



The Innovation Lab

Summer Internship 2022

Mentor-Intern Meeting 3 VAAYUBHOOMI

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Problem Statement



Networked robots for reconnaissance over open environments

- Localization of objects in known and unknown terrains
- Recon based network autonomous system
- USP: Communication between UAV and UGV
- Helps overcome disadvantage of either system

Proposed Approach



We intend to execute this project in two phases : Phase 1 is a simulation of the UAV and Phase 2 is an implementation of an autonomous system with the UGV.

- Phase 1 UAV - Patrol bot that works in a specified area
 - Detects specific targets while on predetermined patrol path
 - Hones in on the same with a freshly generated path
 - After target acquisition by the sensors, path planning occurs. Location saved as a node.
 - Simulation occurs in ROS + Gazebo
- Phase 2 UGV - Ground vehicle
 - Pose of the target acquired, path planned
 - Cameras and sensors integrated for autonomous capabilities
 - Potential Hardware aspects explored contingent on time

ROS

Overview and Problems Solved

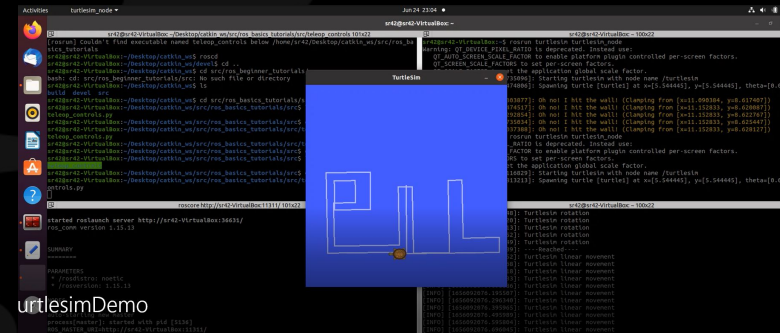
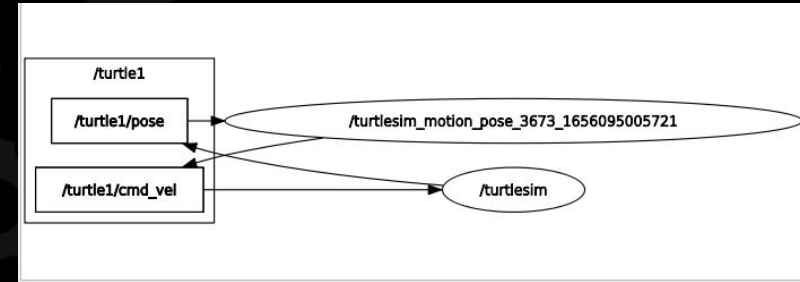


- Most surveillance systems depend on either a UAV or a UGV but few have combined the two in a robust manner
- We intend to use the UAV to surveil long range areas and get a lay of the land
- The UGV shall then proceed to enter the site of interest and carry out operations
- Our main use case is one of disaster management
- The UAV shall recon a collapsed structure for example, detect openings in the structure and perform pre set patrolling maneuvers and deploy obstacle avoidance to avoid debris
- Once adequate information is acquired, UGV(s) shall be deployed to the landing site
- The UGV's shall use algorithms like A^* and gmapping to plan a path and map the environment
- Using lasers and cameras, obstacle avoidance is deployed
- The UGV's enter the site of the disaster and fulfill mission requirements

Progress



- ROS Tutorial by Anis Koubaa on Udemy
 - Covers messages, topics, nodes, services, publishers and subscribers
 - Worked with Turtlesim as part of the course
 - Understood the framework of ROS and Catkin
 - Supplemented with an EdX course
- Compiled nodes to send messages from publisher to subscriber.
- Wrote publisher nodes and abstracted movement functions for turtlesim.
- Worked with the `rqt_graph` to understand conceptualisation of pub & sub
- Installed and set up our ROS packages and workspaces using the catkin build system.
- Took a course on Git version control and set up a repository for the project.



