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Motion Planning Final Project

SheepDog Robot

Team - 9
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Overview

1. Introduction / Problem statement
2. Motivation
3. Algorithm design
4. Implementation
5. Enhancements
6. Analysis
7. Future work
8. Conclusion

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Introduction

Problem Statement :

Moving an object (or multiple objects) to a desired goal state by influencing it's motion using another object that already has a notion of where the goal is.

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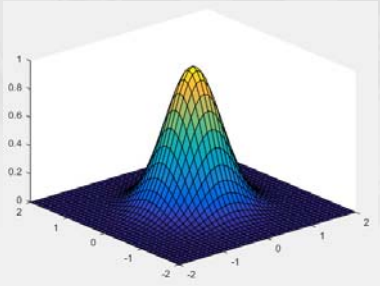
Motivation

- Potential field theory : We were motivated to apply potential field theory to achieve the relative forces (either repulsive or attractive)between the objects.



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Sheep-Dog problem

Given: flock of sheep in a grazing field.

Plan the motion of a robotic dog that would herd the flock of sheep towards the goal.

Intuition for the solution: The sheep would be scared of the dog and drive the sheep away from the dog

Assumption: The dog would have sense of the position of the goal in the grazing field.

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Algorithm design

Components:

- Dog (robot)
- Sheep
- Boundary (environment limits)
- Obstacles (trees)

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Algorithm design

Bodies : Sheep, Dog, Boundaries
At every time step:

1. Dog.D:
   FS <- Farthest sheep;
   Align FS towards the goal;
   Apply repulsive force on FS;
2. Sheep.S:
   For each Sheep.S
   If S is not FS
   Continue grazing;

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Implementation

Simulation environment:
Box2D : a C++ based physics simulator engine

Assumptions while implementation:

- Dog is completely aware of the world and the position of sheep and the goal.
- The Dog has a sphere of influence. The sheep scare away from the dog only if they come within this region.

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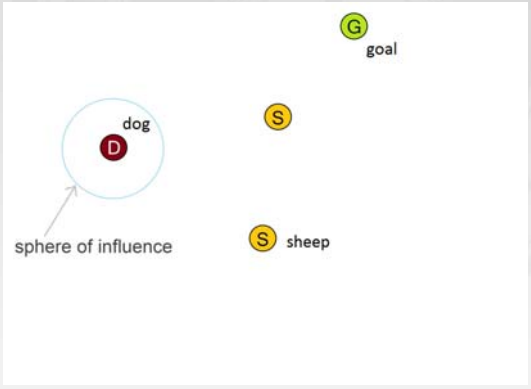
Implementation



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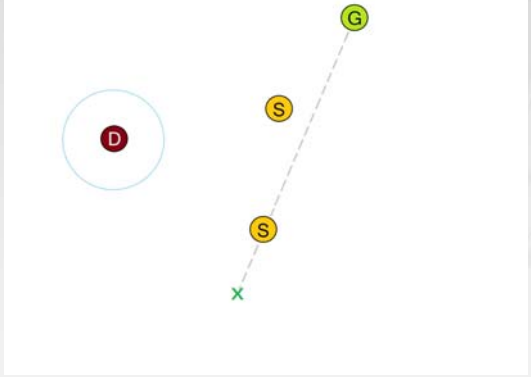

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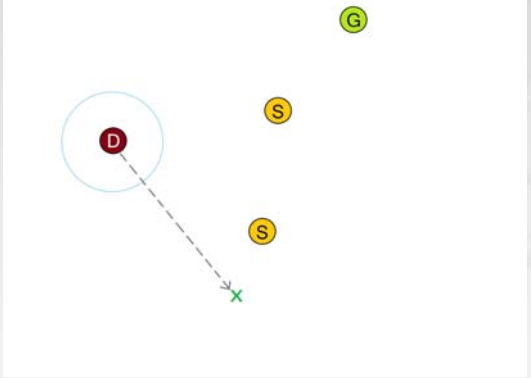

