Lab 1: Camera Calibration and 3D Alignment with Blender and FSpy

Computer Graphics Course

Learning Objectives

- Understand the relationship between 3D scenes, camera parameters, and 2D images.
- Explore virtual camera modeling and projection using real photographs.
- Learn to align 3D models with photographs using Blender and FSpy.

Materials Needed

- Camera (for example your personal smartphone's camera).
- Blender software installed (`https://www.blender.org/`).
- FSpy software (`https://fspy.io/`).
- A few simple objects to photograph on a table (e.g., books, eraser, rectangular pencil box, etc).

Setup

The exact procedure for installation depends on your OS (Windows, MacOS, Linux, etc.)

- Install Blender.
- Install Fspy.
- Download and install Fspy addon for Blender (if not present). To do this, download the .zip file at `https://github.com/stuffmatic/fSpy-Blender`. Then open Blender and open Preferences/Settings (under the Edit menu). Click on 'Add Ons' on the left of the preferences window. You should see a list of add ons on the right side. If FSpy is not listed, drag the zip file onto the installed list. Alternatively, you can click the little arrow on the top right corner for 'Install from disk...'.

With these you are ready to go!

Exercise Steps

Step 1: Capture a Scene (10 minutes)

a. Take a photograph of a simple scene using your phone camera. You can create your own scene if you would like to practice ahead of your lab (not necessary, but some of you asked). However, the scene that will be setup in the Lab will be used for your assessment. Each lab group will have a objects at slightly different positions.

b. It usually helps if the scene includes at least three distinct reference points (corners of objects, edges, etc.).

Step 2: Analyze Camera Parameters with FSpy (15 minutes)

a. Open the photo in FSpy. You can do this by dragging the photo into the FSpy window.

b. Identify key lines along the X, Y, and Z axes to establish vanishing points.

c. Let FSpy estimate the focal length and camera orientation.

d. Try to do this with 1 vanishing point first. See `https://fspy.io/tutorial/`.

e. Export the camera data as an `.fspy` file.

Step 3: Import Scene and Camera into Blender (20 minutes)

a. Open Blender and import the `.fspy` file using the FSpy add-on. You should see this via the menu under File→import.

b. Observe how the virtual camera matches the perspective of your photograph.

c. Add simple 3D objects (cube, plane, cylinder) and align them with features in the photo.

d. Adjust scale, rotation, and position for accurate alignment.

Step 5: Reflection and Discussion (5 minutes)

- Summarize observations about:
  - Perspective and focal length estimation.
  - Aligning 3D models to real-world images.
  - Challenges in accurate camera calibration.

a. **Set up rendering:**

- In Blender, go to the `Render Properties` tab (camera icon).
- Choose your render engine (e.g., `Cycles` or `Eevee`, the latter will be much faster).

- Set the output resolution to match the original photograph.

b. **Enable transparent background:**

- In `Render Properties` → `Film`, check `Transparent`.
- This will render only the objects, without the default world background.

c. **Render the scene:**

- Press `F12` or go to `Render` → `Render Image`.
- Save the rendered image in a format that supports transparency (e.g., PNG with RGBA channels).

d. **Composite the render onto the photograph using Blender nodes:**

- Switch to the `Compositing` workspace and enable `Use Nodes`.
- Add an `Image` node and load the original photograph.
- Connect the `Render Layers` node (with your rendered objects) to an `Alpha Over` node.
- Connect the original photograph node as the background input of the `Alpha Over` node.
- Connect the output of the `Alpha Over` node to the `Composite` node.
- Adjust scale, position, or transparency to align the render with the photograph.
- Press `F12` or `Render` → `Render Image` to view the final composite.

e. **Optional adjustments:**

- Apply color grading or adjust brightness/contrast to match the photograph.
- Compare perspective alignment and note any discrepancies.