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Handwritten Digit Recognition

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Abstract: Digital recognition is also remarkable an important issue. As handwritten digits are not a same size, thickness, position and direction, in this case by the way, various difficulties should be considered find the handwritten digital recognition problem. I unique and a variety of creative styles for different people moreover have an influence on the model as well the presence of digits. It is a strategy to see again edit written digits. It has a wide variety applications, for example, scheduled bank checks, post offices and tax documents and so on. The purpose of this project is to use the classification algorithm to identify handwritten digits. Background results are probably the most widely used Machine Learning Algorithms such as SVM, KNN and RFC and in-depth reading calculations like CNN multilayer using Keras and Theano and Tensorflow. Using these, 98.70% accuracy was used by CNN (Keras + Theano) compared to 97.91% using SVM, 96.67% using KNN, 96.89% using RFC was obtained.
Keywords: SVM, RFC, KNN, CNN.

I. INTRODUCTION

Awareness identifies or distinguishes an object or person from past experience or learning. Similarly, Digital Recognition is nothing other than recognizing or identifying digits in any document. The framework of digital recognition is simply the operation of the machine to prepare or interpret digits. Handwritten Digit Recognition is the power of computers to translate handwritten digits from a variety of sources such as text messages, bank checks, papers, photos, etc. method etc.

Machine Learning offers a variety of ways in which human effort can be reduced to seeing handwritten digits. In-depth reading is a machine learning method that trains computers to do what most people can easily access: learning by example. With the use of in-depth learning methods, human efforts can be reduced in perception, learning, perception and in too many regions. Using in-depth learning, the computer learns to perform distinctive functions in images or content anywhere accuracy, in addition to the performance of the human level. The digital recognition model uses large data sets to detect digits from different sources.

Character recognition has been around since the 1980s. The handwritten digital recognition function, using a separator, has extraordinary value and is used such as - online digital recognition on PC tablets, posting zip codes, processing bank check rates, handwriting numerical categories (for example - tax forms) and more. There are various challenges to be faced in trying to solve this problem. Handwritten digits do not always have the same size, thickness, or shape and shape as related to genes. The main objective was to make the character matching method realistic to identify handwritten digits provided in the MINIST dataset for handwritten digital images (0–9).

II. BOOK RESEARCH

Anuj Dutt in his paper showed that using the Deep Learning programs, he was able to achieve a high degree of accuracy. By using the Convolutional Neural Network with Keras and Theano as a backend, he was gaining 98.72% accuracy. In addition, CNN performance using Tensorflow provides an astonishing 99.70% better result. Despite the fact that the complexity of the process and the codes seem to be much greater compared to conventional machine learning algorithms, the accuracy they gain is becoming increasingly apparent. In a paper published by Saeed AL-Mansoori, the Multilayer Perceptron (MLP) Neural Network was used to identify and predict handwritten digits from 0 to 9. The proposed neural system was trained and tested on data obtained from MNIST.

A. Existing System

These days, a growing number of people are using images to transfer data. In addition it is the main distribution to separate the important data from the images. Image Recognition is an important research area for your most used apps. In general, in the field of pattern recognition, one of the most difficult tasks is the precise computerization of human handwriting. Without a doubt, this is a very difficult subject because there are so many variations of handwriting from person to person. Despite the fact that, this difference does not cause problems for humans, however, it is becoming increasingly difficult to instruct computers to interpret common handwriting. In the case of image recognition, for example, classification by hand, it is important to know how the information is displayed in the pictures.

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The Handwritten Recognition from the MNIST database is well known to scientists as through the use of different parameters separators, the error rate is reduced.for example, from the line phase (1 layer NN) and 12% to 0.23% with a board of 35 convolution neural systems. The scope of this is to use the Handwritten Digital Awareness Framework and think of different categories and strategies by focusing on how to achieve closeness to personal performance. In the task of naming different digits (0-9) for different people the most common issue to be dealt with is the issue of digit order and the closeness between digits such as 1 and 7, 5 and 6, 3 and 8, 9 and 8 and so on. .

In addition, people create the same digit with different ideas, the diversity and diversity in the handwriting of different people also contributes to the development and existence of digits.

III. ARCHITECTURE

The purpose of this document is to look at the design possibilities of the proposed system, such as architectural design, block diagram, sequence diagram, data flow diagram and system user interface design to define steps such as pre-processing, output, partition, segmentation and digital recognition.



