Panic Driven Human Motion

End-Semester Presentation

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Problem Statement

- To understand panic driven motion of people under different conditions.
- To model the motion of panic driven minds which tend to make rash collective decisions.
- Try to come up with strategic solutions to minimize the trouble caused due to panic related rush.

Motivation of Work

- Destructive panic behaviour has always been observed in life-threatening situations such as fires in crowded buildings, stampedes, concert scenarios.
- Panicking individuals tend to clearly showcase maladaptive and relentless mass behaviour like jamming and life-threatening overcrowding which has often been attributed to social contagion.
- By studying optimal configurations of the panic environment we can reduce the injuries caused potentially save lives.

Basic Methodology

- People can be approximated to be point objects moving towards exit(s)
- We analyse the force relations between different people and between people and walls, we can effectively simulate a panic situation.
- Helbing, Dirk, Illes Farkas, and Tamas Vicsek. ”Simulating dynamical features of escape panic.” Nature 407.6803 (2000):487-490. gives us the required equations

Equations

m_i : mass of agent, v^o_i: desired velocity e^o_i : desired exit direction τ_i: characteristic time, f_{ij}: forces between agents i and j, f_{iw}: forces between agents i and wall

$$m_i \frac{dv_i}{dt} = m_i \frac{v_i^0(t) e_i^0(t) - v_i}{\tau_i} + \sum_{j \neq i} f_{ij} + \sum_W f_{iW}$$

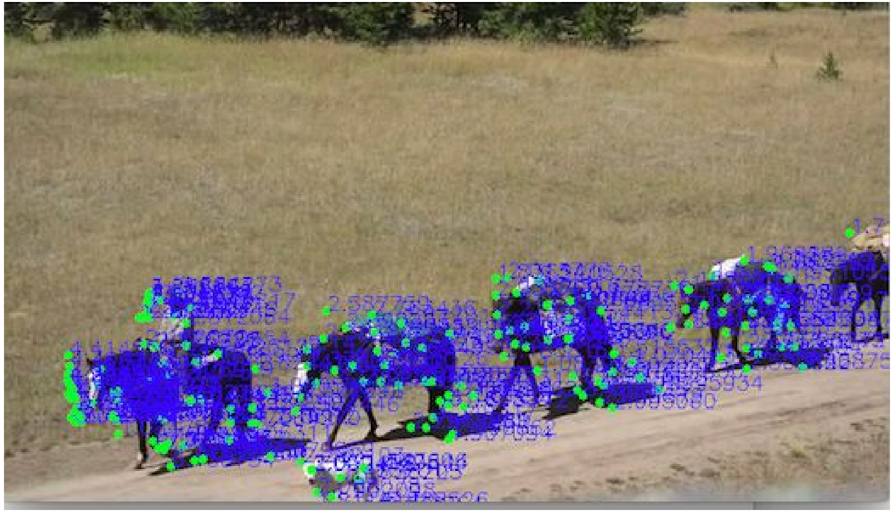
m_i : mass of agent, v^o_i: desired velocity e^o_i : desired exit direction τ_i: characteristic time, d_{ij}: distance between agents i and j, g(x) = 0 if agents don't touch else x, d_{iw}: distance between agents i and wall r_{ij}: difference in position vector between agents i and j, t_{ij}: tangential direction., A_i, B_i,k, $\varkappa$: constants

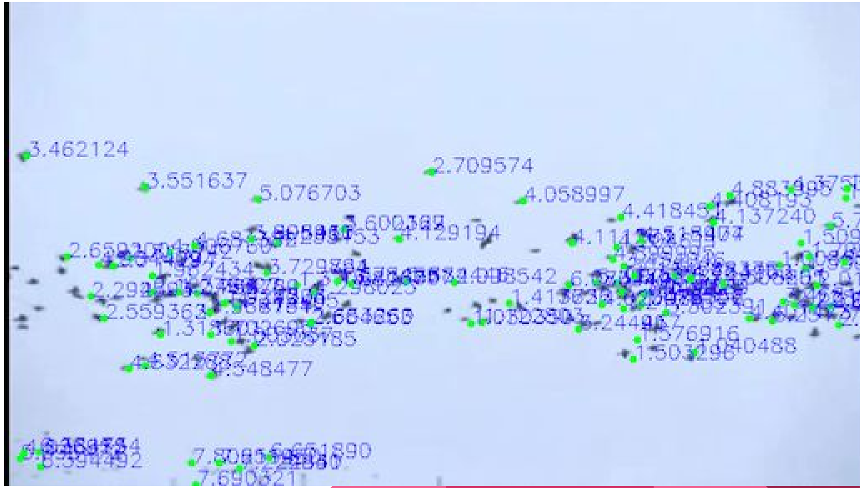
$$f_{ij} = \{A_i exp[(r_{ij} - d_{ij})/B_i] + kg(r_{ij} - d_{ij})\}n_{ij} + \varkappa g(r_{ij} - d_{ij})\Delta v^t_{ij} t_{ij}$$

