

SURVEY ON LETTER RECOGNITION USING DEEP LEARNING

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ABSTRACT

Handwritten character recognition is famous because of its wide scope of utilization. Processing application structures, digitizing antiquated articles, postal location processing, bank check processing and numerous others are the developing fields in territory of handwritten character processing. Handwritten character is drawing in researchers since last 3 decades. Numerous methodologies have been proposed for successful recognition. The programmed recognition of handwriting has been under scrutiny since the 1950's when applications for the moderately new digital computer technology happened to revenue. From that point forward, there has been consistent research exertion into the programmed processing and recognition of handwriting. The overall classes into which the processing of handwriting can be isolated are introduced. Empowering progress has been accounted for in the programmed recognition of numerical formulae, printed characters, cursive content and mark confirmation, and there has been a restricted measure of research into applying programmed picture processing to individual recognizable proof and record validation through essayist ID or the location of masked or fashioned handwriting. Notwithstanding the recognition of Roman scripts and symbols there has been escalated work into the recognition of Chinese, Japanese, and other handwritten scripts. Different utilizations of handwriting recognition are workable for altering, commenting on and other profoundly intuitive exercises which require pointing and explanation. In this day and age it has gotten simpler to prepare profound neural organizations on account of accessibility of enormous measure of information and different Algorithmic developments which are occurring. Now a-days the measure of computational force expected to prepare a neural organization has expanded because of the accessibility of GPU's and other cloud based administrations like Google Cloud stage and Amazon Web Services which give assets to prepare a Neural Network on the cloud. . Handwriting recognition has picked up a great deal of consideration in the field of example recognition and AI because of its application in different fields. Optical Character Recognition (OCR) and Handwritten Character Recognition (HCR) has specified domain to apply. Different strategies have been proposed to for character recognition in handwriting recognition framework. Numerous examinations and papers portrays the strategies for changing over literary substance from a paper report into machine meaningful structure. In coming days, character recognition framework may fill in as a vital factor to establish a paperless climate by digitizing and processing existing paper records. This paper presents a definite audit in the field of Handwritten Character Recognition.

Keywords: Handwritten Character Recognition, Optical Character Recognition.

I. INTRODUCTION

In 1917, A 18-year-old Mary Jameson demonstrated the Optophone. Light from a printed page indicates a selenium cell, and the machine lets out a melodic harmony. Ms. Jameson, who is visually impaired, can print at a record-breaking velocity of one word/min.



Fig.-1: A man demonstrates the Optophone in 1921

In 1951, David Shepard built up a machine that could perceive each of the 26 letters of the Latin letters in order, as created by a standard kind essayist. He called it "Gismo", which later developed into the Farrington Machine. By the 1960s, OCR technology is being utilized altogether in mail-arranging by the U.S. postal help.



Fig.-2: Postal employee showing off the Farrington Automatic Address Reader in the 1960s.

In 1974, Kurzweil Technologies delivered the CCD flatbed scanner, the first omni-text style optical character recognition framework. Prior to 1974, OCR could just peruse text styles extraordinarily intended for machine meaningfulness. During the 70s, the extent of OCR is enlarging, and the innovative universe is starting to envision its future effect.

In 1992, The Newton MessagePad was dispatched on May 29th, wandering into a muddled domain of OCR technology called handwriting recognition. The Newton was a disappointment.



Fig.-3: The Newton MessagePad

In 2006, Google took the OCR software, Tesseract, under the care of its, quickening industry coordinated effort. In the coming years, OCR is hitched to neural organizations. Rather than contributing the principles of language into a machine, neural organizations will permit OCR to perceive designs for themselves.

