

Final Project:

Autonomous Collision Avoidance for Drones

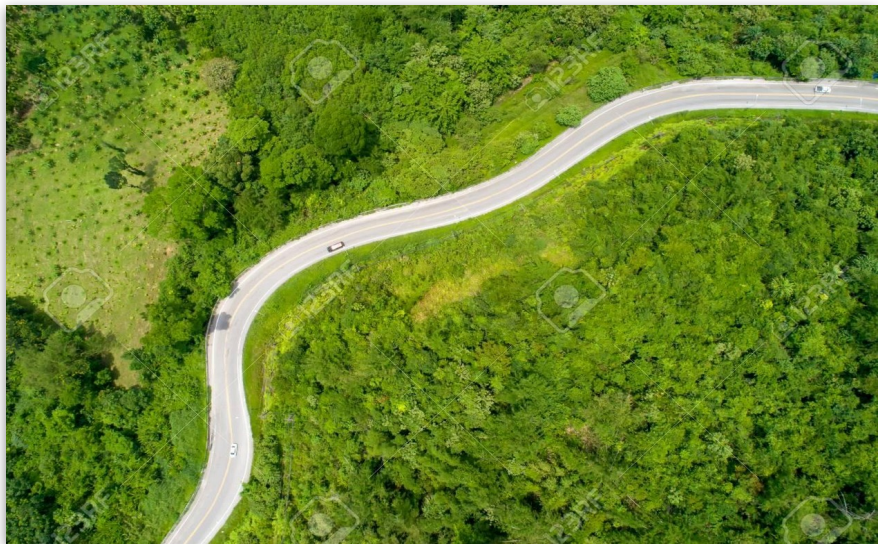
Team: Marcus Berg, Mason Hawver, Vaagishwaran
Sivakumar



Introduction

Objective:

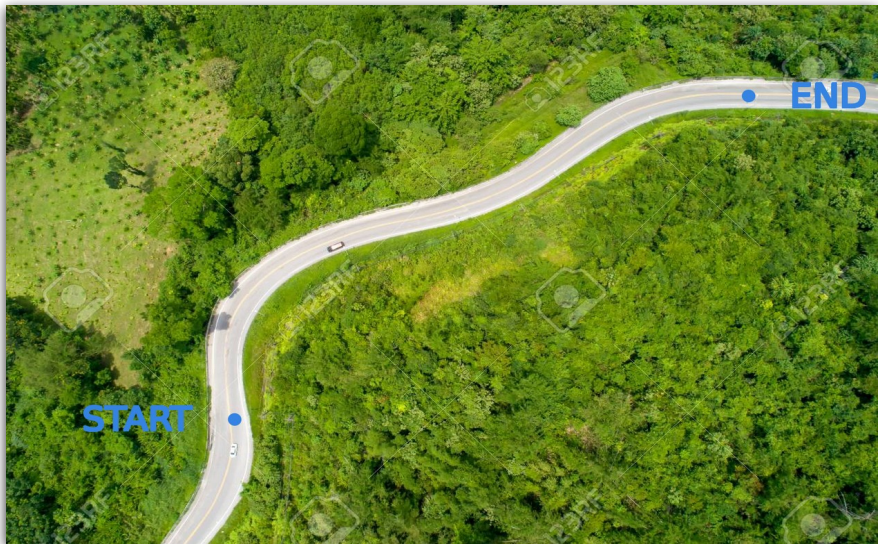
- Plan collision free trajectories through an environment to control a drone



Introduction

Objective:

- Plan collision free trajectories through an environment to control a drone



Introduction

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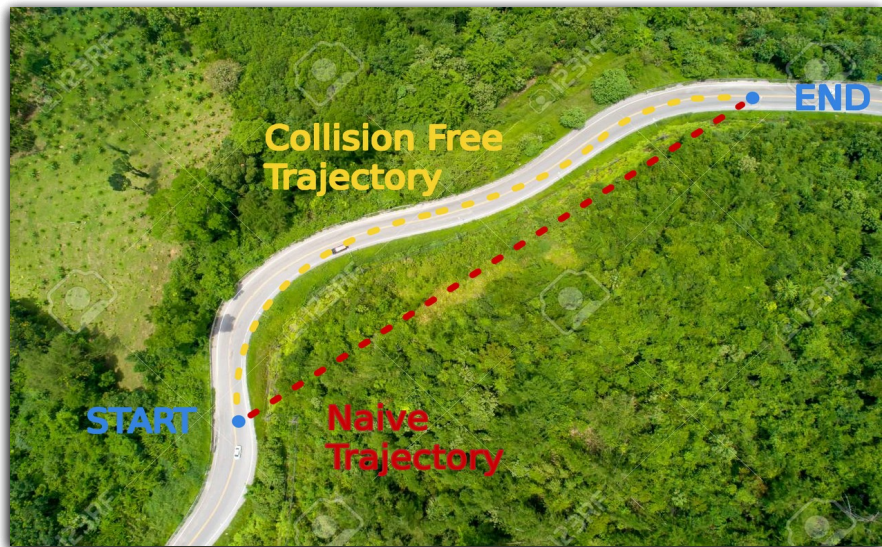
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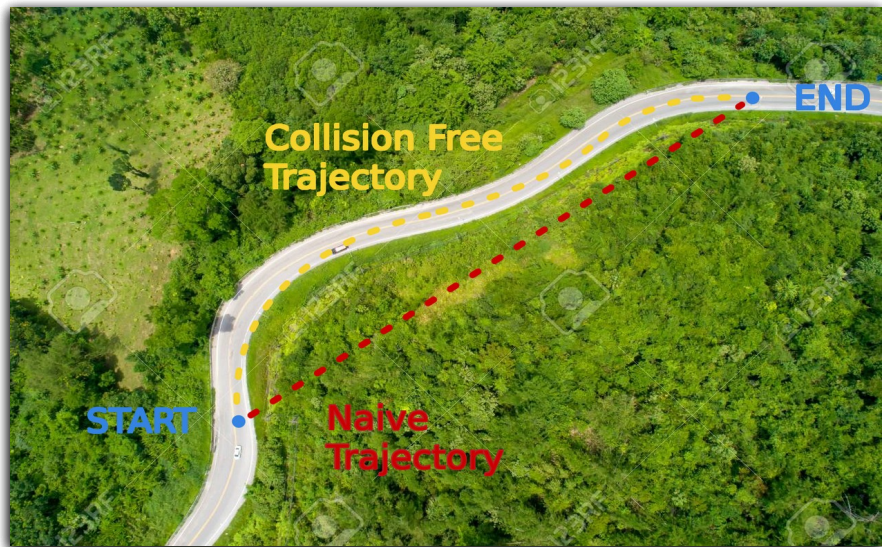
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Introduction