Progress

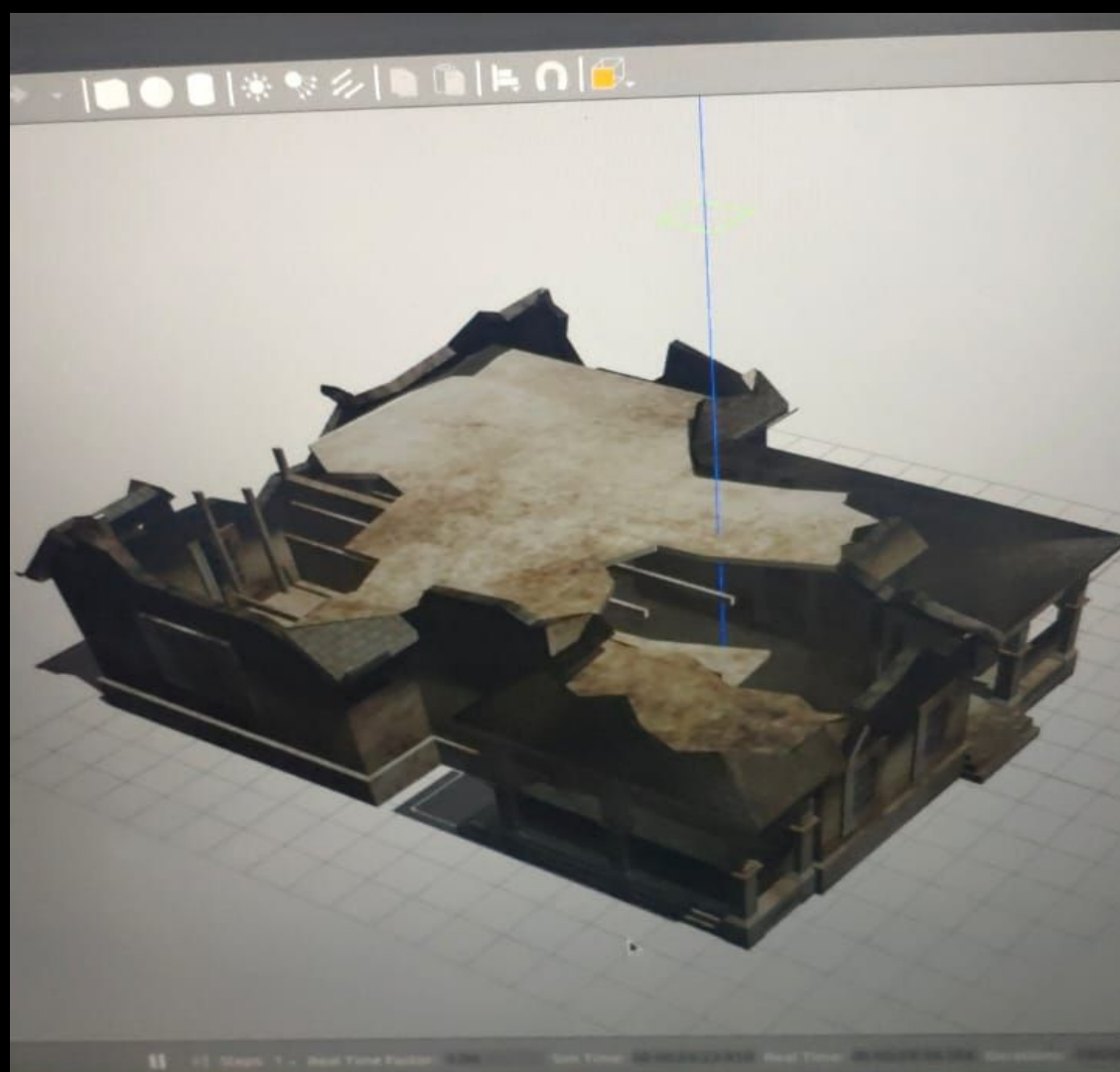


- Installed TurtleBot 3 and hector quadrotor packages and completed set up of the environment
- Built a P controller and improved it to create a PID controller for the turtlesim and TurtleBot 3
- Did multiple target traversal on the TurtleBot 3 using P and PID controller
- Camera and scan topics acquired
- Implemented Obstacle avoidance on the TurtleBot 3 and hector quadrotor
- Implemented teleop_keyboard control on the hector quadrotor
- Researched A* algorithm and developed a pseudocode for path planning
- OpenCV and CV bridge implemented

