EE/CprE/SE 4910 WEEKLY REPORT #7

4/9/25 - 4/15/25

Group number 15

Vision Based Camera Motion Tracking

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Team Members:
Andrew Gooding
Eric Wittrock
Isaac Kenyon
Will Ernatt

Weekly Summary

We tested a new software, ORB-SLAM, which was built for camera tracking. This algorithm was designed for robotics, so the results don't have the precision we require, but when combined with our current gradient-descent-based solution, the hybrid shows promise. We continue to work on the gradient descent algorithm alongside searching for existing tools because we intend to combine the two. This week, we added new parameters such as distortion coefficients.

Past Weekly Accomplishments

Eric Wittrock

- Worked on camera projection code
    - The virtual camera now has more parameters, namely distortion coefficients
    - The new implementation doesn't yet have the ability to move through space and pan. This will be implemented later.
- Optimization
    - A performant algorithm is becoming increasingly important now that more variables are being introduced
    - Worked on refactoring the code to leverage numpy so that the algorithm is performant.

Isaac Kenyon

- Worked on a Photometric Error Minimization algorithm
    - Assumes a brightness stays the same among frames
    - Loads grayscale image frames, normalized intensities.
    - Able to define camera information, like focal length and center.

    - Worked on a warping function.
- Testing prototype with different video inputs to see where limitations may be.

Will Ernatt

- Wrote basic script using ORB-SLAM to take video as input and output a csv containing camera position overtime.
    - Order of magnitude faster than Meshroom(~3 hours for 20 sec video using Meshroom vs ~2 min using ORB-SLAM.
    - The generated path from my algorithm is laden with errors, however the general trajectory matches the actual path taken by the camera, which leads me to believe further optimization could produce a sufficiently accurate path.
- Wrote conversion tool for blender to take a csv file containing coordinates and keyframes and map it to 3d space within blender as a camera object.

Andrew Gooding

- Updating script to make it completely automated. There are still some things I was not able to get completely automated. So I will be working on trying to get those things automated.

Pending Issues

- **Eric Wittrock:** The new camera projection technique was a tradeoff. It relies more heavily on matrices, which may result in more speed later on, but forces us to discard our elegant solution for camera spatial transformations. Some functionality now must be rebuilt.
- **Isaac Kenyon:** Speed of the Photometric Error Minimization algorithm and if it is in the range of usable.
- **Will Ernatt:** Algorithms remain mostly inaccurate. Might be necessary to further educate myself on ORB-SLAM, perhaps look into how it has been implemented for other purposes.
- **Andrew Gooding:** May not be able to get the error deletions process to automate the way I need it too.

Individual contributions

Name	Individual Contributions	Hours This Week	Hours Cumulative

Eric Wittrock	Implemented a more realistic virtual camera by adding distortion coefficients, which entailed a rewrite of the projection math	6	44
Will Ernatt	Wrote OpenCV ORB-SLAM script to output camera path coordinates. Wrote Blender plugin to take camera path coordinates and create camera objects.	6	43
Andrew Gooding	Worked to improve error detection for blender script written to automate camera tracking process.	6	36
Isaac Kenyon	Worked on a Photometric Error Minimization algorithm. Testing prototype with different video inputs to see where limitations may be.	6	41

Plans for the upcoming week

Andrew Gooding

- Continue working on making my script be able to delete errors automatically.

Eric Wittrock

- Get the camera to move and rotate again. Carry out the previous week's goal, which was not completed: test on real data.

Isaac Kenyon

- Determine if the photometric error minimization will be useful for the project. Need to show how it can be useful.

Will Ernatt

- Fix/optimize ORB-SLAM algorithm. Implement logging for debugging purposes.