Objective:

- Plan collision free trajectories through an environment to control a drone



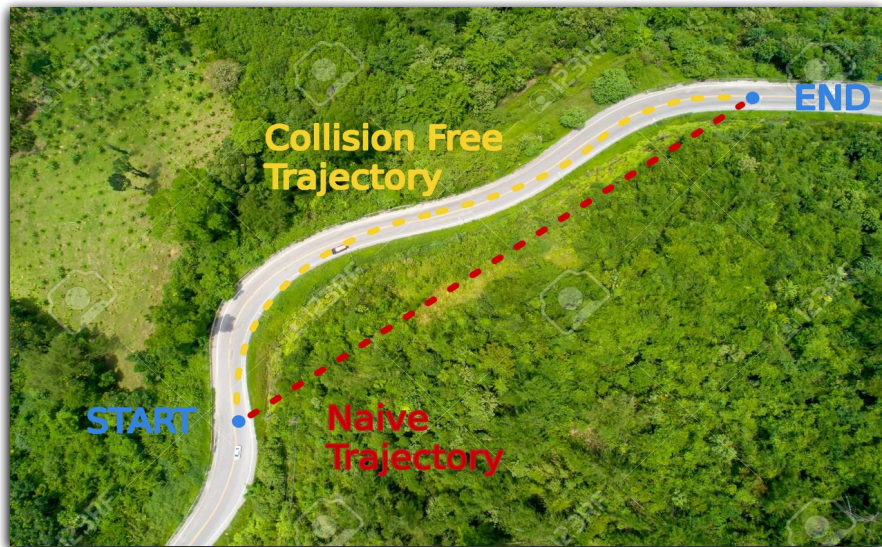
Problem:

- Conventional approaches to find collision free trajectories require localization and mapping
 - which is error prone and slow

Introduction

Objective:

- Plan collision free trajectories through an environment to control a drone



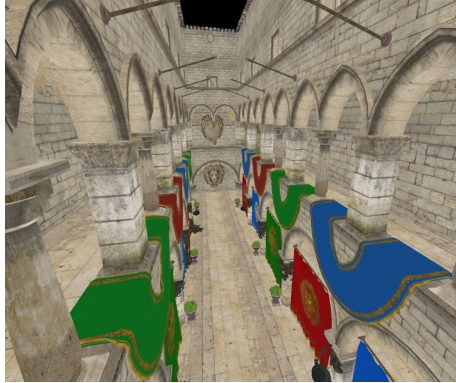
Proposed Solution:

- The Paper, *Learning High-Speed Flight in The Wild* [1], proposes training a visual policy to create collision free trajectories

Problem:

- Conventional approaches to find collision free trajectories require localization and mapping
 - which is error prone and slow

Methodology



Simulated Environment

Expert Policy: (Conventional Approach)



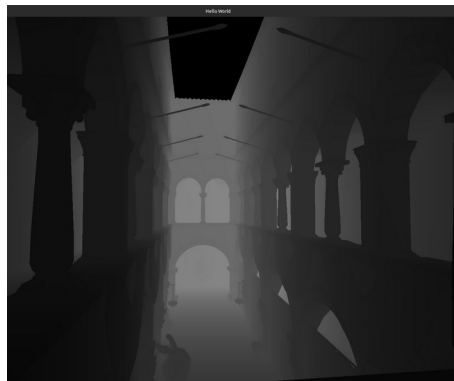
Simulated Environment



Student Policy: (Learns from Expert)



**Localization and
Mapping**
(hard to obtain IRL)



Depth Map
(can be produced IRL and noise from IRL can be simulated)

Expert Policy:
(Conventional Approach)



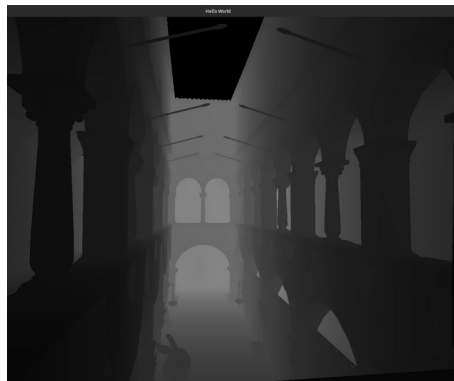
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Student Policy:
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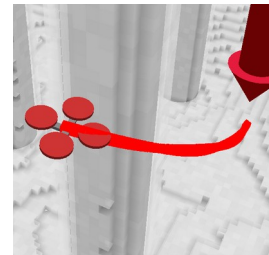
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Depth Map

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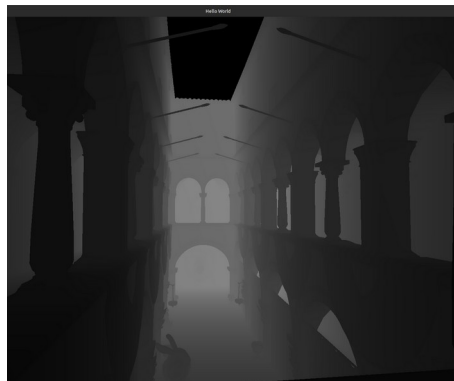
Conventional Approach
(Slow)



Expert Policy:
(Conventional Approach)



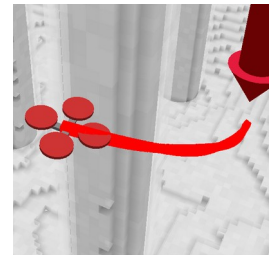
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Depth Map