Fig 1:- Architecture of the Proposed System

Figure 1 above shows a diagram of the properties of the proposed system. The proposed model consists of four stages for planning and obtaining digits:

1) Preliminary consideration
2) Separation
3) Feature Domain
4) Separation and Recognition

A. Previous Analysis

Part of the pre-processing step that performs various functions in the input image. Enhances the image by making it a reason for the split. The basic motivation for pre-processing is to produce an interesting example from the background. For the most part, sound filtering, smoothing and suspension should be done at this stage. Preliminary analysis shows little exposure to the model. Binarization changes instead of gray scale image into binary image.

The first method is to teach a set of images to be processed to reduce data, by combining it into a binary image. Figure 2 shows a sample of photos taken on the MNIST website.



Fig 2:- Sample images taken from MNIST database

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B. Segmentation

Once the pre-processing of the input images is complete, individual digital images are created from the sequence of images. Pre-processed digital images are subdivided into individual digital images, which are assigned to each digit. Each digit is resized to pixels. In this step the method of obtaining a limit on dividing a database image is used.

C. Feature Extraction

After the completion of the pre-processing phase and the separation phase, the pre-processed images are represented in the form of a matrix containing pixels of images of the largest size. In this way it will be useful to represent the digits in the images that contain the required information. This function is called feature removal. In the extraction feature the data reuse is deleted.

D. Classification and Recognition

In the process of separation and recognition the vectors of the extracted element are considered the death of the individual in the subsequent segmentation. In order to model the operating system the output components are grouped and defined using the following three categories:

- K-Close Neighbor
- Random Forest Classifier
- Vector Support Machine

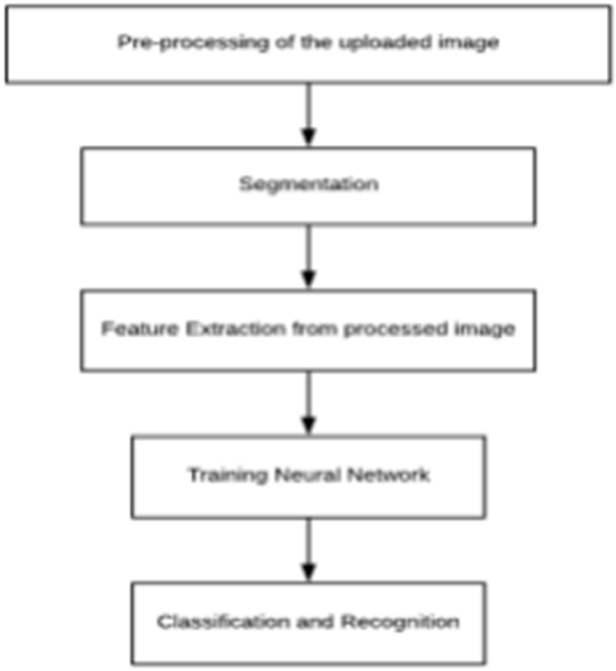


Fig 3:- Block Diagram of proposed model

1) *Close Neighbor:* KNN is an example-based learning algorithm. There are two main advantages of using the KNN algorithm, namely, it is strong on sound training data and works best when the data is very large in size. For optimal performance, this algorithm requires a set of training data sets that include data points with complete labels. KNN is also a non-parameter separator. The algorithm considers the new data point as input and makes the distinction by calculating the distance between new and labeled data points using Euclidean or Hamming distance formulas. The Euclidean range is calculated using the following :
2) *Random Forest Classifier:* RFC is a supervised learning environment. It means that there is a rapid correlation between the total number of trees and the effect it gets: the larger the number of trees, the greater the effect. This section can be used for retrospective and split. In the RFC algorithm if there are enough trees then the separator will not fit very well with the model, instead avoiding more problems with installation. This category may deal with missing amounts. Once the training has been done, predictions are taken from each tree and the estimate is calculated using the following formula :

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3) Vector Support Machine: SVM is also a supervised learning method. It is also used for both separation and reversal functions. In this type of algorithm, there are data objects that are considered n-dimensional space points. This section finds a hyper plane by making sections between the two classes. One of the main advantages of this algorithm is that it provides a customization parameter that avoids overlap problems. The block diagram shown below in Figure 3 illustrates all of the above steps.

IV. METHODOLOGY

Each research task requires some measurement, in order to measure the accuracy and performance of the handwritten digits, the MNIST database is used for such purposes. MNIST is a widely used standard for handwritten digital recognition. MNIST is a large and standard website of handwritten digits. The MNIST database is often used as a test for the division of algorithms in the digital manuscript recognition framework .

The first step that will be done is to set up the database, which can be done successfully using the Keras system interface. Images in the MNIST database are available in the form of a collection that includes 28x28 values that form the image and its labels. This is ideal if there may be a case for experimental images. Pixels are given as variants of 784-d pixels and range from 0 to 255 for example 0 means Black and 255 means White.

