

Interaction Fields: Sketching Collective Behaviours

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CCS CONCEPTS

• **Computing methodologies** → **Multi-agent systems**; *Interactive simulation*; *Simulation by animation*; Real-time simulation.

KEYWORDS

animation, user interface, expressivity, intelligent agent, collective behaviour

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1 INTRODUCTION

Many applications of computer graphics, such as cinema, video games, virtual reality, training scenarios, therapy, or rehabilitation, involve the design of situations where several virtual humans are engaged. In applications where a user is immersed in the virtual environment, the (collective) behavior of these virtual humans must be realistic to improve the user’s sense of presence. As part of the realism, expressive behaviour appears to be a crucial aspect. For example, Slater et al. [5] showed that the expressive behaviour of an audience in VR had a direct impact on the speaker’s performances and perception of themselves. This work concerns the motion through an environment of virtual humans. In the area of crowd simulation, collective behaviours are typically simulated using models based on forces [2], potential fields [6], velocity selection [7], or vision [3]. However, those techniques lack expressiveness and do not allow to capture more subtle scenarios (e.g., a group of agents hiding from the user or blocking his/her way), which require the ability to simulate complex interactions. As subtle and adaptable collective behaviours are not easily modeled, there is

therefore a need for more intuitive ways to design such complex scenarios.

In this work, we propose a novel approach to sketch such interactions to define collective behaviours. Although other sketch-based approaches exist, these usually focus on goal-oriented path planning, and not on modelling social or collective behaviour. For instance, Patil et al. [4] proposed a customizable system where users can draw a “guidance” path to lead agents through the scene. However, this guidance is only used to propose a preferred path to the agent and does not involve interactions between agents. In comparison, we present the concepts of a new approach based on a user-friendly application enabling users to draw target interactions between agents through intuitive vector fields (Figure 1). In the future, our goal is to use this approach to facilitate the design of expressive and collective behaviours. By considering more generic and dynamic situations, we design diversified and subtle interactions, which so far have mostly focused on predefined static scenarios [1].

2 INTERACTION FIELDS

In line with crowd-simulation research, we simulate the environment as a 2D plane, and agents as disks whose positions and velocities are 2D vectors. The task of an interaction field (IF) is to describe how agents should move through the environment in the presence of another agent (which we call the *source agent*). An IF is a square with the position of the source agent at its center. Each point in this square prescribes a velocity that other agents should use when they are located there. In practice, we store an IF as a grid, and we compute velocities via interpolation between grid cells. During the simulation, if an agent *A* is near a source agent *S*, it will translate and rotate the IF to match the current position and orientation of *S*. Agent *A* will then choose the velocity that the IF prescribes for *A*’s current position.

We developed a simple interface enabling a user to intuitively draw the IF for each agent. In this interface, the user can spawn a new agent and its corresponding control vectors are intuitively drawn directly around the source agent. The IF then impacts all the surrounding neighbouring agents of the source to define their interaction with the source of the IF. Then, using interpolation techniques, the interaction field is deduced from the control vectors. Figure 1 shows different examples of IF designed using the

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