Unmanned Aerial Vehicle Delivery System

GROUP – 9

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ABSTRACT

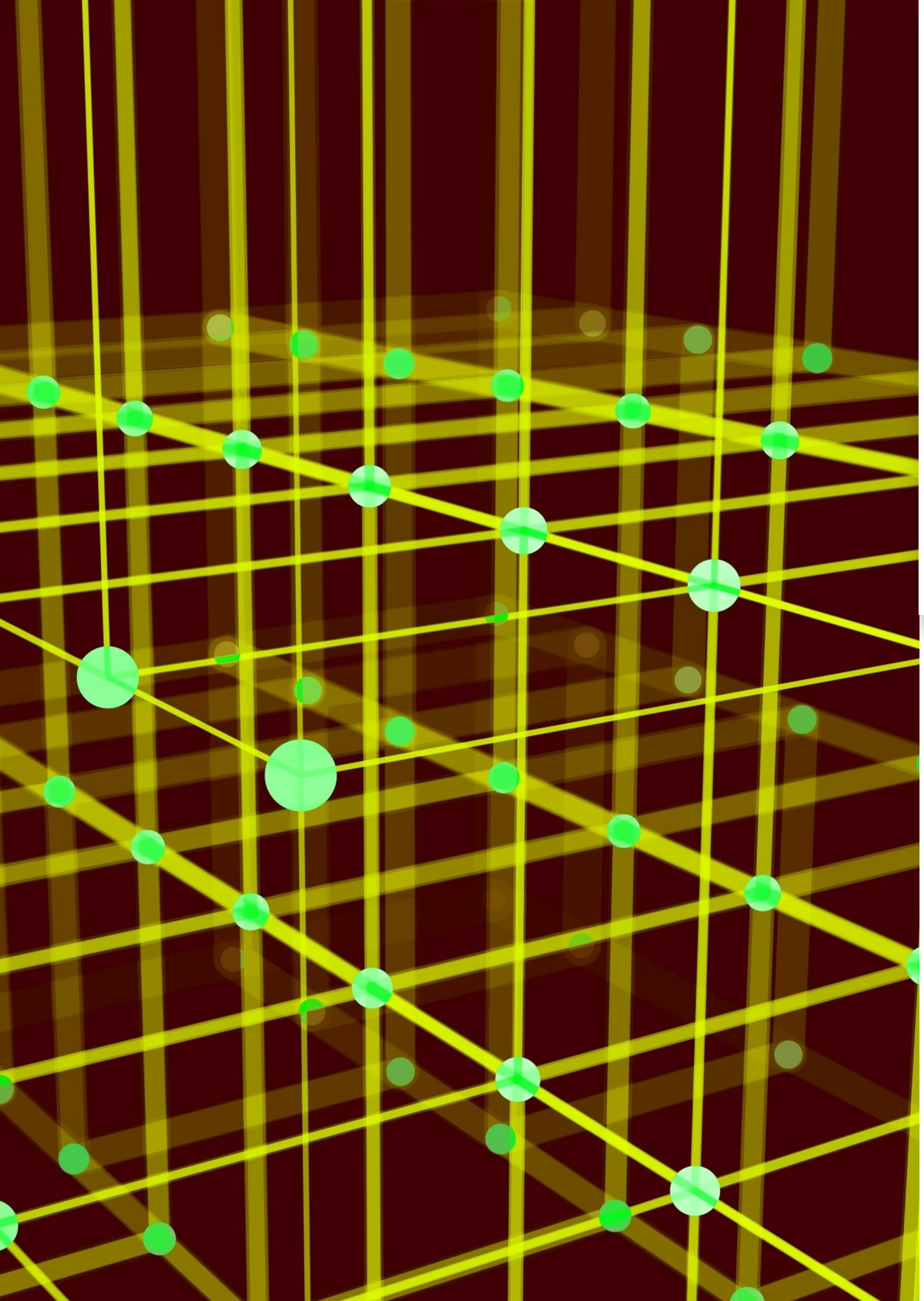
- Our main aim is to find the shortest path, enhance delivery time, minimize the efficiency cost and budgeting of an UAV (Unmanned Aerial Vehicle Delivery System).

- Heroes (Nodes) of our project: Drones, Stores, Customers and Charging Stations with real-time coordinates of Denton.

- Algorithms used to achieve are Dijkstra’s Algorithm and A* Algorithm for route optimization.

INTRODUCTION

- **Setup of the Project**: Utilized Denton, Texas area real-time map coordinates.
- **Components used for Simulation**:
  - **Nodes** - Stores, Customers and Charging stations.
  - **Networking**: To connect these nodes, we used NetworkX library.
- **NFZ (No Fly Zone)**: A restricted area space (airspace) where drones should not fly.
- **Finding Shortest Path and Navigation**: We find effective yet short routes by avoiding NFZs. Also, ensures minimum cost and battery usage.
- **Collision and Safety Control**: Drone Altitude Management and Collision control to safe operations.



METHODOLGY CONNECTING GRAPH THEORY

- The main algorithms used to calculate the shortest path between two nodes and to take optimal path are **Dijkstra’s and A* algorithms**.
- **Grid Mapping as a Graph**: The map represented as a grid is divided into parts or cells which is a Node. Applying A* algorithm helps managing spatial and complexity of the coordinates.
- **Construction of Graph**: Each Vertex is considered as a Node whereas Edge is the network between the nodes.

