ICSIPA

Proceedings of the

2021 IEEE International Conference on Signal and Image Processing Applications (IEEE ICSIPA 2021)

Kuala Terengganu, Malaysia (Virtual)

September 13 - 15, 2021

IEEE Signal Processing Society Malaysia Chapter

2021 IEEE International Conference on Signal and Image Processing Applications (ICSIPA) | 978-1-6654-3592-5/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICSIPA52582.2021.9576803

2021 IEEE International Conference on Signal and Image Processing Applications (ICSIPA) | 978-1-6654-3592-5/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICSIPA52582.2021.9576809

IEEE Catalog Number: CFP2173I-ART
ISBN: 978-1-6654-3592-5

2021 IEEE International Conference on Signal and Image Processing Applications (ICSIPA) | 978-1-6654-3592-5/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICSIPA52582.2021.9576777

Conference Program

Day 1 - Monday, 13th September 2021

Track 7: Object Detection & Tracking

Track 8: Trending Technologies in Signal and Image Processing

Day 3 - Wednesday, 15th September 2021

Track 9: Applied Signal, Image and Speech Processing

Classification of Digital Chess Pieces and Board Position using SIFT

Brandon Sean Kong
Faculty of Computer Science & IT
Universiti Malaysia Sarawak
Kota Samarahan, Malaysia
brandonkong@protonmail.ch

Irwandi Hipiny
Faculty of Computer Science & IT
Universiti Malaysia Sarawak
Kota Samarahan, Malaysia
mhihipni@unimas.my

Hamimah Ujir
Faculty of Computer Science & IT
Universiti Malaysia Sarawak
Kota Samarahan, Malaysia
uhamimah@unimas.my

***Abstract*—Assistive technology has been given more attention in recent years to help people with disabilities to perform common tasks. Rather than designing a specialised tool for the task, it is more cost-effective and less inhibitory to make use of existing hardware integrated with a smart interface. Towards this end goal, we present our work on assisting a visually impaired person playing an online chess game. We evaluated an invariant feature descriptor, i.e., SIFT, for the task of classifying individual chess pieces across multiple visual themes. We compared two strategies for building the visual codebook, i.e., k-means clustering vs. image blending. The proposed pipeline receives live screen feeds from the browser at a fixed interval and produces an output in the form of chess pieces' label and board position. Our proposed pipeline, paired with a visual codebook built using k-means clustering, managed an average accuracy rate of 6/10.**

***Keywords*—chess, classification, scale-invariant feature transform (SIFT)**

I. Introduction

Chess is a one of the oldest board games that is still popular today. Throughout the centuries, it has evolved through many variations and the current popular medium for playing it is via ranked online matches. We focus on image-based classification of digital chess pieces inside screen grabs of these chess-playing websites with the motivation of helping the visually impaired group to seamlessly participate in matches. Screen grabs are captured at a fixed interval and fed to the built prototype. The prototype returns the chess pieces' label and board position. This information can be relayed back to the user via audio feedback. The goal of this research is to create a universal interface that will work with most chess-playing websites, regardless of the screen layout and visual theme.

According to [1], recognition of chess pieces and chessboards is still an open research problem in the Computer Vision community. Recent work had utilised deep learning models such as Convolutional Neural Network (CNN) and regular machine learning algorithms such as Support Vector Machine (SVM). The latter is typically trained using Lowe's Scale-invariant Feature Transform (SIFT) [2] or Dalal and Triggs' Histogram of Oriented Gradients (HOG) [3]. CNN is widely used for image classification task involving large-scale datasets and a wide number of categories, for example [4] and [5]. Models employing handcrafted features such as SIFT and HOG are typically used for category-specific dataset, for example, animal re-ID [6][7][8], handwritten characters [9][10] and plant species identification [11].

II. Background

The core component of our prototype is the feature matching algorithm. The algorithm is very important to ensure that the prototype can reliably classify the chess pieces, as well as estimating their individual board position. This subsection starts with a review of the seminal work on invariant feature descriptors, followed by a summary of existing work on chess piece classification.

A. Invariant Feature Descriptors

1) Oriented FAST and Rotated BRIEF (ORB): ORB [12] is constructed from Features from Accelerated Segment Test (FAST) keypoint detector, and modified Binary Robust Independent Elementary Features (BRIEF) descriptor. The algorithm uses modified BRIEF descriptor due to the BRIEF descriptor being unstable during rotation-invariant cases.

2) Binary Robust Invariant Scalable Keypoints (BRISK): BRISK [13] describes a keypoint by identifying its characteristic direction hence making the descriptor rotation-invariant.

3) Scale-invariant Feature Transform (SIFT): SIFT [*2*] locates the keypoints by finding scale-space extrema inside a *give*n image. SIFT uses 2x2 Hessian matrix to eliminate keypoints found around the edges. The resulting descriptor contains magnitude and orientation of gradient inside 4x4 subregions surrounding the keypoint. Each subregion consists of 8 orientation bins, thus producing a 4x4x8=128-bit descriptor.

B. Quantitative Comparison

TABLE I. COMPARISON OF FEATURE DESCRIPTORS [14].

Criteria	Rank
Feature Matching Time per Keypoint	SIFT > BRISK > ORB
Outlier Rejection and Homography Fitting Time per Keypoint	SIFT > BRISK > ORB
Total Image Matching Time	SIFT > BRISK > ORB
Accuracy of Image Matching	ORB > BRISK > SIFT