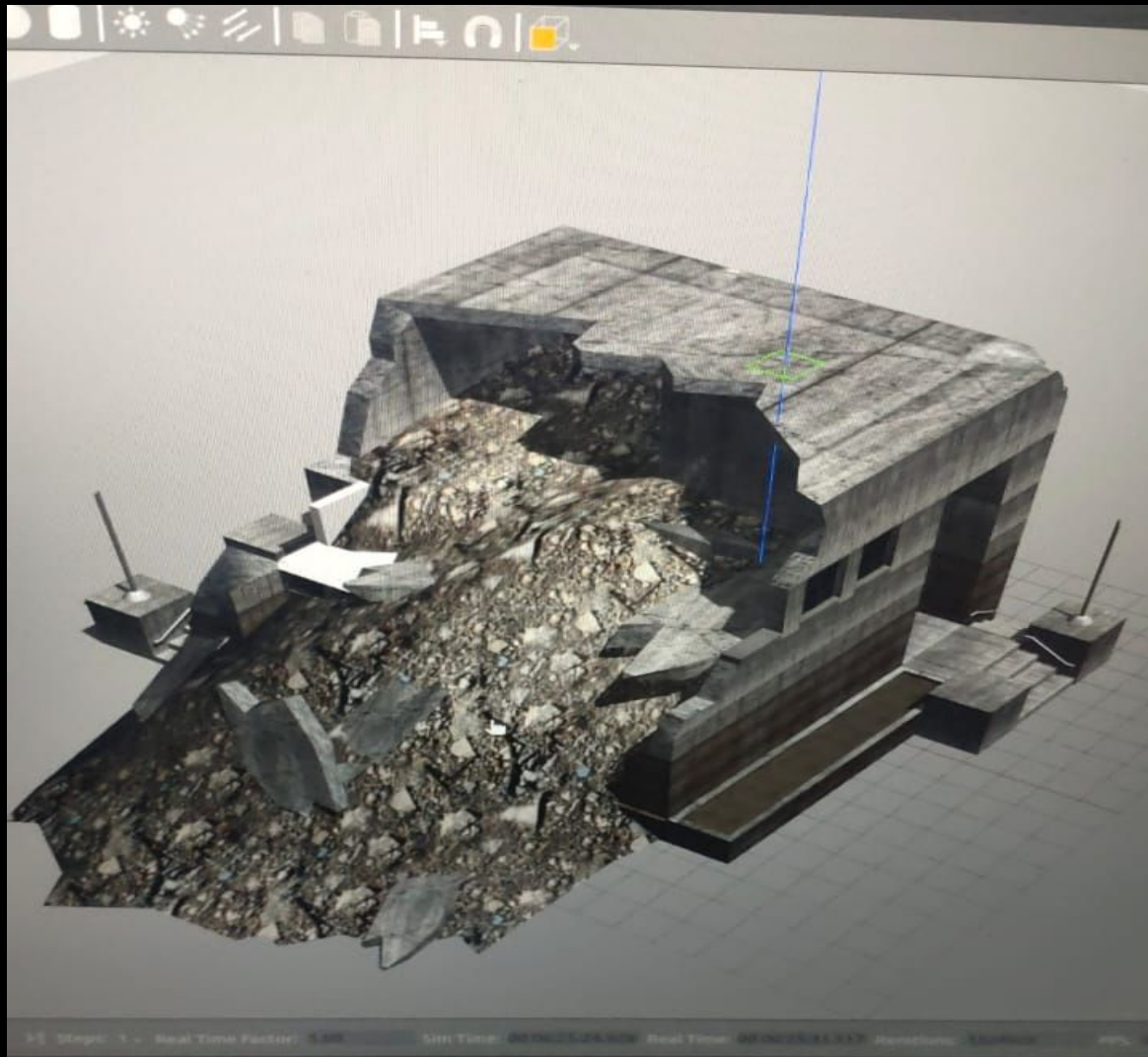
Roadmap

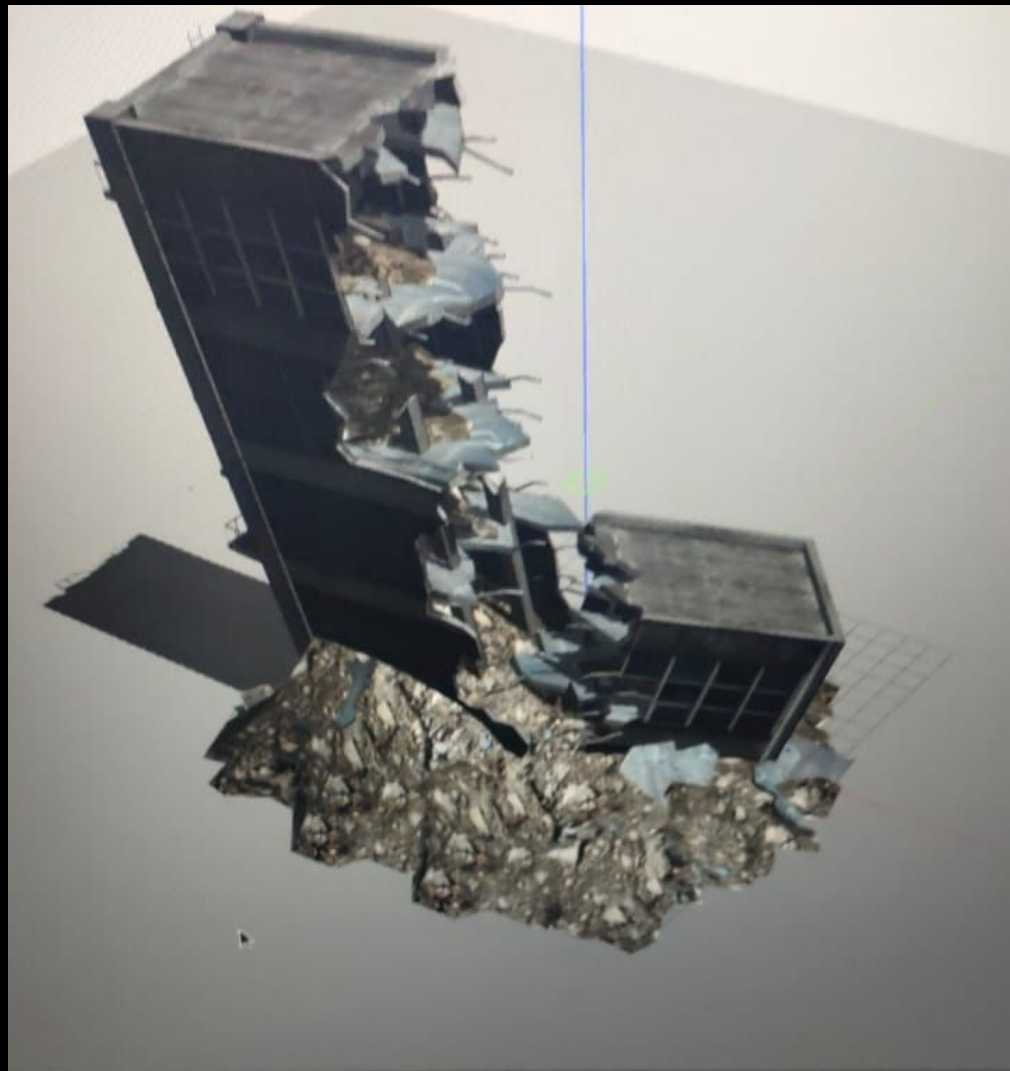


- Path planning algorithm to be implemented - A* is the most viable option
- Obstacle avoidance to be advanced from reversal to deviation
- UAV Orientation towards structure implementation
- Computer Vision for object detection to be implemented
- Integration of path planning, obstacle avoidance and vision
- Development of collapsed structure to aid accurate simulation
- UAV model modification to transport UGV
- UGV phase-2 implementation commencement
- Lidar scan and cameras in UGV - SLAM and gmapping, gmapping+AMCL provides a cost map, Dynamic A* uses the map to perform SLAM and path plan