(can be produced IRL and noise from IRL can be simulated)

Conventional Approach
(Slow)



Simulated Environment



Student Policy:
(Learns from Expert)

Medium Sized CNN Model
(Fast)

Expert Policy:
(Conventional Approach)



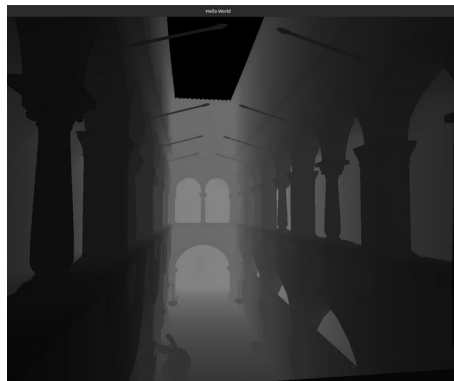
Simulated Environment



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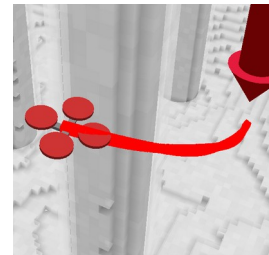
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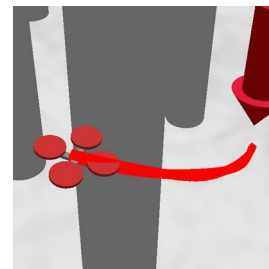
Conventional Approach
(Slow)



Imitation Learning Trains the child policy to mimic the output of the parent policy

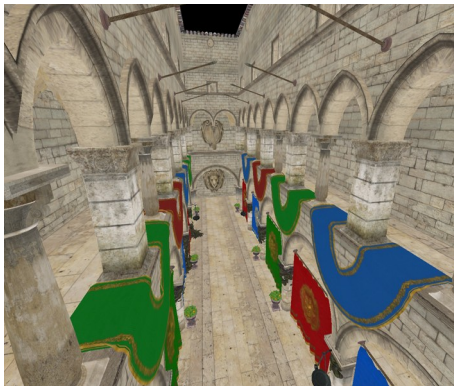


Medium Sized CNN Model
(Fast)



Expert Policy

- **Input:** Localization, Mapping, and the Starting and Ending positions
- **Output:** Multiple low cost local trajectories at each time step

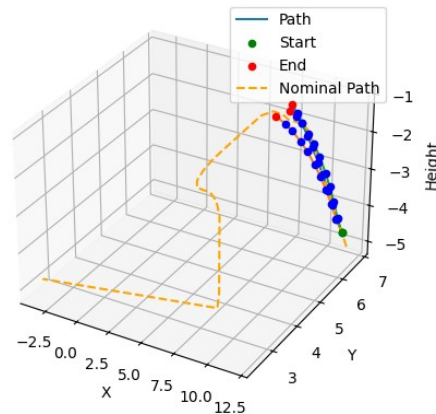


Simulated Environment

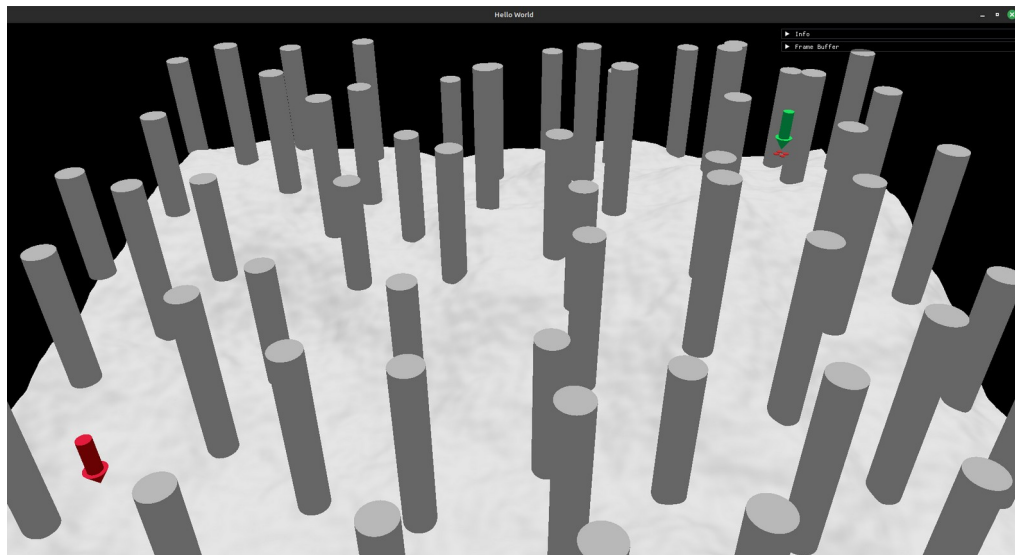


Conventional Approach:

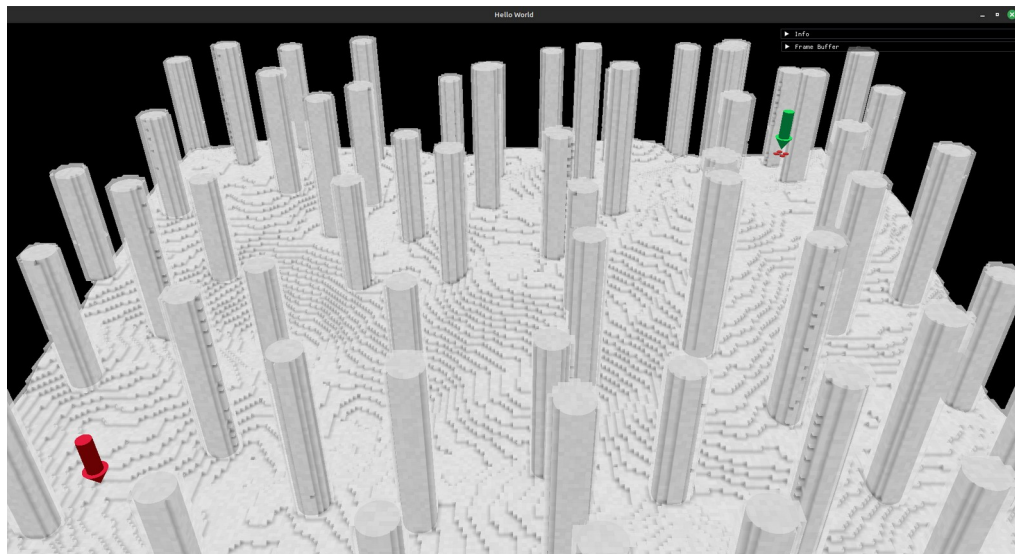
A* search →
Min-Snap Trajectory Optimization →
Metropolis Hastings Search →
Optimal Local Trajectories for each
mode (left or right) →
Model Predictive Controller
(Slow and Requires Perfect Knowledge)



