CS5330: Project 4

Calibration and Augmented Reality

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Description:

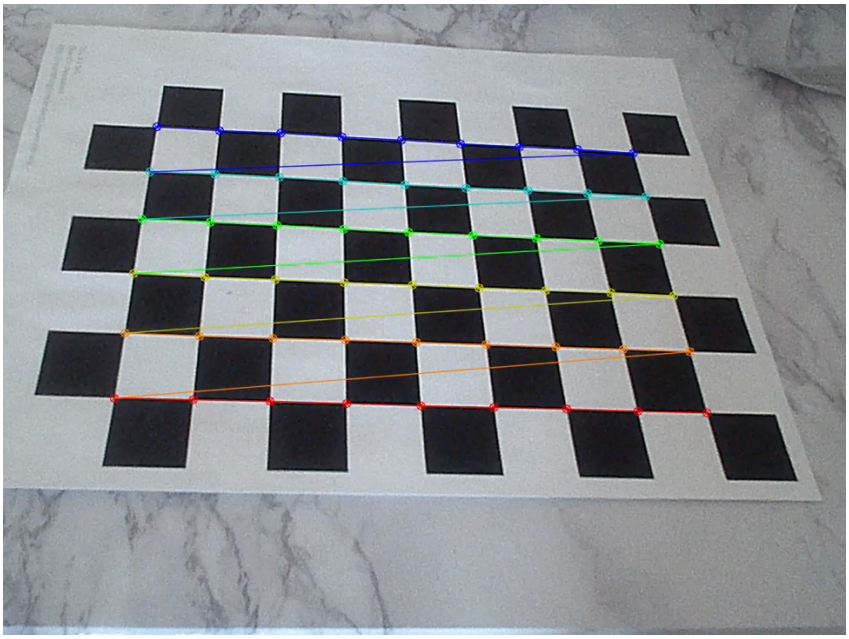
The first segment of code performs camera calibration and pose estimation using a chessboard pattern. It starts by loading camera intrinsic parameters from a YAML file named "intrinsics.yml". Then, it captures frames from a webcam and detects a predefined chessboard pattern in each frame. The code then draws the detected corners on the frame and estimates the pose (rotation and translation) of the pattern using solvePnP. Finally, it projects predefined 3D points onto the image plane to draw a coordinate system, indicating the pose of the pattern.

The second segment extends the previous code by adding the functionality to draw 3D objects on top of the detected chessboard pattern. It defines the 3D coordinates of vertices for a pyramid, cube, and prism. Using the estimated pose obtained from solvePnP, it projects these vertices onto the image plane and draws the corresponding 3D objects. This addition allows for visualizing multiple 3D objects in the camera frame along with the chessboard pattern.

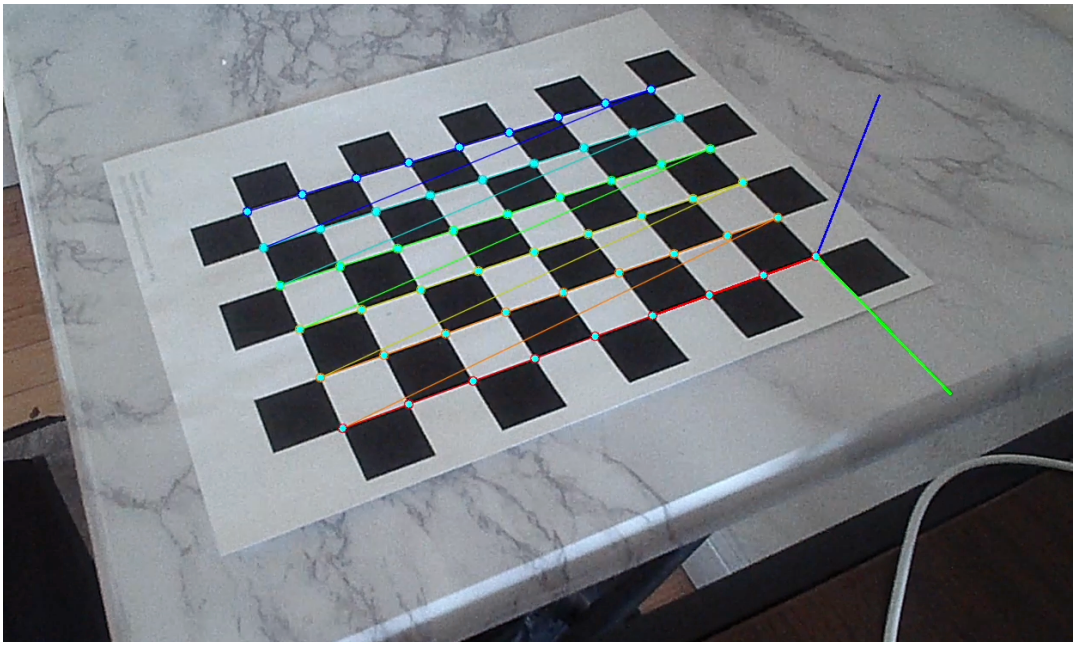
The third segment focuses on detecting Harris corners in live video streams from a webcam. It utilizes the cornerHarris function from the OpenCV library to detect corners based on the Harris corner detection algorithm. The code captures frames from the webcam, converts each frame to grayscale, and applies the Harris corner detection algorithm to detect corners. It then normalizes the result and draws circles around the detected corners on the original frame. This segment enables real-time detection and visualization of Harris corners in live video streams.