Custom Message Communication between Nodes

```
pramuk@pramuk-IdeaPad:~$ rosrunc distance_msgs publisher.py
```

```
[INFO] [1656095580.911997]: Distance : 10  
[INFO] [1656095581.012401]: Distance : 10  
[INFO] [1656095581.112340]: Distance : 10  
[INFO] [1656095581.212401]: Distance : 10  
[INFO] [1656095581.312349]: Distance : 10  
[INFO] [1656095581.412341]: Distance : 10  
[INFO] [1656095581.512335]: Distance : 10  
[INFO] [1656095581.612326]: Distance : 10  
[INFO] [1656095581.712296]: Distance : 10  
[INFO] [1656095581.812451]: Distance : 10  
[INFO] [1656095581.912371]: Distance : 10  
[INFO] [1656095582.012360]: Distance : 10  
[INFO] [1656095582.112329]: Distance : 10  
[INFO] [1656095582.212304]: Distance : 10  
[INFO] [1656095582.312322]: Distance : 10  
[INFO] [1656095582.412350]: Distance : 10  
[INFO] [1656095582.512304]: Distance : 10
```

```
pramuk@pramuk-IdeaPad:~$ rosrunc distance_msgs subscriber.py
```

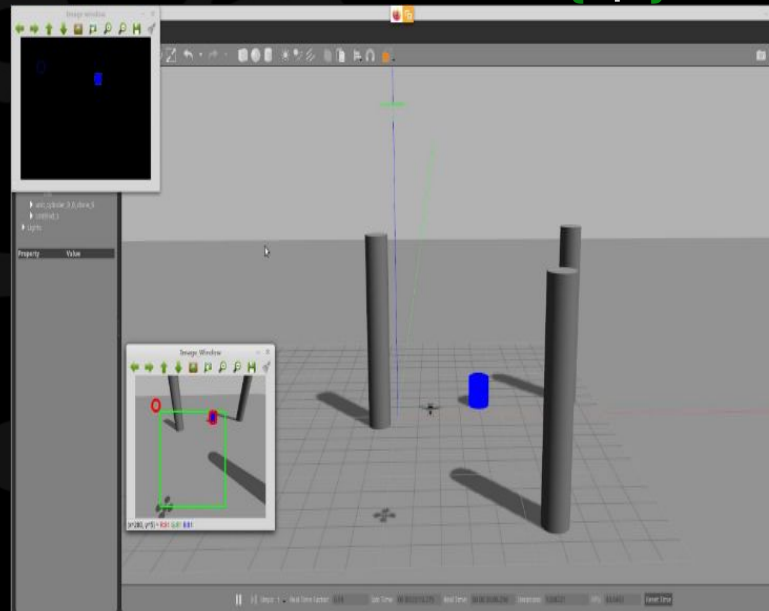
```
[INFO] [1656095580.915812]: I heard 10.0 from HC-05  
[INFO] [1656095581.016681]: I heard 10.0 from HC-05  
[INFO] [1656095581.116471]: I heard 10.0 from HC-05  
[INFO] [1656095581.217452]: I heard 10.0 from HC-05  
[INFO] [1656095581.317312]: I heard 10.0 from HC-05  
[INFO] [1656095581.417207]: I heard 10.0 from HC-05  
[INFO] [1656095581.517016]: I heard 10.0 from HC-05  
[INFO] [1656095581.616882]: I heard 10.0 from HC-05  
[INFO] [1656095581.716265]: I heard 10.0 from HC-05  
[INFO] [1656095581.816806]: I heard 10.0 from HC-05  
[INFO] [1656095581.916832]: I heard 10.0 from HC-05  
[INFO] [1656095582.016620]: I heard 10.0 from HC-05  
[INFO] [1656095582.116766]: I heard 10.0 from HC-05  
[INFO] [1656095582.216580]: I heard 10.0 from HC-05  
[INFO] [1656095582.316743]: I heard 10.0 from HC-05  
[INFO] [1656095582.417112]: I heard 10.0 from HC-05  
[INFO] [1656095582.516996]: I heard 10.0 from HC-05
```

```
sensor_msgs/Range dist  
int32 mno  
string mname
```