Expert Policy

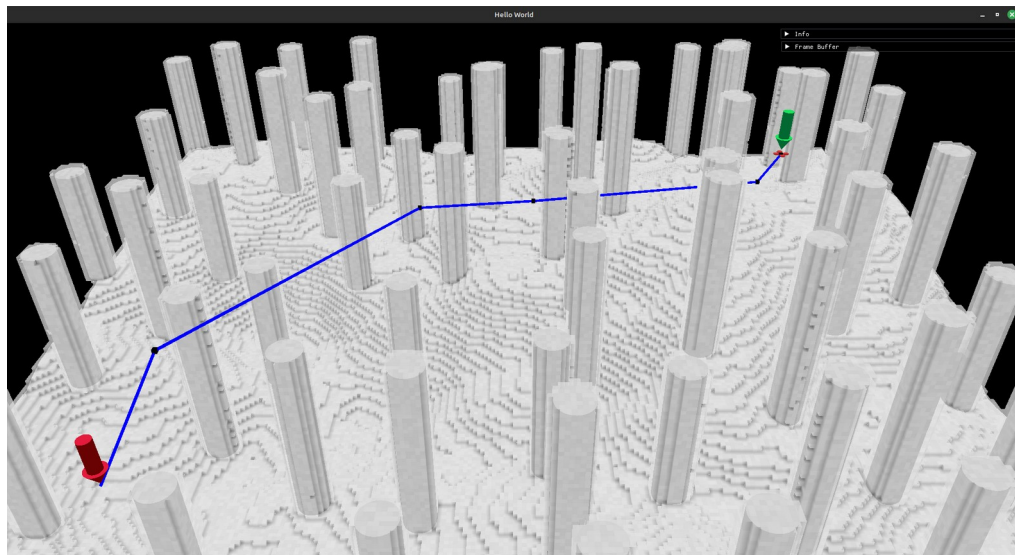


Expert Policy



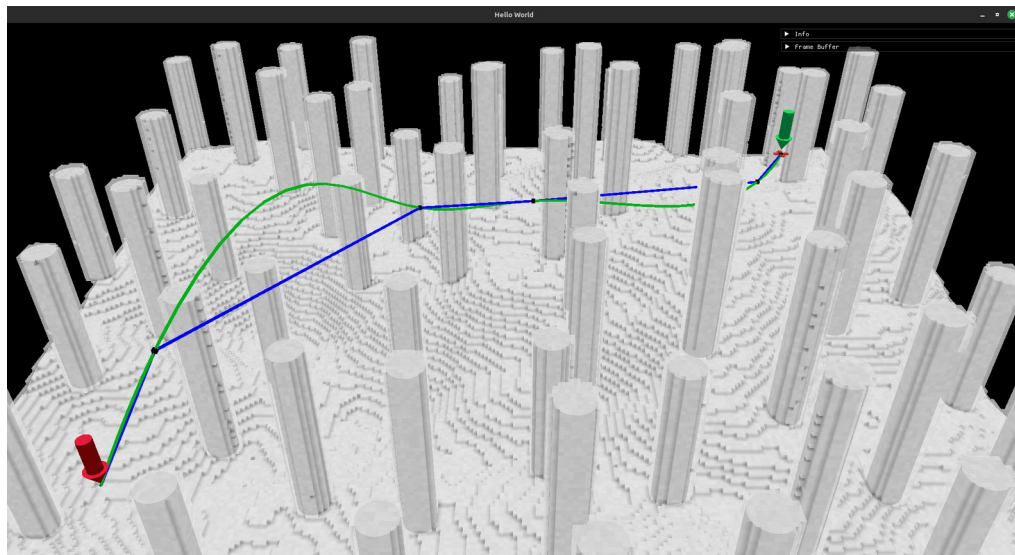
Occupancy Grid Mapping

Expert Policy



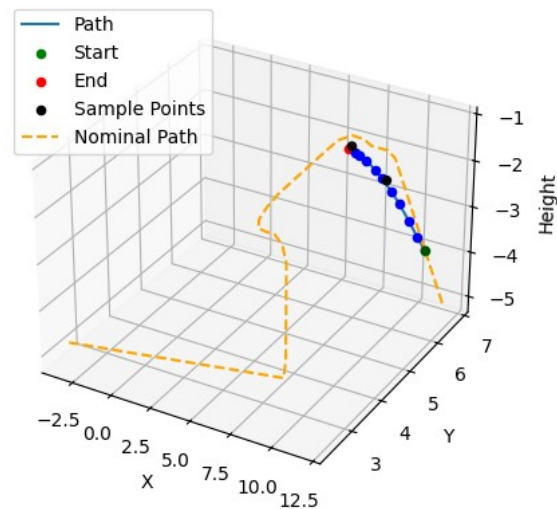
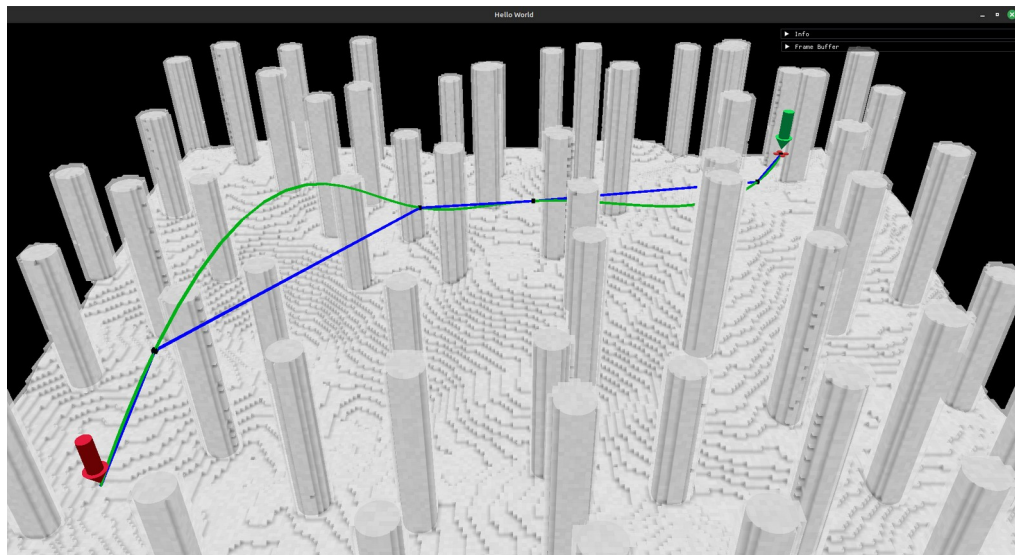
Θ^* Search (Modified A*)