$$f_{iW} = \{A_i exp[(r_{iW} - d_{iW})/B_i] + kg(r_i - d_{iW})\}n_{iW} - \varkappa g(r_i - d_{iW})(v_i . t_{iW})t_{iW}$$

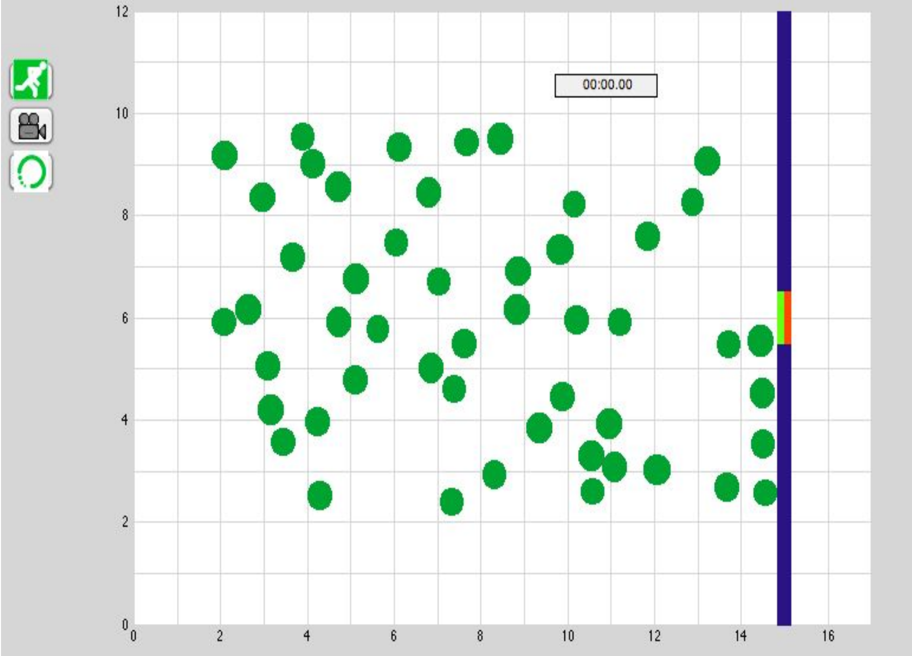
Work done before mid-term evaluation

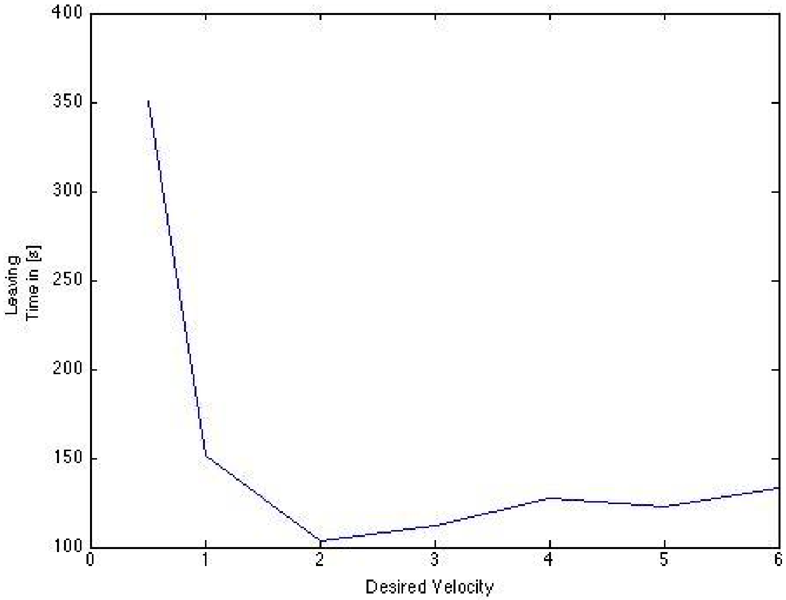
Optical flow computation using Lucas-Kanade algorithm from videos.





