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Pattern Recognition using Convolutional Neural Network for Handwritten Gujarati Numerals

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Abstract: ***Day-to-day technology is going in no time, digital acknowledgement are taking part immensely and providing additional scope to perform scrutiny in CNN techniques. Recognition of Gujarati transcribed numeral is difficult compared to different western numerals. However, several analyzers have provided real time answer for transcribed Gujarati numerals. This paper represents acknowledgement of transcribed Gujarati digits which enhances Convolutional Neural Network. Current analysis offers several solutions on Gujarati handwritten documents analysis and reasonable accuracy for concerning transcribed digit recognition.***

Index Terms: ***Gujarati handwriting; Gujarati numerals; handwritten numerals, Convolution Neural Network, CNN, and Data-Set***

I. INTRODUCTION

From the Indian languages, Gujarati is an Indic language and spoken preponderantly by the Gujarati folks. It is one of the sixth broadly uttered languages in Asian country by range of native speakers, 55.5 million speakers that range to concerning about 4.5% of the entire Indian population. The written Gujarati Numerals on a paper converted into digital type face a lot of issues with great electronic importance. There are some solutions for clearly imprint documents in several language scripts. Solutions for handy written documents still face several challenges in almost all the languages. The reason is design differs from individual to individual, because of immensity, pattern, etc. Here for Gujarati handwritten numeral recognition, the concepts were taken from various papers of numerous languages for handwriting recognition.

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Table 1. Pronunciation of English and Gujarati Numerals

English Numerals	Pronunciation	Gujarati Numerals	Pronunciation
0	Zero	૦	Shoonya
1	One	૧	Ek
2	Two	૨	Be
3	Three	૩	Tran
4	Four	૪	Chaar
5	Five	૫	Panch
6	Six	૬	Chha
7	Seven	૭	Saat
8	Eight	૮	Aath
9	Nine	૯	Naav

II. LITERATURE REVIEW

Neha Sahu, Nitin Kali Raman [1], in this paper Character acknowledgment frameworks for various dialects and content have been picked up significantly in 10 past years and is one of the space of enthusiasm for a few analysts. Their advancement is effectively coordinated with Neural Networks. Be that as it may, perceiving Devnagari is nearly greater test due to content's intricacy. Various procedures are implemented for this disadvantage with a few improvements to this point. This paper portrays the occasion and usage of one such framework containing mix of numerous stages. Principally ANN method is utilized to plan and to pre-process, area and recognize Devnagari content characters. The framework was structured, authorized, prepared and situated to display partner degree exactness of 75.6% on humming characters. Munish Kumar, M. K. Jindal, R. K. Sharma [2], the expanding need of an interpreted character acknowledgment framework inside the Indian workplaces has made it a key field of investigation. In current paper, Authors have offered an interesting hierarchal procedure for separated Gurmukhi composed character investigation. A tough list of capabilities of one zero five element parts is arranged underneath this work for acknowledgment of disconnected composed Gurmukhi characters exploitation four sorts of topological choices. Ashutosh Aggarwal, Karamjeet Singh, Kamalpreet Singh [3], in this investigation framework composed Gurmukhi dataset exploitation angle information for highlight deliberation method is arranged.

Work has also been prolonged to check the presentation of the component of angle utilizing reflection strategy on tests of Gurmukhi dataset consolidated along. Archana N. Vyas, Mukesh M. Goswami [4], this paper tends to the matter of dissecting composed digits for the Gujarati Language. Three systems are given for highlight extraction. One has a place with the unique space and elective two has a place with the rebuild area. Inside the underlying system, a fresh out of the box new technique has been anticipated for the uncommon space that depends on native chain code.