Expert Policy



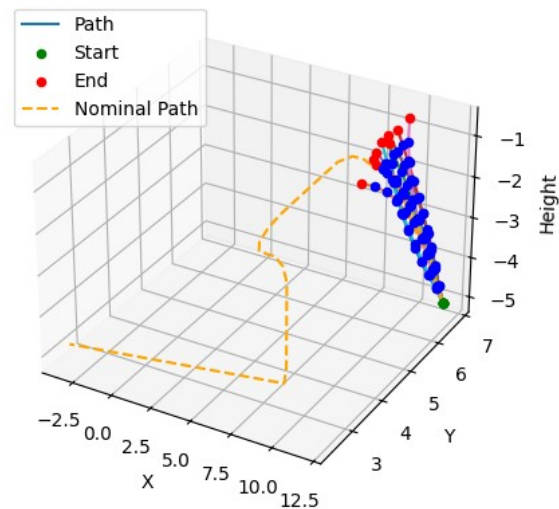
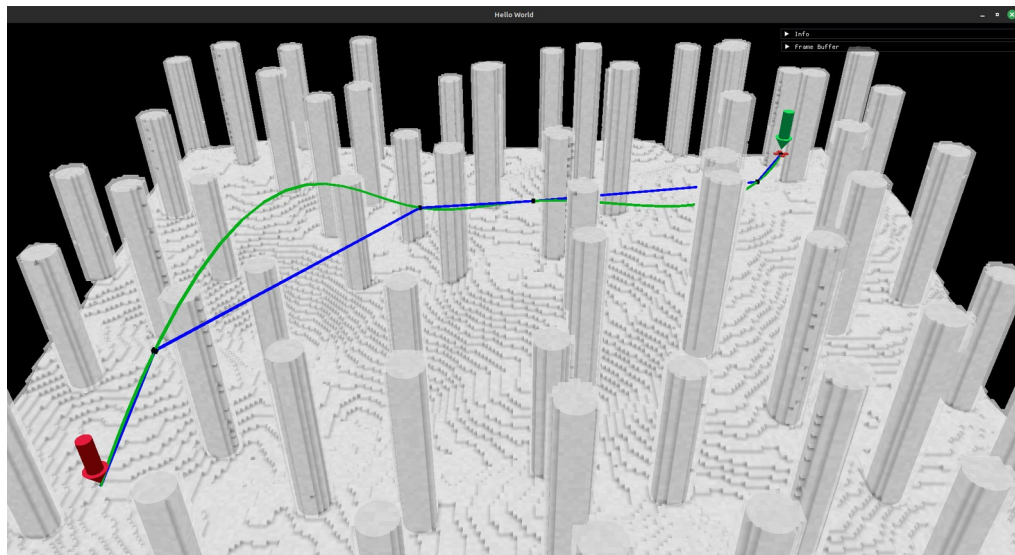
Min-Snap Trajectory Optimization with Collision Constraints

Expert Policy



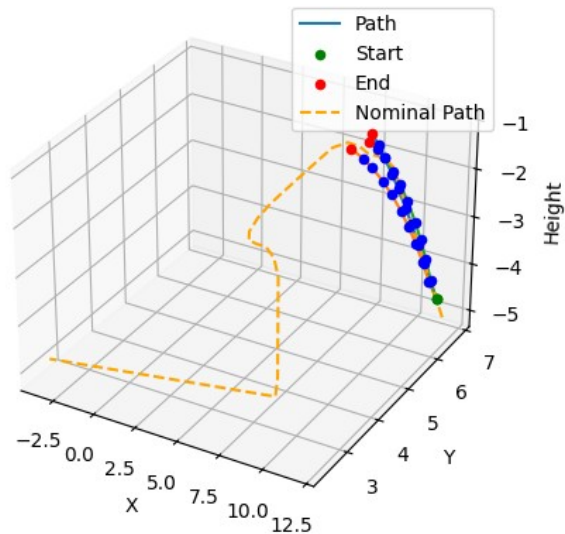
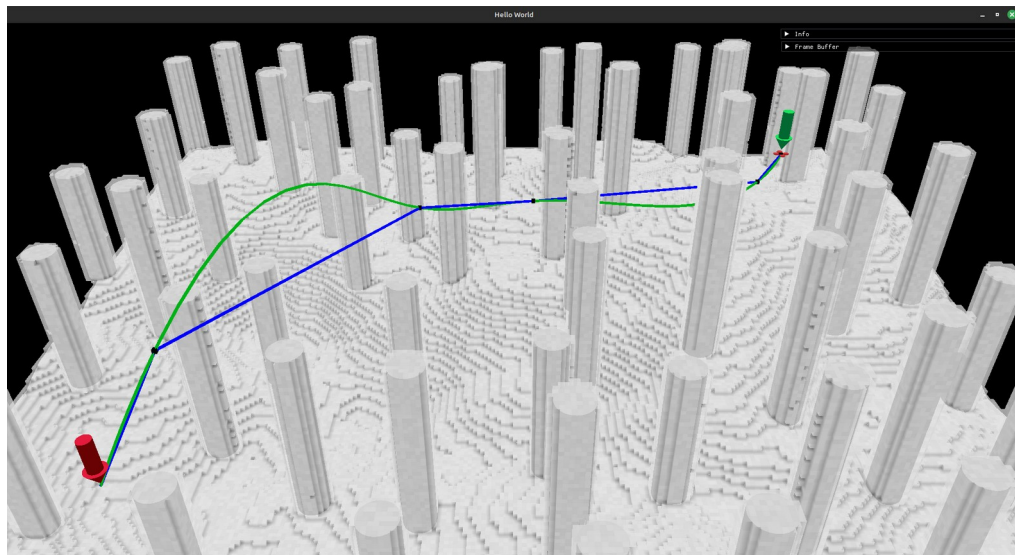
Metropolis Hastings Search for Locally Optimal Modes of Trajectories

