Assignment Question 2: Perform ROS + Gazebo Simulation

Scenario

This project simulates a drone (UAV) working in a war environment to detect and track a large ground vehicle (Tank) using computer vision techniques. The drone operates within a ROS + Gazebo simulation environment and performs a complete workflow: detect → approach → hit the target.

Objective

The main objective is to use computer vision and tracking to control the drone's actions automatically:

- The drone starts and takes off to an altitude of 10 meters.
- It searches for a Tank within its field of view.
- Once the target is detected, the drone descends and approaches the tank.
- When it reaches near the target, it performs a hit action (simulation of attack).

Additionally, the system is designed to handle:

- Temporary loss of visual contact when the object goes out of frame.
- Re-identification of the same object if multiple similar targets are present.

Workflow

1. Takeoff:
The drone initializes in the simulation and takes off to 10 meters altitude using ROS flight control commands.

2. Object Detection:
A pre-trained YOLO-based model or OpenCV object detection algorithm identifies the tank in the video feed.
The bounding box and confidence level help determine the object's position.

3. Object Tracking:

Once the target is detected, a tracking algorithm (e.g., SORT or CSRT) keeps following it frame by frame.

4. Trajectory Planning:

Based on the target's location in the frame, the drone adjusts its flight path:

- If the tank is centered → maintain direction.
- If the tank moves left/right → adjust yaw.
- If the tank moves closer/farther → control pitch and altitude.

5. Target Approach:

The drone continuously updates its movement trajectory based on the target's position until it comes within a proximity of 1 meter.

6. Hit Event:

When the distance between the drone and the tank becomes very small, the system logs a "HIT EVENT" to indicate the successful completion of the mission.

Trajectory Discussion

The trajectory of the drone is adaptive:

- The drone moves forward and downward in a straight line when the tank is clearly visible.
- If the tank temporarily disappears from view, the drone hovers and performs a small circular search pattern.
- Once the tank is re-identified, it realigns and continues its descent.
- The approach follows a smooth curved path rather than a direct vertical drop, ensuring stable flight.

Simulation Output

When the simulation is executed using:

python main.py

You can observe logs like:

[23] HIT EVENT: drone reached target proximity (dist=0.57 m)

Demo saved to outputs\demo_q2.mp4

Tracker log (recent):

('init', 1)

('del', 1)

('init', 2)

This output confirms that:

- The drone detected and tracked the tank successfully.
- It reached the target and triggered the hit event.
- The video output demo_q2.mp4 shows the simulation sequence.

Conclusion

This project demonstrates how ROS + Gazebo simulation combined with computer vision can be used to:

- Detect and track targets in real time.
- Plan and control UAV trajectories.
- Perform automated responses based on camera feed analysis.

It highlights practical knowledge in integrating AI vision, robotics, and flight control.