A. Pseudocode

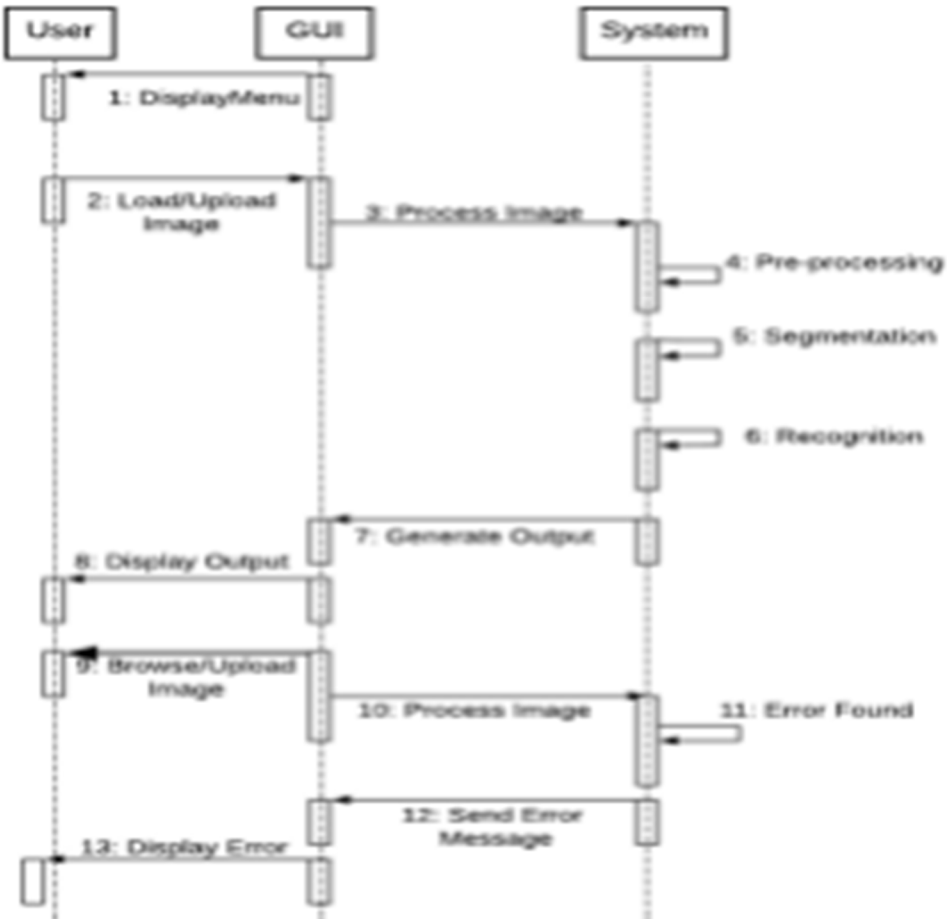


Fig4:- SSystem sequence diagram

Figure 4 shows the sequence diagram of the system model. The figure describes the sequence of steps to be taken while performing. The CNN model works in the following sequence. Users upload a specific image of any digit they want to see. The picture will be processed. When you use a system code the output is generated which shows which digit it was loaded with than in the code, the output indicates an error, and indicates an error message in use.

B. Algorithm Used

The following Figure 5 describes a data flow diagram of the proposed system model. There are two ways to provide input into the system. The user can upload a digital image they want to receive or data from the MNIST database. Input images are pre-processed. Using different dividers the accuracy of known digits is compared and the result is obtained. The results obtained are displayed with accuracy.



Fig 5:- Data Flow Diagram of the system model **V.**

V. IMPLEMENTATION

A. Software Platform

1) *Tensorflow:* TensorFlow is an amazing information sharing machine from the Google Reading Team developed by the Google Mind Team and made open source in 2015. It is intended to facilitate use and is broadly related to both numerical and neural issues as separate spaces. Basically, TensorFlow is low a level tool for doing the math involved and guiding professionals who realize what they are doing to build exploratory learning structures, play with them and transform them into ongoing programs. In particular, it can be considered a planning framework in which one can gain the right to count as graphs. The notes on the graph speak mathematical operations, and the edges contain a series of interrelated tensors (tensors).
2) *Python 3.7*: Python is widely used worldwide and is an advanced programming language. It was introduced primarily to stand out from the code, and its language structure enables application developers to express ideas in a few lines of code. Python is a programming language that gives you the opportunity to work faster and link frames more effectively.
3) *Anaconda3 5.3.1 :* Ruser also shows the accuracy level predicted by the model. Uploading images with different adjustments and more. Anaconda is a free and open source platform. Python and R system for acquiring logical knowledge such as information science, AI applications, large-scale data processing, scientific research, and more. Anaconda comes with over 1,400 packages just like the Conda package and the visual environment director, called Anaconda Navigator, so it takes a while to find a way to launch the library freely. Anaconda Navigator is a graphical UI (GUI) embedded in the Anaconda distribution that enables clients to send requests and manage conda packages, situations and channels without using command line direction.

