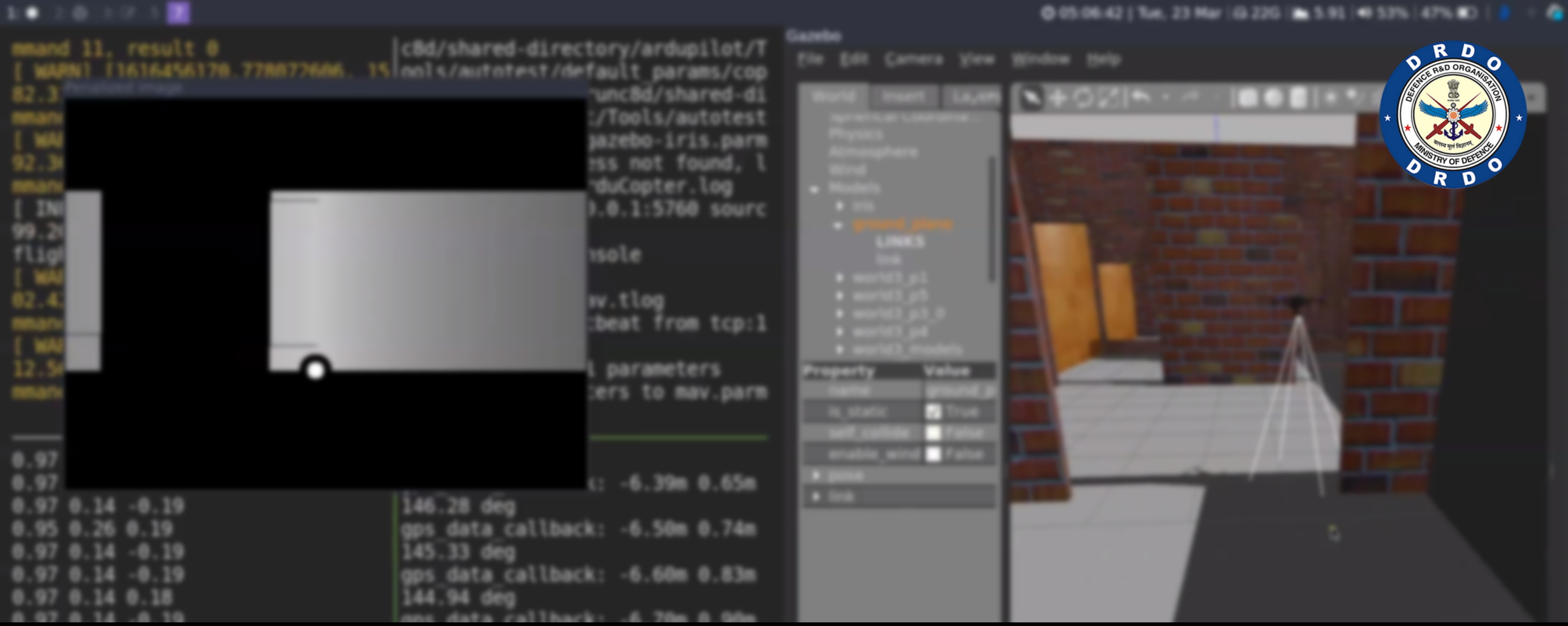
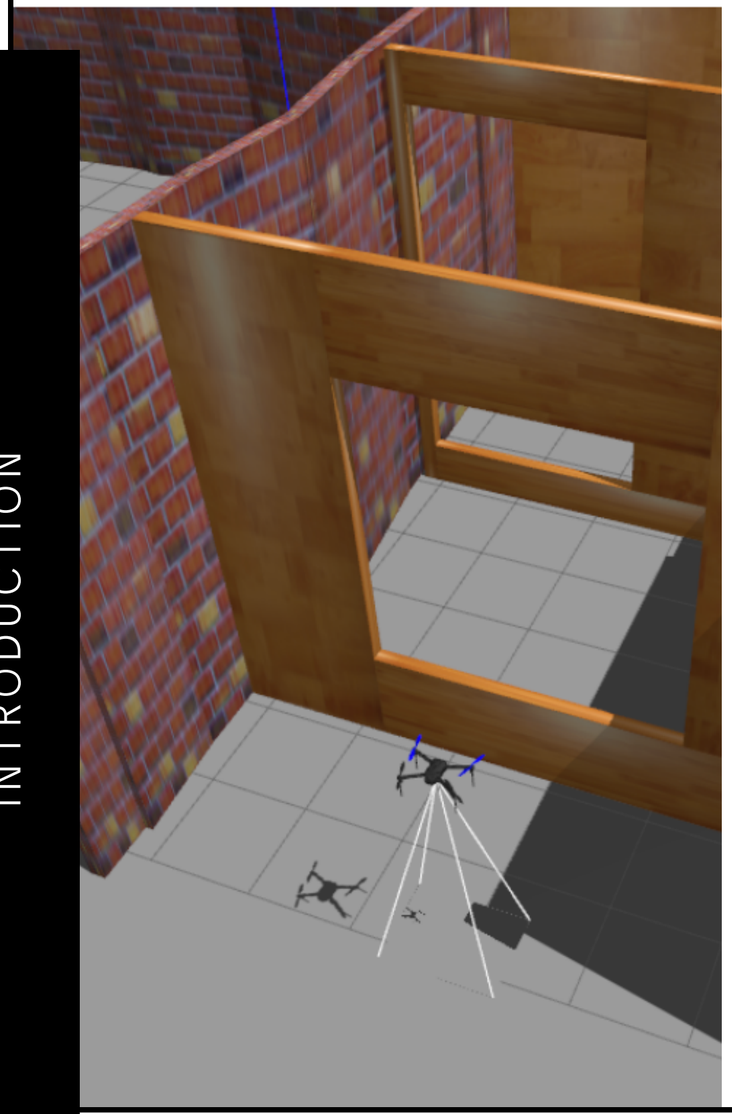


