Indian Institute of Technology Indore

Discipline of Computer Science and Engineering

Minor Project in the course “Computational Intelligence”

Spring 2022-2023

Title: Text Detection in Images

Final Report

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Under the Supervision of

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Problem Statement:

Detecting text from images involves using image processing techniques and optical character recognition (OCR) technology to extract text from images and convert it into machine-readable format. The process typically includes pre-processing the image to improve the quality and contrast, detecting regions of interest that contain text, and using OCR algorithms to recognize and extract the text.

1) Dataset Used

The dataset used is called Standard OCR Dataset. It contains 45,500 images. These images are divided into A-Z and 0-9 characters, with each character having around 1200 images. This dataset will help the model to recognize different alpha-numeric characters.

Dataset Link: https://www.kaggle.com/datasets/preatcher/standard-ocr-dataset

2) Data Pre-processing

The 7 steps used for Image Data Pre-processing in Text Extraction for images are as follows:

- Normalization: This process changes the range of pixel intensity values. It changes pixel range from [0, 255] to [0, 1]
- Skew Correction: The image might be slightly skewed or rotated. So, the image is de-skewed.
- Scaling: Scaling is used to increase pixel intensity. For character recognition, it should be more than 300 PPI (Pixels per inch)
- Noise Removal: This step removes the small dots/patches which have high intensity compared to the rest of the image for smoothening of the image.
- Thinning and Skeletonization: This step is performed for the handwritten text, as different writers use different stroke widths to write. It makes the width of strokes uniform.

- Gray-Scaling: This process converts an image from other color spaces to shades of Gray. The color varies between complete black and complete white.
- Thresholding or Binarization: This step converts any image into a binary image that contains only two pixel values determined by a threshold.

Image before pre-processing:

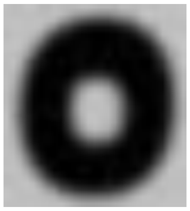
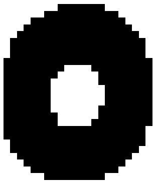
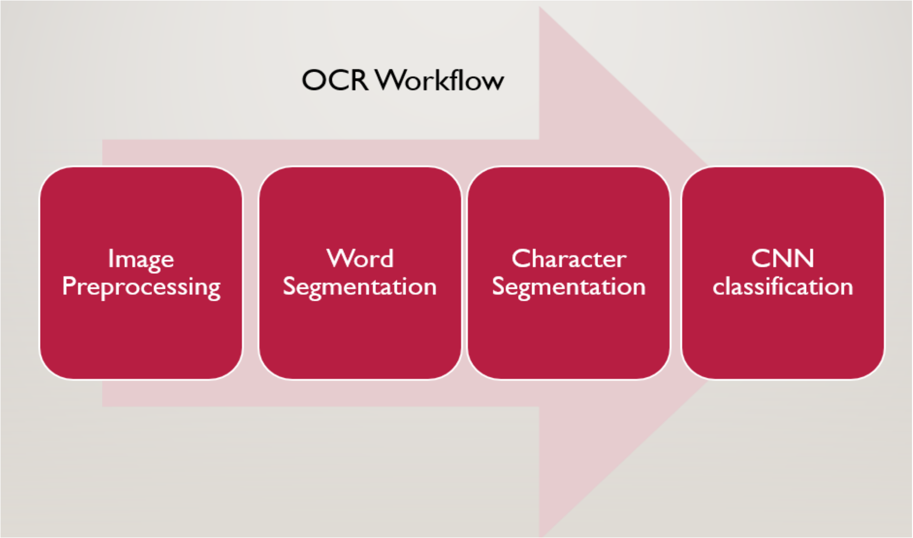


Image after pre-processing:



3) Algorithm

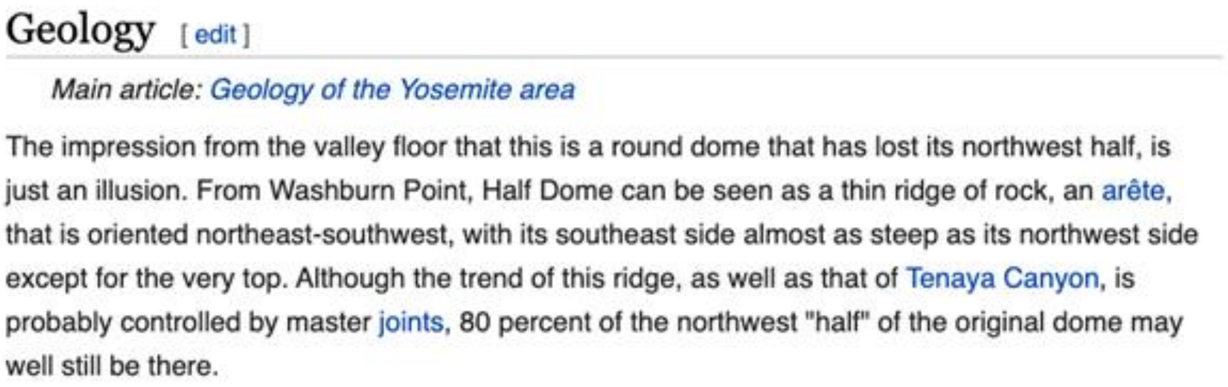
The OCR workflow is as follows:



A) Word Segmentation:

- After Data-Preprocessing, Words are detected from the image using Contours.
- Change in Contour is used for Edge-Detection
- A bounding box is created across every word using the detected Edges

Input:

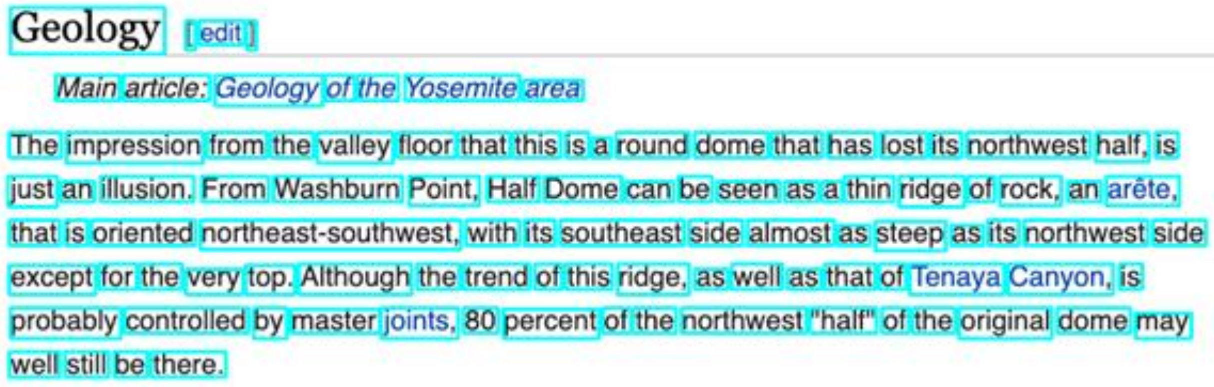


Geology [edit]

Main article: Geology of the Yosemite area

The impression from the valley floor that this is a round dome that has lost its northwest half, is just an illusion. From Washburn Point, Half Dome can be seen as a thin ridge of rock, an arête, that is oriented northeast-southwest, with its southeast side almost as steep as its northwest side except for the very top. Although the trend of this ridge, as well as that of Tenaya Canyon, is probably controlled by master joints, 80 percent of the northwest "half" of the original dome may well still be there.