This procedure acquires the world bearing by considering n × n square thus dispenses with the clamor that happens on account of local course. M. A. H. Akhand, Md. Mahbubar Rahman, P. C. Shill, Shahidul Isla, M. M. Hafizur Rahman [5], Current paper contains, a CNN based Bangla deciphered digit acknowledgment is assessed. The arranged BHNR-CNN standardizes the composed numeral pictures thus use CNN to group singular numerals. It doesn't utilize any component extraction procedure like option associated works. 17000 translated digits with totally extraordinary structure; enormity and varieties are utilized in this examination. The arranged procedure is demonstrated tasteful examining exactness and outflanked option recognized leaving ways. Akanksha Gaur, Sunita Yadav [6], in this paper acknowledgment of Hindi characters is done by utilizing a three stage strategy. Opening move is preprocessing, during which binarization of the picture and divisions of characters are performed. Each Hindi word envelops a high bar on the most noteworthy of word. That bar is moreover expelled in preprocessing area. Behnam Alizadehashraf, Samad Roohi [7], this investigation intends to look into the effectiveness of CNN on Persian manually written character acknowledgment issues. To inquire about the presentation of CNN systems, a data set of Persian composed characters has been utilized as ground truth information. The dataset parts conceived again into pictures with the size of 64×64 picture components in pixels. To explain the out performance of anticipated procedure, it's contrasted and striking average strategies in PHCR issues. Deepak Mane, Kulkarni U. V. [8] proposed customized CNN to recognize Marathi numerals.

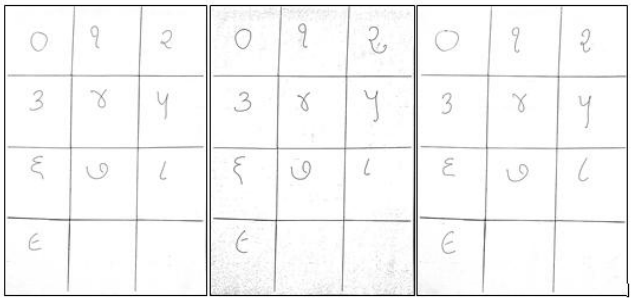

Figure 1: Samples of Handwritten Gujarati Digits

Table 2.Comparative Description of Transcribed Gujarati numeral

Work Reference	Methods used	Accuracy (%)
Neha Sahu ; Nitin Kali Raman	OCR	84%
Munish Kumar ; M. K. Jindal ; R. K. Sharma	Extract Characters in first segment	97.14%
Ashutosh Aggarwal ; Karamjeet Singh ; Kamalpreet Singh	OCR	97.38%
Archana N. Vyas ; Mukesh M. Goswami	OCR, KNN; ANN, SVM	85.67%
M. A. H. Akhand ; Md. Mahbubar Rahman ; P. C. Shill ; Shahidul Islam ; M. M. Hafizur Rahman	CNN	93.60%
Akanksha Gaur ; Sunita Yadav	K-means , SVM	92.80%
Behnam Alizadehashraf ; Samad Roohi	CNN	93%
Deepak Mane; Kulkarni U.V.	CCNN	94%

III. PRE-PROCESSING OF DATA

Because of insufficiency of an informational collection out there for training anticipated model, an informational collection has been made for proposed venture. Along these lines, a dataset of 250 pictures containing Gujarati numerals from 0-9, gathered from people of various ages. Each individual has composed ten Gujarati digits on an A-4 size paper with 4×3 framework. Subsequently, the information gathered from 250 entirely unexpected people brought about 250 arrangements of pictures with a total of 2500 separate digits. A few examples are appeared in beneath where each RGB picture is recovered into a dark scale picture. From the start, each numeral was edited on an individual premise from each arrangement of pictures. Everything about edited examples is then resized to a 28 × 28 size picture. Each picture of digit is remunerated and spared with their guardian document tag and furthermore the numeric value accommodated in it, for example for example 1_0.jpg, 1_1.jpg. To expand the informational index, various changes are accomplished where each picture is ascended by an irregular size and moved to a substitution arbitrary point; upright slanting: each picture is slanted vertically by a component of 0.5; level slanting: each picture is slanted on a level plane by a component of 0.5. At long last, component estimations of each edited examples are changed over and utilized for further handling.

