Literary Survey
Team ID: PNT2022TMID53272
Project Name: A Novel Method for Handwritten Digit Recognition System

What is the purpose of a handwritten recognition project?

In a fast paced digital world where data is consumed at such a rapid rate, it is essential that it should be in a compatible form given the rapid change in technology. Handwritten data will pose a hinderance in terms of this incompatibility in addition to being difficult to preserve. Hence it is essential that manual transcripts of data should be in digital format in order to tackle the problems stated.

Due to the large amount of handwritten data that needs to be digitalised, Artificial Intelligence became an effective tool to do this translation. Many methods have been studied to accurately translate manual transcripts to their digital versions.

In order to improve accuracy of the output, it is essential that new methods be further studied and implemented.

Methods studied

1. Image Segmentation based handwritten character recognition system
2. Character Segmentation using LSTM
3. Handwritten character recognition using ML algorithms
4. Handwriting Recognition using Unsupervised Learning

Methods explained

Image Segmentation based handwritten character recognition system

1. A publicly available dataset NIST which contains samples of handwritten characters from thousands of writers is used. The neural network model used is Convolutional Neural Networks (CNN).
2. CNN was trained using TensorFlow model, which is an open source library used for deep learning applications.
3. OpenCV, an open source library for image processing, was used to perform various operations like segmentation, thresholding and Morphological operations.
4. Obtained an accuracy of upto 94%.

Character Segmentation using LSTM

1. A publicly available dataset IAM Handwriting dataset was used which contains handwritten text of over 1500 forms including 5500+ sentences and 11500+ words.
2. An alternative approach to CNN where instead of classifying a dataset directly based on words, it is segmented based on characters and classified individually.

3. The characters are then reconstructed to form a word.
4. We used Tesseract LSTM with convolution model retrained on the aforementioned dataset.
5. Character level showed better test accuracy of 31% compared to word level which gave an average test accuracy of 22% (low accuracy due to a mini batch considered).
6. Yet it is not feasible to apply this method in practical applications due to imperfections in segmentation of the model.

Handwritten character recognition using ML algorithms

1. Digit dataset provided by Austrian Research Institute for Artificial Intelligence is used. It contains 1893 training samples and 1796 testing samples.
2. In this method, different machine learning methods such as
    1. Multilayer Perceptron
    2. Support Vector Machine
    3. NaFDA5
    4. Naive Bayes
    5. Bayes Net
    6. Random Forest
    7. J48
    8. Random Tree
3. These models are used to classify the images and compared based on accuracy.
4. Multilayer Perceptron gave the best accuracy with a score of 90%.

Handwriting Recognition using Unsupervised Learning

1. A publicly available dataset IAM Handwriting dataset was used which contains handwritten text of over 1500 forms including 5500+ sentences and 11500+ words.
2. Hidden Markov Model, an unsupervised probabilistic model, is used for classification.
3. Character error rate and word error rates are compared and the former shows lesser error rates. The rates for both gradually decrease indicating better learning by the model.
4. Comparing these results to supervised learning systems, it is shown to be higher.
5. Hence supervised learning system is better.

Technologies needed for development

1. HTML/CSS/JavaScript/Bootstrap - Front end development
2. Python
3. TensorFlow
4. PyTorch
5. Image Processing Basics
6. Flask - Back end development
7. Git and GitHub - Project management
8. IBM Cloud - Hosting
9. IBM Watson - Training the Deep Learning Model

References

1. **Image Segmentation based handwritten character recognition system** : https://ieeexplore.ieee.org/abstract/document/8473291?casa_token=1Qitrq5Qj5YAAAAA:TQe6tCr1Ujonvl49Le4QnAMaxOfGuKLPzgpwlaHqZzI9cnquVudvxmRnleSV1ipcAbu7uC1FUQ
2. **Character Segmentation using LSTM** : http://cs231n.stanford.edu/reports/2017/pdfs/810.pdf
3. **Handwritten character recognition using ML algorithms** : https://computerresearch.org/index.php/computer/article/view/1685/1669
4. **Handwriting Recognition using Unsupervised Learning** : https://ieeexplore.ieee.org/abstract/document/6981077?casa_token=jcwM4VT6dmQAAAAA:b980YTZGAfVzgaqPKaN16Xfx9Xq90LyEgSnjlYri-bdrZqfF4LsuSnVV9OLfQ8zUjyUMEGr6GA