Output:



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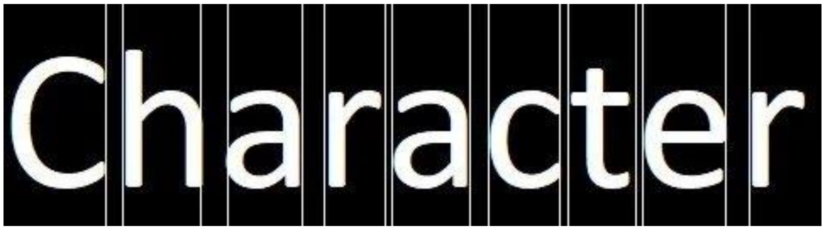
B) <u>Character Segmentation:</u>

- Vertical Projection Profile(VPP) is used to segment letters
- VPP calculates column sum of pixel values in the image
- Sum = 0 indicates break between characters. This is used to separate characters in a word



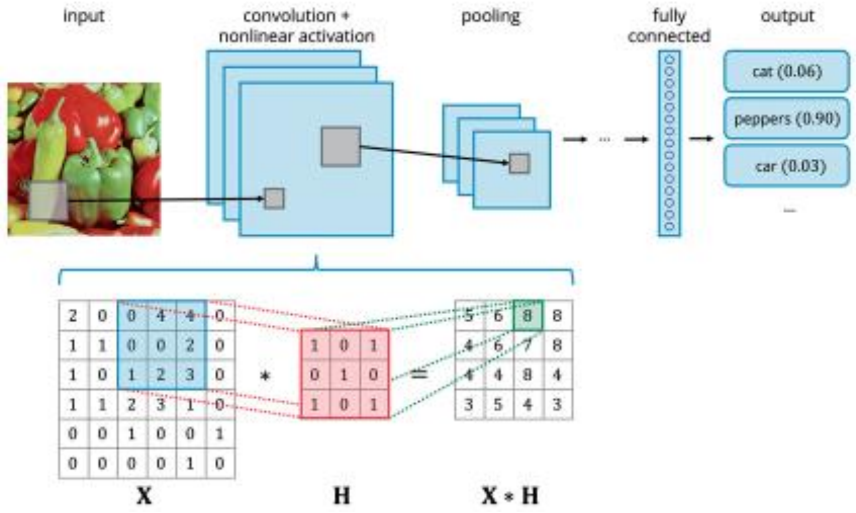
C) CNN Classification:

For Character Recognition, we plan to use Deep Learning with Convolutional Neural Network (CNN) architecture

The different layers used in CNN architecture are:

- Convolutional Layer:

  1) Convolutional layer helps in feature extraction
  2) Weight matrix called Kernel is multiplied with image to get features.



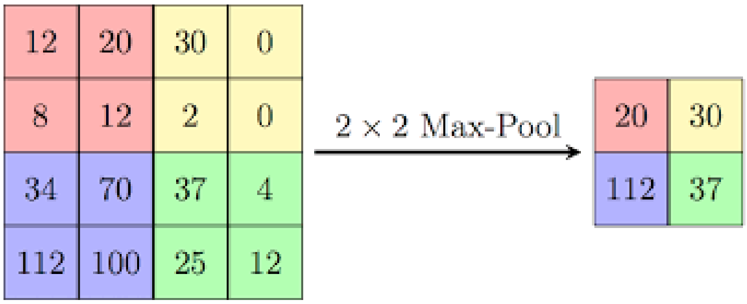
2	0	0	4	4	0
1	1	0	0	2	0
1	0	1	2	3	0
1	1	2	3	1	0
0	0	1	0	0	1
0	0	0	0	1	0

1	0	1
0	1	0
1	0	1

5	6	8	8
4	6	7	8
4	4	8	4
3	5	4	3

- Pooling Layer:

  1) Pooling layer reduces size of feature map
  2) Different types include Max-Pooling, Average-Pooling, etc.