Recognition of handwriting is a functioning and troublesome investigation zone. The ID system for handwriting has an extremely huge impact in the globe of today. Recognition of handwriting is a typical and expensive work. Presently, finding the correct criticalness of handwritten papers is hard. There are numerous spots where words, letter sets and digits should be perceived. There are numerous postal locations for applications, bank checks where we need to perceive handwriting. There are fundamentally two particular sorts of web and offline handwriting recognition techniques for handwriting. There are numerous strategies for the ID plan of offline handwriting. This audit record will portray the requirements and superiorities of different methods utilized for the distinguishing proof plan for handwriting. Recognition of handwriting has been researched over numerous years. Handwriting distinguishing proof framework can be utilized to fix many muddled issues and encourage the occupation of creatures. In handwriting recognition (HWR) the gadget deciphers the client's handwritten characters or words into a configuration that the computer comprehends (e.g., Unicode text). The info gadget commonly contains a pointer and a touch screen. There are numerous degrees of HWR, beginning from the recognition of disentangled individual characters to the recognition of entire words and sentences of cursive handwriting.

II. LITERATURE REVIEW

The procedure by which a computer framework can perceive characters and different symbols composed by hand in normal handwriting is called handwriting recognition framework. Handwriting recognition is characterized into offline handwriting recognition and online handwriting recognition.

An early remarkable endeavor in the zone of character recognition research is by Grimsdale in 1959. The source of a lot of research work in the mid sixties depended on a methodology known as investigation by-amalgamation technique proposed by Eden in 1968. The incredible significance of Eden's work was that he officially demonstrated that all handwritten characters are shaped by a limited number of schematic highlights, a point that was certainly remembered for past works. This thought was later utilized in all techniques in syntactic (primary) approaches of character recognition

On the off chance that handwriting is checked and, at that point comprehended by the computer, it is called offline handwriting recognition. In the event that, the handwriting is perceived while composing through touch cushion utilizing pointer pen, it is called online handwriting recognition. From the classifier viewpoint, character recognition frameworks are grouped into two principle classifications for example division free (worldwide) and division based (insightful). The division free otherwise called the comprehensive way to deal with perceive the character without portioning it into subunits or characters. Each word is spoken to as a bunch of worldwide highlights, for example ascender, circles, cusp, and so forth Though division based methodology [1]; each word/ligature is portioned into subunits either uniform or non-uniform and subunits are considered freely. Handwritten character processing frameworks are space and application explicit, similar to it is beyond the realm of imagination to expect to plan a conventional framework which can deal with a wide range of handwritten scripts and language. Bunches of work has been done on European dialects and Arabic (Urdu) language. While homegrown dialects like Hindi, Punjabi, Bangla, Tamil, Gujarati and so on are extremely less investigated because of restricted utilization.

K. Gaurav, Bhatia P. K. [2] Et al, this paper manages the different pre-processing procedures associated with the character recognition with various sort of pictures goes from a basic handwritten structure based records and reports containing hue and complex foundation and changed forces. In this, extraordinary preprocessing procedures like slant location and amendment, picture improvement methods of difference extending, binarization, clamor expulsion strategies, standardization and division, morphological processing methods are talked about. It was presumed that utilizing a solitary method for preprocessing, we can't totally handle the picture. Nonetheless, even in the wake of applying all the said strategies may unrealistic to accomplish the full precision in a preprocessing framework.

Salvador España-Boquera et al [3], in this paper cross breed Hidden Markov Model (HMM) model is proposed for perceiving unconstrained offline handwritten writings. In this, the underlying piece of the optical model has been demonstrated with Markov chains, and a Multilayer Perceptron is utilized to appraise the emanation probabilities. In this paper, various procedures are applied to eliminate incline and inclination from handwritten content and to standardize the size of text pictures with directed learning strategies. The critical highlights of this recognition framework were to build up a framework having high exactness in preprocessing and recognition, which are both dependent on ANNs.

In [4], an altered quadratic classifier based plan to perceive the offline handwritten numerals of six famous Indian scripts is proposed. Multilayer perceptron has been utilized for perceiving Handwritten English characters.

In [5] the highlights are extricated from Boundary following and their Fourier Descriptors. The character is recognized by breaking down its shape and looking at its highlights that recognize each character. Additionally an investigation has been done to decide the quantity of shrouded layer hubs to accomplish superior of the back engendering network. A recognition exactness of 94% has been accounted for Handwritten English characters with less preparing time.

