Final Project Proposal

Group

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Goal

The goal of this project is to implement the camera calibration and sparse point-cloud generation stage of the Gaussian Splatting pipeline. Using this custom calibration implementation, we will then train a Gaussian Splat scene model and compare its performance to the baseline pipeline that uses COLMAP for calibration.

A custom implementation will be considered successful if the resulting splat-based scene reconstruction is visually and numerically similar to the reconstruction generated using COLMAP's calibration and sparse reconstruction.

Plan

Setup and Baseline Reproduction

1. Clone original Gaussian Splat project repository (https://github.com/graphdeco-inria/gaussian-splatting)
2. Deploy project on GCP to train models using cloud GPU instance
3. Reproduce original paper results by:
    a. Training a Gaussian Splat model on a provided dataset (Train dataset).
    b. Verifying that the reproduced model matches reference outputs.

Data Collection & Baseline Calibration

4. Record our own custom video of a static scene.
5. Convert the video to an image sequence.
6. Run COLMAP and the repository's preprocessing scripts to generate:
    a. Camera intrinsics/extrinsics
    b. Sparse point cloud
7. Train a Gaussian Splat model with this COLMAP-generated data and render the results for validation.

Custom Camera Calibration and Sparse Reconstruction

8. Develop custom camera calibration script to generate camera and sparse point data.
9. Run our custom calibration pipeline on:
    a. Our recorded dataset
    b. One dataset from the original paper (Train set)

Custom Camera Calibration and Sparse Reconstruction

10. Train Gaussian Splat models using our custom-generated calibration and sparse cloud.
11. Compare the resulting scene renderings and evaluate differences.

Data

- Official Gaussian Splatting datasets, primarily the Train dataset packaged in the original repository.
- A custom dataset recorded as a short controlled video, converted into image frames for calibration/testing.
- Data produced by:
    - COLMAP (baseline)
    - Our custom OpenCV pipeline (experimental)

Resources

We Will Implement

- Custom camera calibration pipeline using OpenCV.
- Feature detection and matching
- Essential matrix estimation
- Pose recovery (intrinsics and extrinsics)
- Sparse point-cloud triangulation
- Data conversion scripts for integrating our calibration output into the Gaussian Splatting training pipeline.

We Will Use

- Gaussian Splatting training and rendering pipeline from the official repo (unmodified).
- GCP GPU compute instances.
- COLMAP preprocessing scripts included in the repo.