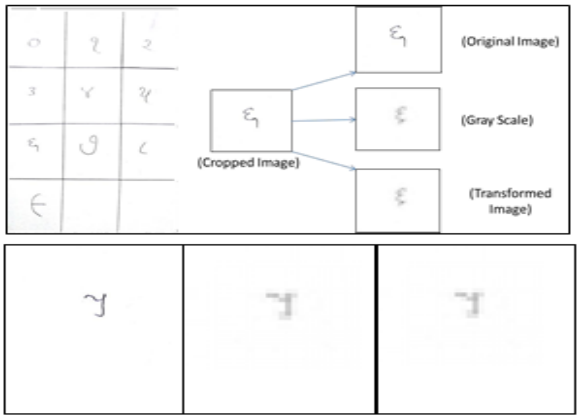

Figure 2: (a) Original image (b) Gray scale image (c) Final image

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IV. PROPOSED SYSTEM

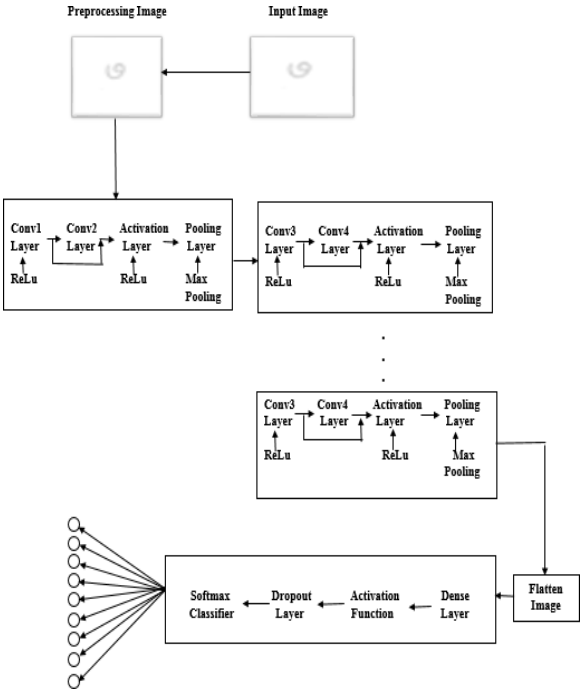

Figure 3: Proposed system

Particular from the compliance of the key CNN, some unmistakable investigation has arranged varieties in two layers on CNN for example shrouded layers and pooling layers. Arranged work tweaks the basic structure of directed CNN such that it identifies and recognizes the Gujarati deciphered digits of 2 Dimensional shape and yields higher outcomes than the inverse leaving methods. Arranged CCNN model doesn't put any confinement on the measure of layers; rather, it improves the sum to satisfy the interest of the issue. Besides, an exceptional channel size has been utilized or middle of the road Convolutional layers. Picture as a contribution of size 28 × 28 is utilized and pre-preparing is done on the same. Later, the same picture is utilized as Associate contribution to arranged CCNN and furthermore the capacity of the Convolutional film is enlarged and accompanied by initiation perform. Max Pooling, accompanied by walk of 2, and utilized for decreasing elements of picture created by Convolutional layers. After this, picture is planated and encouraged to the Multi-Layer Perceptron. Throughout the time of this layer, picture is bolstered by completely associating layer. At last, delicate max classifier is utilized to permit the opportunity of the picture for each class going from 0-9.

Convolutional Neural Networks (CNNs) are dazzled by multi-layer perceptron. Conv nets are a taxon of neural systems with constrained property designs between certain layers. Neural Networks, independent from anyone else, regularly don't scale well to full pictures. Likewise, conventional neural systems bring about the matter of over-fitting. CNN, on the contrary hand, misuses the local choices of the photos, for example it treats input pixels that are settled intently and removed, something else. CCNN is utilized to group totally various pictures upheld the choices inside the picture. An informational collection of pictures of composed Gujarati language numerals has been made for anticipated work. The alternatives of those numerals will be, the plan during which each numeral is composed. Here, layer shrewd picture of CCNN is furthermore given for acknowledgment of composed Gujarati language numerals, to encourage the different examination being directed during this space.

A. Convolutional Neural Network

A convolutional neural system (CNN) is one of the exceptional plans of counterfeit neural systems, anticipated by Yann LeCun in 1988. The most errand of picture grouping is acknowledgment of the information picture and furthermore the accompanying meaning of its group. This is an ability that people gain from their introduction to the world and can essentially discover that the picture inside the picture is an elephant. Anyway the PC sees the pictures in an unexpected way. Rather than the picture, the PC sees partner degree exhibit of pixels. For instance consider picture size as 28 x 28. During this case, the size of the cluster will be 28x28x3. Any place 28 is broadness, next 28 is stature and 3 are RGB channel esteems. The PC is selected an incentive from 0 to 255 to everything about numbers. This merits portraying the force of the component at each reason. To settle this drawback the PC shows up for the attributes of the base level. In human understanding such characteristics are as an example the trunk or massive ears. For the PC, these qualities are limits or ebbs and flows. Thus through the groups of Convolutional layers the PC builds a ton of unique thoughts.