B. Hardware Platform

1) *NVIDIA GeForce Graphic Card:* Nvidia Corporation is often referred to as Nvidia (translated as NVIDIA), an American founding organization. Build graphics processing units (GPUs) for gaming markets and professionals, such as frame, system on chip units (SoCs) for flexible statistics and automotive display. The most important GPU product is named "GeForce". With its outstanding GPU architecture, Nvidia offers the same processing power to analysts and researchers who allow it to successfully use high-performance applications.

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C. Results

The following Figure 6 shows the formation of the front end of the system exit. There are four buttons for the four algorithms as shown in the figure.



Fig 6:- Front-end design of the sys

The following statistics show the sequence of steps that must be taken to achieve the desired result.

Figure 7 shows the instructions for using the separator code .

```
validation data points: 135
testing data points: 450
EVALUATION ON TESTING DATA
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        43
           1       0.95      1.00      0.97        37
           2       1.00      1.00      1.00        38
           3       0.98      0.98      0.98        46
           4       0.98      0.98      0.98        55
           5       0.98      1.00      0.99        59
           6       1.00      1.00      1.00        45
           7       1.00      0.98      0.99        41
           8       0.97      0.95      0.96        38
           9       0.96      0.94      0.95        48

   micro avg       0.98      0.98      0.98       450
   macro avg       0.98      0.98      0.98       450
weighted avg       0.98      0.98      0.98       450

Digit is: 4
```

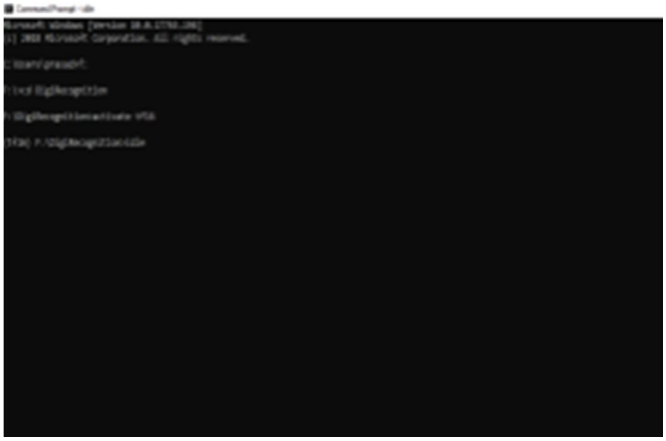
Fig 7:- Command to run the Classifying code

Figure 8 shows the code usage instructions that train the images.



Fig 8:- Command to train the code

The Figure 9 shows the commands that are used to run the Tensorflow virtual environment.



KNN algorithm.

Fig 10:- Output generated by KNN



Fig 9:- Commands to create a virtual environment to run the code .

The following figure 11 describes the digit seen by the SVM algorithm. The confusion matrix is displayed using a matrix where each row shows examples in the predicted class, while each column shows them in the actual category.

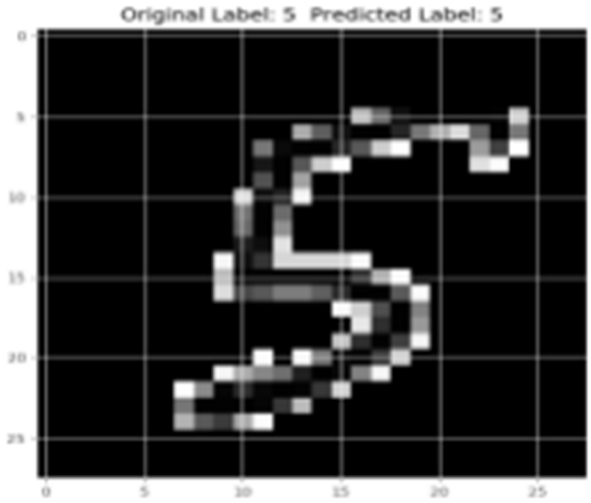


Fig 11:- Digit Recognized by SVM algorithm

Figure 12 shows the output generated by training CNN.