DRDO DRGE'S

VISION BASED OBSTACLE AVOIDANCE DRONE

9.0

INTRODUCTION



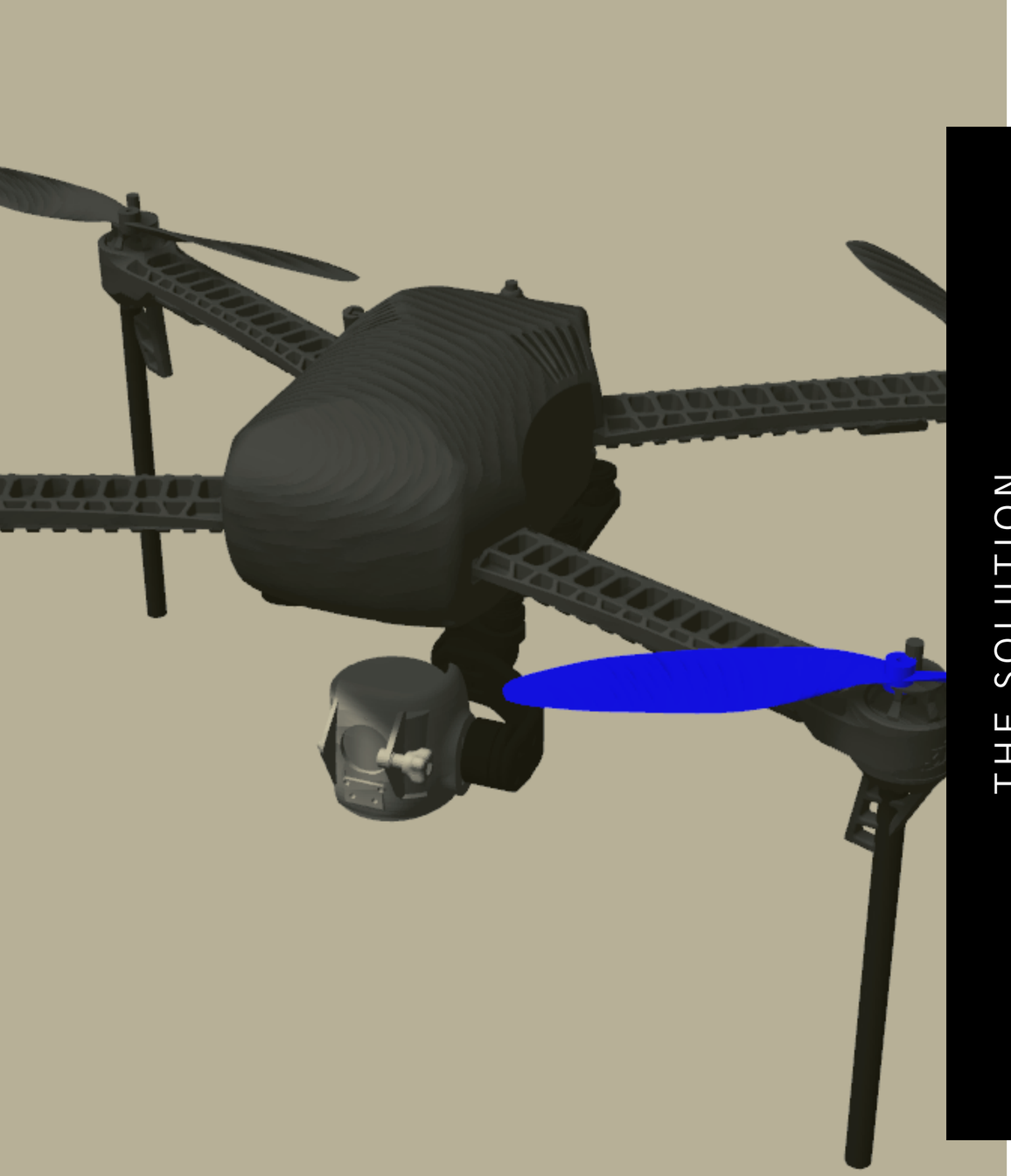
PROBLEM STATEMENT

The objective is to design an autonomous drone that navigates in a static environment by avoiding collisions with any obstacles and reaching the target destination after its correct detection.

IMPACT ON HUMAN LIVELIHOOD

SIGNIFICANCE

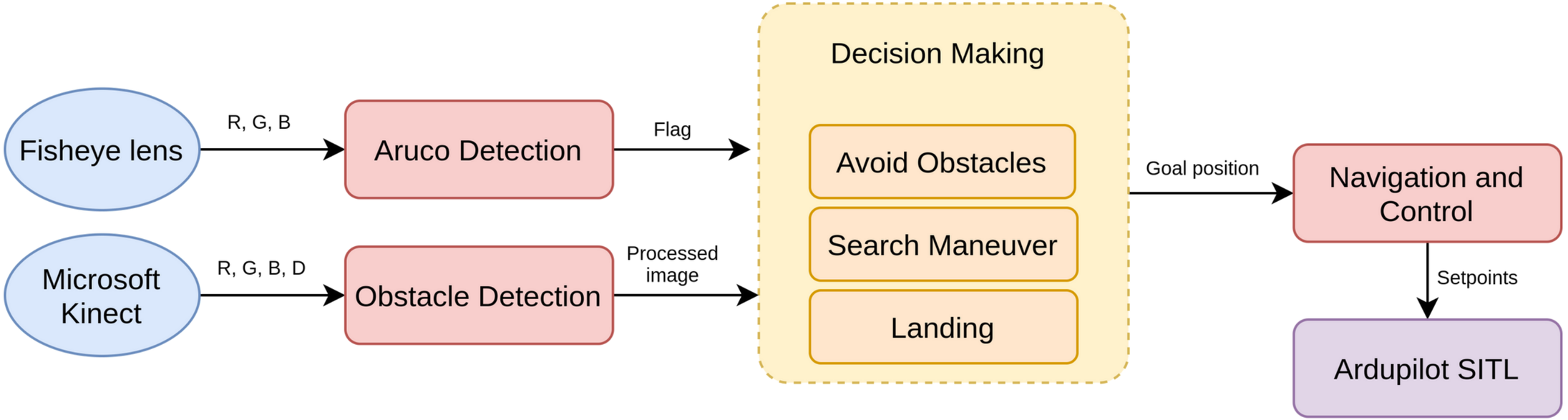
- Search operations after floods or earthquakes
- Fast response in disaster management
- Underground mine survey
- Security and surveillance
- Indoor warehouse management



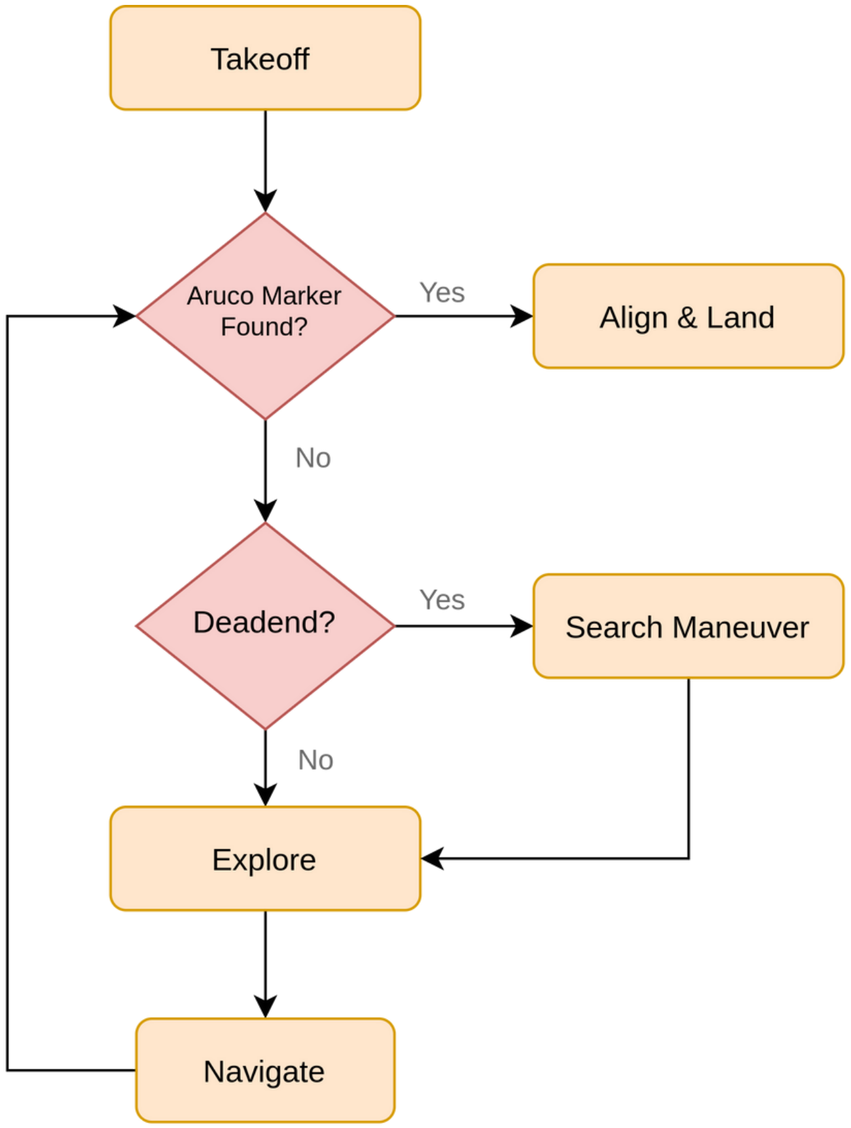
THE SOLUTION

OUR APPROACH

ALGORITHM DESIGN



ARCHITECTURE



ALGORITHMS

DECISION MAKING

Identify the best direction using loss-based approach

Losses for:

- Proximity to obstacle edge
- Deviation in altitude of drone
- Vertical and Horizontal Veering

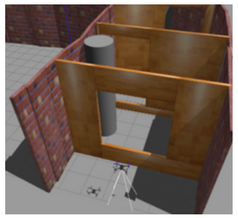
At dead-ends, perform yaw sweep maneuvers at different altitudes

LEVEL 1

GREEDY EXPLORATION

LAYERS OF INTELLIGENCE

EXPLORATION PIPELINE



3D world
World in which drone is rendered

>>

Raw Depth Image
Depth Image from Gazebo

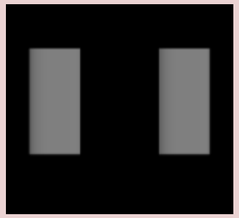
>>

Cleaning NaN values
Substitution with maximum intensity and depth normalizing

>>

Sky and Ground Mask
Masking elevation greater than 4.5m and less than 0.5m

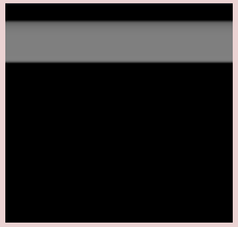
BUTTERWORTH FILTER



Left Vertical Edges

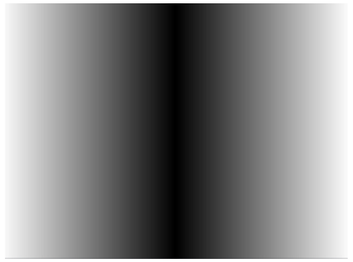
Right Vertical Edges

Bottom Horizontal Edges



Top Horizontal Edges

IMAGE FILTERS

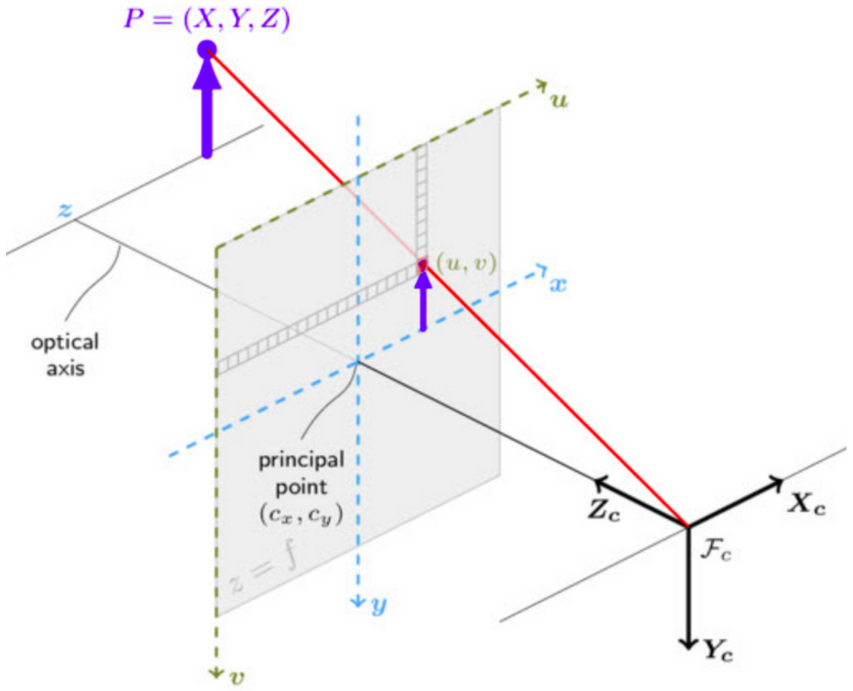


Horizontal Veering Penalty

