IoT Project 2023

Distributed Drone Patrolling

Airborne Dynamics

University of Rome "La Sapienza"

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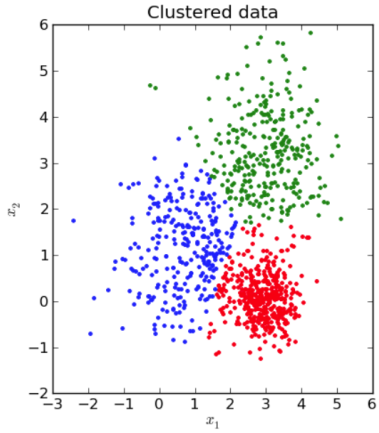
Algorithm

Clustering

- *Divide et Impera*.
  - Divide the point cloud in clusters.
- One cluster per drone.
  - Clearly defined work load.
- Clusters are **disjoint**.
  - Might implement *Fuzzy Clustering* in the future.
- We chose **K-Means**.



Priority Function

- Our distance metric D is made of two parts:
  1. d: euclidean distance between points.
  2. B: *bonus* decided by the current state of the destination target.

$$D = d\alpha - B\beta \tag{1}$$

- Given two points p_1 and p_2 we compute the euclidean distance d between them:

$$d = \sqrt{(p_{1,x} - p_{2,x})^2 + (p_{1,y} - p_{2,y})^2 + (p_{1,z} - p_{2,z})^2} \tag{2}$$

Priority Function (2)

- p_2: destination
- a: current age of information of p_2
- t: threshold of p_2
- w_a: age of information weight
- w_v: violation weight

- The **Bonus** will be:

$$A = a^2 w_a \tag{3}$$

$$V = (a - t)\, w_v \tag{4}$$

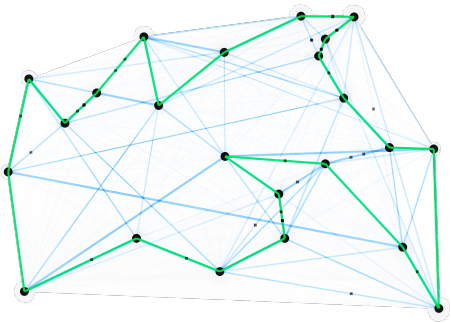
$$B = \begin{cases} A \cdot V, & \text{if } V > 0. \\ \frac{A}{|V|}, & \text{if } V < 0. \end{cases} \tag{5}$$

Ant-Colony

- This algorithm send out a number of ants to different paths on a computed graph, guided by the distance metric, and then returns the best one found.
- We use the *ant-colony* approach when:
  1. The cluster has outliers far away from the center of mass.
  2. The thresholds of the targets in the cluster are similar.
  3. The cluster is big.

Ant-Colony (2)

1. The *ants* **probabilistically** choose the next step of the path
2. Performs **backward updates** to said probability
   - Adding the inverse of the path's distance.
3. Repeat for a number of steps
4. the *best path* found has the **highest probability**.
5. *Example*:



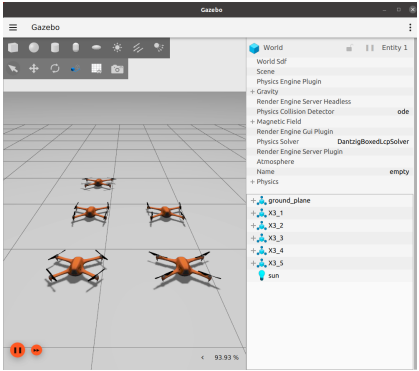
Greedy

- The greedy solution at **every step** evaluates the targets' priorities in the cluster
- Points the drone towards the **most urgent** one based on our dynamic distance metric.
- We choose *greedy* when:
  1. The wind is too strong.
  2. The cluster is small.
  3. The thresholds of the targets in the cluster are very different.

Drones

Movement

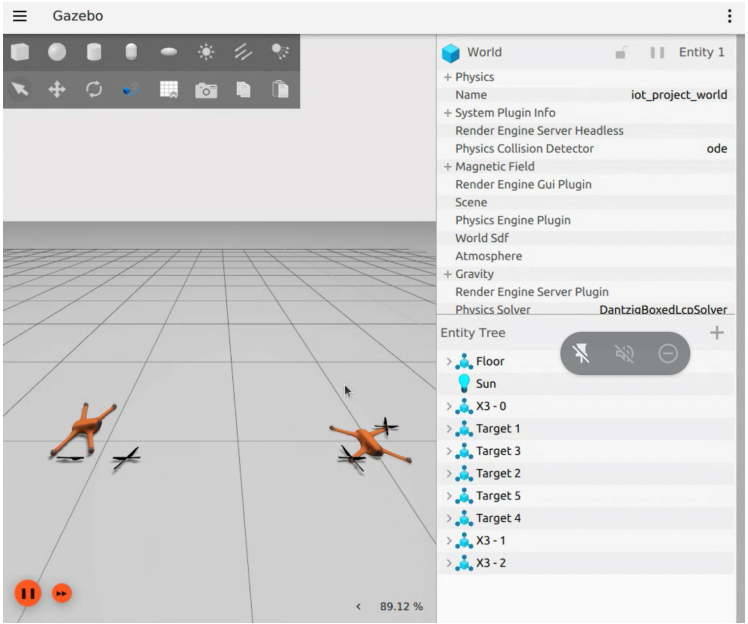
- Removed the *stop and rotate* phase
  - Much faster overall movement
- We assign the clusters based on the **starting position** of the drones
  - To avoid collisions after takeoff while trying to reach the clusters



Wind

- Change in the distance precision
  - Smaller ϵ value
  - delay the *deceleration* phase
- Issues with *angular vector* in windy scenarios
  - Drones rotate and loose the orientation

Fin.


Gazebo
World
Entity 1
Physics
Name
iot_project_world
System Plugin Info
Render Engine Server Headless
Physics Collision Detector
ode
Magnetic Field
Render Engine Gui Plugin
Scene
Physics Engine Plugin
World Sdf
Atmosphere
Gravity
Render Engine Server Plugin
Physics Solver
DantzigBoxedLcpSolver
Entity Tree
Floor
Sun
X3 - 0
Target 1
Target 3
Target 2
Target 5
Target 4
X3 - 1
X3 - 2
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