METHODOLGY CONNECTING GRAPH THEORY

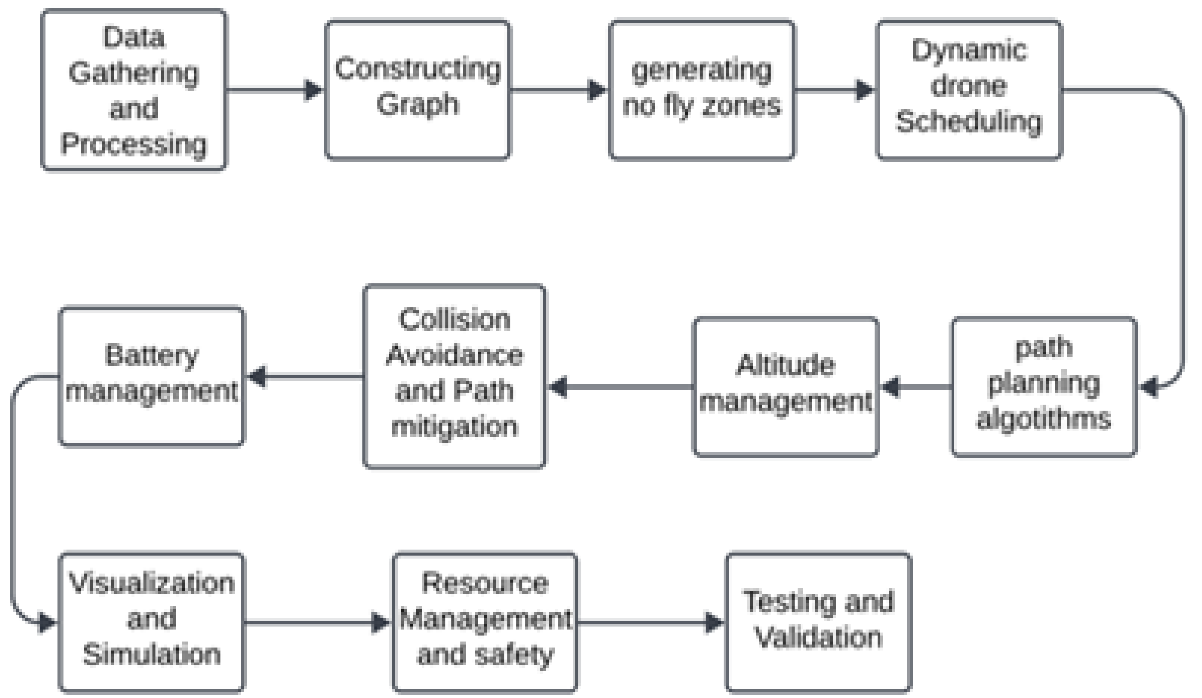
- **Collision or Obstacle Control**: Flying drones at same altitude without collisions is achieved by assigning same “**weights**” on the paths that are intersecting.

- **Use of Centrality for Scheduling**: Closeness Centrality is used to schedule the drones that are near to the store by enhancing efficiency

OBJECTIVES

- Route Optimization and Navigation
- Safety and Collision Control
- Visualization and Simulation
- Efficient Operation
- Resource Management.

WORKFLOW

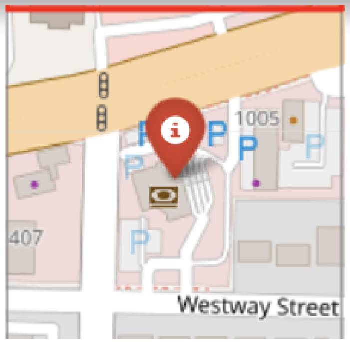


Data Gathering and Processing
Constructing Graph
generating no fly zones
Dynamic drone Scheduling
path planning algotithms
Altitude management
Collision Avoidance and Path mitigation
Battery management
Visualization and Simulation
Resource Management and safety
Testing and Validation

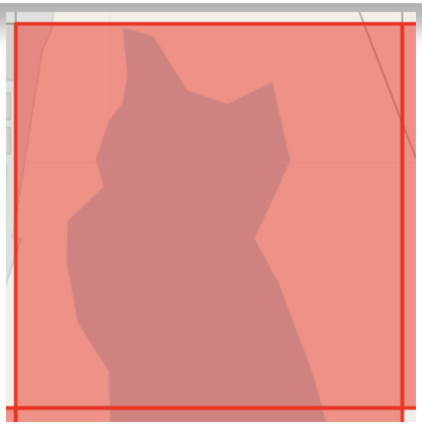
EVALUATION METRICS

- Delivery Time
- Cost-Efficiency
- Environmental Impact
- Safety Performance
- Route optimization
- Utilization of Resources
- Adaptability and Scalability
- Overall System Performance

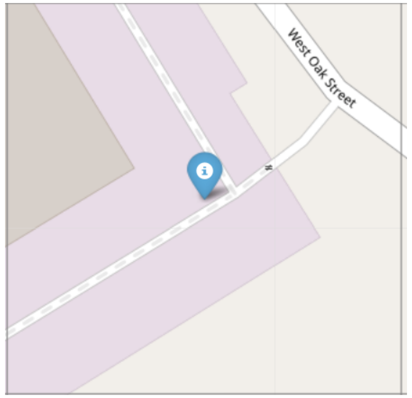
Node representations



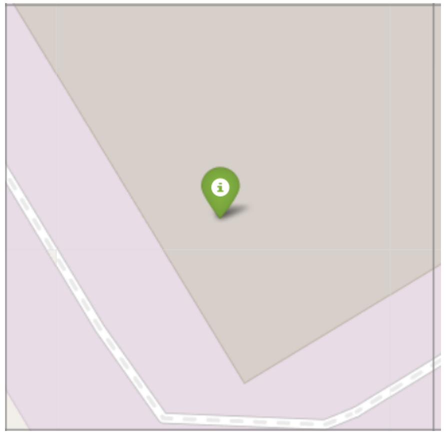
< Charging Station node



< NFZ (no fly zone)