Results:

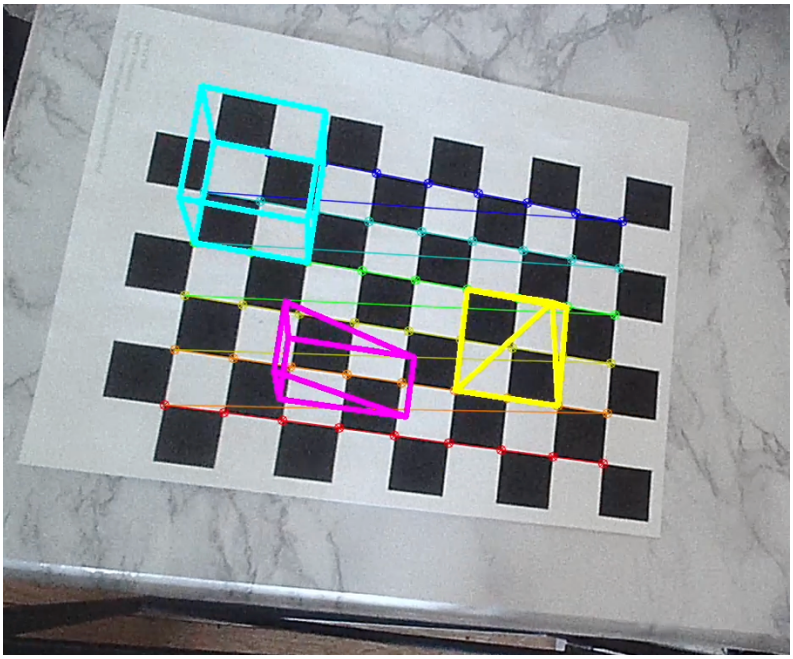
This is an image that shows calibration with chessboard corners detected.



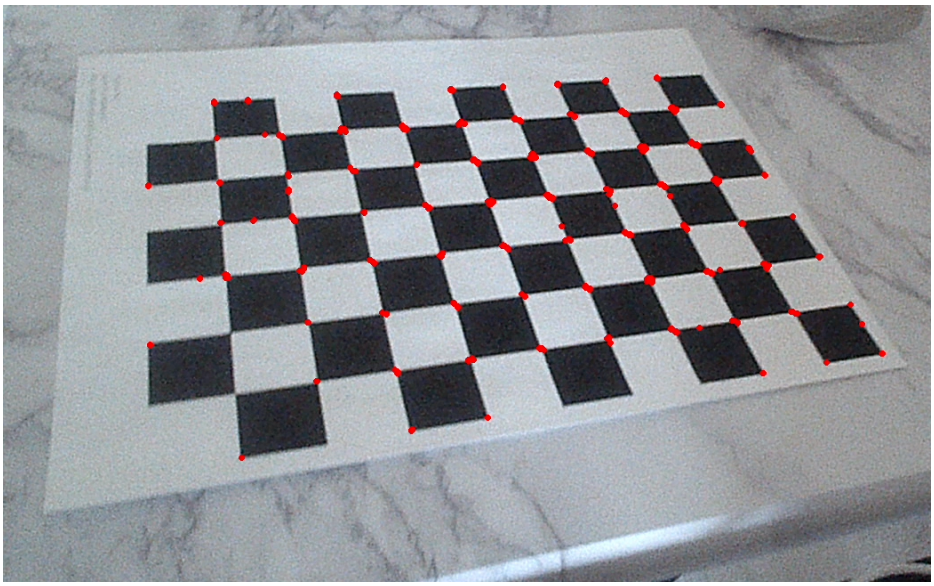
Projecting 3D points onto the image plane and visualizing the orientation of the pattern.



This image displays the detected chessboard pattern along with the overlaid 3D objects representing its orientation.



This image displays the original frames with Harris corners marked.



Reflection:

I explored camera calibration methods, real-time video processing, chessboard corner detection, pose estimation, and 3D visualization. Starting with loading camera calibration parameters from a file, I then detected a chessboard pattern in live video frames captured from a webcam. After refining the detected corners, I estimated the pose of the chessboard pattern in 3D space and visualized it with coordinate axes and reprojected corners. I delved into Harris corner detection, where I learned about image processing, feature highlighting, thresholding, and normalization techniques. These experiences collectively provided me with a comprehensive understanding of key computer vision concepts through practical implementation.

Acknowledgement:

I would like to thank Prof. Bruce Maxwell for helping me grasp these concepts with ease. The class lectures and notes were very useful in completing this project.

- https://docs.opencv.org/4.x/dc/dbb/tutorial_py_calibration.html
- https://aliyasineser.medium.com/opencv-camera-calibration-e9a48bdd1844
- https://docs.opencv.org/4.x/d9/db7/tutorial_py_table_of_contents_calib3d.html