Project 13 - Scrabble Assistant

Digital Image Processing

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Goals

1. Digitizing the scrabble board using image processing techniques to a matrix of characters.
2. The determined matrix of characters is given as input to a 'Scrabble Oracle' that provides the best possible word for the given configuration.

Problem Definition

Scrabble is a commonly played word game in which players take turns forming words using a set of seven letter tiles and placing them onto a grid, following placement rules similar to a crossword puzzle. While turns are not usually timed, creativity and vocabulary are both important to achieving a high score.

Since technology is evolving and becoming a part of our daily lives, we can use it for our benefit or in the form of an opponent for the game where the computer can play on its own by determining a word in the current scenario of the Scrabble board. In order to achieve such futuristic goals, board detection and character recognition play a very important role.

This project develops software using image processing techniques and algorithms to digitize the Scrabble board using a single image as an input. After digitizing the board, we feed this as an input to an Oracle that will give us the best possible word that can be formed for the current scenario.

Commercial applications rarely take the board state as input and only consider the user's available tiles; entering the board manually is tedious for the user and may be unreliable, but digitizing the board automatically using an image makes the process convenient and easy.

Other applications of the approach used here could be various other board/grid based games like Sudoku, Crosswords, etc. Moreover, this project does involve OCR, as some text needs to be extracted from the image and this has far reaching applications from automated digitization of documents to sign understanding. This could also be applied in extracting graphs and/or matrices in mathematical documents involving graph theory and linear algebra.

Steps To Be Followed

1. Preprocessing: Denoising and cleaning the images to make them more clear using various techniques such as histogram equalization, etc.
2. Tile size estimation using MSERs and normalization to a fixed size in grayscale.
3. Grid detection using edge detectors and morphological operations.
4. Fix viewing angles by detecting corners, estimating quadrilateral pose and applying appropriate affine transformations to unskew the grid.
5. Grid fitting using an initial estimate from equal division and MSERs.
6. Character detection using MSERs and edge maps.
7. Character recognition using template matching methodology with reference tiles.
8. Classification of character positions in grid based on their centres to obtain the final filled matrix equivalent to the scrabble board configuration.
9. Error estimation and plotting.

Project Results and Deliverables

Determine Best Possible Word

We would like to determine what would be the best possible word that can be formed for specific configurations of the board using our software for a few images and compare it with the corresponding best human estimated solution.

Grid Detection Accuracy

We will compare our detected grid location and dimensions as well as the estimated affine transformation with the groundtruth obtained by other sophisticated applications such as CamScanner or manual annotation, etc.

Character Recognition Accuracy

As we will try to extract the characters from the tiles, we have to determine the accuracy too! These rates are calculated as the number of correctly recognized characters in the image, ignoring blank tiles.

Milestones and Timeline

Tentative Dates	Milestones
9th Nov	Present Project Proposal
16th Nov	Complete data pre-processing Begin grid detection
20th Nov	Complete grid detection and fitting Begin character detection
24th Nov	Complete character detection along with recognition
27th Nov	Complete integration with the oracle
29th Nov	Debugging, finishing touches and bonus component(s) implementation (if time permits).

Additional Requirements

- Images Dataset

  Get input images used in the paper by the author, David Koeplinger. Also collect and use input images of our personal scrabble board.

- Template Matching Dataset

  This is required to determine the characters that are obtained from the images of the scrabble board. The matching of characters can be done using OpenCV's 'Template Matching' module.

- Scrabble Oracle

Potential Bonus Segments

- Finding and comparing the results with other models as baselines. It is not necessary to find other models that do the exact same thing, we could settle for baselines that only tackle some specific part of the above pipeline such as models that simply do OCR.
- Trying to improve the results compared to the original proposed pipeline by trying out a few ideas and changes in some parts.
- Implementing our own backend to solve for a given configuration and return the best word that can be formed.
- A Graphical User Interface (GUI), in the form of a webapp, for the above-mentioned software, where the user can upload an image of the Scrabble board and obtain the predicted results right there.