In [6], inclining highlight extraction has been proposed for offline character recognition. It depends on ANN model. Two methodologies utilizing 54 highlights and 69 highlights are picked to assemble this Neural Network recognition framework. To think about the recognition proficiency of the proposed inclining technique for include extraction, the neural organization recognition framework is prepared utilizing the flat and vertical element extraction strategies. It is discovered that the slanting strategy for highlight extraction yields the recognition exactness of 97.8 % for 54 highlights and 98.5% for 69 highlights.

Sandhya Arora in [7], utilized four component extraction strategies in particular, convergence, shadow include, chain code histogram and straight line fitting highlights. Shadow highlights are figured universally for character picture while crossing point highlights, chain code histogram highlights and line fitting highlights are processed by separating the character picture into various portions. On experimentation with a dataset of 4900 examples the general recognition rate noticed was 92.80% for Devanagari characters.

Mohammed Z. Khedher, Gheith A. Abandah, and Ahmed M. Al Khawaldeh [8] et al, this paper portrays that Recognition of characters enormously relies on the highlights utilized. A few highlights of the handwritten Arabic characters are chosen and examined. A disconnected recognition framework dependent on the chose highlights was fabricated. The framework was prepared and tried with reasonable examples of handwritten Arabic characters. Assessment of the significance and precision of the chose highlights is made. The recognition dependent on the chose highlights give normal correctnesses of 88% and 70% for the numbers and letters, separately. Further enhancements are accomplished by utilizing highlight loads dependent on bits of knowledge picked up from the exactnesses of individual highlights.

In writing [9], T. Som have talked about fluffy participation work based methodology for HCR. Character pictures are standardized to 20 X 10 pixels. Normal picture (intertwined picture) is framed from 10 pictures of each character. Holding box around character is dictated by utilizing vertical and even projection of character. In the wake of editing picture to bouncing box, it is resized to 10 X 10 pixels size. From that point forward, thing is performed and diminished picture is put in individually crude of 100 X 100 canvas. Likeness score of test picture is coordinated with combination picture and characters are arranged.

In [10], Renata F. P. Neves have proposed SVM based offline handwritten digit recognition. Creators guarantee that SVM outflanks the Multilayer perceptron classifier. Examination is completed on NIST SD19 standard dataset. Preferred position of MLP is that it can fragment non-straightly divisible classes. Be that as it may, MLP can without much of a stretch fall into a district of neighborhood least, where the preparation will quit accepting it has accomplished an ideal point in the mistake surface. Another block is characterizing the best organization design to take care of the issue, thinking about the quantity of layers and the quantity of perceptron in each concealed layer. Due to these detriments, a digit recognizer utilizing the MLP structure may not deliver the ideal low blunder rate.

G. Pirlo and D. Impedovo in his work on [11], introduced another class of participation capacities, which are called Fuzzymembership capacities (FMFs), for drafting based classification. These FMFs can be handily adjusted to the particular characteristics of a classification issue to augment classification execution. In this research, a realcoded hereditary calculation is introduced to discover, in a solitary streamlining system, the ideal FMF, along with the ideal drafting portrayed by Voronoi decoration. The exploratory outcomes, which are completed in the field of handwritten digit and character recognition, demonstrate that ideal FMF performs in a way that is better than other participation capacities dependent on dynamic level, positioned level, and estimation level weighting models, which can be found in the writing.