Vertical Veering Penalty

Keeps the drone centered for stability purposes

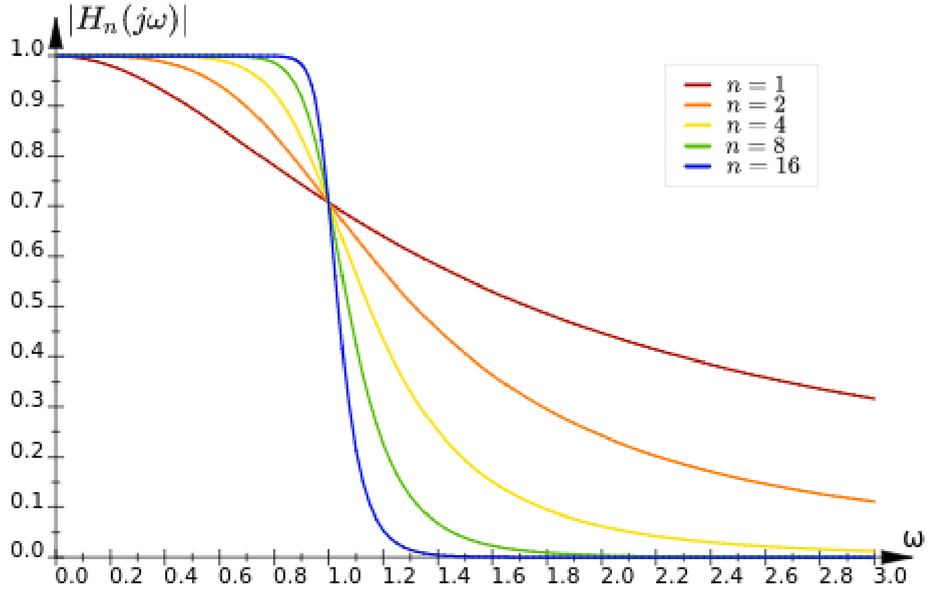
PROJECTIVE GEOMETRY



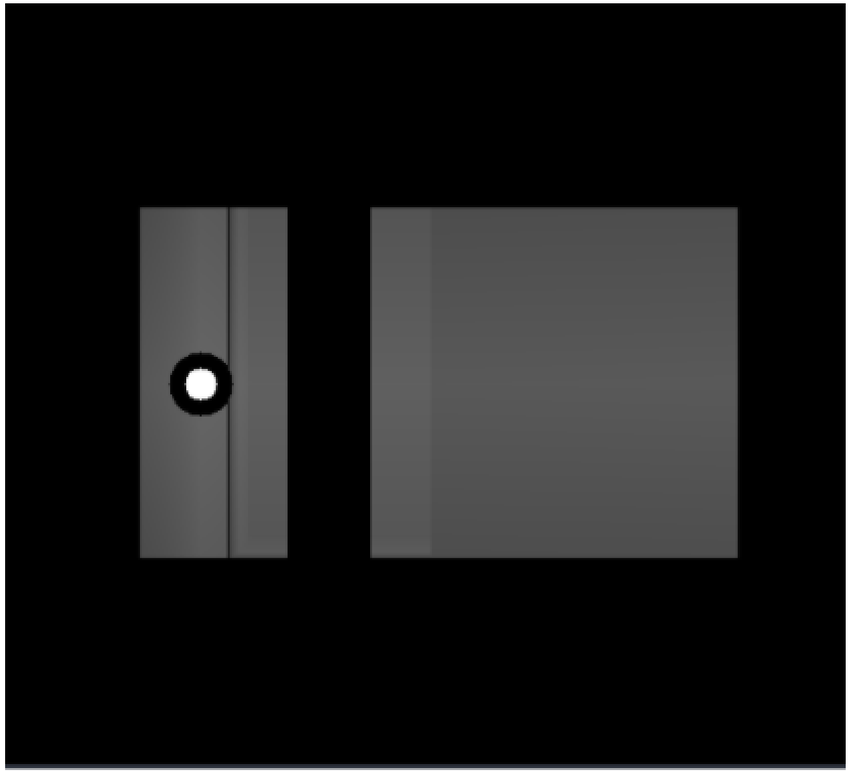
We use projective geometry to arrive at notional x,y,z values for out of range sensor data in the PointCloud feed

BUTTERWORTH FILTER

The Butterworth Filter's tunable diminishing nature makes it especially useful to vision-based obstacle avoidance

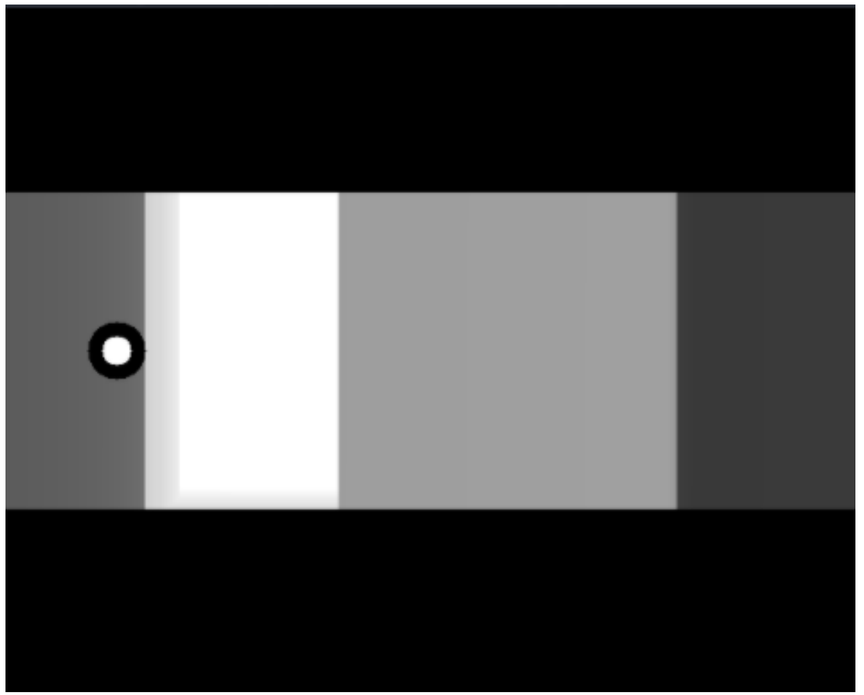


FINAL OUTPUT



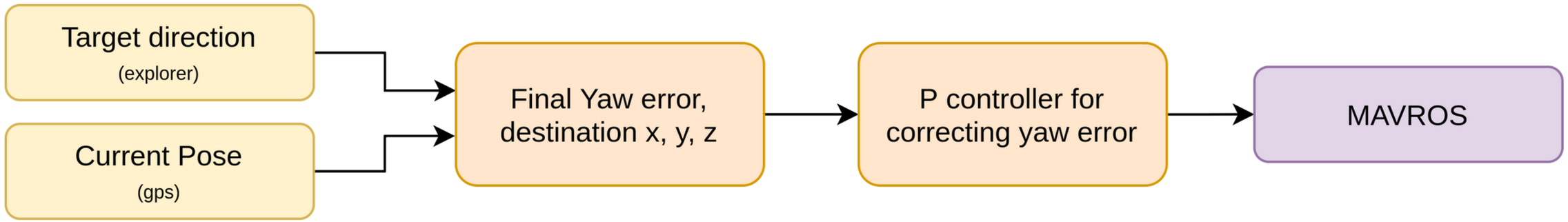
Cascade of penalties image
with target direction
marked in white circle

Target direction overlayed on
cleaned depth image

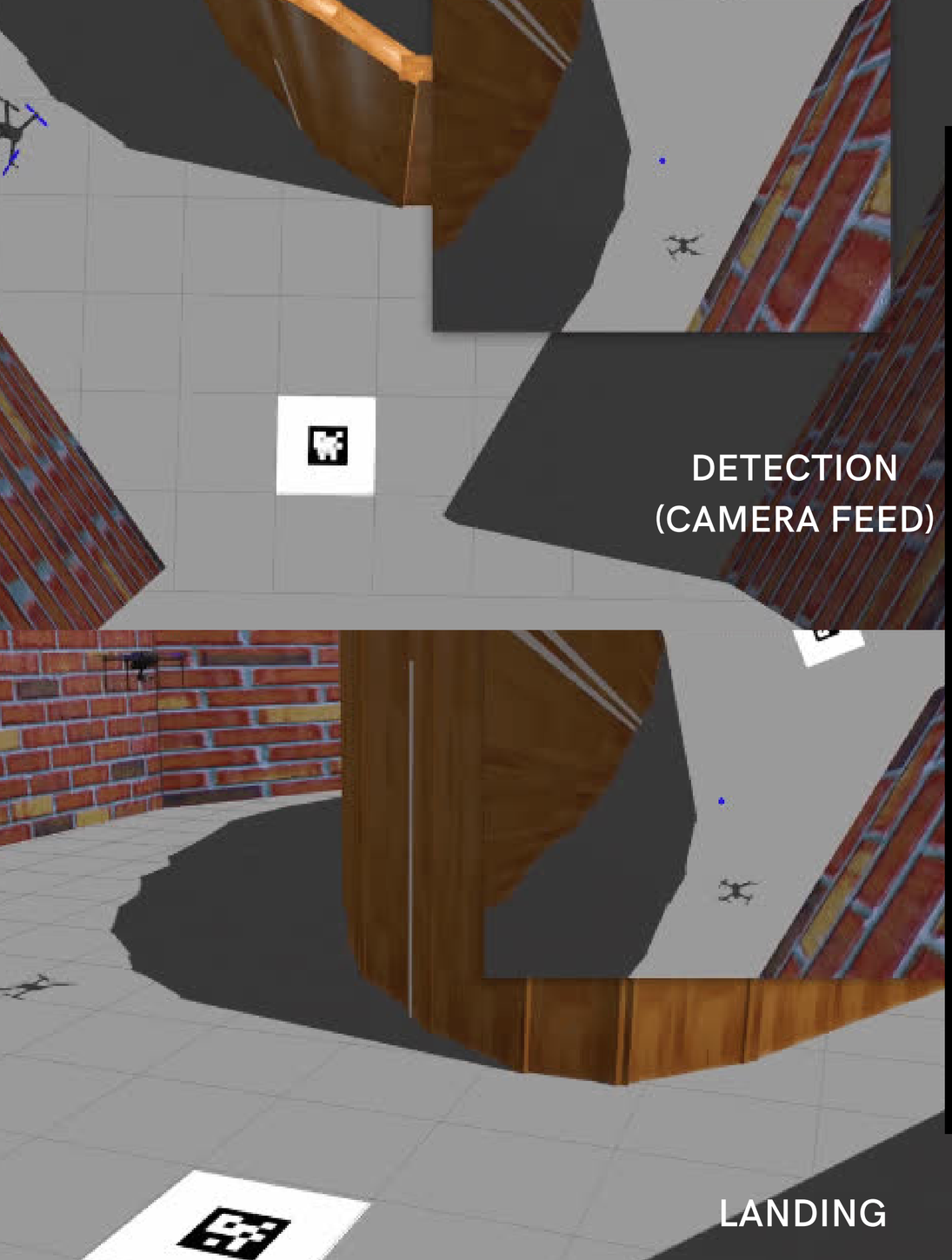


OVERLAYED OUTPUT

- Receives target vector direction
- PI controller used for yaw correction
- PoseStamped message used to translate in x,y,z

