A Novel Method for Handwritten Digit Recognition System

Introduction:

Everyone in the world has a unique writing style, handwriting identification is one of the fascinating research projects now being conducted. It is the ability of a computer to automatically recognize and comprehend handwritten numbers or letters. Every aspect of life is being digitalized to lessen the need for human labor as a result of advancements in science and technology. Thus, handwritten digit recognition is required in many real-time applications. The MNIST data collection, which contains 70000 handwritten digits, is frequently utilized for this recognition method. In order to train these photos and create a deep learning model, we use artificial neural networks. This provides an effective and reliable method for the recognition of handwritten digits.

Literature Survey:

[1] This paper proposes that using neural network classifiers with single-layer training can be applied ably to complex real time classification queries like recognizing handwritten digits. This paper initiates the STEPNET algorithm, which breaks the major problem into simpler sub problems. Given suitable data representations and learning regulations are indulged, performance which are similar to those acquired by more compound networks can be achieved. It propagates the outcomes of 2 dissimilar databases; a European database consists 8000 plus separated digits, and zip code database from the US Postal Service consists 9000 plus segmented digits.

Algorithms Used: STEPNET, MLP

Advantage: The discussed system gives the STEPNET structure and training procedure to give a very satisfactory recognition rate moderately. The performance in real world environments also appears to be at standard level of present-day recognition systems.

Disadvantages: STEPNET procedure gives the problem of classification problems. Training times and classification times favorably with respect to the MLP. It is greatly based on hardware implementation.

[2] Here they demonstrate a backpropagation network application for handwritten zip code recognition. The architecture of the network was very limited and made expressly for the task, so little pre-processing of the data was necessary. The network's input consists of solitary digits in size-normalized pictures. The accuracy of the zip code digits 92%. Using structured neural networks, considered to be "statistical methods with structure" that bridge the gap between purely statistical and fully structural methods.

Algorithms Used: Neural Networks

Advantages: Handwritten zip code recognition was successfully implemented by back propagation. The by pyramidal architecture and constraints on the weights were designed incorporate geometric knowledge. This model's adaptability is very well suited to problems with high variability and / or noise. Task specific information needed was comparatively very less.

Disadvantages: The necessity to normalize the size of the pixel image, which is quite expensive operation. However, implementation of neural net chips suggest that brute force methods are possible. The raw speed of the chips allows to run several networks in parallel at various scales and positions on the region of interest

[3] It is explained how a neural network algorithm-based system can read handwritten ZIP codes seen on actual US mail. The system employs a recognition-based segmenter, which combines vertical cuts, connected-components analysis (CCA), and a recognizer from a neural network. CCA handles connected components with single digits. The vertical-cut segmenter handles CCs that are merged or divided into digits. Preprocessing, where noise is eliminated and the digits are de-italicized, CCA segmentation and recognition, vertical-cut-point estimation and segmentation, and immediately lookup are the four key processing steps. The algorithm was trained and tested using five- and nine-digit ZIP code fields obtained from actual mail in about 10,000 photos.

Algorithms Used: CNN (Convolutional Neural Network), CCA (Connected Components Analysis)

Advantages: Makes the sorting task much easier and also reduces the time taken.

Disadvantages: Error in preprocessing which leads to important parts of the image to be removed as noise.

[4] Doctors in developing nations don't have a digitized prescription system and thus still make use of handwritten prescriptions. This makes it challenging for the patients to know what medicines have been prescribed as the handwriting is sometimes not legible enough. This paper suggests the use of a smartpen which will recognize the writings and digitize this in real life.

Advantages:

- Reducing Medical error
- Reduce healthcare cost.
- Improving patient outcomes.

Disadvantages:

The use of a smartpen becomes mandatory. The cost of such is device is still high for developing nations, which try to cut on costs to operate profitably.