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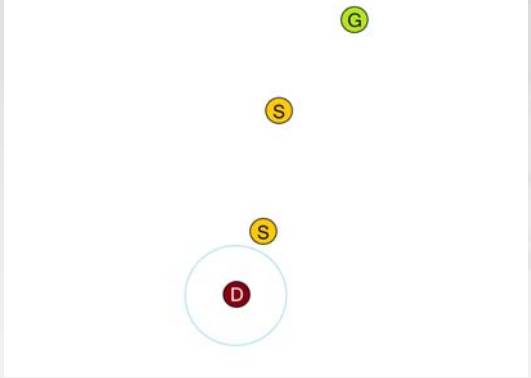

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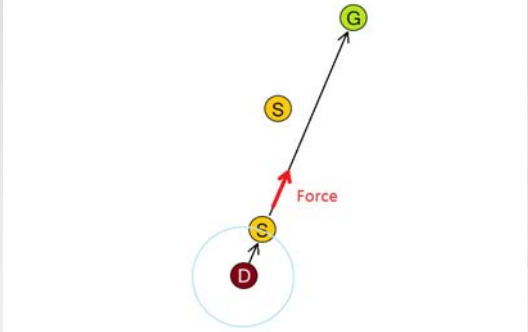

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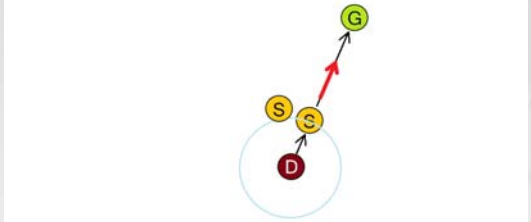

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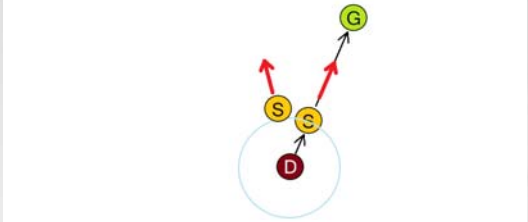

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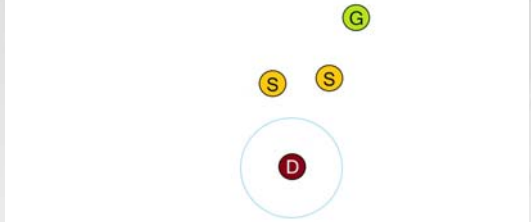

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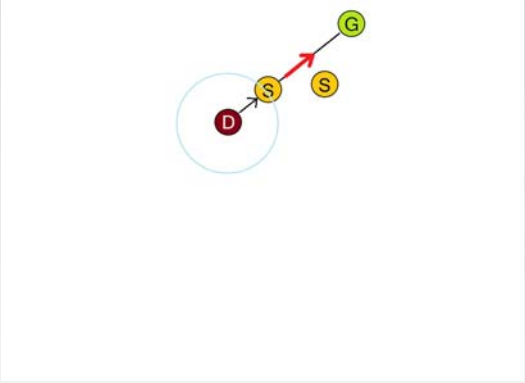

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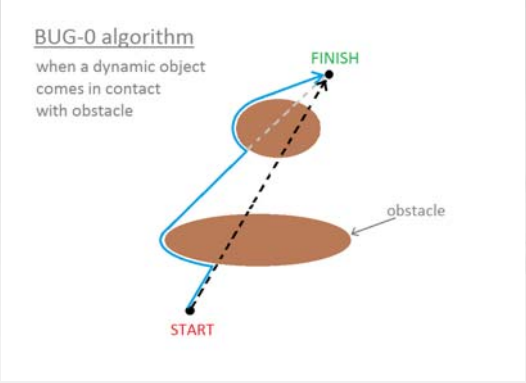

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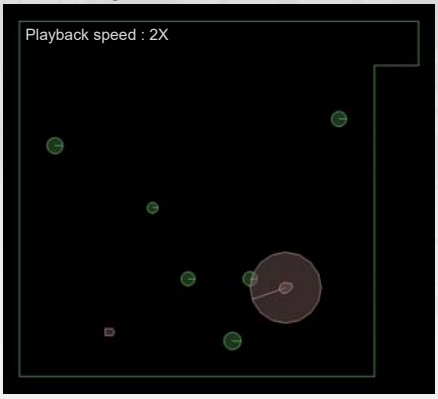

