Chessy3D: A study of 3D Chessboard Detection and Pose Estimation

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***Abstract*—In this paper, we present a novel framework for chessboard corners detection and chess-pieces object detection. Our approach tackles the significant challenges posed by the variability of the photos taken of the chessboard and sizes, color and differences of the chess pieces. We propose a new method for chessboard keypoint detection that utilizes a combination of deep learning and geometric constraints to accurately identify the keypoints on the chessboard and the squares within it. This method is robust to variations in lighting, angle, and chessboard designs, making it suitable for real-world applications. Additionally, we developed a chess-piece object detection model that can accurately detect and classify chess pieces in various conditions. Our study delves into the intricacies of chessboard detection, addressing the challenges of different chessboard designs and piece variations. The proposed approach using YOLOv8 for chess-piece detection demonstrates superior performance in terms of accuracy and robustness compared to existing methods. We used two datasets for training and testing our models: ChessRed2K and another small dataset found on Roboflow. After the object detection we will propose a FEN annotation method for converting the chessboard state into a FEN (Forsyth-Edwards Notation) string, which is a standard notation for describing the state of a chess game. Additionally we show a method for retrieving similar images using one hot encoding and a similarity search algorithm.**

I. Introduction

The detection and analysis of keypoints in images have become crucial tasks in the field of computer vision, with applications ranging from object recognition and tracking to augmented reality and autonomous driving.

Identifying corners in images is a fundamental problem in computer vision, with applications in object recognition, image stitching, and 3D reconstruction. Chessboard detection is a specific case of keypoint detection that has gained significant attention due to its importance in camera calibration, pose estimation, and robotics. The chessboard pattern provides a regular and structured grid that can be easily detected and used to estimate the camera's intrinsic and extrinsic parameters. In this paper, we present an approach for chessboard corners detection and chess-pieces object detection using deep learning and geometric constraints. Our method is designed to handle the challenges posed by the variability of chessboard photos, including different lighting conditions, angles, and chessboard designs.

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We have been through a series of steps to achieve our goal:

- We started with the chessboard corners detection, using a combination of deep learning and geometric constraints to accurately identify the keypoints on the chessboard.
- We then moved on to chessboard squares detection, which involves detecting the individual squares on the chessboard.
- Next, we focused on chess-pieces object detection, using YOLOv8 to detect and classify chess pieces in various conditions.
- After that, we developed a FEN annotation method for converting the chessboard state into a FEN string.
- Finally, we implemented an image similarity search method using one hot encoding and a similarity search algorithm.
- We also conducted a series of experiments to evaluate the performance of our approach, comparing it with existing methods and demonstrating its effectiveness in real-world scenarios.

We used two datasets for training and testing our models: ChessRed2K and another small dataset found on Roboflow. The rest of the paper is organized as follows:

- Section II discusses the related work in chessboard detection and keypoint detection.
- Section III describes the proposed approach for chessboard corners detection.
- Section IV presents the chessboard squares detection method.
- Section V details the chess-pieces object detection using YOLOv8.
- Section VI explains the FEN annotation method.
- Section VII discusses the image similarity search method.

II. Chessboard Corners Detection

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III. Chessboard Squares Detection

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IV. Chess-Pieces Object Detection

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V. FEN Annotation Method

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VI. Image Similarity Search

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VII. Conclusion

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