An Effective Approach of English Braille to Text Conversion for Visually Impaired Using Machine Learning Technique

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AN EFFECTIVE APPROACH OF ENGLISH BRAILLE TO TEXT CONVERSION FOR VISUALLY IMPAIRED USING MACHINE LEARNING TECHNIQUE

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Machine learning is a burgeoning technology where the machine learns from the historical data. Predictions are made using a variety of algorithms based on past data. Braille is a fundamental system of raised dots that enables the visually challenged and impaired (VI) to write and read by touch. In the digital age, the visually impaired are facing great challenges in accessing digital content, integrating speech software as output will assist them in gaining more knowledge. The existing papers, uses SVM classifier, Braille script, keypad and microphone as input and the relevant English alphabets are produced as output. This project proposes a novel approach to convert English Grade 2 braille to English text using various different pre-processing steps using SVM Classifier. Braille images are captured by digital camera and pre-processed. The features of the scanned images are extracted by Segmentation. Support Vector Machine (SVM) Classifier with PCA feature extraction were used for Braille character recognition.

Keywords: Braille, PCA, SVM Classifier, Braille cell recognition.

INTRODUCTION

At least 2.2 billion people worldwide suffer from a near- or distance vision impairment. Nearly half of these cases, or at least 1 billion, involve vision damage that either might have been prevented or is still unaddressed. The majority of those who are blind or have visual problems are over 50, however visual impairment can affect anyone at any age. Louis Braille created Braille in 1824 as a reading and writing system for the persons who are blind. The basic Braille system consists of six raised dots that can be combined to form 64 different signs. Blind or visually impaired people can read embossed characters by feeling them with their fingers. In the Braille language, each character has a distinct code that makes it easier to distinguish between them.

An estimated 90 percent of the 37 million blind persons worldwide reside in developing nations. India is home to about 15 million of them. However, in India there are only 1% of the population that can read braille.

This era is highly technologically advanced period, it is challenging for the visually impaired and the blind to access the accessible digital content. VI and blind people can access these technologies in numerous ways. Screen readers, refreshable braille displays [1], and digital screen magnification are examples of what is referred to as assistive technology that blind people utilize to interact with high-tech items.

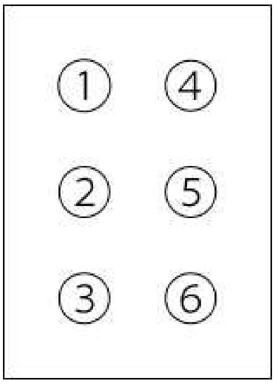


Fig 1: The Braille cell

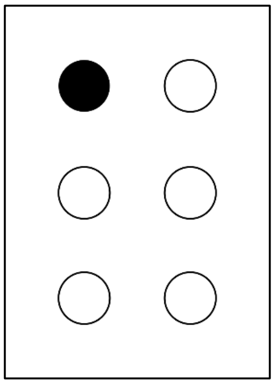
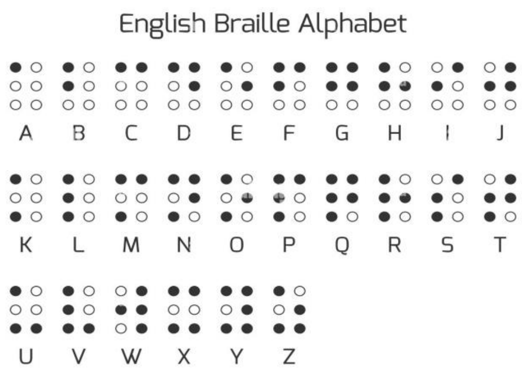


Fig 2: Braille letter 'a'



Screen readers are a boon for online users who use desktops and laptops and computers. Users who are blind or visually impaired can navigate the computer and use the core of its features largely owing to software products like [2]JAWS(Job Access With Speech) for Windows which is too expensive and out of reach for most people, [5]NVDA (Non-Visual Desktop Access) is a free, open source software which enables the VI and blind to access computers, ARIA, also known as "Web Accessibility Initiative - Accessible Rich Internet Applications," is a set of web standards that increase the accessibility of websites and mobile applications for those who are blinds and visually impaired. The integration of speech recognition software with the currently accessible digital materials will increase the digital literacy.

The aforementioned advancements in technology and challenges are the primary factors behind the need to develop an efficient solution for translating English braille into text and speech for the visually impaired and the blind. The necessary system must be simple to learn, affordable, and user-friendly. The proposed system uses Support Vector Algorithm (SVM), which is a machine learning technique to recognize English braille to text.

METHODOLOGY

The technique is divided into two phases: training and testing phases. This work is composed of various operations, including Image Acquisition, Image Pre-processing, Segmentation, Feature Extraction, SVM Classifier and Braille cell

The digitized Braille file is gathered during the testing phase and sent to the pre-processing block.

