Intern Roadmap

Phase-I

POSE ESTIMATION FOR NON-COOPERATIVE SPACECRAFT RENDEZVOUS

Background

The pose estimation of non-cooperative satellite rendezvous deals with estimating the **6-DoF (degrees of freedom) pose** (position + orientation) of satellite **without prior cooperation**, meaning:

- The pose of satellite is known only when the mission system meets with it
- No markers for satellite
- Often under space environment settings

Before starting with the problem statement, it's required to know the background behind the pose estimation of any objects. Read and understand the mentioned topics below. The link provided serves as a reference for each topic, but is not limited.

1. Machine vision system coordinate systems and parameters of camera
    - https://industry.goermicro.com/blog/tech-briefs/machine-vision-coordinate-systems-and-parameters-of-camera.html
2. Camera rotation with respect to the object
    - https://www.basic.ai/blog-post/camera-lidar-sensor-fusion-key-concept-extrinsic-parameters
3. Camera calibration, intrinsic & extrinsic parameters
    - https://docs.opencv.org/4.x/d9/d0c/group__calib3d.html
4. Camera Matrix and Distortion Coefficients
    - https://www.cs.cmu.edu/~16385/s17/Slides/11.1_Camera_matrix.pdf
    - https://docs.opencv.org/4.x/dc/dbb/tutorial_py_calibration.html

5. Euler Angle and Gimbal lock

    - https://mecademic.com/insights/academic-tutorials/space-orientation-euler-angles/
    - https://math.umd.edu/~immortal/MATH431/book/ch_gimballock.pdf
    - https://base.movella.com/s/article/Understanding-Gimbal-Lock-and-how-to-prevent-it?language=en_US

6. Quaternions

    - https://lisyarus.github.io/blog/posts/introduction-to-quaternions.html
    - https://www.youtube.com/watch?v=zjMuIxRvygQ
    - https://eater.net/quaternions

7. Direction Cosine Matrix

    - https://www.vectornav.com/resources/inertial-navigation-primer/math-fundamentals/math-attitudetran

8. 6DoF (Degree of Freedom), Understanding of relative motion, rigid body dynamics

    - https://industrial-ia.com/what-are-the-6-degrees-of-freedom-6dof-explained/

9. Keypoints

    - https://blog.roboflow.com/what-is-keypoint-detection/

10. Coordinate frames, transformations (SO(3), SE(3))

    - https://w3.cs.jmu.edu/spragunr/CS354_F22/readings/frames.pdf

Revision

Revise and practice the following key technical areas:

- **Python**
  - Review core syntax, data structures, functions, and modules.
- **PyTorch**
  - Refresh understanding of tensors, neural network building, training loops, and key functions.
- **OpenCV**
  - Revise image and video processing basics, common functions, and integration with Python.
- **SciPy**
  - Review scientific computing tools, especially for optimization, integration, interpolation, and signal processing.
- **Matplotlib**
  - Brush up on creating plots, visualizing data, and customizing graphs for better insights.