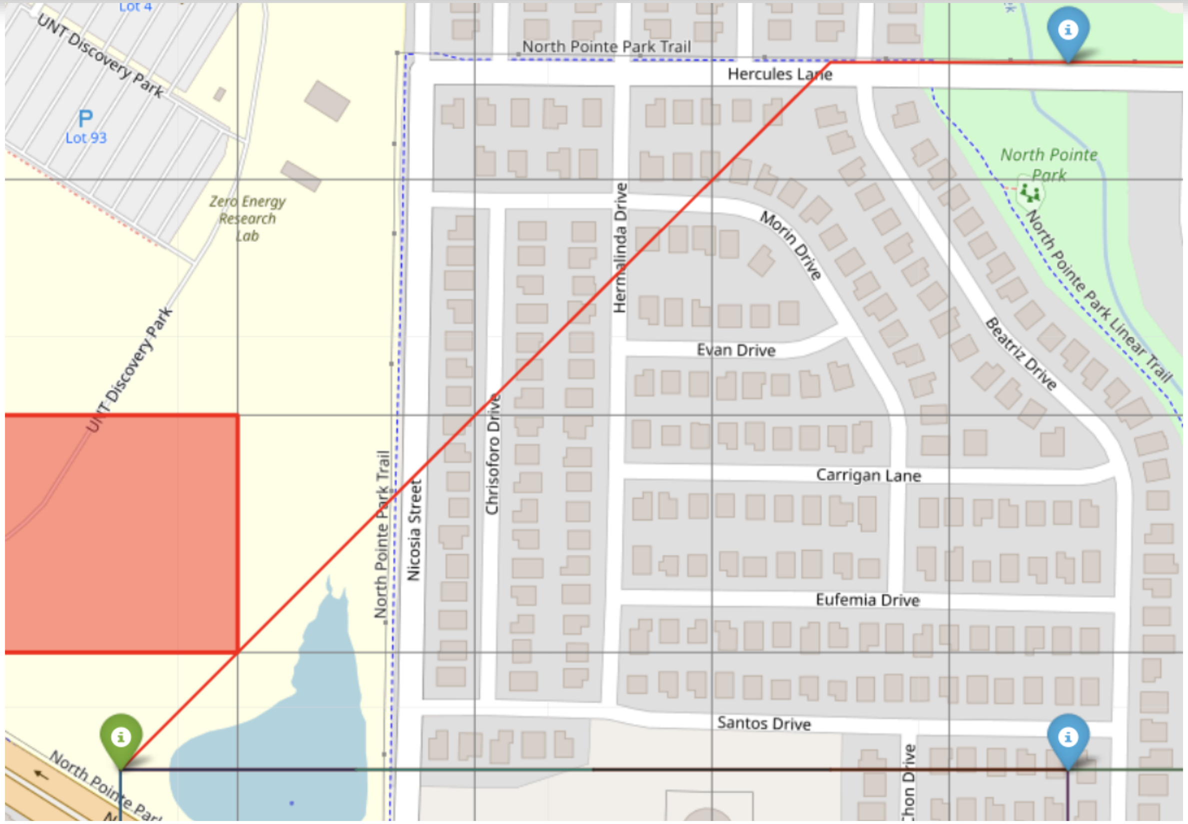


< Customer node



< Store node

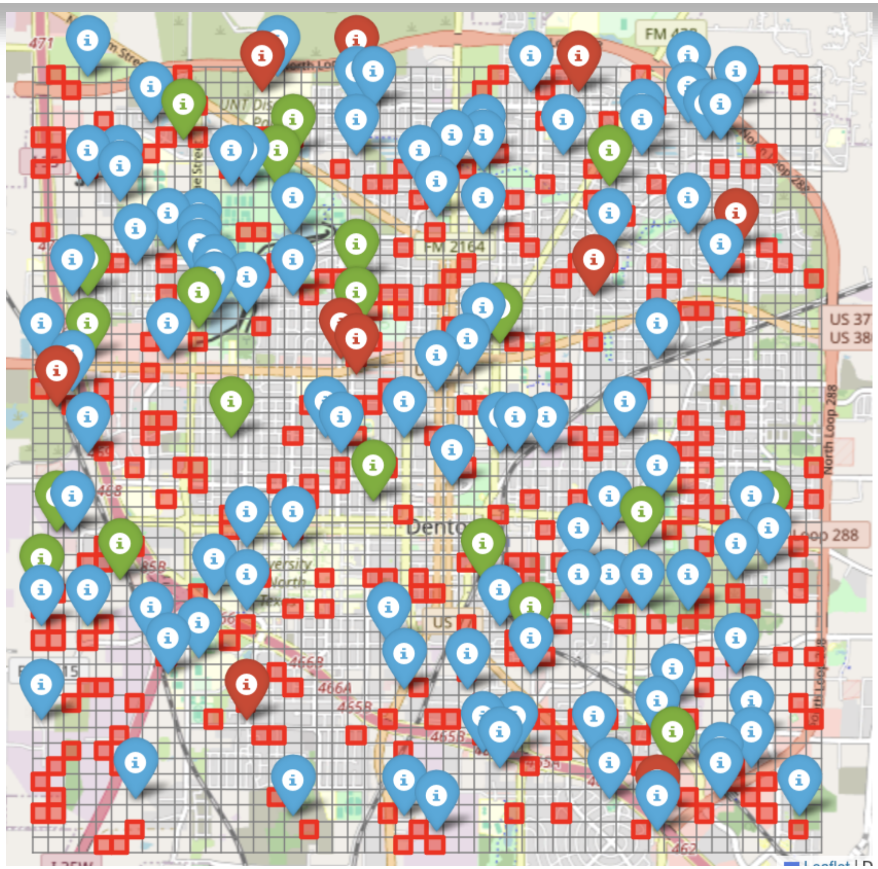
Delivery path and returning path

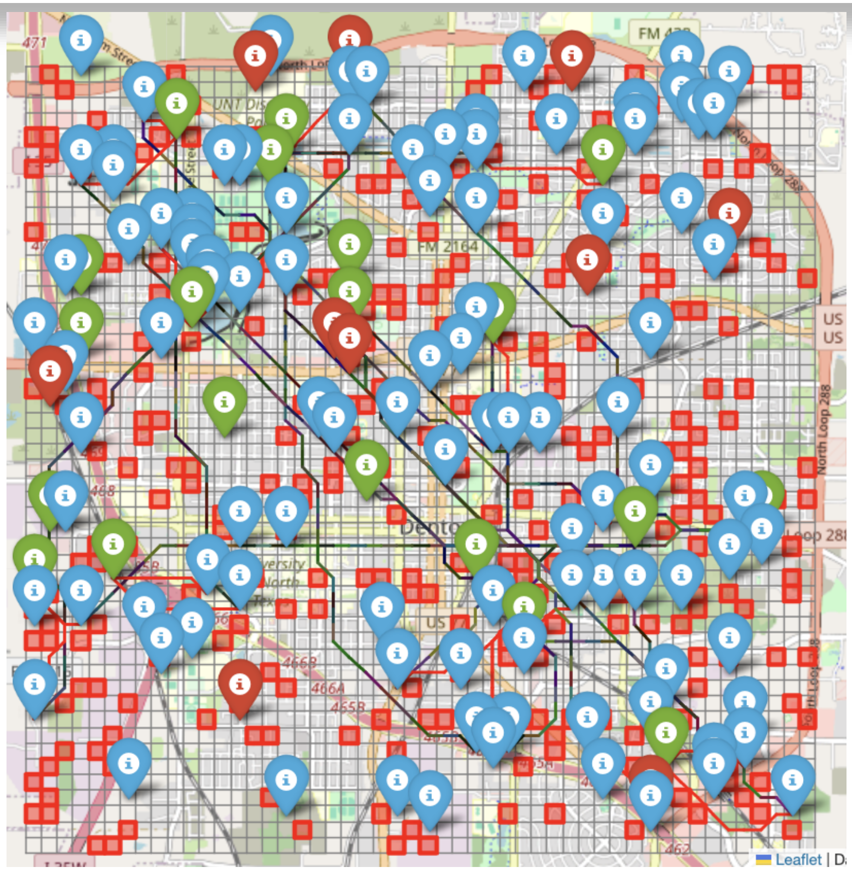


Red indicates drone returning to the nearest store

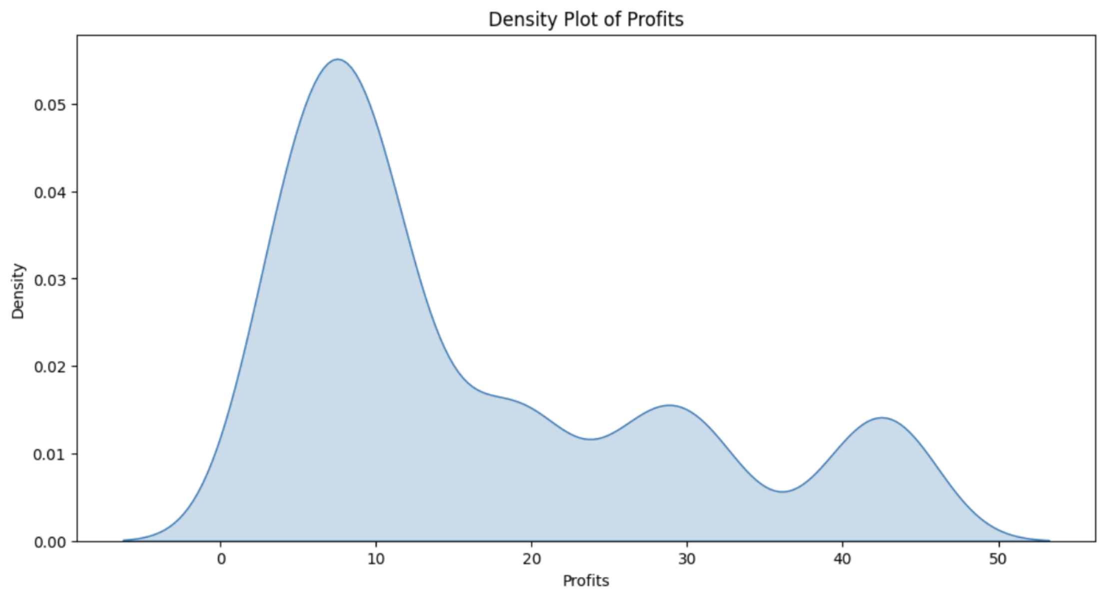
Black or any other dark colour other than red indicates delivery path

Visualizations and outputs (initial vs final map)



