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HANDWRITTEN DIGIT RECOGNITION

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Abstract-- This project dives into the fundamentals of machine learning victimization associate degree approachable and well-known artificial language, Python. And here we'll be reviewing 2 main components: 1st, we'll be learning regarding the aim of Machine Learning and wherever it applies to the important world. Second, we'll get a general summary of Machine learning topics like supervised learning, model analysis, and Machine Learning algorithms.

Keywords— OCR; Handwritten digit recognition; Slant Correction; PCA; Accuracy; Confusion Matrix

I. INTRODUCTION

Digit recognition system is that the operating of a machine to coach itself or recognizing the digits from totally different sources like emails, bank cheque, papers, images, etc. and in numerous real-world eventualities for on-line handwriting recognition on laptop tablets or system, acknowledge range plates of vehicles, process bank cheque amounts, numeric entries in forms stuffed up by hand (say — tax forms) then on.

II. PROBLEM FORMULATION

A. Problem Statement

The goal of this project is to make a model which will be ready to acknowledge and confirm the written digits from its image by exploitation the ideas of Convolution Neural Network. Although the goal is to make a model which may acknowledge the digits, it will be extended to letters associated an individual's handwriting. The most important goal of the planned system is knowing Convolutional Neural Network and applying it to the written recognition system.

B. Problem Definition

THE PROBLEM OF THIS PROJECT WAS: CAN OCR USE THE COMBINATION OF IMAGE PREPROCESSING, FEATURE EXTRACTION AND CLASSIFIERS TO IMPROVE THE ACCURACY OF HANDWRITTEN DIGIT RECOGNITION TO MORE THAN 99%?

The null hypothesis (H0) of this project is that the accuracy of written digit recognition exploitation the mix of image pre-processing, feature extraction and classifiers supported the OCR would be but ninety nine whereas the choice hypothesis (H1) is that accuracy can no but ninety nine. Supported the analysis and comparison of the four models, the results have clearly shown the distinction within the performance of the classifier. Finally, the popularity rates of the classifiers were assessed to reject the null hypothesis. 80 OCR may be a technique that acknowledges written text in scanned documents. In OCR applications, the operate that involves in accuracy and speed of character recognition is vital to overall performance. OCR may be a advanced method which has many steps, particularly pre-processing, feature choice and classification. Further, some issues occur throughout the event of the OCR system. Blurred or inclined written digit gift difficulties for laptop recognition. Another drawback is that extracting options with ground noise, like the distinction of fonts and paper. Most significantly, extracting applicable structural options from advanced shapes is additionally a substantial challenge. There's proof that image preprocessing technology will take away noise, sleek and normalize the computer file that is important for higher differentiation of patterns within the feature house. numerous feature extraction strategies are advanced for the character recognition system. PCA will give a lower-dimensional illustration if a variable knowledge is pictured as a series of coordinates within the high dimensional knowledge house. Effectively, it reduces the size of the discovered knowledge by eliminating redundancy.

III. INFORMATION ANALYSIS

Handwritten digit recognition could be a advanced downside because of the actual fact that variation exists in style of various writers. The development that produces the matter more difficult is that the inherent variation in writing designs at completely different instances. because of this reason, building a generic recognizer that's capable of recognizing written digits written by numerous writers isn't continually possible. However, the extraction of the foremost informative options with extremely discriminatory ability to boost the classification accuracy with reduced complexness remains one in all the foremost necessary issues for this task. it's a task of nice importance that there area unit customary databases that enable completely different approaches to be compared and valid India could be a trilingual country with twenty three constitutionally recognized languages written in twelve major scripts. Besides these, many different languages area unit employed in India, everyone with variety of dialects. The formally recognized languages area unit Hindi, Bengali, Punjabi, Marathi, Gujarati, Oriya, Sindhi, Assamese, Nepali, Urdu, Sanskrit, Tamil, Telugu, Kannada, Malayalam, Kashmiri, Manipuri, Konkani, Maithili, Santh ali, Bodo, English, and Dogri. The twelve major scripts want to write these languages area unit Devanagari script, Bangla, Oriya, Gujarati, Gurumukhi, Tamil, Telugu, Kannada, Malayalam, Manipuri, Roman, and Urdu. in an exceedingly trilingual country like India, it's a standard state of affairs that a document like application type, railway price tag reservation type, and then forth consists of text contents written in several languages/scripts so as to succeed in a bigger cross section of individuals. The variation of various scripts could also be within the variety of numerals or alpha numerals in an exceedingly single document page. However the techniques developed for text identification typically don't incorporate the popularity of digits. this is often as a result of the options needed for the text identification might not be applicable for characteristic the digits.