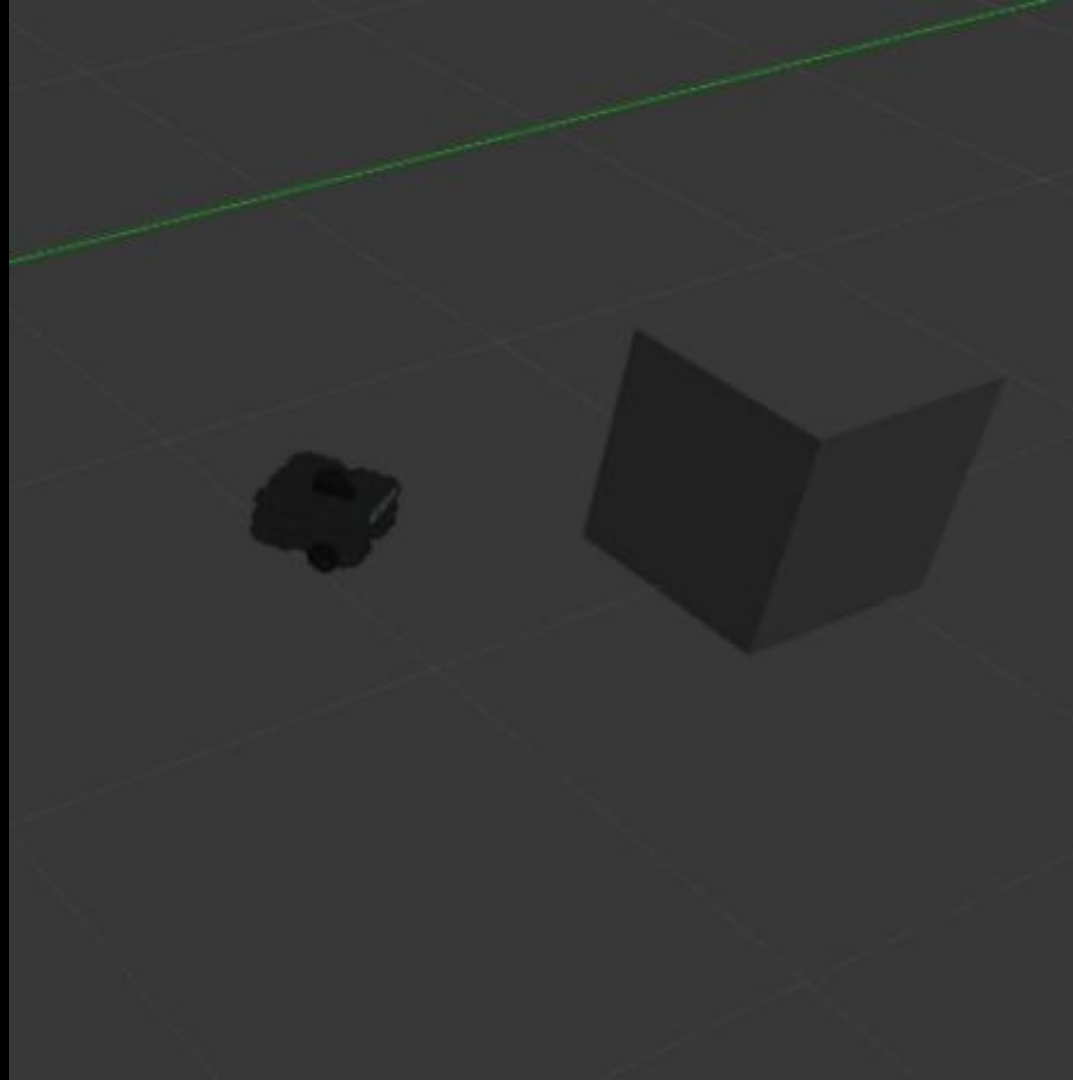
Plan for the next 2 weeks

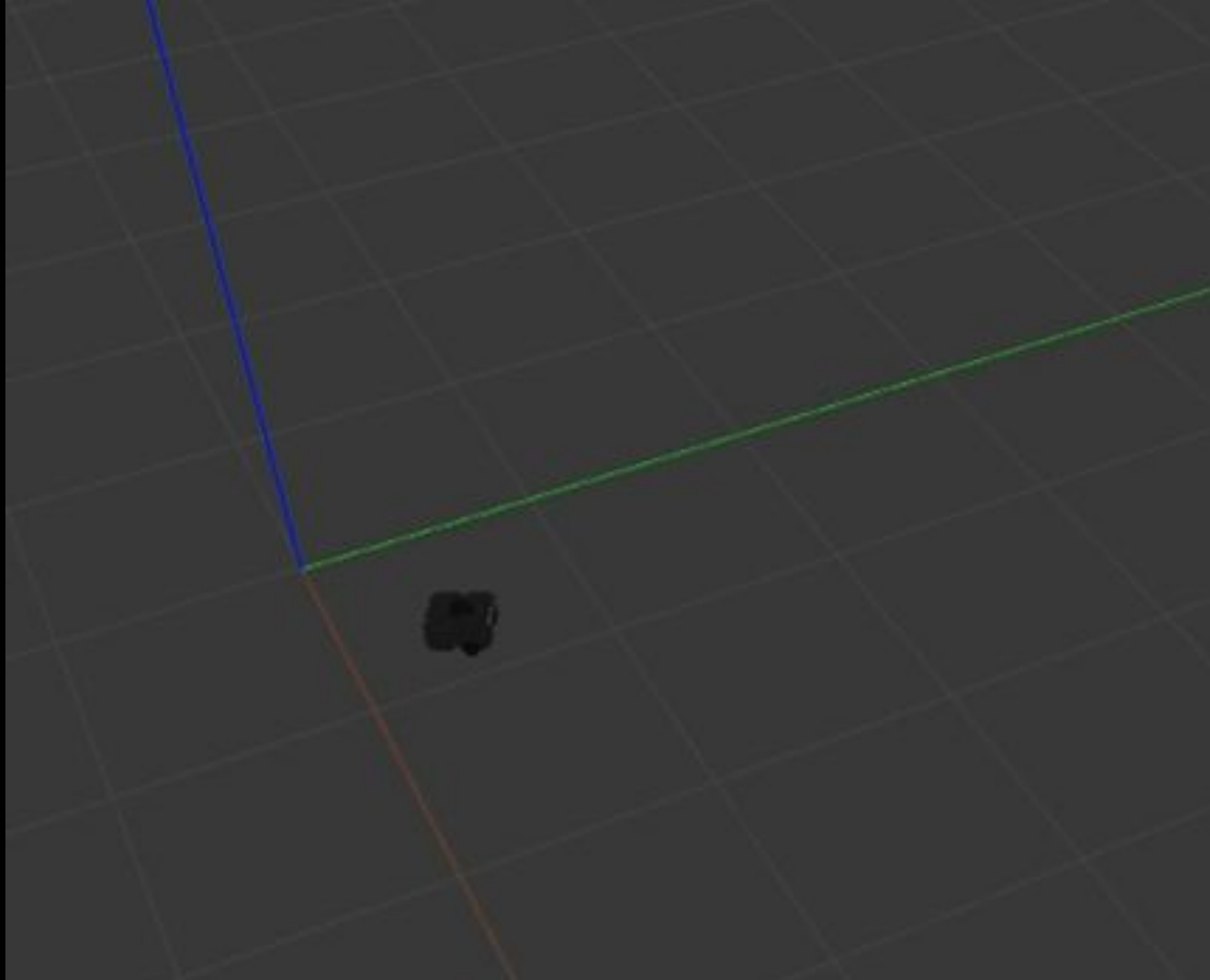


- Hector Quadrotor package
- UAV completion - integration of path planning, patrolling, obstacle avoidance and vision
- Testing of UAV in the simulated environment
- UGV commencement
- Begin work on TurtleBot 3
- Implementation of A*, SLAM, path planning, obstacle avoidance and vision
- Mechanics of UGV transport on UAV
- Creation of collapsed structure in gazebo











Thank You