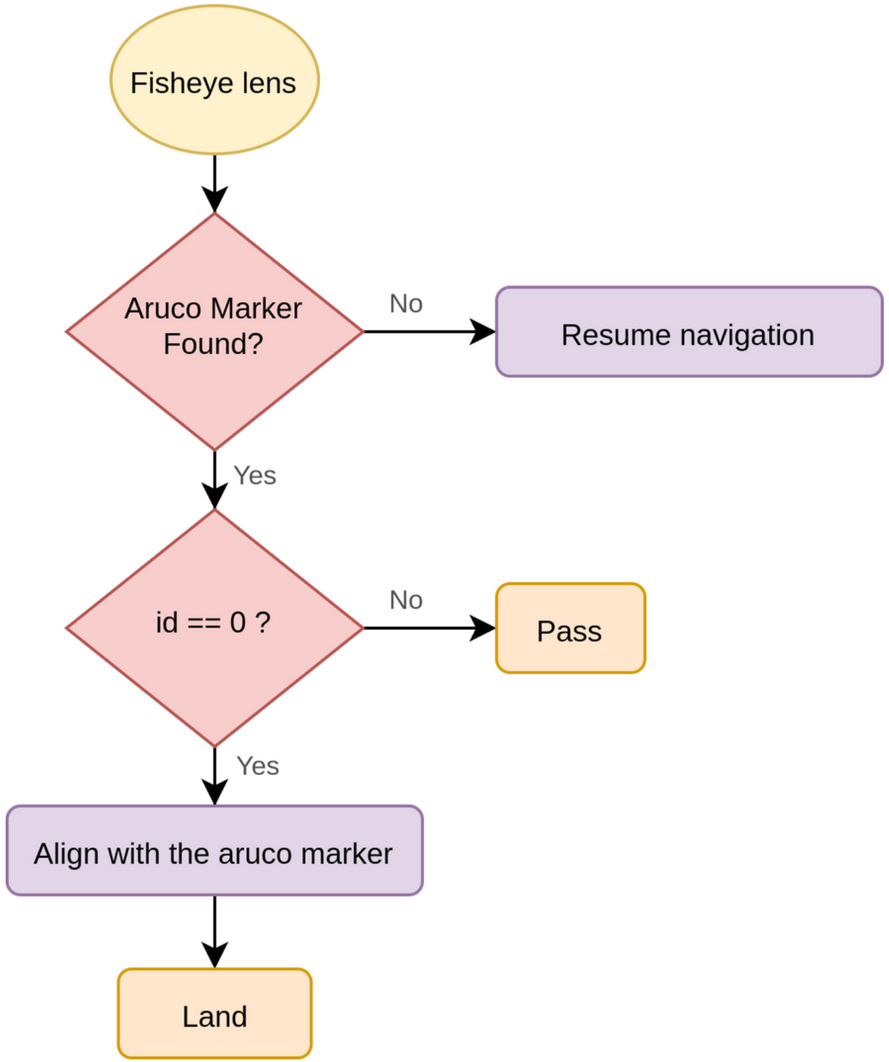


NAVIGATOR NODE



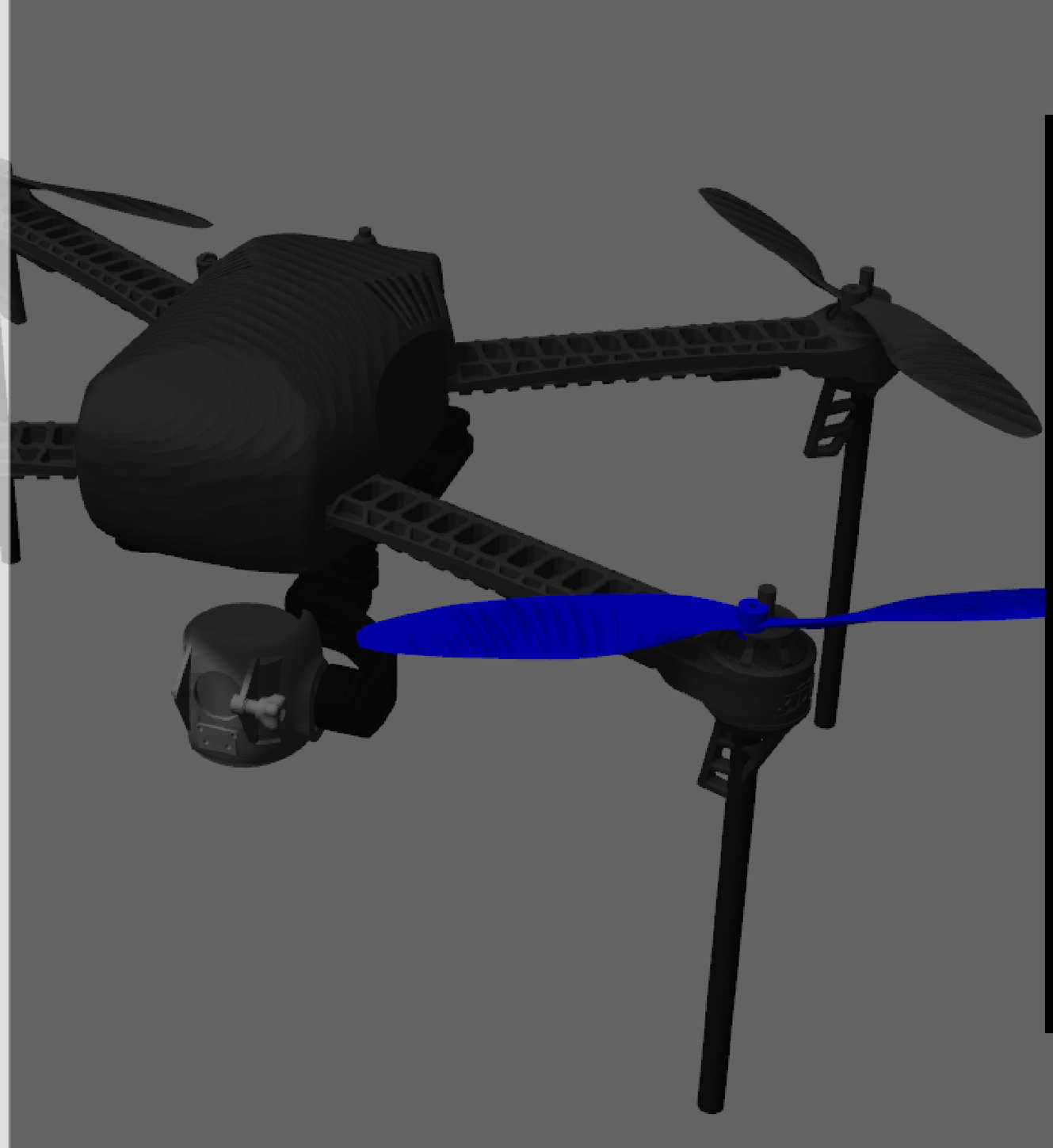
ALGORITHMS

LANDING



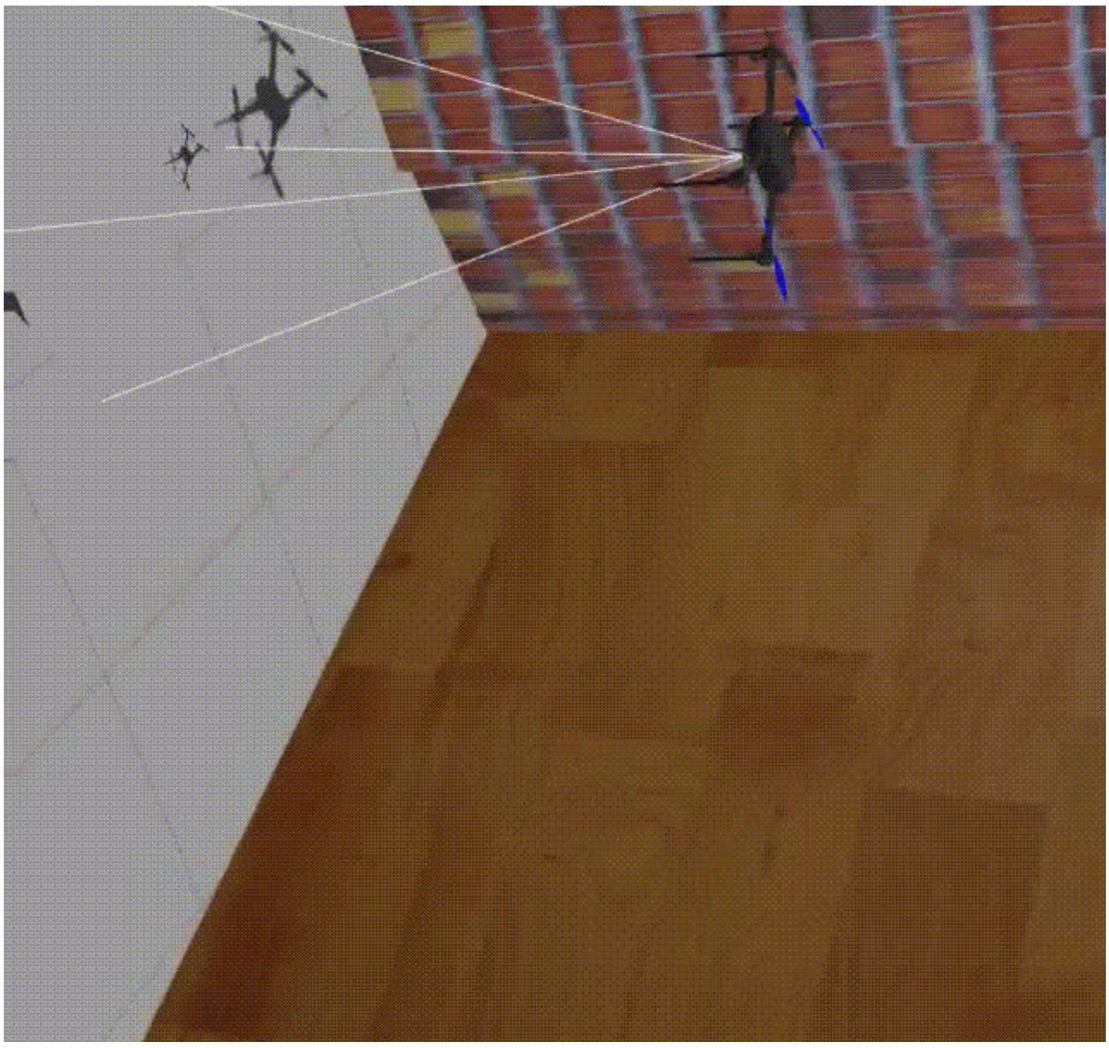
LEVEL 2

SCAN AND SURVEY

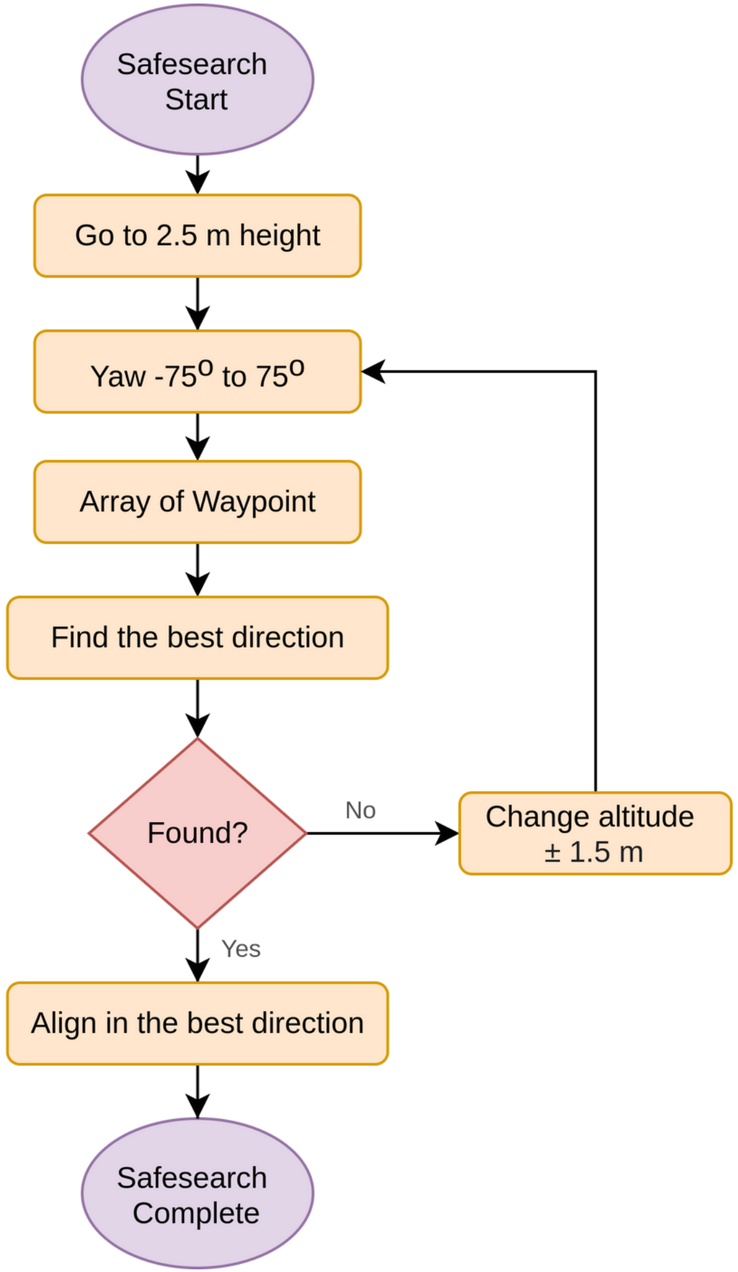


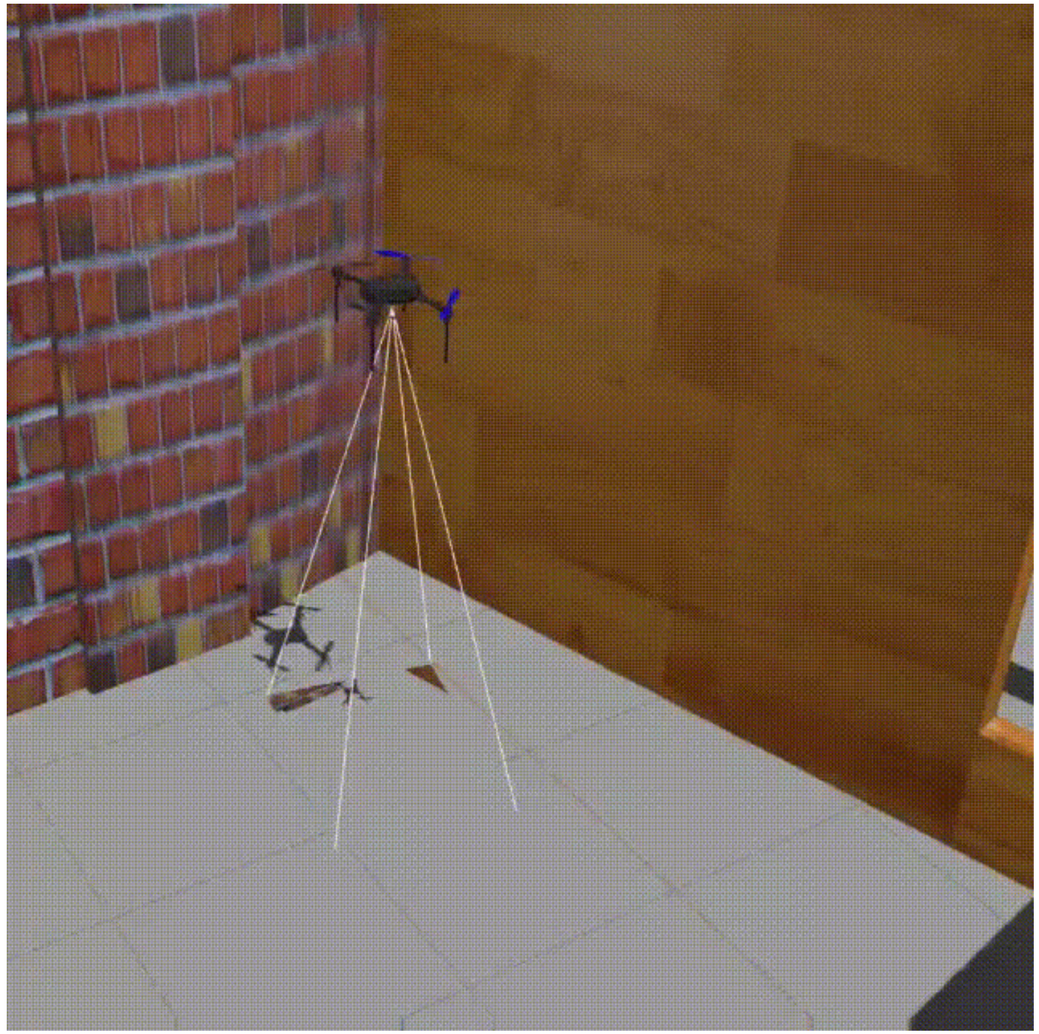
LAYERS OF INTELLIGENCE

SURVEY PIPELINE PROBLEM



