodology is created based on the Belief, Desire, and Intention architecture and the OCEAN personality behavior [1] to represent decision-making during a fire evacuation simulation while considering human emotion. The methodology in [1] is designed to represent human decision-making processes in graphical representations, which can be simply translated for the implementation phase, such as to simulate various case studies. The methodology focuses on modeling a more realistic simulation closer to real human behavior where human emotion is used as one of the factors affecting decision-making. Hence, the personality and behavior from the OCEAN personality model [2] are used as the affecting factors that trigger certain emotions and actions based on different scenarios. Therefore, in this paper, a fire bush simulation will be done using emotion-based BDI methodology.

Some studies highlighted the importance of considering emotion's influence in multi-agent decision-making and producing more believable agents [3], [4]. In addition, integrating the emotional empathy of intelligent agents can increase the adaptability of the agent in dynamic situations [5]. Meanwhile, human cognition modeling with emotion is important in real-world AI application development [6]. According to Zena et al. [7], emotion determines the moving speed of an individual during crowd evacuation. Several works have been done on creating a simulation considering complex human emotion in various scenarios or case studies, especially in multi-agent simulations.

Argente et al. [3] introduced the computational models of emotion and integrated emotion and norm in multi-agent systems. In this case, an abstract architecture of a Normative emotional agent is presented. Emotion is important in decision-making processes, in which emotion is taken into account apart from rules and consequences of human actions. Taverner et al. [8] proposed the representation of emotion for multi-agent systems by incorporating culture and language in