A. IMAGE ACQUISITION:

The fundamental step in image processing starts with Image Acquisition. The purpose of image acquisition is to convert an optical image into a collection of numerical data that can then be processed by a computer. There are several steps that are gone through in this process:

i. Gray scale conversion
ii. Noise reduction
iii. Image enhancement
iv. Image filtering
v. Contrast enhancement

The process of Gray scaling involves changing an image from another colour space, such as RGB to a shade of grayscales ass in below equation. Additionally, the colour information that is produced by digitizing them is useless in our system, making colour features unimportant. where the red, green, and blue channels of the RGB colour scheme are R, G, and B, respectively.

$$Grayscale = \left(\frac{R + G + B}{3}\right)$$

Random noise is produced during image acquisition and is spatially distributed throughout the image. Utilizing filtering image techniques is significant since they reduce noise from photos while retaining their original details. Digital images are modified during the process of image enhancement to provide outcomes that are better suited for enhanced image analysis. Using intensity adjustment, the dots acquire another level of improvement. This method of image enhancement maps an image's intensity values to a new range.

B. SEGMENTATION

The image is first split into lines and then into Braille cells in order to ensure the smooth the extraction of Braille characters. Further segmentation into binary dot patterns occurs within each cell. These are accomplished using traditional Braille measurements and projection profiles. The edge detected image is subjected to horizontal profiling, and a zero profile implies that there are no dots and lines. Among various such lines, the topmost line that is closest to the dots is used as a reference. The remaining lines are drawn where the X projection is zero, at the typical vertical distance between two Braille cells. This process is repeated till the end of the document.

C. FEATURE EXTRACTION

The technique of transforming raw data into numerical features that can be handled while retaining the information in the original data set is known as feature extraction. The current study translates Braille to English alphabet text using Principal component analysis (PCA)-based feature extraction algorithms with SVM.

i. Principal component analysis (PCA)

One of the widely used feature extraction techniques for dimensionality reduction is PCA. It is employed for data exploration and the development of prediction models. Typically, PCA seeks out the lowest-dimensional surface to project the highest-dimensional data. PCA functions by taking into account each attribute's variance since a high attribute indicates a solid split between classes, which lowers the dimensionality. PCA retains the majority of the variance while developing new features. PCA is used to identify correlations and patterns in a dataset, so that it can be reduced in size while keeping all of the relevant information. A projection-based multivariate data analysis is built on PCA. The most typical use of PCA is to reduce the number of variables in a multivariate data table so that trends, jumps, clusters, and outliers may be seen.

An effective method for analysing datasets with missing values, category information, and inaccurate measurements is PCA. The Principal Components are the newly created, altered features or the result of PCA. The removal of correlation between the dataset's components, accelerated algorithm performance, elimination of the overfitting issue in the model, and improved visualization are the main benefits of employing PCA.

D. SVM CLASSIFIER

A support vector machine (SVM) is a supervised learning algorithm widely used for a variety of classification and regression tasks, including voice and image recognition, medical signal processing, and natural language processing. The proposed technique uses unsupervised classification, which negates the necessity for prior knowledge. SVM[2] performs better than other classification algorithms in terms of classification performance.

SVM needs minimal time and effort during training and is effective at handling outliers. In high-dimensional areas, SVM creates a hyperplane to improve classification. If the functional margin of the hyperplane is high, a classifier can operate effectively. A larger margin lowers the possibility of generalized errors. SVM identifies the hyperplane that offers the most insightful minimum distance for the training set. In the input space, a nonlinear transformation function $\emptyset(.)$ is performed if the data cannot be separated linearly. This function then transfers the data points ($x \in IR^n$) to a high-dimensional space (H), which is known as a feature space.

A kernel function called K (.,.) is used to describe mapping in the SVM classifier, and it often represents the inner product in H. as, K (x, t) = (X). $\emptyset$(t). The only places for which these coefficients are not zero are the support vectors, which are also the points closest to the distinct boundary.

The data are compared to the test data for matching after training. The prediction is made in a way that the feature with the greatest degree of similarity is picked to obtain the matched Character.

CONCLUSION

The Braille literacy is posing a significant barrier to the visually impaired people's ability to take their best possible position in society. For them, using the Braille system is essential. This paper focuses on how to effectively translate English braille into text for blind and visually impaired people. The mapping of Braille is standard and varies from language to language. The alphabets are identified using the right mapping for each language, and they are then saved as text. The initial pre-processing stages for the acquired Braille are performed using SVM classifier to ensure correct text conversion. English Braille alphabet recognition is performed using SVM with the PCA-based feature extraction method. There are 26 classes of braille characters. The training and test dataset was split in a ratio of 80:20. The ML methodology, SVM with Linear and RBF kernels were used to boost the accuracy, as linear kernel is good for large dataset and RBF yields high accuracy. By making changes in the values of hyperparameters in GridSearchCV, it is found that, performance of model gives better accuracy. After training the model, the test data are sent to testing phase to predict the appropriate Braille characters.

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