12	20	30	0
8	12	2	0
34	70	37	4
112	100	25	12

20	30
112	37

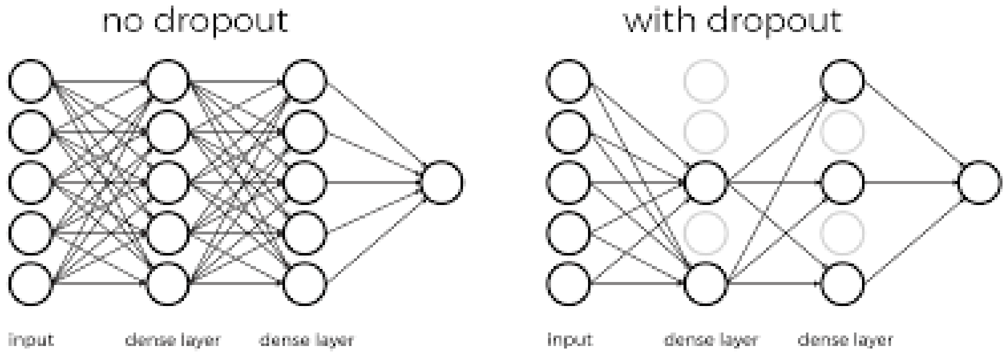
- Dense Layer

  1) It is fully connected layer

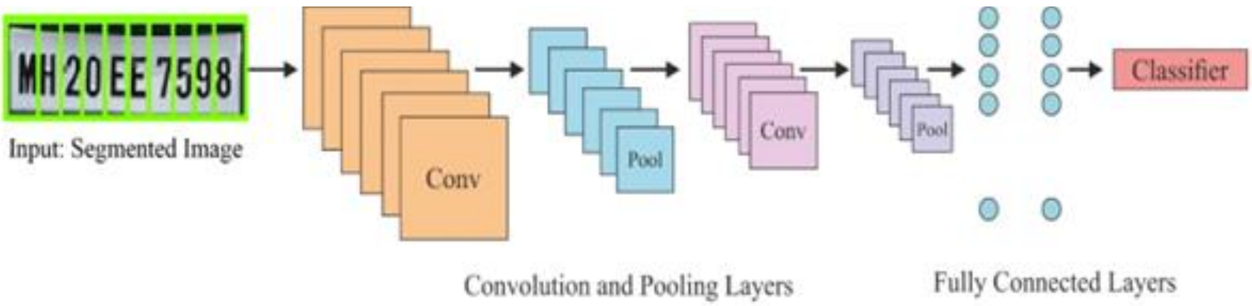
2) Every neuron between 2 adjacent layers has a connection

- Dropout Layer

  To prevent overfitting, some neurons are dropped while training



CNN Working Example



<u>Model Optimizer:</u> Adam (A variation of gradient descent)

<u>Model Loss Function:</u> Categorical CrossEntropy (Used for multiclass classification). Here 36 classes (10 numbers + 26 alphabets) are present

<u>Activation Functions:</u> Softmax is used for final layer as it gives probability for each class. For all other layers, ReLU activation is used.