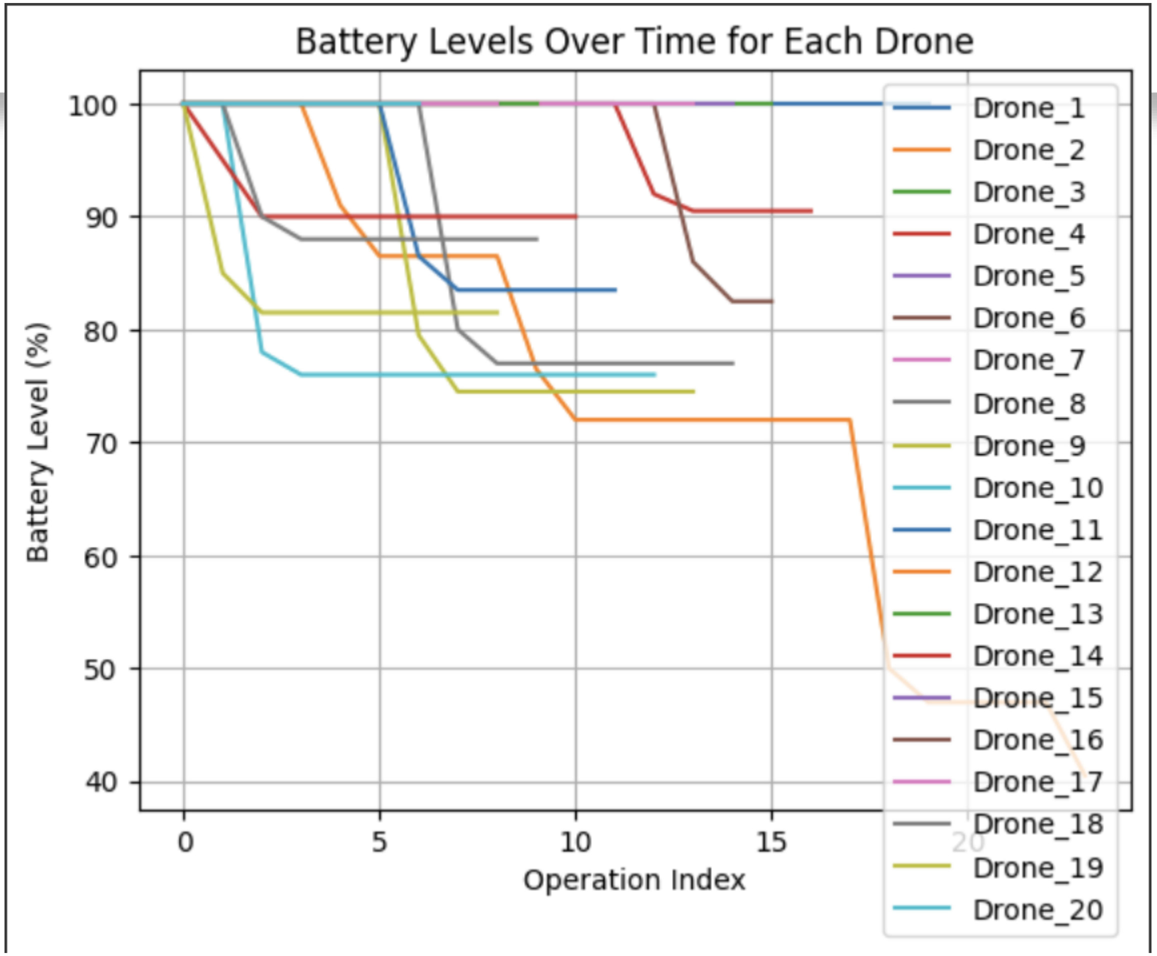


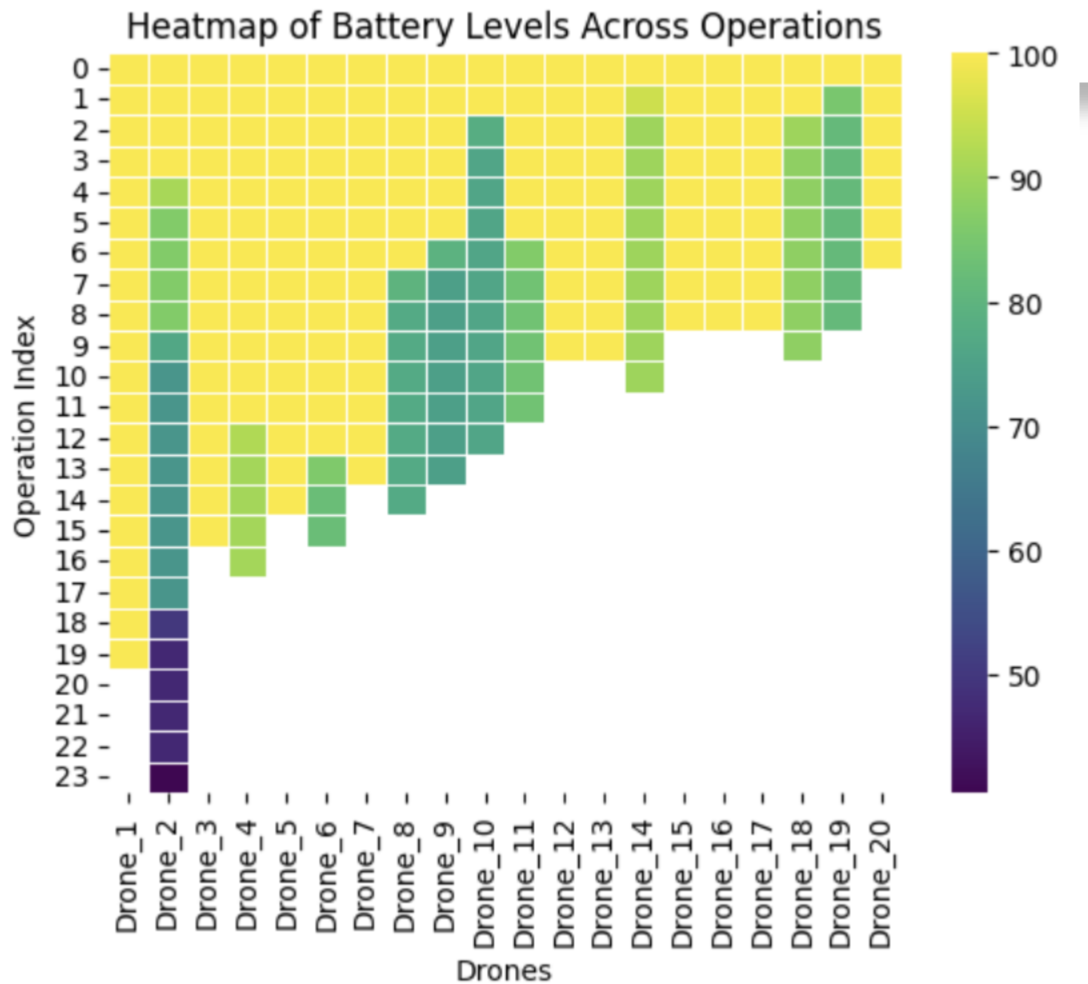
KDE of profits and battery schedule.




```
Drone_1 : grid position (22, 21) : 100% battery : status active
Drone_2 : grid position (19, 38) : 100% battery : status active
Drone_3 : grid position (17, 5) : 100% battery : status active
Drone_4 : grid position (20, 1) : 100% battery : status active
Drone_5 : grid position (16, 0) : 100% battery : status active
Drone_6 : grid position (17, 28) : 100% battery : status active
Drone_7 : grid position (36, 20) : 100% battery : status active
Drone_8 : grid position (42, 15) : 100% battery : status active
Drone_9 : grid position (44, 16) : 100% battery : status active
Drone_10 : grid position (20, 46) : 100% battery : status active
Drone_11 : grid position (32, 29) : 100% battery : status active
Drone_12 : grid position (35, 3) : 100% battery : status active
Drone_13 : grid position (31, 3) : 100% battery : status active
Drone_14 : grid position (13, 31) : 100% battery : status active
Drone_15 : grid position (42, 36) : 100% battery : status active
Drone_16 : grid position (33, 10) : 100% battery : status active
Drone_17 : grid position (26, 12) : 100% battery : status active
Drone_18 : grid position (33, 20) : 100% battery : status active
Drone_19 : grid position (45, 9) : 100% battery : status active
Drone_20 : grid position (5, 40) : 100% battery : status active
```

Visualizations of battery levels over time and operations





Generated Summary and grid representation of map.

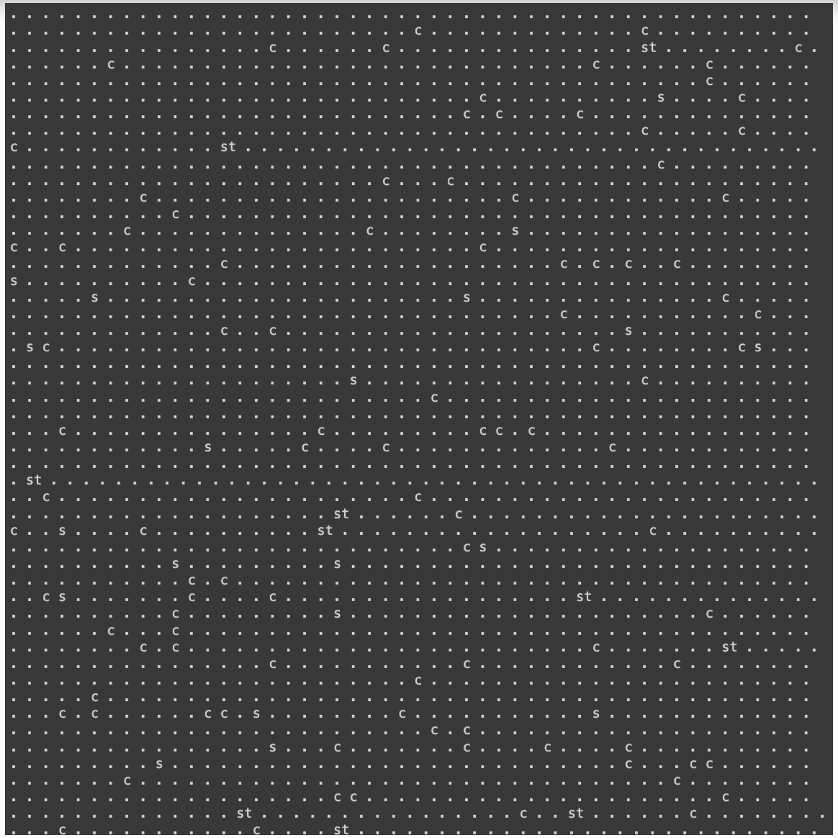
Generated Summaries:
The summary of the text provided involves several drones and their activities relating to their loc

Here's a structured overview in table format:

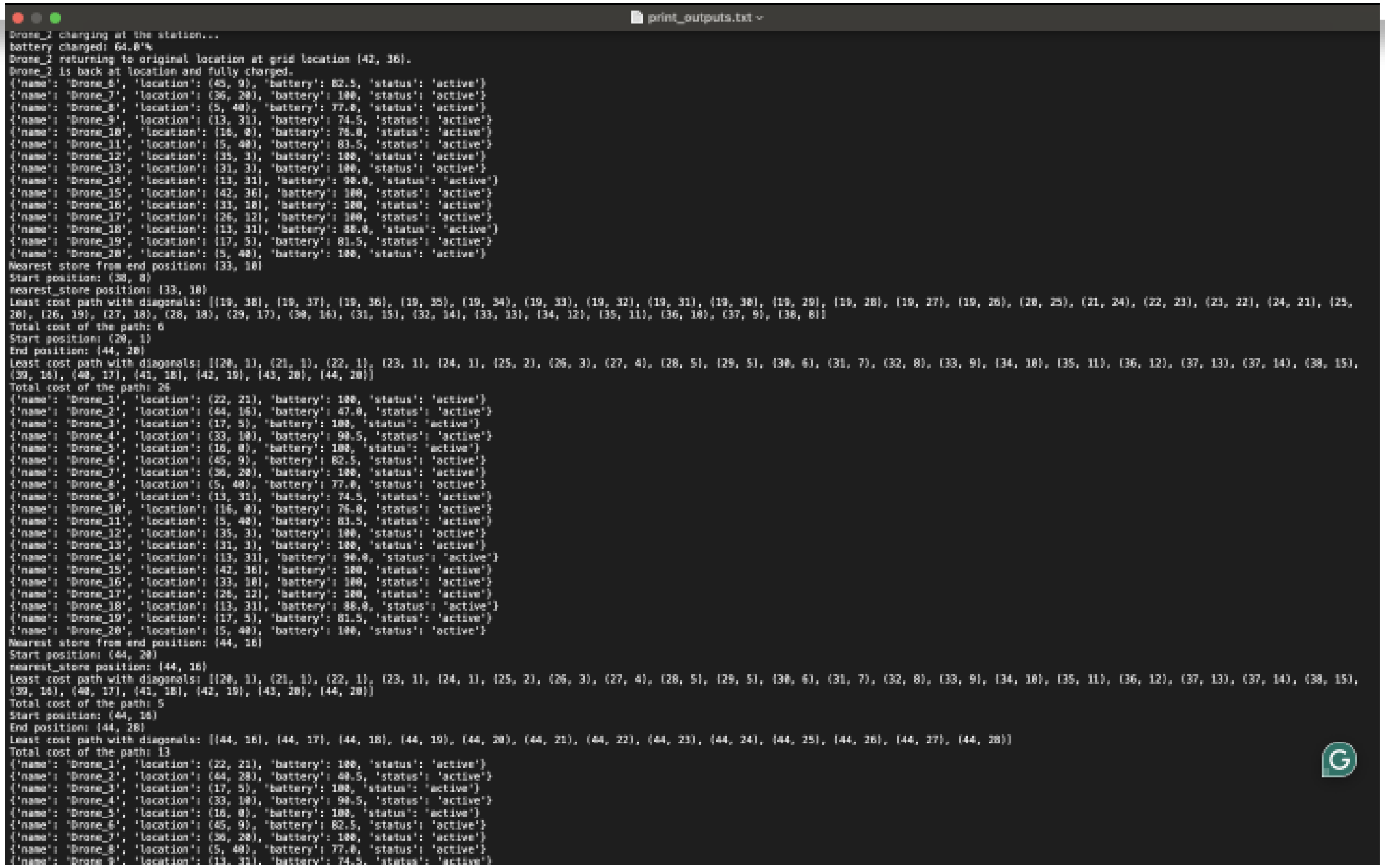
Drone	Location	Battery	Status	Nearest Store Location	Path Cost
Drone_1	(22, 21)	100%	Active		
Drone_2	(44, 28)	40.5%	Active	(42, 36)	9
Drone_3	(17, 5)	100%	Active		
Drone_4	(33, 10)	90.5%	Active		
Drone_5	(16, 0)	100%	Active		
Drone_6	(45, 9)	82.5%	Active		
Drone_7	(36, 20)	100%	Active		
Drone_8	(5, 40)	77.0%	Active		
Drone_9	(13, 31)	74.5%	Active		
Drone_10	(16, 0)	76.0%	Active		
Drone_11	(5, 40)	83.5%	Active		
Drone_12	(35, 3)	100%	Active		
Drone_13	(31, 3)	100%	Active		
Drone_14	(13, 31)	90.0%	Active		
Drone_15	(42, 36)	100%	Active		
Drone_16	(33, 10)	100%	Active		
Drone_17	(26, 12)	100%	Active		
Drone_18	(13, 31)	88.0%	Active		
Drone_19	(17, 5)	81.5%	Active		
Drone_20	(5, 40)	100%	Active		

Various Paths	Start Position	End Position		Start Position	Path Cost
Path 1	(44, 20)	(44, 16)		Various Points	5
Path 2	(20, 1)	(44, 20)		Various Points	26

The details include the path movements from the start position to the end position, including inter