The Figure 10 shows the output generated by running the



Fig 12:- Output generated by CNN

VI. CONCLUSION

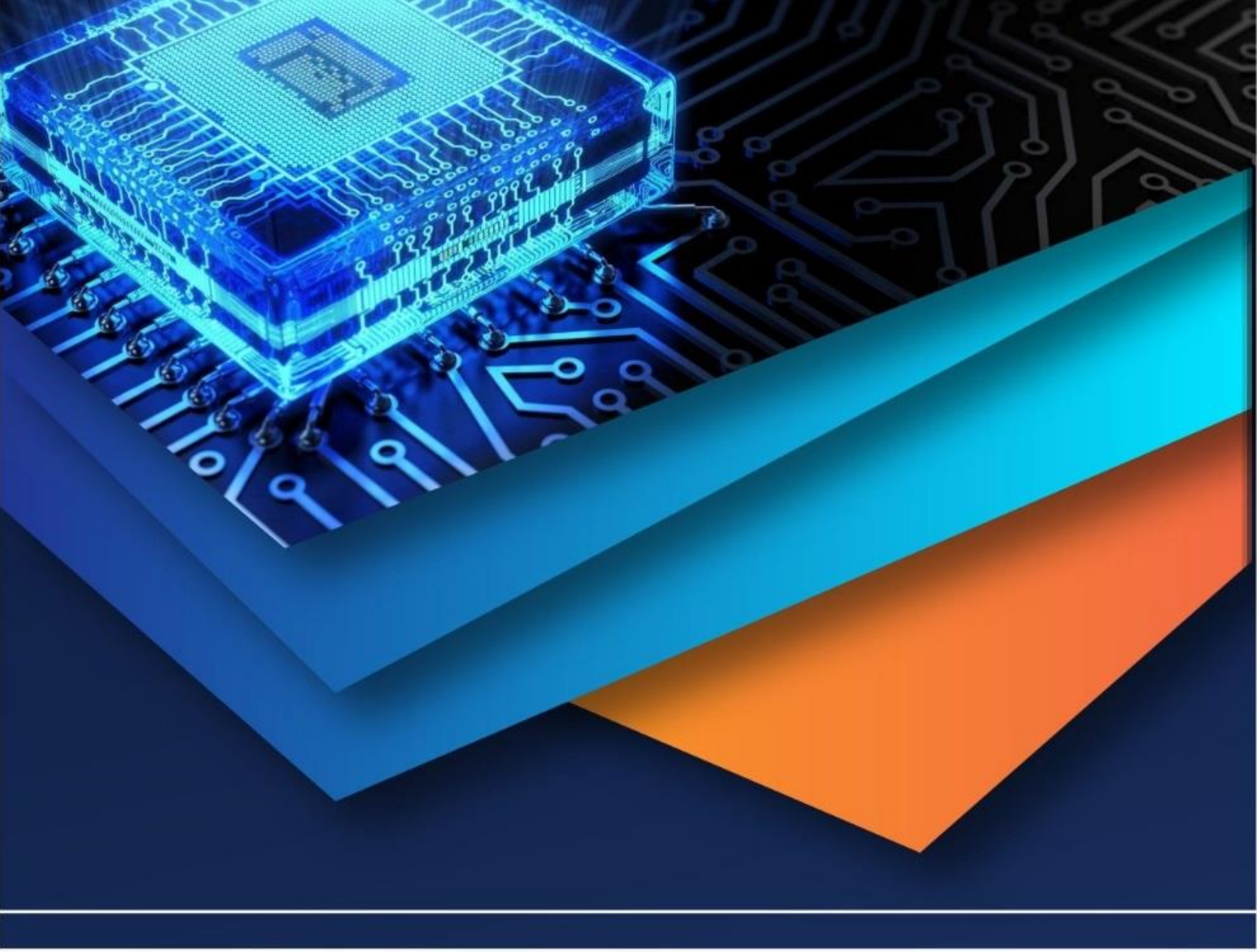
In this paper, Handwritten Digital Recognition is used In-depth learning strategies have been developed. Many widely used machine learning algorithms, KNN, SVM, RFC and CNN trained and tested on the same data into find comparisons between dividers. Use these are deeper learning methods, the higher the level of accuracy can be found. Compared to other research methods, this method focuses on which category works best for developing more than 99% separation accuracy models. Use Keras as backend and Tensorflow as software, CNN The model is able to provide about 98.72% accuracy. In the first one test, CNN provides 98.72% accuracy, while KNN provides 96.67% accuracy, while RFC and SVM are not what is outstanding .

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