SURVEY PIPELINE SOLUTION



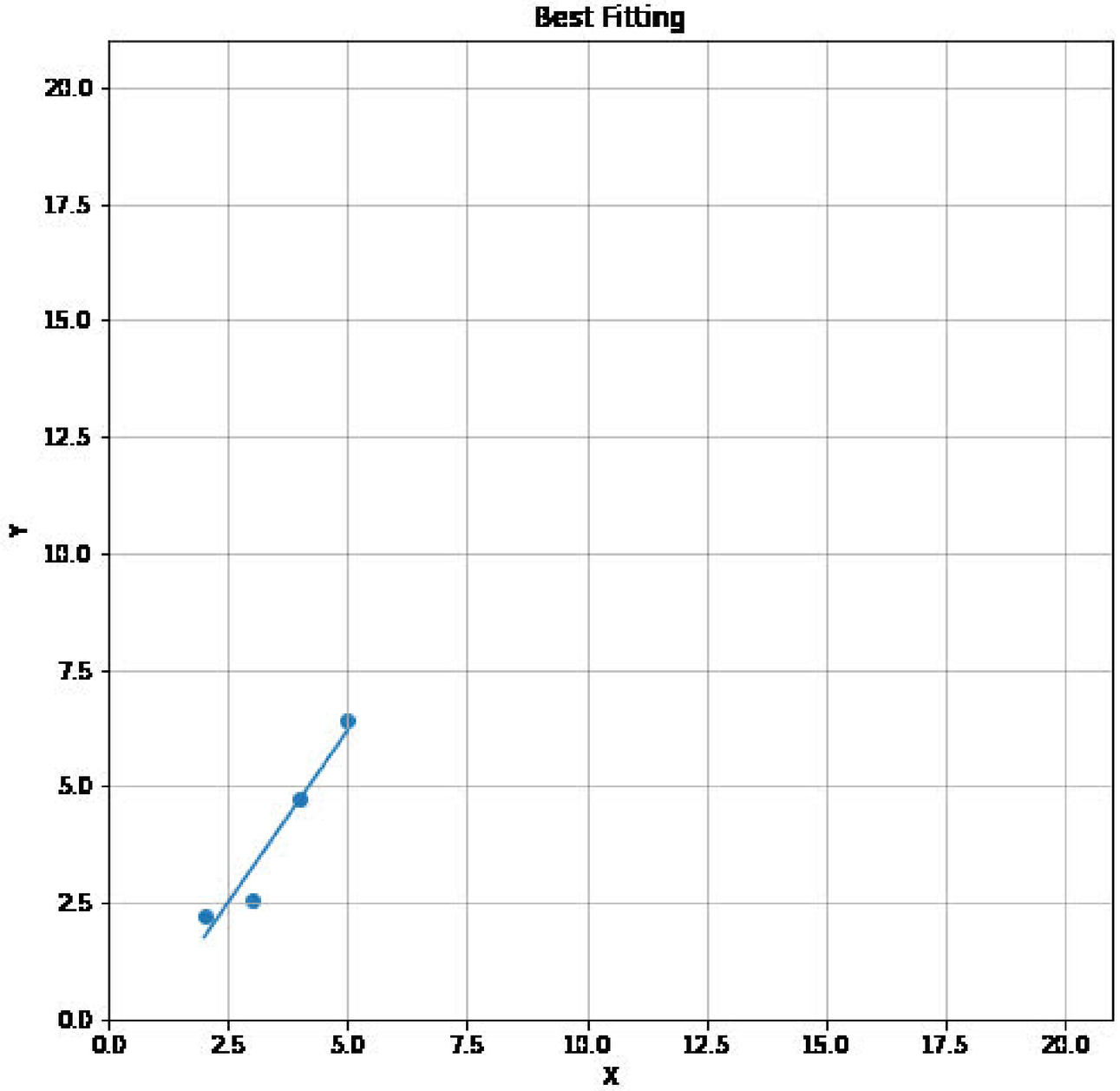


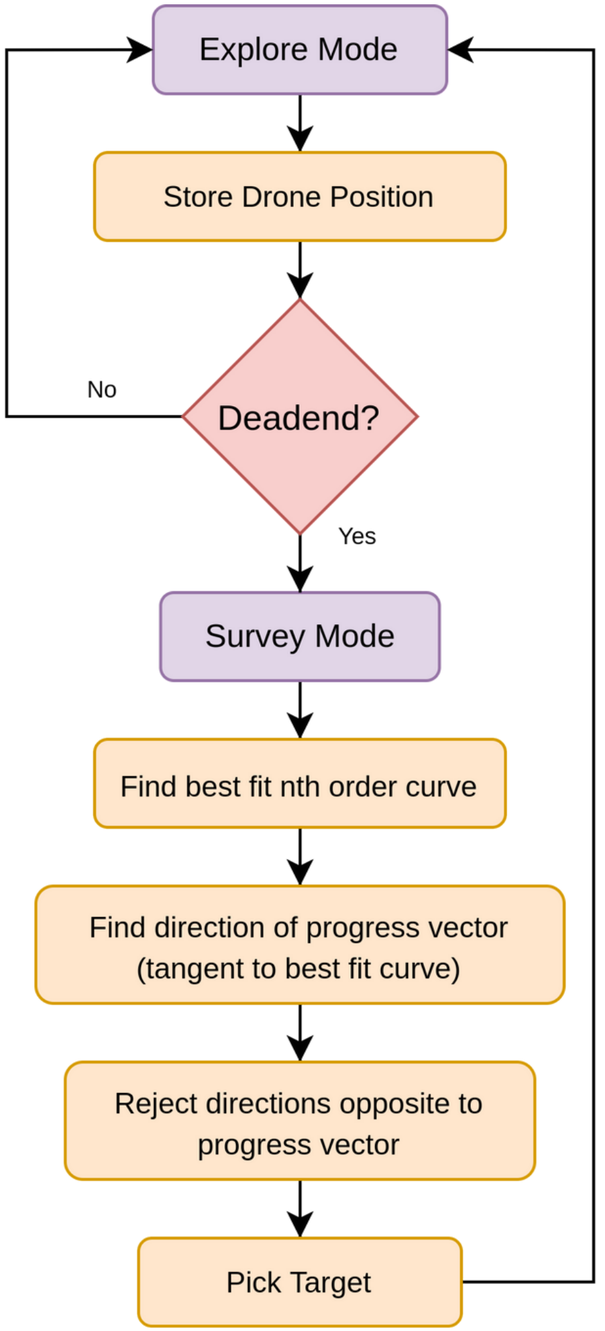
LEVEL 3

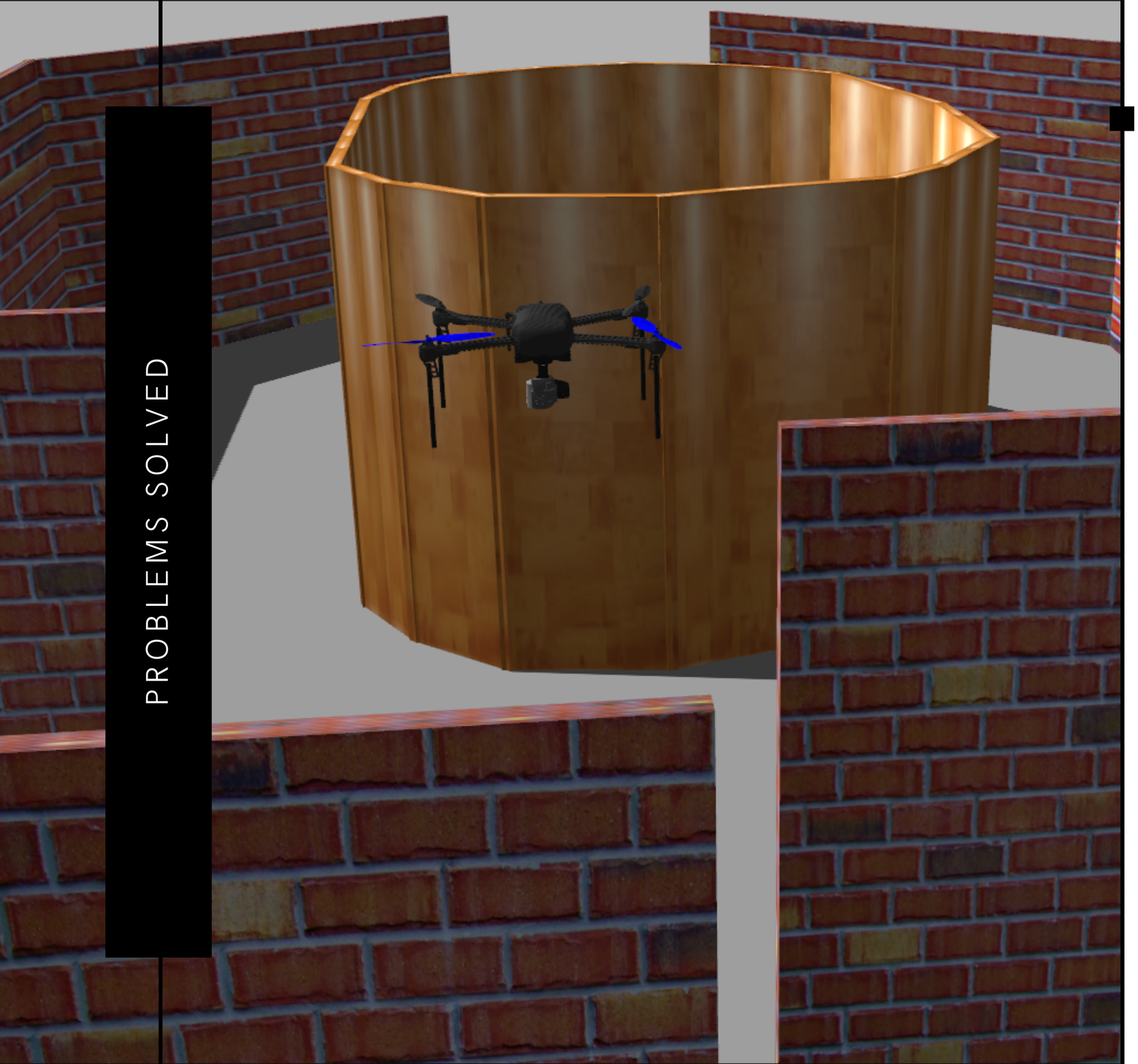
SENSE OF PROGRESS VECTORS

LAYERS OF INTELLIGENCE

SENSE OF PROGRESS VECTORS







PROBLEMS SOLVED

NAN VALUES IN DEPTH IMAGE

- Imaginary wall at pointcloudCutoffMax
- Converted NaN to maximum depth

NAN VALUES IN POINTCLOUD

- Use depth image
- Identify 3D coordinates using projective geometry

FUTURE WORK

FURTHER IMPROVEMENTS

Fuse feed from downward-facing RGB Fishlens camera for danger trigger. The drone is **no longer blind-sided** from the left and right.

Tune the navigator's PID values to achieve smoother motion towards the changing target. This would help **stabilize** the motion of the drone in the roll direction when it finds two disparate optimal directions.

Backtrack and scout a wide-angle in order to identify and work around any **overhanging obstacles** while simultaneously looking for better directions

THANK YOU