Ouputs saves as a txt file



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print_outputs.txt
Drone_2 charging at the station...
battery charged: 64.0'%
Drone_2 returning to original location at grid location (42, 36).
Drone_2 is back at location and fully charged.
{'name': 'Drone_6', 'location': (45, 9), 'battery': 82.5, 'status': 'active'}
{'name': 'Drone_7', 'location': (36, 20), 'battery': 100, 'status': 'active'}
{'name': 'Drone_8', 'location': (5, 40), 'battery': 77.0, 'status': 'active'}
{'name': 'Drone_9', 'location': (13, 31), 'battery': 74.5, 'status': 'active'}
{'name': 'Drone_10', 'location': (16, 0), 'battery': 76.0, 'status': 'active'}
{'name': 'Drone_11', 'location': (5, 40), 'battery': 83.5, 'status': 'active'}
{'name': 'Drone_12', 'location': (35, 3), 'battery': 100, 'status': 'active'}
{'name': 'Drone_13', 'location': (31, 3), 'battery': 100, 'status': 'active'}
{'name': 'Drone_14', 'location': (13, 31), 'battery': 90.0, 'status': 'active'}
{'name': 'Drone_15', 'location': (42, 36), 'battery': 100, 'status': 'active'}
{'name': 'Drone_16', 'location': (33, 10), 'battery': 100, 'status': 'active'}
{'name': 'Drone_17', 'location': (26, 12), 'battery': 100, 'status': 'active'}
{'name': 'Drone_18', 'location': (13, 31), 'battery': 88.0, 'status': 'active'}
{'name': 'Drone_19', 'location': (17, 5), 'battery': 81.5, 'status': 'active'}
{'name': 'Drone_20', 'location': (5, 40), 'battery': 100, 'status': 'active'}
Nearest store from end position: (33, 10)
Start position: (38, 8)
nearest_store position: (33, 10)
Least cost path with diagonals: [(19, 38), (19, 37), (19, 36), (19, 35), (19, 34), (19, 33), (19, 32), (19, 31), (19, 30), (19, 29), (19, 28), (19, 27), (19, 26), (20, 25), (21, 24), (22, 23), (23, 22), (24, 21), (25, 20), (26, 19), (27, 18), (28, 18), (29, 17), (30, 16), (31, 15), (32, 14), (33, 13), (34, 12), (35, 11), (36, 10), (37, 9), (38, 8)]
Total cost of the path: 6
Start position: (20, 1)
End position: (44, 20)
Least cost path with diagonals: [(20, 1), (21, 1), (22, 1), (23, 1), (24, 1), (25, 2), (26, 3), (27, 4), (28, 5), (29, 5), (30, 6), (31, 7), (32, 8), (33, 9), (34, 10), (35, 11), (36, 12), (37, 13), (37, 14), (38, 15), (39, 16), (40, 17), (41, 18), (42, 19), (43, 20), (44, 20)]
Total cost of the path: 26
{'name': 'Drone_1', 'location': (22, 21), 'battery': 100, 'status': 'active'}
{'name': 'Drone_2', 'location': (44, 16), 'battery': 47.0, 'status': 'active'}
{'name': 'Drone_3', 'location': (17, 5), 'battery': 100, 'status': 'active'}
{'name': 'Drone_4', 'location': (33, 10), 'battery': 90.5, 'status': 'active'}
{'name': 'Drone_5', 'location': (16, 0), 'battery': 100, 'status': 'active'}