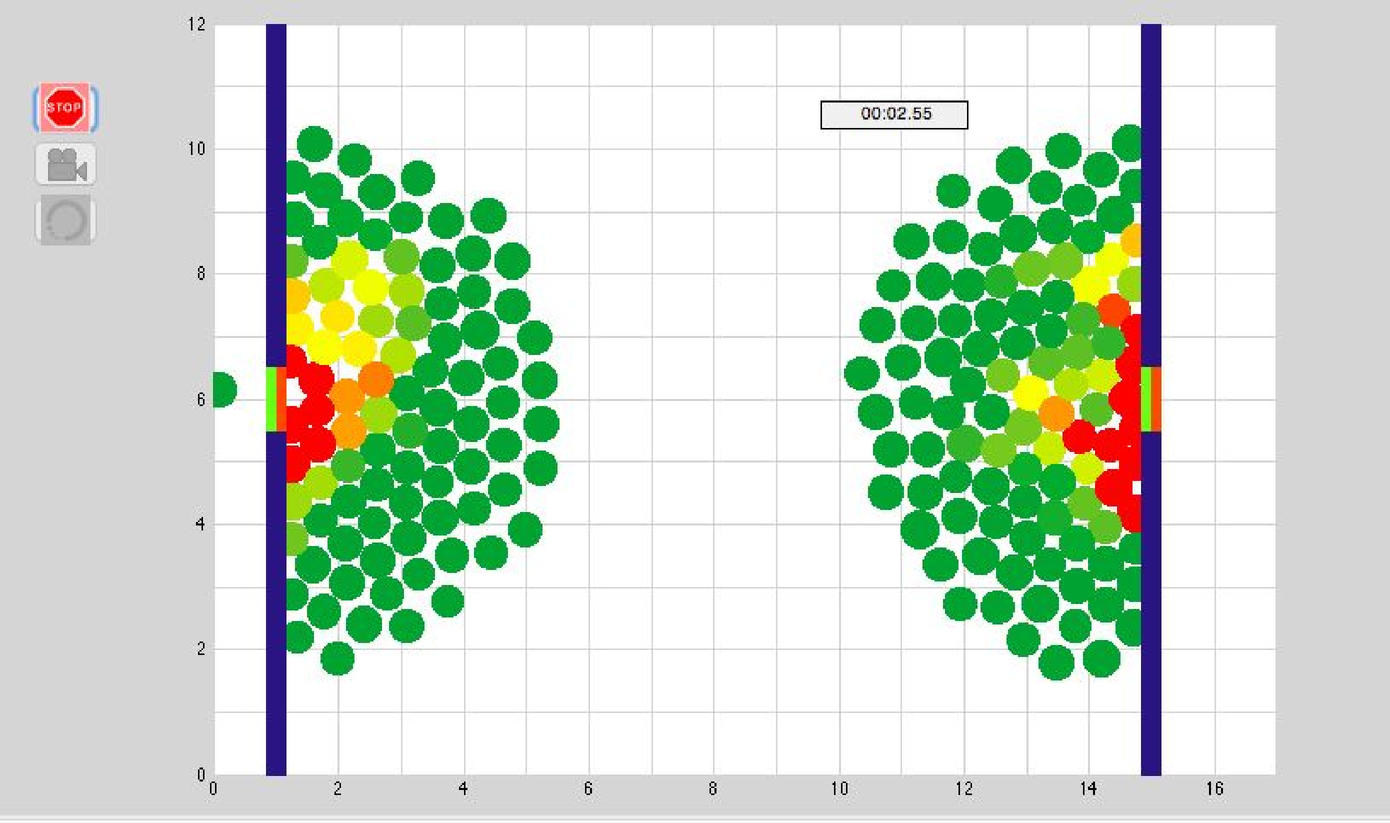
Reproducing results from Dirk's paper.





Work done after mid-term evaluation

- Successfully extended the code to support multiple exits. Equations governing the behaviour exactly the same as for single exit case, only difference being the exit direction is chosen as the shortest distance to the nearest exit.
- Added pressure indicator on the point objects. The color of the agent varies from green(no pressure) to red (high pressure).
- Performed simulations for multiple exit case, observing the leaving time for different desired velocities.