B. Pooling Layer

The pooling layer pursues the nonlinear layer. It works with broadness and tallness of the picture and plays out a down inspecting activity on them. Thus the picture volume is decreased. This proposes if a few alternatives (concerning occasion limits) have just been known inside the past convolution activity, than a nearby picture isn't any more drawn out required for more procedure, and it's compacted to less explained film.

C. Fully Connected Layer

The completely associated layer takes the yield information from Convolutional systems. Appending a completely associated layer to the highest point of the system prompts partner degree N dimensional vector, any place N is that the amount of classes from that the model chooses the required classification.

V. ALGORITHM

A. Convolutional Neural Network (CNN)

Acknowledges a magnitude of capacity fX1* I1*E1g
Following are the hyper parameters:
1. Number of _lter L
2. Their spatial degree I
3. The walk T
4. The measure of zero cushioning Q
Generates a magnitude of capacity X2 _ I2 _ E2 where:
X2= (X1H+2Q)/T+1
H2= (I1H+2Q)/T+1
(For example width and tallness are figured similarly by evenness)
E2=L
With parameter sharing, it presents I _ I _ E1 loads per _lter, for a sum of
(I _ I _ E1) _ K loads and L

predispositions. In the yield volume, the d-th profundity cut (of size X2* I2) is the aftereffect of playing out a substantial convolution of the d-th _lter over the info magnitude with a walk of S, and afterward o-set by d-th predisposition.
A typical setting of the hyper parameters is H=3, T=1, Q=1
Be that as it may, there are basic shows and dependable guidelines that spur these hyper parameters.

VI. DATASET

The undertaking depends on digit acknowledgment task. As we probably are aware, there are 10 digits for example 0 to 9 or 10 classes to foresee. Results are accounted for utilizing expectation mistake, which is just the altered arrangement exactness. As the dataset of Gujarati digits isn't accessible on the web so we have built it by taking written by hand tests of Gujarati digits of individuals of various age gatherings. Our dataset comprises of pictures of Gujarati Digits from 0 to 9. Each picture is of 28x28 pixel size.
Subsequent to taking the information, we perform pre-handling on information to make well-characterized dataset. After pre-handling the RGB picture is changed over to grey-scale picture. The information has been separated into two classifications which structure the preparation set and the test set. Sets of information were gathered from the individuals of various age bunches for testing reason.

VII. MATHEMATICAL MODEL

Let's consider T as complete system:

T={I/O, Proc, O/P}

A. Input:
I/O= {I}

B. Process:
Proc= {DA, PP, DD, CNN}

C. Output:
O/P= {DR}

VIII. RESULTS

Tendered model prepared is of 250 arrangements of various pictures restraining 2500 composed Gujarati digits. Those 2500 examples were separated like, 2000 preparing, 500 testing. To build the system so as CCNN can extricate abnormal state highlights from the photos, Python Keras 2 is utilized. Intel i3 is the processor utilized and AMD Graphics Processing unit i.e. GPU is utilized. The focal preparing unit together with GPU has assisted in accelerating these handling of preparing and testing CCNN replica. Ensuring correct preparation, approval of exactness ascertained in every age. Succeeding replica advancement, later tried by obscure examples for searching testing precision. Thereafter chart is to get a handle on misfortune variety was upgraded are frequently found in Fig. 6 gives confusion matrix and Fig.7 shows classification report with parameters. The overall average accuracy by suggested framework is 95.40%.