Expert Policy



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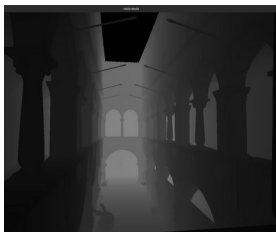
Metropolis Hastings Search for Locally Optimal Modes of Trajectories

-
-

Child Policy

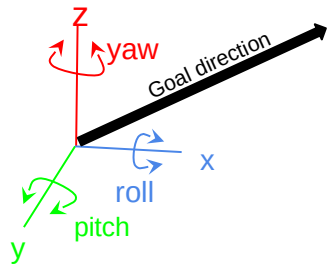
Input: Depth image, Drone Position, Orientation, Velocity, and Goal direction

Output: Collision-free trajectory waypoints

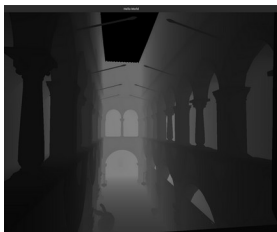


Depth Image

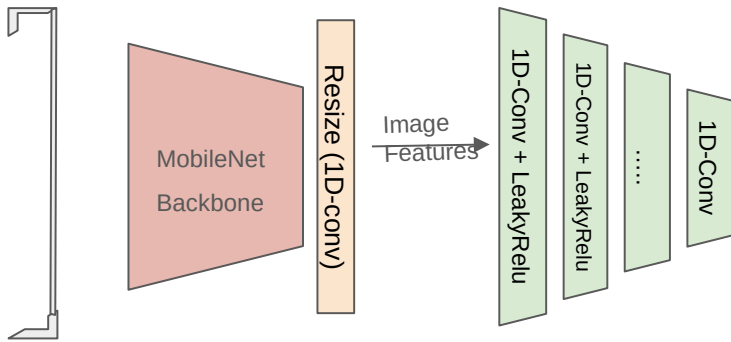
Child Policy



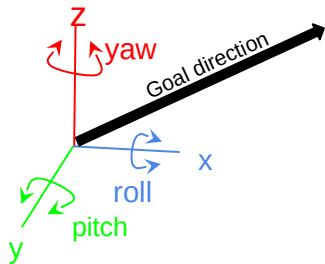
Velocity, orientation, and
goal direction



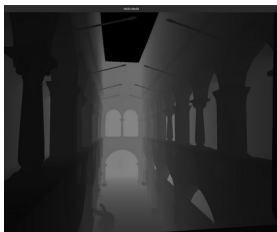
Depth Image



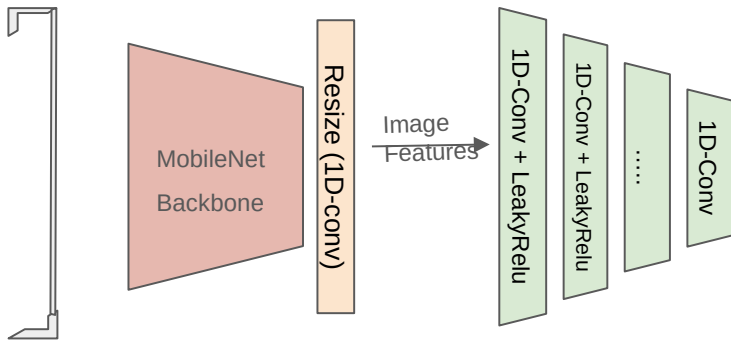
Child Policy



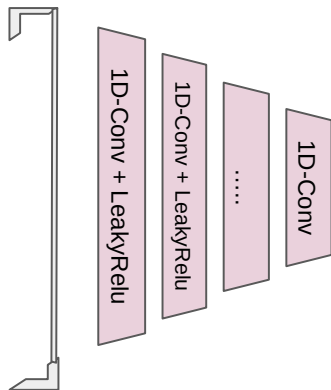
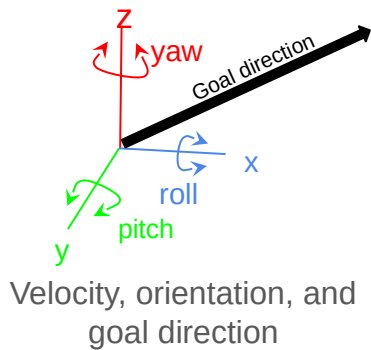
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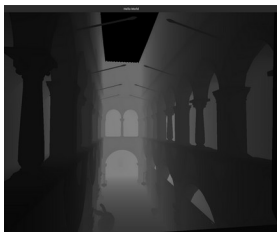