STOP
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2
4
6
8
10
12
14
16
0
2
4
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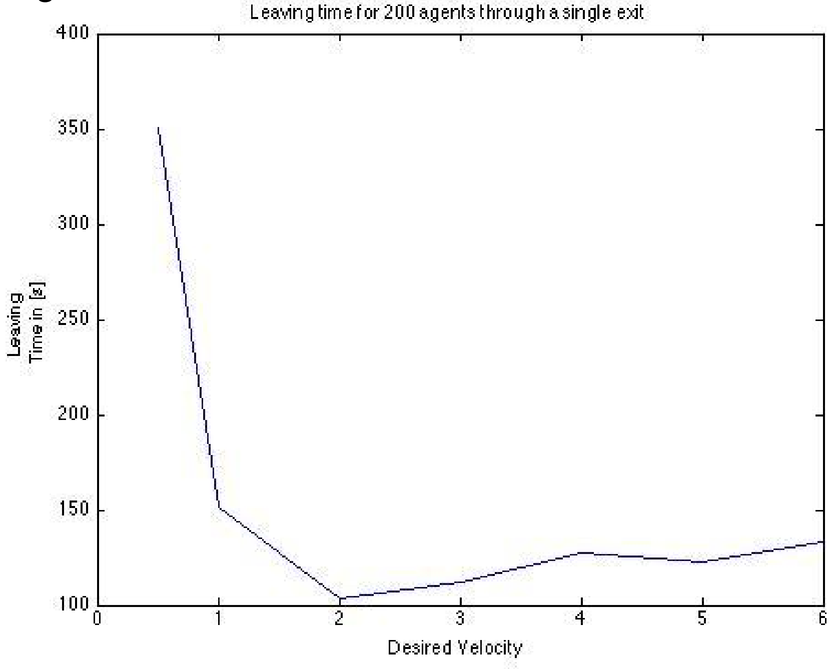
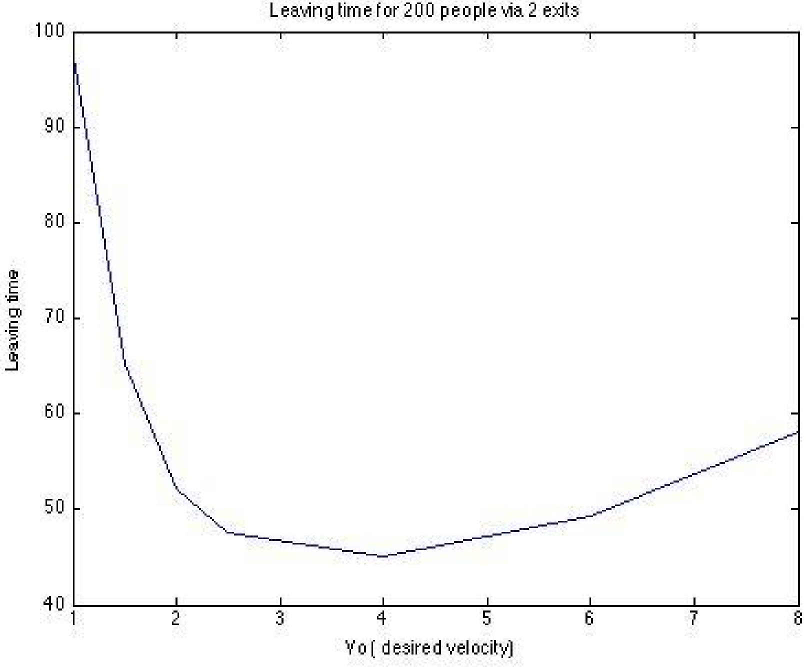
8
10
12

Results:

We observe that the leaving time as calculated using our simulations for 200 agents in a 15 x 15 room in case of 2 symmetrically placed exits at desired velocity of 4 m/s is 48 sec as compared to ~135 sec for single exit, **which is 64.4% faster!.** This indicates that we could reduce stress in panic situations if we can find optimal configurations.





Further Aims

- Further analysis of environment configuration, adding a moving/expanding point of panic to make the simulation closer to real life panic situations
- Analysis of videos to see how the simulations match up to real cases.

References

[1] Helbing, Dirk, Ill ́es Farkas, and Tamas Vicsek. ”Simulating dynamical features of escape panic.” Nature 407.6803 (2000): 487-490

[2] Kelley, H. H., Condry, J. C. Jr, Dahlke, A. E. Hill, A. H. Collective behavior in a simulated panic situation. J. Exp. Social Psychol. 1, 2054 (1965)