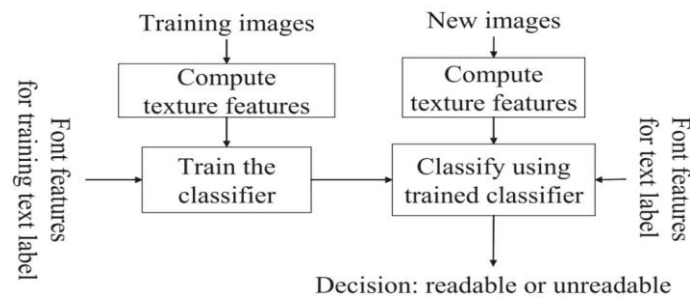
Nafiz Arica et al. [12] proposed a technique which evades the majority of the pre-processing tasks, which causes loss of significant data. One of the significant commitments of the technique is to advancement of an amazing division calculation. Usage of the character limits, neighborhood maxima and minima, incline point, upper and lower baselines, stroke tallness and width, and ascenders and descenders improve the hunt calculation of the ideal division way, applied on a dim scale picture. This methodology diminishes the over-division. Another commitment is the utilization of Hidden Markov Models (HMM) preparing, for the assessment of model boundaries, yet in addition for the assessment of some worldwide and highlight space boundaries. Additionally, HMM probabilities are utilized to quantify the shape data and rank the applicant character. One dimensional portrayal of a two dimensional character picture builds the intensity of the HMM shape recognizer.

M. Hanmandlu, O.V. Ramana Murthy[13] have introduced in their investigation the recognition of handwritten Hindi and English numerals by speaking to them as remarkable enrollment capacities which fill in as a fluffy model. The recognition is done by adjusting the dramatic enrollment capacities fitted to the fluffy sets. These fluffy sets are gotten from highlights comprising of standardized distances acquired utilizing the Box approach. The participation work is changed by two underlying boundaries that are assessed by enhancing the entropy subject to the accomplishment of enrollment capacity to solidarity. The general recognition rate is discovered to be 95% for Hindi numerals and 98.4% for English numerals. to be 95% for Hindi numerals and 98.4% for English numerals.

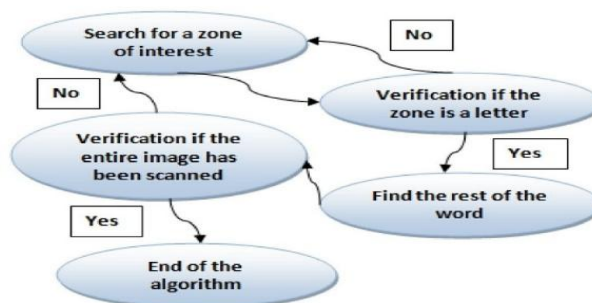
In [14], a technique to develop a handwritten Tamil character by executing a succession of strokes is proposed. A structure or shape-based portrayal of a stroke was utilized in which a stroke was spoken to

as a line of shape highlights. Utilizing this string portrayal, an obscure stroke was recognized by contrasting it and an information base of strokes utilizing an adaptable string coordinating system. A full character was perceived by distinguishing all the part strokes.

[15] depicts an example recognition way to deal with decide comprehensibility of text names in expanded reality frameworks. In many expanded reality applications, one of the manners by which data is introduced to the client is to put a book mark over the territory of interest. Notwithstanding, if this data is put over occupied and finished foundations, this can influence the coherence of the content. The objective of this work was to distinguish techniques for quantitatively depicting conditions under which such content would be meaningful or indiscernible. Alex Leykin and Mihran Tucery utilized surface properties and other visual highlights to decide whether a book put on a specific foundation would be clear or not. In light of these highlights, a regulated classifier was constructed that was prepared utilizing information gathered from human subjects' judgment of text clarity. Utilizing a fairly little preparing set of around 400 human assessments more than 50 heterogeneous surfaces the framework can accomplish a right classification pace of over 85%. Design of this framework is appeared in the accompanying chart Fig 4.