Depth Image

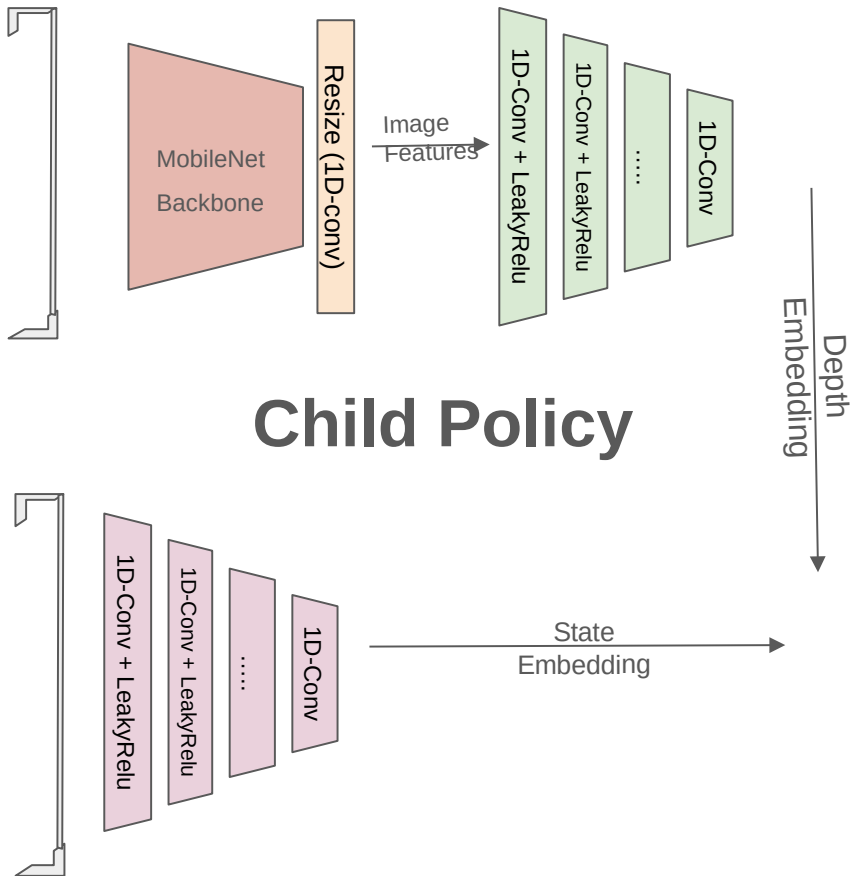
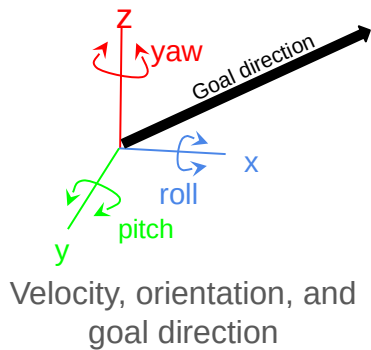


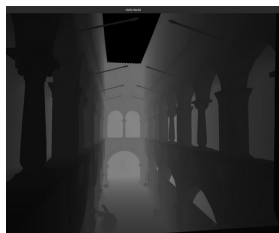
Child Policy



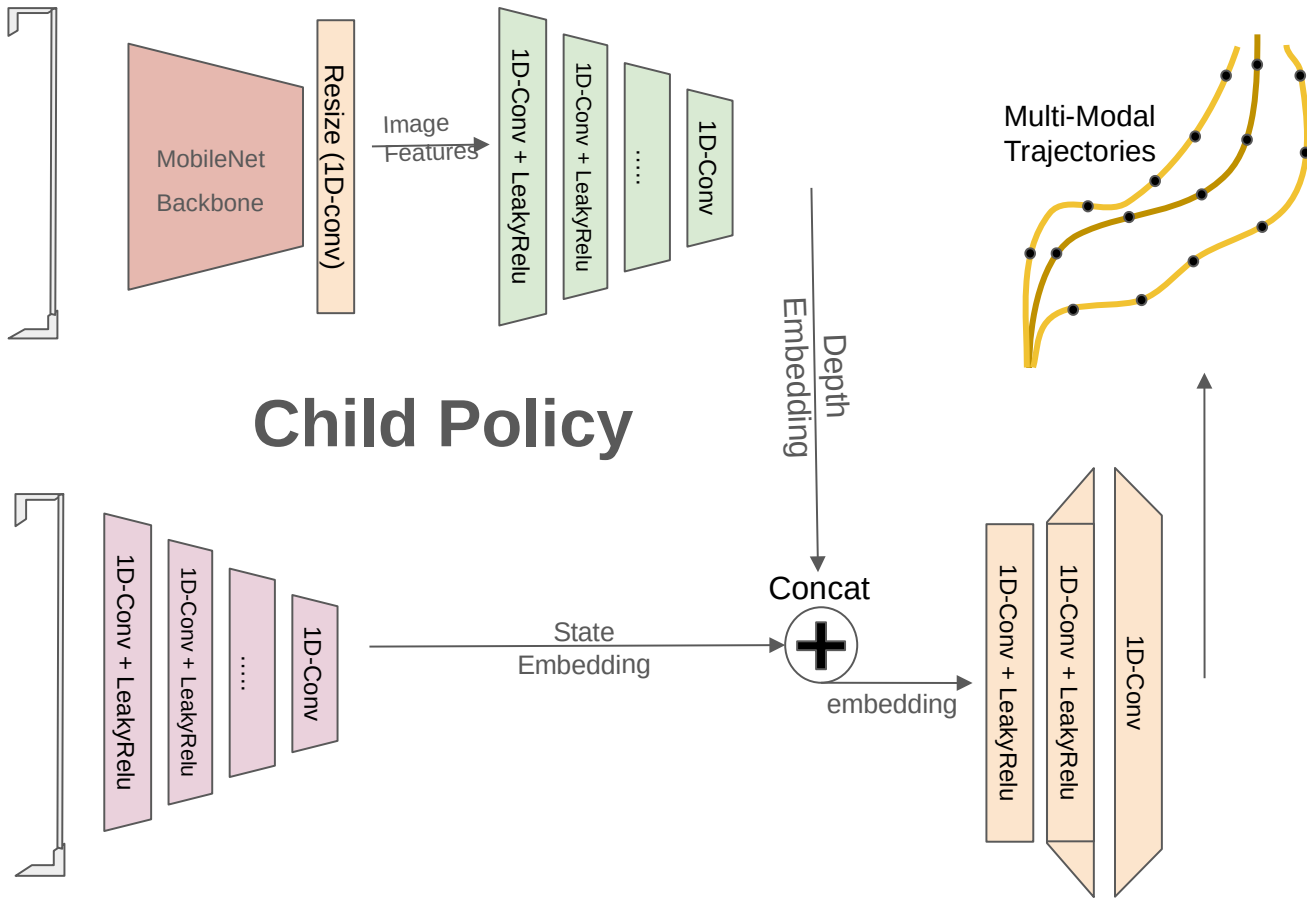
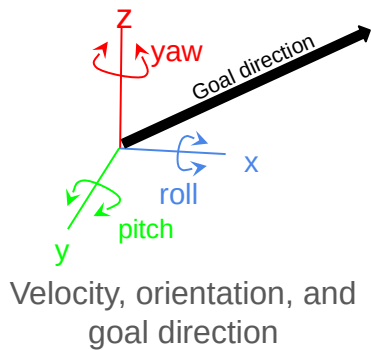


