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

Luca Villani
matr. 200412
University of Modena and Reggio Emilia
269419@studenti.unimore.it

Alessandro Mezzogori
matr.
University of Modena and Reggio Emilia
271617@studenti.unimore.it

Davide Della Casa Venturelli
matr.
University of Modena and Reggio Emilia
xxxxx@studenti.unimore.it

***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.

Identifying keypoints on vehicles from different perspectives poses sig- nificant challenges. Traditional methods often rely on ex- tensive manual annotation, which is both time-consuming and prone to errors. Moreover, models trained on synthetic data frequently suffer from domain-shift when applied to real-world images, resulting in decreased performance. This study aims to address these challenges by developing a comprehensive keypoint detection framework inspired by FastTrakAI [1], thus focusing on enhancing automotive safety and efficiency through innovative AI solutions. However, the inherent variability in the shapes, sizes, and appearances of these vehicles presents significant challenges for developing robust keypoint detection models. Our approach involves identifying a set of 3D models representing a category of vehicles and defining a set of keypoints common to all vehicles. This step ensures that our approach is adaptable across various vehicle types. To build our dataset, we rendered over 2000 images of these vehicles from dif- ferent perspectives and enriched them with keypoint anno- tations. To avoid the laborious task of manually annotating each image, we devised a strategy that automates a signifi- cant portion of this process. After creating the dataset, we trained a keypoint detection model tailored to these anno- tated images. We then rigorously tested the model on cap- tures of a 3D model never seen during the training phase. This testing approach evaluates the model's robustness and its ability to generalize to new, unseen data. By following this methodology, we aimed to develop a keypoint detection system that is both accurate and robust, capable of handling the variability inherent in vehicle categories. The insights gained from this research can contribute to the advancement of computer vision technologies in the automotive industry and beyond, fulfilling the objectives of FastTrakAI by DAT and Prometeia to push the boundaries of AI-driven automo- tive innovation..

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Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

B. Units

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Please use "soft" (e.g., `\eqref{Eq}`) cross references instead of "hard" references (e.g., `(1)`). That will make it possible to combine sections, add equations, or change the order of figures or citations without having to go through the file line by line.

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TABLE I
TABLE TYPE STYLES

Table Head	**Table Column Head**		
	Table column subhead	***Subhead***	***Subhead***
copy	More table copy[a]		

[a]Sample of a Table footnote.

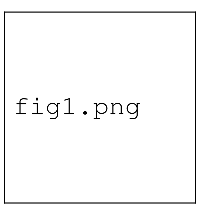

Fig. 1. Example of a figure caption.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity "Magnetization", or "Magnetization, M", not just "M". If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write "Magnetization (A/m)" or "Magnetization {A[m(1)]}", not just "A/m". Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)", not "Temperature/K".

ACKNOWLEDGMENT

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REFERENCES

Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use "Ref. [3]" or "reference [3]" except at the beginning of a sentence: "Reference [3] was the first ..."

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

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