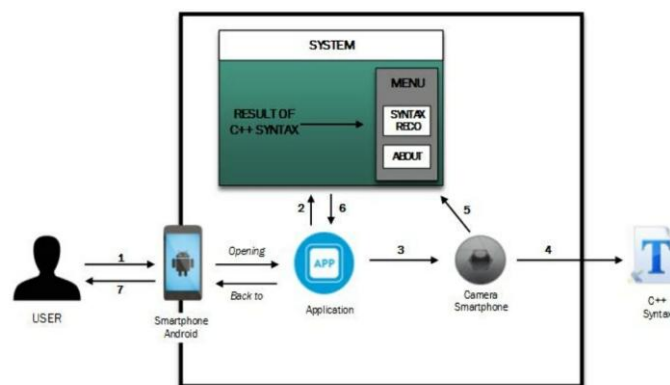
In [16], Marc Petter, Victor Frago, Matthew Turk and Charles Baur have presented a quick programmed text location calculation concocted for a versatile expanded reality (AR) interpretation framework on a cell phone. In this application, scene text should be distinguished, perceived, and converted into an ideal language, and afterward the interpretation is shown overlaid appropriately on this present reality scene. To offer a quick programmed text identifier, they centered their underlying pursuit to locate a solitary letter. Distinguishing one letter furnishes valuable data that is prepared with effective principles to rapidly discover the token of a word. This methodology considers distinguishing all the coterminous content areas in a picture rapidly. We likewise present a technique that abuses the excess of the data contained in the video transfer to eliminate bogus alerts. Their trial results evaluate the precision and effectiveness of the calculation and show the qualities and shortcomings of the strategy just as its speed (around 160 ms on a new age cell phone, not improved). The calculation is appropriate for constant, certifiable applications. Calculation utilized is appeared beneath in Fig 5:



[17] states that as of late with the quickly development of PDAs/gadgets, enlarged reality turns out to be essential for some versatile applications. For example, we can refer to the interpretation applications. This paper gives an account of an audit of writing on expanded reality text interpretation. The fundamental parts of any enlarged reality interpretation application are: text location, text extraction and text interpretation. In this manner the elements considered in our examination include: the utilized Optical Character Recognition (OCR) for text extraction, the pre-owned procedure/calculation for recognizing the content, the pre-owned API's for text interpretation, the pre-owned instruments in building up these applications and utilized programming language(s), the application supporting platform(s), the upheld interpretation dialects, the dataset utilized for assessing the framework and

ultimately, the aftereffects of the analyses. Altogether, 12 investigations distributed somewhere in the range of 1998 and 2016 were broke down. The principle discoveries from this survey give the present status of the craftsmanship on research in expanded reality in content interpretation. Moreover, the paper licenses to set up the ways towards building up an android versatile application for constant Arabic content interpretation. In spite of the fact that the advancement and the reconciliation of the new innovations in the interpretation cycle, the current applications are as yet restricted to not many number of dialects. Arabic language is one of those not yet upheld.

[18] introduced Augmented Reality executed in an application called ARC++ with ongoing recognition and data extraction. Application perceived the C++ punctuation and showed the data subtleties of language structure through Smartphone to the client. In motivation behind constant recognition, we utilize Optical Character Recognition. Technique to plan and assemble the application depends on Prototyping model. Utilizing markerless Augmented Reality, Optical Character Recognition and Vuforia, the application was constructed, introduced and running on Android working framework. C++ language structure as markerless item target, utilize a handwritten or printed grammar. The usefulness of utilization has been tried with different grammar classes to pick up consequences of how well the application identify, perceive and remove data from object target sentence structure that has been filtered. The testing of ARC++ application is estimated by the exactness of location and recognition. In light of the testing situation, this application shows essentially recognitions about 70% to 100% for handwritten grammar, printed sentence structure with various sizes, shadings, styles and unique characters. Despite the fact that there is just 30% effective recognition while utilizing underline sentence structure as article focused on punctuation, yet ARC++ can distinguish, perceived and extricate extra data from C++ grammar. ARC++ application conceivably can be utilized as an alluring of learning C++ punctuation. Fig 6



III. PROPOSED WORK

Aim -

1. System will be designed in way to ensure that offline Handwritten Recognition of English characters.
2. Our old and epic HCR literature can be restored in digital form.
3. Use of Neural Network for classification.
4. Large number of training data set will improve the efficiency of the suggested approach.

Purpose -

Our software will permit clients to interpret every one of those signs and notes into electronic words in a doc format. The upside of this electronic storage is that this information just needs far less actual space. Another favorable position of the electronic storage is that it requires less workers to figure out the reports, sort out and to keep the information storage distribution center.