Depth Image





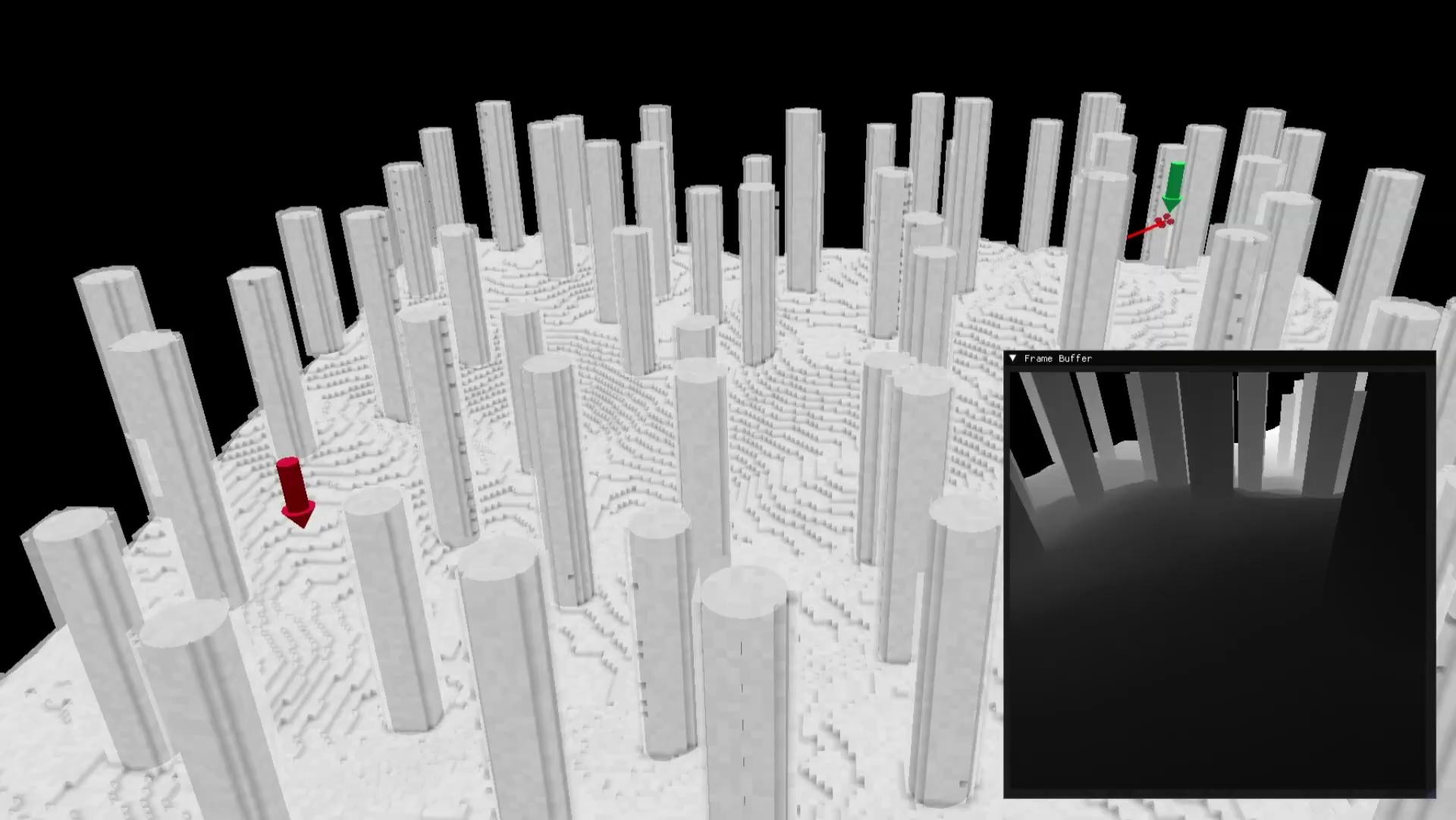
Depth Image





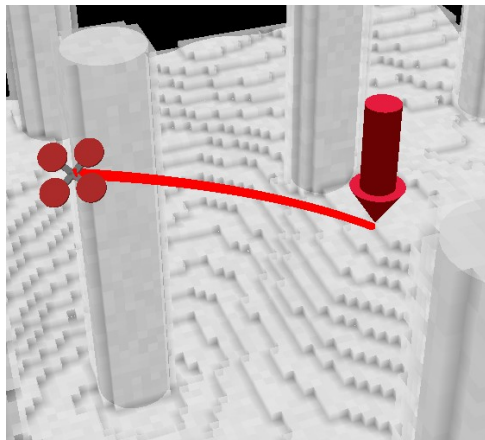
▼ Frame Buffer





Accomplished:

- Generated Environments
- Generated Depth Images
- Generated 3 Best Low Cost Trajectories
- Working on Student Policy
- Creating our Dataset



To do:

- Train the student policy on their dataset then ours

Future Work:

- Add Dynamic Obstacles to Training Environment

