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 keypoint 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. In this paper, we focus on the detection of keypoints in chessboard images, which presents unique challenges due to the variability in chessboard designs, lighting conditions, and camera angles. Chessboards are commonly used in computer vision tasks due to their regular grid structure, which provides a rich source of geometric information. The primary objective of this study is to develop a robust and efficient method for detecting keypoints in chessboard images, enabling accurate analysis of chessboard states and facilitating further applications such as chess piece detection and game state analysis.

We started our work by getting keypoints from the chessboard and then understading the position of the squares. After that we focused on the chess pieces detection in order to get the positions of every piece on the chessboard. With the two streams above we got all the information we needed to generate a FEN string, which is a standard notation for describing the state of a chess game. The FEN string has been encoded in a one-hot encoding format to allow for easy retrieval of similar chessboard states.

We used multiple datasets for training and testing our models. The first dataset is ChessRed2K, which contains a large number of chessboard images with different designs and lighting conditions. The second dataset is a small dataset found on Roboflow, which contains images of chess pieces in various conditions.

And for the similarity search we used a dataset of 14 million possible chessboard states to retrieve similar images based on the FEN string.

II. Chessboard Keypoint Detection

III. Chessboard Squares Detection

IV. Chess Piece Detection

V. FEN Annotation

VI. One-Hot Encoding and Similarity Search

VII. Conclusion

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