IV. SCOPE

The scope of this paper is written digit recognition regarding the applying of machine learning algorithms supported image pre-processing and have extraction. To boot, the requirements are not alone to reinforce this recognition performance, but together to hunt the simplest trustiness inside the applications of written digits. The aim of this project is to implement a classification algorithm to acknowledge written digits (0- 9). it has been shown in pattern recognition that no single classifier performs the foremost effective for all pattern classification problems consistently. Hence, the scope of the project together closed the elementary study the varied classifiers and combination ways, and live the caveats around their performance throughout this specific disadvantage of written digit recognition. This report presents our implementation of the principal part Analysis (PCA) combined with 1- Nearest Neighbor to acknowledge the numeral digits, and discusses the other wholly completely different classification patterns.

A. IMPLEMENTATION

Implementing the Regression

Tensor Flow has to be foreign exploitation the below code: `import tensorflow as tf` `x = tf.placeholder(tf.float32, [None, 784])` Here, `x` is not a selected worth. `x` may be a placeholder, we are going to input the worth after we got to run a computation. this can be as a result of any range of input pictures should be accepted and every planate into a 784-dimensional vector. A structure `[None, 784]` is employed to represent this as a 2-D tensor of floating-point numbers. (Here `None` means a dimension will be of any length.) Weights and biases are required for our model. It may well be treated these like extra inputs, however Tensor Flow has an excellent higher thanks to handle it: `Variable`. A `Variable` may be a modifiable tensor that lives in TensorFlow's graph of interacting operations. The model parameters are usually `Variables` in machine learning applications. `W = tf.Variable(tf.zeros([784, 10]))` `b = tf.Variable(tf.zeros([10]))` however we have a tendency to initialize each `W` and `b` as tensors jam-packed with zeros by giving `tf.Variable` the initial worth of the `Variable`. Since the model learns `W` and `b`, it does not matter abundantly what they at the start ar. Notice that `W` encompasses a form of `[784, 10]` as a result of we wish to multiply the 784-dimensional image vectors by it to provide 10- dimensional vectors of proof for the distinction categories. `b` will be intercalary to output since it's a form of `[10]`. `y = tf.nn.softmax(tf.matmul(x,W) + b)` initial, multiply `x` by `W` with the expression `tf.matmul(x, W)`. this can be flipped from once it increased them in our equation, wherever we have a tendency to had `Wx`, as a tiny low trick to subsume `x` being a second tensor with multiple inputs. Then add `b`, and eventually apply `If nn.softmax`. It solely took one line to outline our model, when one or two short lines of setup. A softmax regression isn't made in particular straightforward by Tensor Flow: it's simply a really versatile thanks to describe several types of numerical computations, from machine learning models to physics simulations.

Training the model

In order to coach the model, shaping what it means that for the model to be sensible is required. But, we have a tendency to usually outline what it means that for a model to be unhealthy in machine learning, referred to as the value or loss, then try and minimize however unhealthy it's. However the two are equivalent. One quite common, terribly nice price operator is "cross-entropy." astonishingly, cross-entropy arises from wondering data pressing codes in scientific theory however it finally ends up being a very important plan in countless areas, from gambling to machine learning. The cross-entropy is measure however inefficient predictions are for describing the reality. To implement cross- entropy we'd like to initially add a brand new placeholder to input the right answers: `metal = tf.placeholder(tf.float32, [None, 10])`. Then we will implement the cross-entropy,