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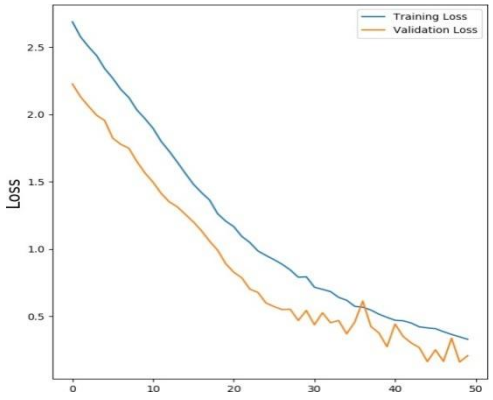

Figure 4: Training Loss Vs Validation Loss

The Y-pivot speaks to the Loss while the X-hub speaks to the Epoch.

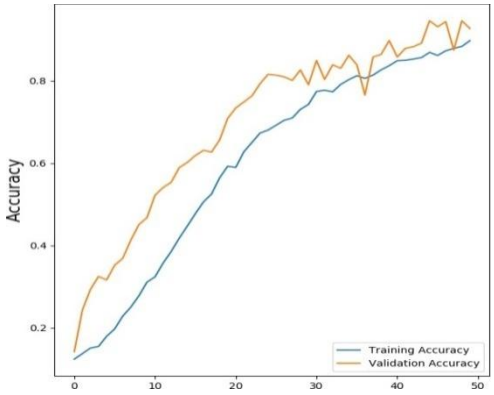

Figure 5: Training Accuracy Vs Validation Accuracy

Table 3.Accuracy of Individual Gujarati Digits

Gujarati Digits	Testing Accuracy (%)
0	98
1	77
2	98
3	98
4	93
5	100
6	100
7	98
8	92
9	100
Average Accuracy (%)	95.4

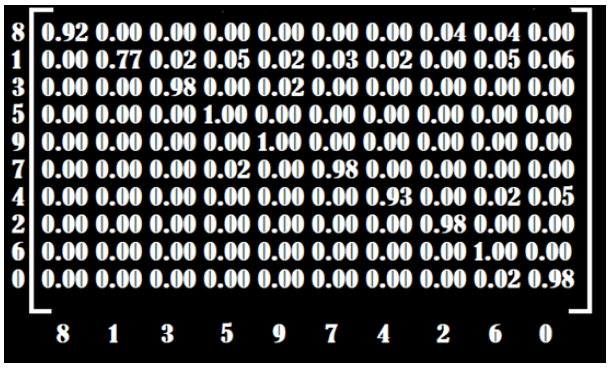

Figure 6: Confusion Matrix

CLASSIFICATION REPORT

	precision	recall	f1-score	support
0	1.00	0.92	0.96	51
1	1.00	0.77	0.87	64
2	0.96	0.98	0.97	48
3	0.92	1.00	0.96	47
4	0.96	1.00	0.98	48
5	0.95	0.98	0.97	43
6	0.98	0.93	0.95	44
7	0.96	0.98	0.97	44
8	0.86	1.00	0.93	44
9	0.88	0.98	0.92	44

Figure 7: Classification Report

IX. CONCLUSION AND FUTURE SCOPE

The introduced paper has concentrated on CCNN based on the most part model for perceiving composed Gujarati integers. The arranged replica scales efficiently by enlarged informational collection. Besides, here expanded informational collection refines the loads of the channel that extra refines execution. Here preparation time for the arranged model is furthermore enormously diminished on account of the work of a GPU together with the CPU. K-overlay cross-approval systems are utilized for higher outcome calculation. Arranged model offers 95.40% for investigate informational collection. The framework for the most part demonstrates unseemly outcomes in view of vulnerability among closely molded digits which may enhance inside what's to come. CCNN might be a model that is acclimated learns alternatives consequently. As a component of future work, this quality will be used, by taking in choices from informational index and giving them as contribution to various classifiers to upgrade the precision. Likewise, in CNN, loads are instated haphazardly. Work can be intermeshed towards giving a base to the instatement of loads which will upgrade arranged model extra.

The suggested method can be used to recognize the handwritten digits of other regional languages of India. Also this method can be used for recognize handwritten alphabets of Gujarati as well as other languages.

APPLICATIONS

Pattern Recognition manages the examination of versatile and expository methods for preparing a lot of information, the extraction of helpful data to decrease the information, and the arrangement of the information as required. With the utilization of this task, human exertion can be diminished in perceiving, learning, forecasts and a lot more zones. Territorial government workplaces require the framework for perceiving digits which are in disjointed structure.

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