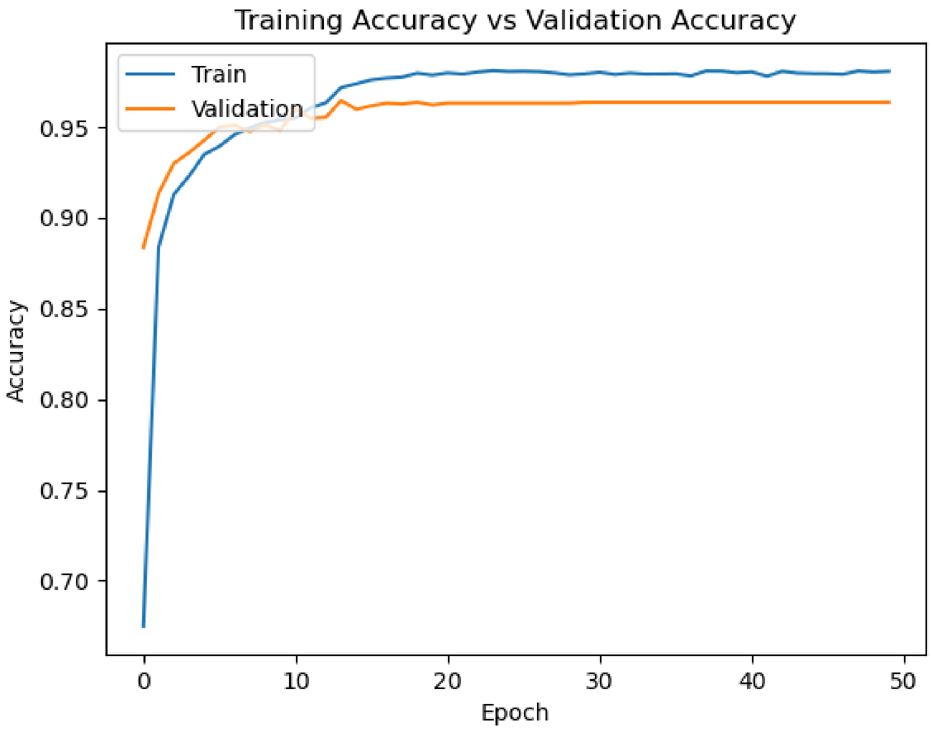
4) Performance Metrics

A) Character Recognition model performance:

- Training accuracy: **98.04%**
- Training loss: **0.0393**

- Testing accuracy: **98.80%**
- Testing loss: **0.0341**

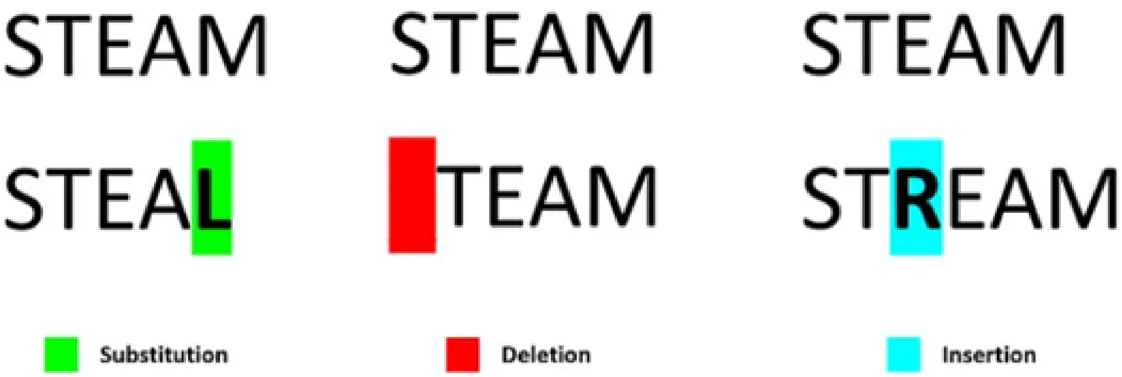
Here, testingaccuracy is actually more than training accuracy. This shows that model is trained well and can accurately classify alphabets and numbers.



Model Training for 50 Epochs

B) OCR Performance:

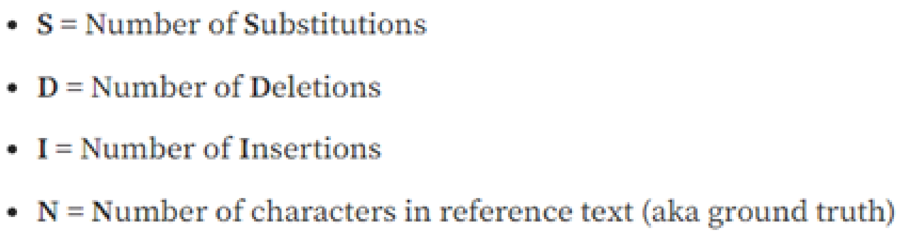
Different types of errors that can occur in optical character recognition:



The character error rate (CER) is defined as:

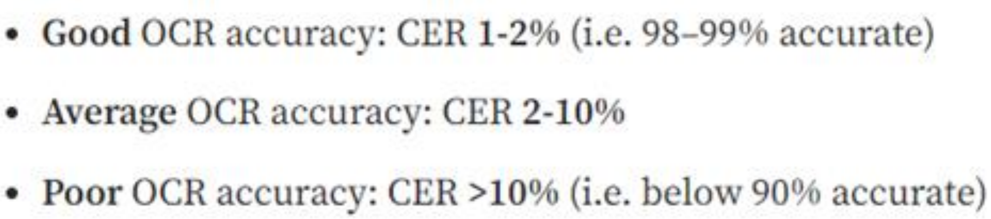
$$CER = \frac{S + D + I}{N}$$

Where,



- **S** = Number of Substitutions
- **D** = Number of Deletions
- **I** = Number of Insertions
- **N** = Number of characters in reference text (aka ground truth)

Different OCR accuracy and loss (CER) are as follows:

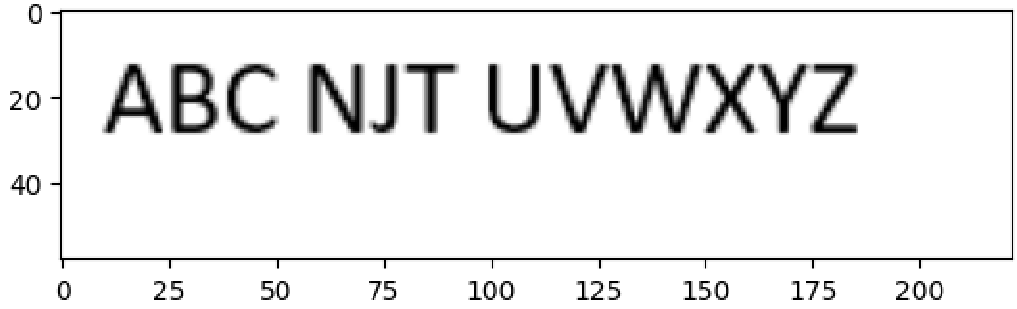


- **Good** OCR accuracy: CER **1-2%** (i.e. 98–99% accurate)
- **Average** OCR accuracy: CER **2-10%**
- **Poor** OCR accuracy: CER **>10%** (i.e. below 90% accurate)

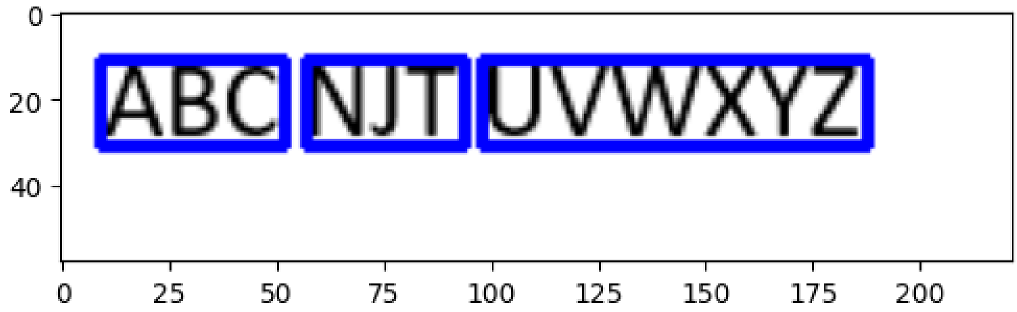
We tested for 1000 wikipedia images and found the CER to be **1.41%.** Thus, our OCR has good accuracy.

OCR example:

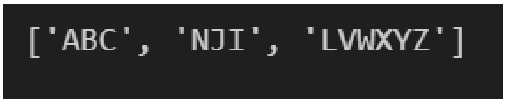
Input Image:



Word Segmentation:



Final result after character segmentation and CNN classification:



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['ABC', 'NJI', 'LVWXYZ']
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Here, OCR Identifies most of the letters correctly

References:

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[2] Ye, Q., Huang, Q., Gao, W., & Zhao, D. (2005). Fast and robust text detection in images andvideo frames. *Image and vision computing*, *23*(6), 565-576.

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[7] Liu, C., Wang, C., & Dai, R. (2005, August). Text detection in images based on unsupervisedclassification of edge-based features. In *Eighth International Conference on Document Analysis and Recognition (ICDAR'05)* (pp. 610-614). IEEE.

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