cross_entropy = tf.reduce_mean(-tf.reduce_sum(y*tf.log(y),reduction_indices=[1])) initial, the log of every part is computed by, tf.log. Next, multiply every part of {y|ytterbium|Yb|atomic number 70|metallic part|metal} with the corresponding element of tf.log(y). Then tf.reduce_sum adds the weather within the second dimension of y, because of the reduction_indices [1] parameter. Finally, The mean over all examples within the batch is computed by tf.reduce_mean. Since the complete graph of our computations is understood, it will mechanically use the algorithmic rule to with efficiency confirm however your variables have an effect on the value we have a tendency to raise it to reduce. Then it will apply our selection of optimisation algorithmic rule to change the variables and cut back the value train_step = tf.train.GradientDescentOptimizer(0.5).minimize(cross_entropy) during this case, it's common to raise Tensor Flow to reduce cross-entropy exploitation the gradient descent algorithmic rule with a learning rate of zero.5. Tensor Flow merely shifts every variable a bit bit within the direction that reduces the value employing a straightforward procedure - Gradient descent. Tensor Flow will give several different optimisation algorithms by simply tweaking one line. currently the model is ready up to coach. One last item before we have a tendency to launch it, it adds associate operation to initialize the variables we have a tendency to created: init = tf.initialize_all_variables() it's currently potential to currently launch the model in a very Session, and run the operation that initializes the variables: marijuana = tf.Session() marijuana.run(init) for in range(1000): batch_xs, batch_ys = mnist.train.next_batch(100) sess.run(train_step, feed_dict=) every step of the loop gets a "batch" of 1 hundred random knowledge points from our coaching set. it's required to run train step feeding within the batches knowledge to interchange the placeholders. random coaching involves the usage of tiny batches of information. during this case, random gradient descent. Ideally, it's possible to United States all our knowledge for each step of coaching as a result of that may offer us a higher sense of what we must always be doing, however that is costly. So, instead, here it uses a distinct set each time. Doing this can be even as helpful and conjointly cheaper

B. Experimental Setup

To accomplish the task of written digit recognition, a model of the convolutional neural network is developed and analyzed for appropriate totally different learning parameters to optimize recognition accuracy and interval. we have a tendency to propose to research variants of CNN design with 3 layers (CNN_3L) and variants of CNN design with four layers (CNN_4L). a complete of six cases (case one to case 6) are thought of for CNN with three-layer design and 5 cases (case one to case 5) for CNN design with four layers. All the cases mechanical device within the range of feature maps, stride sizes, padding, dilation and received receptive fields. The recognition method of the written digits consists of the subsequent steps:

- 1.To acquire or collect the MNIST written digit pictures.
- 2.To divide the input pictures into coaching and check pictures.
- 3.To apply the pre-processing technique to each the coaching dataset and therefore the check dataset.
- 4.To normalize the information in order that it ranges from zero to one.
- 5.To divide the coaching dataset into batches of an acceptable size.
- 6.To train the CNN model and its variants exploitation the labelled knowledge.
- 7.To use a trained model for the classification.
- 8.To analyze the popularity accuracy and interval for all the variants.

C. Research Methodologies

Hypothesis: The null hypothesis (H0) of this analysis is that the accuracy of written digit recognition mistreatment the mix of image pre-processing and classifiers supported the OCR are going to be but ninety fifth, whereas the choice hypothesis (H1) is that accuracy are going to be no but ninety nine. The objective of the analysis is to indicate the notably template-based model, like CNN and RF. However, the error rate will increase once the quantity targeted on the bounding box instead of the middle of mass. So, feature extraction is one in every of the pretreatment steps, aimed at reducing the dimension of {information} and extracting the relevant information. On the opposite hand, image preprocessing like sharpening, slant correction or elastic distortion is critical as a result of the oblique numbers and blurred pictures can have an effect on the accuracy of feature extraction. ancient manual style feature choice could be a cumbersome and time- intense mission that can't method the first image, whereas associate automatic extraction methodology by the LeNet5 CNN design will retrieve options directly from the first image and HOG is another feature descriptor. The analysis ways employed in this paper square measure quantitative. Specifically, quantitative ways emphasize objective measurements and manipulate pre-existing applied mathematics information mistreatment package tools. The MNIST information files square measure on-line freely accessible train.csv of 60,000 examples and check.csv of 10,000 samples that contain pictures of written English numerals. Also, the RF, CNN, K-NN and SVM in Python were accustomed study and build prediction models. The four preprocessed models are going to be evaluated and compared, then the results can clearly show the distinction in performance for the classifiers. Moreover, the accuracy of the classifiers are going to be assessed to work out whether or not to reject or settle for the null hypothesis.