Other than that, information recovery is another favorable position of handwriting recognition. Actual information recovery consistently expects work force to figure out actual duplicates of old data. The information should consistently have been put away and effectively coordinated and furthermore it should have legitimate support and upkeep on the actual duplicates. To hold this data or information, we perform electronic information recovery by utilizing a record search by utilizing explicit watchwords, for instance, similar to the names and the dates of the document or archive. Handwriting recognition software permits the old records to be saved in a legitimate electronic organization. This is the manner by which handwriting recognition software helps in saving the old records or significant archive. For a model, a few centers incline toward keeping their patient's clinical records and handwriting recognition

helps in the present circumstance by protecting these clinical records in the computer. This information or records can be inspected and refreshed chance to time when required without stressing if the date will be lost.

Another preferred position of our software is verifiable protection. Verifiable papers generally exist in actual organization. Instances of authentic papers are genealogical data, composed manuscripts, old family records, and some close to home journals and here and there even shared old past stories. Yet at the same time in some cases, these chronicled papers may be harmed or adulterated because of certain mishaps and there is when handwriting recognition software is actually quite supportive. Handwriting recognition assists with changing the compositions in the papers to a book archive design which can likewise be said as comprehensible electronic configuration. By thusly, chronicled realities can be put away, evaluated and shared effectively such a large number of individuals.

In conclusion, the favorable position is literary examinations. A printed study is a class of writing contemplates. Writing examines include auditing the first manuscripts of writing in examination with the printed variant. This implies that the story has been burrowed and changed by an editor. This is the reason unique manuscripts are well cared for yet this requires a total survey of the original copy. Handwriting recognition assists with being careful these unique manuscripts in an electronic organization and it very well may be inspected without harming the first duplicate of the manuscripts.

Objective -

1. Use Neural signs in literature domain.
2. Reduced man-power to convert old literature into digitized form manually.
3. Proposed system served as guide and working in character recognition areas.
4. Making rich the digitized library with English language

Working Principle -

A server -_This is the backend of our framework. This server is a computer which is equipped for executing a python content. It is required in light of the fact that an android PDA doesn't have the calculation power needed for running neural organizations and performing picture processing activities. Additionally the utilization of server for performing computationally escalated assignments empowers clients of more seasoned advanced cells to utilize our framework. We utilized the Convolutional Neural Network Model in our framework. We utilized the freely accessible NIST Dataset which contains tests of handwritten characters from a great many essayists. The neural organization model which we have utilized is Convolutional Neural Network. CNN's are State-of-Art neural organizations which have colossal applications is field of Computer Vision. The neural organization model was prepared utilizing Tensorflow which is an open source library utilized for Machine learning applications. OpenCV was utilized to perform different picture processing activities like division , thresholding and Morphological Operations. OpenCV is an open source library which is utilized for Image processing.

An application - This is the frontend of our framework. The application causes the client to click an image of text which is to be perceived , utilizing their cell phone camera. This image is given to a python content running on a server which further cycles this picture to separate the pertinent data

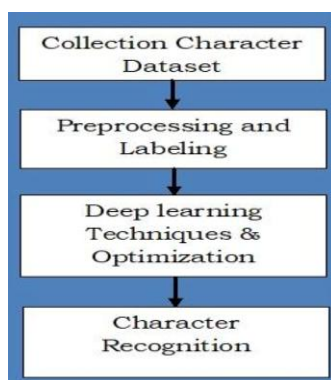


Fig.-7: Block diagram representing handwriting recognition using deep learning.

IV. CONCLUSION

We have talked about in detail all advances in the territory of handwritten character recognition. The most exact arrangement gave around there straightforwardly or in a roundabout way relies on the quality just as the idea of the material to be perused. Different methods have been depicted above for character recognition in handwriting recognition framework. A short comparison is displayed between the changed strategies proposed so far in the above table. From the examination done thus far, it is learnt that the determination of the classification and the feature extraction strategies should be appropriate to achieve great rate in perceiving the character. Studies uncover that there is still chance of upgrading the calculations just as improving the pace of recognition of characters.

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