{'name': 'Drone_6', 'location': (45, 9), 'battery': 82.5, 'status': 'active'}
{'name': 'Drone_7', 'location': (36, 20), 'battery': 100, 'status': 'active'}
{'name': 'Drone_8', 'location': (5, 40), 'battery': 77.0, 'status': 'active'}
{'name': 'Drone_9', 'location': (13, 31), 'battery': 74.5, 'status': 'active'}
{'name': 'Drone_10', 'location': (16, 0), 'battery': 76.0, 'status': 'active'}
{'name': 'Drone_11', 'location': (5, 40), 'battery': 83.5, 'status': 'active'}
{'name': 'Drone_12', 'location': (35, 3), 'battery': 100, 'status': 'active'}
{'name': 'Drone_13', 'location': (31, 3), 'battery': 100, 'status': 'active'}
{'name': 'Drone_14', 'location': (13, 31), 'battery': 90.0, 'status': 'active'}
{'name': 'Drone_15', 'location': (42, 36), 'battery': 100, 'status': 'active'}
{'name': 'Drone_16', 'location': (33, 10), 'battery': 100, 'status': 'active'}
{'name': 'Drone_17', 'location': (26, 12), 'battery': 100, 'status': 'active'}
{'name': 'Drone_18', 'location': (13, 31), 'battery': 88.0, 'status': 'active'}
{'name': 'Drone_19', 'location': (17, 5), 'battery': 81.5, 'status': 'active'}
{'name': 'Drone_20', 'location': (5, 40), 'battery': 100, 'status': 'active'}
Nearest store from end position: (44, 16)
Start position: (44, 20)
nearest_store position: (44, 16)
Least cost path with diagonals: [(20, 1), (21, 1), (22, 1), (23, 1), (24, 1), (25, 2), (26, 3), (27, 4), (28, 5), (29, 5), (30, 6), (31, 7), (32, 8), (33, 9), (34, 10), (35, 11), (36, 12), (37, 13), (37, 14), (38, 15), (39, 16), (40, 17), (41, 18), (42, 19), (43, 20), (44, 20)]
Total cost of the path: 5
Start position: (44, 16)
End position: (44, 28)
Least cost path with diagonals: [(44, 16), (44, 17), (44, 18), (44, 19), (44, 20), (44, 21), (44, 22), (44, 23), (44, 24), (44, 25), (44, 26), (44, 27), (44, 28)]
Total cost of the path: 13
{'name': 'Drone_1', 'location': (22, 21), 'battery': 100, 'status': 'active'}
{'name': 'Drone_2', 'location': (44, 28), 'battery': 40.5, 'status': 'active'}
{'name': 'Drone_3', 'location': (17, 5), 'battery': 100, 'status': 'active'}
{'name': 'Drone_4', 'location': (33, 10), 'battery': 90.5, 'status': 'active'}
{'name': 'Drone_5', 'location': (16, 0), 'battery': 100, 'status': 'active'}
{'name': 'Drone_6', 'location': (45, 9), 'battery': 82.5, 'status': 'active'}
{'name': 'Drone_7', 'location': (36, 20), 'battery': 100, 'status': 'active'}
{'name': 'Drone_8', 'location': (5, 40), 'battery': 77.0, 'status': 'active'}
{'name': 'Drone_9', 'location': (13, 31), 'battery': 74.5, 'status': 'active'}
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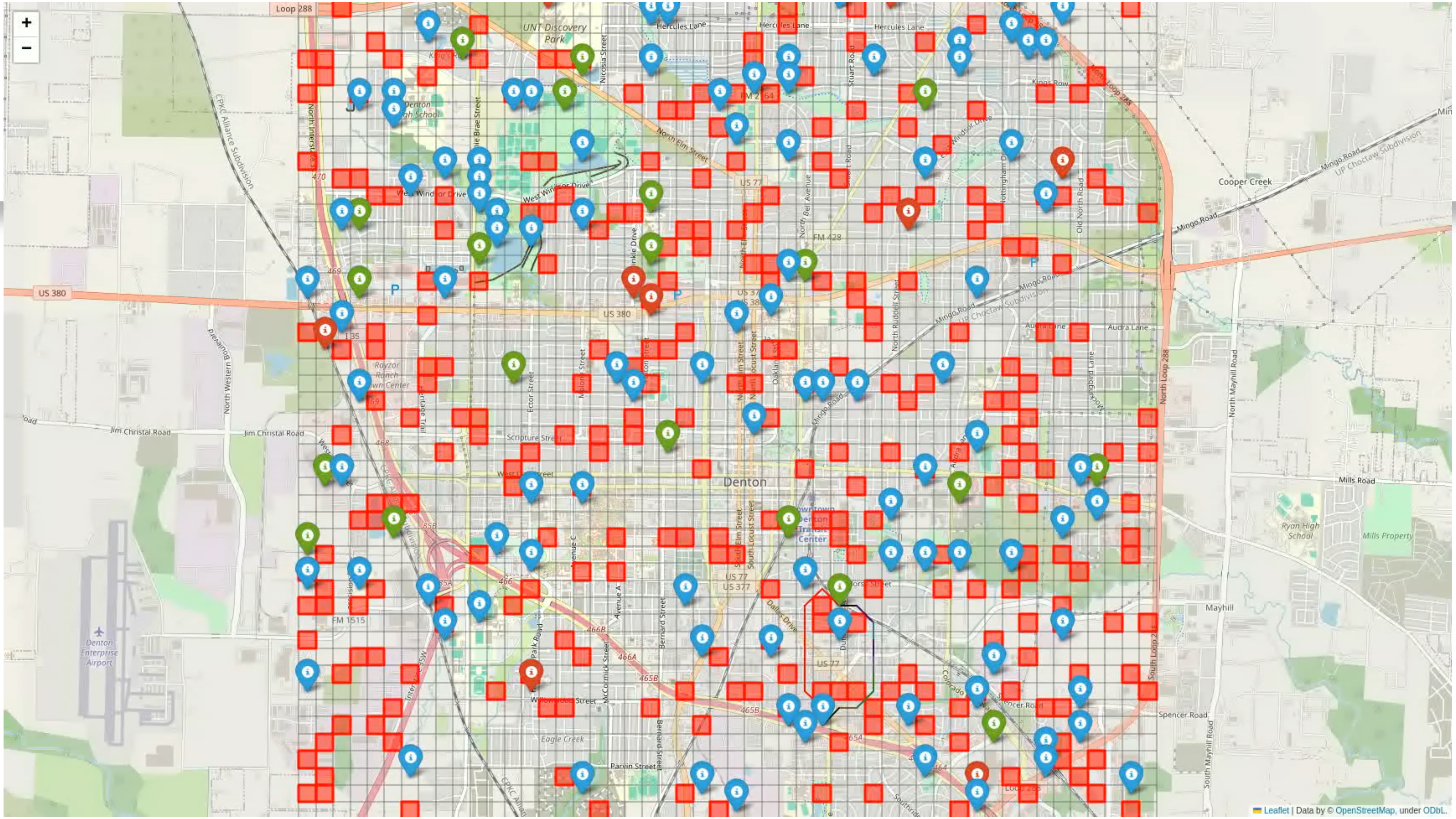
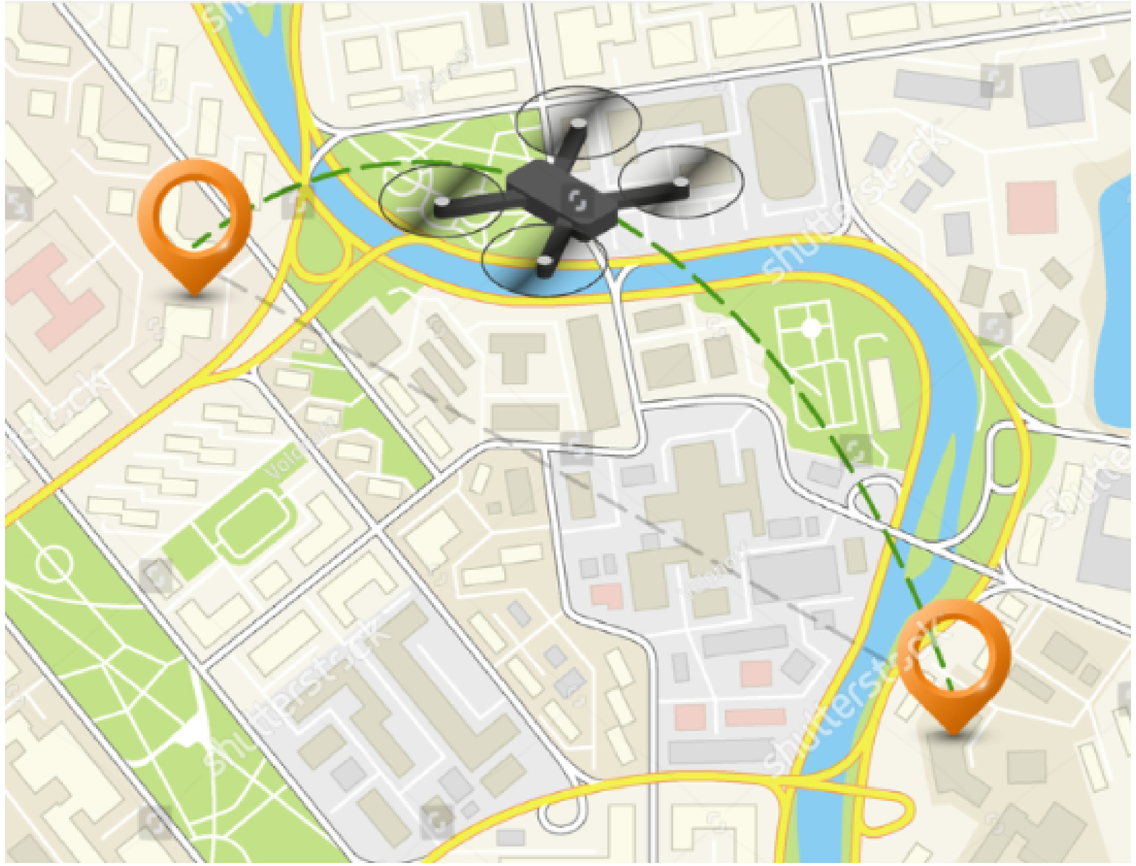
Video of execution