D. Abbreviations and Acronyms

Symbol Description

PCA	Principal Component Analysis
OCR	Optical character recognition
H0	Null Hypothesis
H1	Alternate Hypothesis
ANN	Artificial Neural Network
CNN	Convolutional Neural Network
K-NN	K-Nearest Neighbor
RF	Radio Frequency
UI	User Interface
SVM	Support Vector Machine
HOG	Histogram of Oriented Gradients
MNIST	Modified National Institute of Standards and Technology

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F. FUTURE SCOPE

Internet security and networking are the 2 fastest-growing industries wherever moral hackers will notice employment. Moral hackers are employed to seek out any vulnerability that exists in a very network and to repair them. They will be a part of the govt. yet as non-public organizations as cyber-security consultants. IT companies are the most recruiters of moral hackers. They will even be needed by monetary service suppliers, airlines, retail chains and hotels. Additionally, government agencies like numerous wings of the military and enforcement, defence organizations, rhetorical laboratories, detective firms and investigatory services supply difficult roles for moral hackers. Some sure-handed hackers work for investigatory agencies just like the Central Bureau of Investigation, the National Security Agency and therefore the Federal Bureau of data.

Figures and Tables

Figure1.System Diagram of the implemented pattern classifier

Figure 2: The flow chart for this experiment

Figure 3 High level Design

Figure 4 DFD level-1

Figure 5 DFD level-1

Figure 6 DFD level-2

Figure 7 DFD level-2(regression model)

Figure 8 DFD level-2 (Build CNN)

LITERATURE SURVEY

Works in character recognition

Research makes an attempt began within the space of character recognition as early as 1959 by Grimsdale. associate approach called analysis-by-synthesis originated within the early sixties on that a good quantity of analysis was based mostly. This methodology was prompt by Eden in 1968. Eden's work evidenced that a finite variety of schematic options type all written characters. this time created it extremely necessary for any works. it had been later employed in all ways in grammar approaches of character recognition. limited review of Pre-processing Techniques is another supply of knowledge for varied techniques which will be accustomed pre-process pictures. It considerations totally {different|completely different} reasonably pictures starting from an easy written type based mostly documents to those containing coloured and sophisticated backgrounds that have different intensities. For recognizing at liberty texts that square measure written, a projected model was the Hybrid Hidden Andre Markoff Model. during this model, the structural elements of text square measure shapely mistreatment Andre Markoff chains. A multilayer perceptron is employed to estimate the emission possibilities. The slope and slant from written text square measure removed mistreatment varied techniques. the scale of text pictures square measure normalized with supervised learning ways. The key options of this recognition system were to develop a system having high accuracy in pre-processing and recognition, that square measure each supported ANNs. A changed quadratic classifier is that the Hand Written Numeral Recognition of six scripts. it's supported a theme to acknowledge the written numerals of six in style Indian scripts. This paper has been a good success to adopt neural network for extremely used native languages in India. The project uses this paper as a concept and reference for the work done. Multilayer perceptron could be a feed forward ANN that has been used for recognizing English characters that square measure written. Boundary tracing is for extraction of options and their Fourier Descriptors. the form of the character is analyzed and also the options that distinguish it square measure compared for recognition. The paper on Diagonal based mostly feature extraction, proposes a diagonal feature extraction for offline character recognition. this offers a high recognition accuracy of ninety seven.8 % for fifty four options and ninety eight.5% for sixty nine options. Offline Handwriting Recognition describes a system for recognition of cursive handwriting. it's supported Hidden Andre Markoff Models mistreatment distinct and hybrid modeling techniques. Devanagiri Character Recognition, used four feature extraction techniques specifically, intersection, shadow feature, chain code bar graph and line fitting options. for every character image, there's a world computation of shadow options. The character image is split into completely different segments and computed for chain code a feed forward ANN that has been used for recognizing English characters that square measure written. Boundary tracing is for extraction of options and their Fourier Descriptors. the form of the character is analyzed and also the options that distinguish it square measure compared for recognition. The paper on Diagonal based mostly feature extraction, proposes a diagonal feature extraction for offline character recognition. this offers a high recognition accuracy of ninety seven.8 % for fifty four options and ninety eight.5% for sixty nine options. Offline Handwriting Recognition describes a system for recognition of cursive handwriting. it's supported Hidden Andre Markoff Models mistreatment distinct and hybrid modeling techniques. Devanagiri Character Recognition, used four feature extraction techniques specifically, intersection, shadow feature, chain code bar graph and line fitting options. for every character image, there's a world computation of shadow options. The character image is split into completely different segments and computed for chain code bar graph options, intersection options and line fitting options. the general recognition rate for a knowledge set of 4900 units was discovered to be ninety two. 80% on experimentation for syllabary characters. Recognizing Arabic characters et al, describes that recognition of characters greatly depends upon the options used. several options of the Arabic characters that square measure written square measure mentioned. associate off-line recognition system supported the chosen options was engineered. Realistic samples of written Arabic characters square measure used for coaching and testing. The importance and accuracy of the chosen options is evaluated. supported designated options, average accuracies of half of 1 mile and seventieth square measure obtained for the numbers and letters, severally.

