Realistic Trail Following Behavior

in a Dynamically Deformable Terrain Using Terrain-Based Penalty Fields

Hamza M. Noor and Muhammad Usman

Graphics and Virtual Dynamics Lab, Ontario Tech University, Oshawa, ON, Canada

CASAXR 2026
Best Paper Award

OntarioTech Science

Graphics and Virtual Dynamics Lab

RESEARCH QUESTION 1

How can virtual agents form and follow trails like real humans?

RESEARCH QUESTION 2

Does Adding trail direction help walkers moving in opposite directions form separate lanes?



Baseline behavior

Walkers leave footprints in the snow. Each walker takes the shortest route to its goal.

Earlier footsteps do not influence the next walker's route.

RESEARCH VIDEO

Watch the Video

Scan to watch the full Trail Following video.

Core idea

How footsteps guide the next walker

1. Footsteps

Agents move through the environment and leave footprints in the snow.



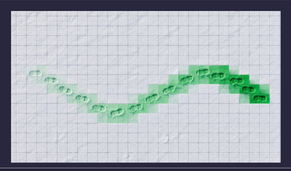
2. Terrain deformation

Footsteps deform the snow, creating persistent and physically-based changes.



3. Trail memorization

Agents observe and remember trails as navigational memory over time.



4. Trail-aware navigation

Agents prefer and follow remembered trails to reach goals efficiently and naturally.



5. Directional crowd organization

Trails guide crowd flow and create directional structure without centralized control.



6. Behavior & animation adaptation

Agent movement, speed, spacing, and animation adapt to trail quality and social context.

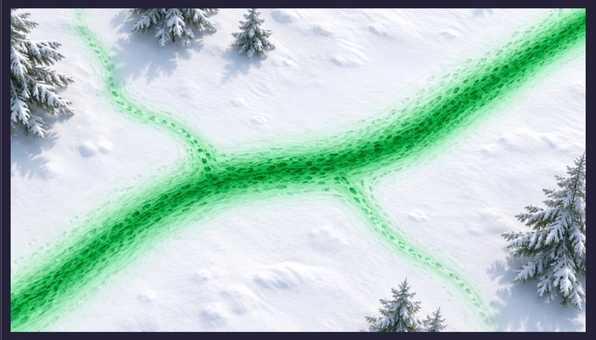


Model simulation results

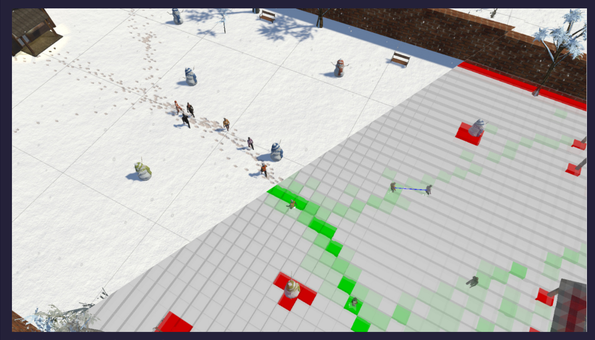
Undirectional trail

High intensity

Low intensity



Illustrated trail-strength heatmap

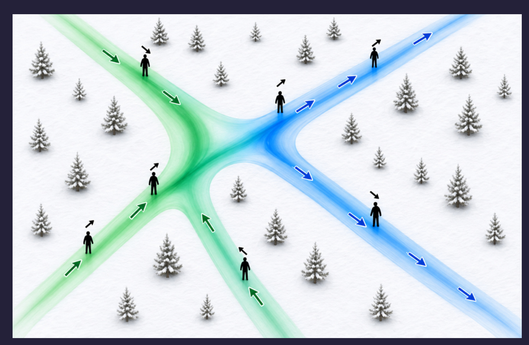


Undirectional simulation

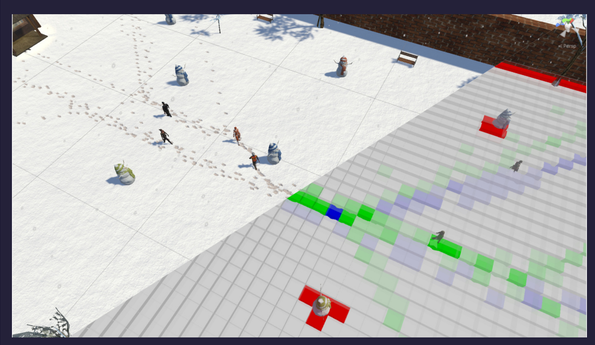
Directional trail

Direction A

Direction B



Black arrows show the walkers' directions.



Directional simulation

Gait Adaptation on Soft Ground

Gait changes as a trail forms.



Untrodden mud · careful steps



Formed trail · relaxed stride

Computer Animation and Virtual Worlds, 37(3), e70149 (2026)

doi.org/10.1002/cav.70149