RISKS

- Safety Concerns: Accidents and Compliance Regulations
- Regulatory Challenges: Adapting airspace restrictions and Legal issues
- Security Risks: Chance of Drone theft and Cyberattacks
- Environmental Impact: Potential Ecological damage
- Technology Constraints: Dependence on GPS and Hardware/Software reliability issue.

CONCLUSION



Our UAV delivery system provides a thorough approach to delivery operations optimization using dynamic scheduling, advanced algorithms, and resource management. We improve safety and efficiency by combining path planning algorithms, collision control logic, and altitude management strategies. Despite obstacles such as regulatory compliance and technical limits, our methodology paves the path for creative and sustainable last-mile logistics solutions.

References

- Khosravi, M., Enayati, S., Saeedi, H., & Pishro-Nik, H. (2021). Multi-purpose drones for coverage and transport applications. IEEE Transactions on Wireless Communications, 20(6), 3974-3987. 3.
- Sohail, M. F., Leow, C. Y., & Won, S. (2019). Energy-efficient non-orthogonal multiple access for UAV communication system. IEEE Transactions on Vehicular Technology, 68(11), 10834-10845. 4.
- H. Wang, G. Ding, F. Gao, J. Chen, J. Wang and L. Wang, "Power control in UAV- supported ultra dense networks: Communications caching and energy transfer", IEEE Communications Magazine, vol. 56, pp. 28-34, June 2018.

THANK YOU!