RESULT

From the check pictures given to America, we tend to square measure able to acquire a most accuracy of seventy eight. 4%. this can be varied by the quantity of eigenvectors values we tend to contemplate compared of the check sample. to realize this result our program considers all seventy eight4 eigenvector values so as to urge associate accuracy of 78.4%; whereas, if we tend to solely contemplate twelve most important eigenvector values we tend to solely get forty.2% accuracy. As the variety of eigenvector values thought of square measure attenuated the accuracy of the system decreases. The diagram below shows the results of the accuracy based mostly of the quantity of eigenvector values.

Outputs:

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V. CONCLUSIONS

In conclusion all that I've tried to mention during this report is that what square measure the foremost basic ways that to hack somebody and also the most simple ways that to guard you. The most purpose of this report was to unfold associate awareness of however it all works and what standards we actually have during this field. And lastly cyber security is one the foremost very important elements of economy of any company and shall be taken seriously whereas taking it under consideration.

REFERENCES

- [1]. S. M. Metev and V. P. Veiko, *Laser Assisted Microtechnology*, 2nd ed., R. M. Osgood, Jr., Ed. Berlin, Germany: Springer-Verlag, 1998.
- [2]. J. Breckling, Ed., *The Analysis of Directional Time Series: Applications to Wind Speed and Direction*, ser. *Lecture Notes in Statistics*. Berlin, Germany: Springer, 1989, vol. 61.
- [3]. S. Zhang, C. Zhu, J. K. O. Sin, and P. K. T. Mok, "A novel ultrathin elevated channel low-temperature poly-Si TFT," *IEEE Electron Device Lett.*, vol. 20, pp. 569–571, Nov. 1999.
- [4]. M. Wegmuller, J. P. von der Weid, P. Oberson, and N. Gisin, "High resolution fiber distributed measurements with coherent OFDR," in *Proc. ECOC'00, 2000*, paper 11.3.4, p. 109.
- [5]. R. E. Sorace, V. S. Reinhardt, and S. A. Vaughn, "High-speed digital-to-RF converter," U.S. Patent 5 668 842, Sept. 16, 1997.
- [6]. (2002) The IEEE website. [Online]. Available: <http://www.ieee.org/>
- [7]. M. Shell. (2002) IEEEtran homepage on CTAN. [Online]. Available: <http://www.ctan.org/texarchive/macros/latex/contrib/supported/IEEEtran/>
- [8]. *FLEXChip Signal Processor (MC68175/D)*, Motorola, 1996.
- [9]. "PDCA12-70 data sheet," Opto Speed SA, Mezzovico, Switzerland.
- [10]. A. Karnik, "Performance of TCP congestion control with rate feedback: TCP/ABR and rate adaptive TCP/IP," M. Eng. thesis, Indian Institute of Science, Bangalore, India, Jan. 1999.
- [11]. J. Padhye, V. Firoiu, and D. Towsley, "A stochastic model of TCP Reno congestion avoidance and control," Univ. of Massachusetts, Amherst, MA, CMPSCI Tech. Rep. 99-02, 1999.