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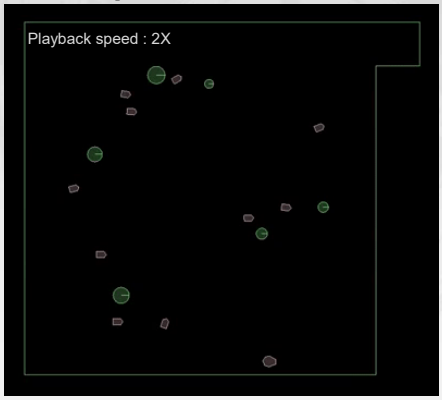

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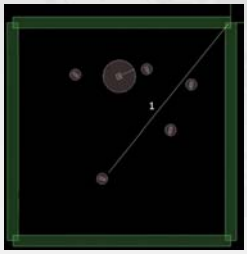
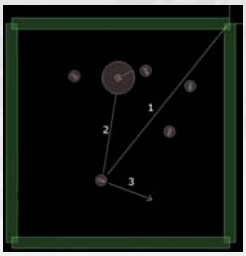
Enhancements

Heuristics & weightages:

- Distance of Sheep from the Goal (~0.3-0.7);
- Distance of Sheep from the Dog (~0.4-0.8);
- Direction of motion of Sheep (~0.15-0.35);





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Tuning Factors

1. Weights of distance between sheep and goal heuristic (~0.3-0.7), distance between sheep and dog (~0.4-0.8) and direction of motion/velocity direction (~0.15-0.25)
2. Total number of sheep's
3. Absolute dog velocity
4. Absolute sheep velocity
5. Distance for which repulsive force is acting

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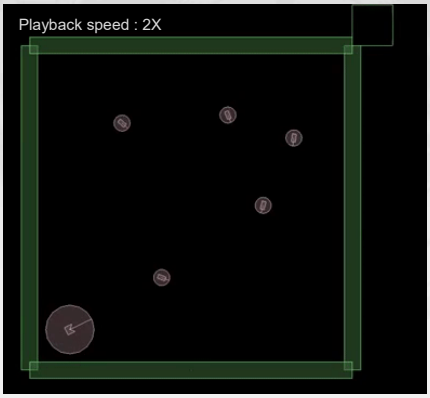
Enhancements



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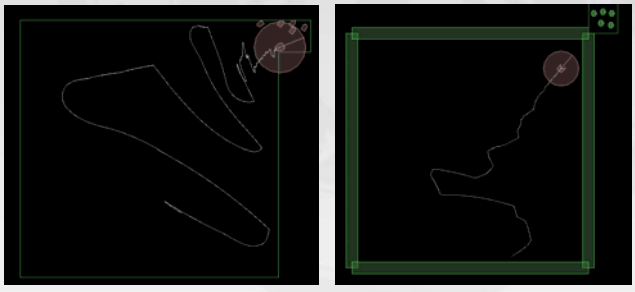

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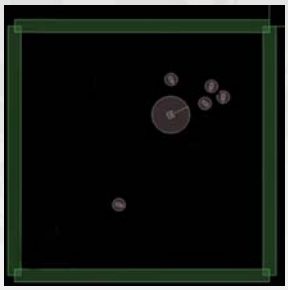
Future work

- Porting the simulation to 3 dimensions.
- Introducing multiple driving objects to reduce the time required to herd the flock.
- Predicting the future position of the sheep and planning the Dog's motion accordingly.
- Considering sophisticated heuristics, e.g. Sum of distances of every sheep from the goal.



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Conclusions

- We could successfully direct the sheep towards the Goal based on the motion of the Dog.
- Exploring the field of planning motion of a dynamic object governed by another dynamic object seems exciting and feasible.

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Thank You

Questions ?