[5] This paper lists various reasons why perfect outcomes can't be achieved with current AI & ML methodologies. Along with this they have mentioned a way to recognize digits with the help of decision tree classifier. Decision Tree classifier has been implemented by using 'numpy', 'pandas' and 'sklearn'. This paper has made use of the Kaggle dataset for handwritten digits. Each image in the dataset is converted into a gray scale image of 28 x 28 pixel. Then the developed model would try to predict the class for the given input. The final accuracy of the model proposed in the system turned out to be 83.4%.

Algorithms Used: Decision tree classifier

Advantage: Here only decision tree classifier is used, so the model is simple to understand.

Disadvantage: The accuracy level of the proposed model is good but when compared to other methods such as using ANN, the accuracy level is considerably low.

[6] RGB color plays the major role in this technology, For the competition, the images are delivered in original size with a resolution of 300 dpi Single Digit dataset consists of 10 classes (0-9) with 3,578 samples per class. For the HDR competition, 7,000 digits (700 digits per class) of 67 writers have been selected as training set. It has equal size has been published with a different set of 60 writers and variations for characterizing the relation between background and foreground, a descriptor based on concavities is used. For each background pixel a 4-bit code yielded by searching for a foreground pixel in four directions is computed, if a foreground is found the corresponding bit is set to 1, in other case to 0.

Advantages: This technology helps to transform the writings in the papers to a text document format which can also be said as readable electronic format. By this way, historical facts can be stored, reviewed and shared easily too many people. Lastly, the advantage is textual studies with the help of HDR digit recognition.

Disadvantages: Huge variability and ambiguity of strokes from person to person, this technology handwriting style of an individual person also varies time to time and is inconsistent.

[7] Neural networks rose to prominence among all character recognition classifiers in the 1980s, as seen by the results obtained by Lacuna's. Lent family of neural networks. which are Convolutional neural networks, as opposed to simple fully connected networks, are sensitive to the topological characteristics of the input (in this case, the image). Another significant occurrence SVMs were introduced in the region. Those SVMs based on the notion of structural risk minimization (SRM) It limits the generalization risk to a minimum, whereas the objective of neural networks is to reduce the empirical risk. In the case of handwritten recognition, SVMs gave very good results and OCR technology is very important in this field.

Advantages: OCR technology provides higher than 99% accuracy with typed characters in high-quality images. However, the diversity in human writing types, spacing differences, and irregularities of handwriting causes less accurate character recognition, as you can see in the featured image

Disadvantages: The main disadvantage is that there is no possibility of obtaining information about the type of the input. First, the text has to be separated into characters or words.

References:

[1] Handwritten Digit Recognition by Neural Networks with Single-Layer Training by *S. Knerr, L. Personnaz, G. Dreyfus* (Link)

[2] Handwritten Zip Code Recognition with Multilayer Network by *Y. Le Cun, O. Matan, B. Boser, J. S. Deker, D. Henderson, R. E. Howard, W. Hubbard, L. D. Jacket, H. S. Baird* (Link)

[3] Reading Handwritten Digits: A ZIP Code Recognition System by *Ofer Matan, Henry S. Baird, Jane Bromley, Christopher J. C. Burges, John S. Denker, Lawrence D. Jackel, Yann Le Cun, Edwin P.D. Pednault, William D. Satterfield, Charles E. Stenard, and Timothy J. Thompson* (Link)

[4] An online cursive handwritten medical words recognition system for busy doctors in developing countries for ensuring efficient healthcare service delivery by *Shaira Tabassum, Nuren Abedin, Md Mahmudur Rahman, Md Moshiur Rahman, Mostafa Taufiq Ahmed, Rafiqul Islam, Ashir Ahmed* (Link)

[5] Handwritten digits recognition with decision tree classification: a machine learning approach by *Tsehay Admassu Assegie, Pramod Sekharan Nair* (Link)

[6] Competition on Handwritten Digit Recognition (HDRC 2013) by *Markus Diem; Stefan Fiel; Angelika Garz; Manuel Keglevic; Florian Kleber; Robert Sablatnig by ICDAR2013* (Link)

[7] A trainable feature extractor for handwritten digit recognition by *Fabien Lauera, Ching Y. Suenb, Gérard Bloch* (Link)