Intelligent Handwritten Digit Identification System For Computer Applications Using IBM Watson Studio

1. INTRODUCTION

1. 1 OVERVIEW

Handwriting recognition is one of the compelling research works going on because every individual in this world has their own style of writing. It is the capability of the computer to identify and understand handwritten digits or characters automatically. Because of the progress in the field of science and technology, everything is being digitalized to reduce human effort. Hence, there comes a need for handwritten digit recognition in many real-time applications. MNIST data set is widely used for this recognition process and it has 70000 handwritten digits. We use Artificial neural networks to train these images and build a deep learning model. Web application is created where the user can upload an image of a handwritten digit. this image is analyzed by the model and the detected result is returned on to UI

1.2 PURPOSE:

Recognizing handwritten numbers is a piece of cake for humans, but it’s a non-trivial task for machines. Nowadays, with the advancement of machine learning, people

have made machines more and more capable of performing this task. The handwritten digit recognition is the ability of computers to recognize human handwritten digits. It is a hard task for the machine because handwritten digits are not perfect and can be made with many different flavors. The handwritten digit recognition is the solution to this problem which uses the image of a digit and recognizes the digit present in the image. In order to analyze the performance of the methods, data is needed to be used for training using machine learning methods.

2. Literature Survey

The motivation behind adopting the literature review is to gain knowledge towards the data sets and the implementation of different types of classifiers to recognize the handwritten digits. A systematic literature review does not opt for this research as the results gathered through this were not used as the results. Once the required data has been obtained from the literature review, then data analysis is performed. Narrative synthesis is adopted as our data analysis method for our literature review. During the literature review, the data collected through the articles were gathered together and they summarized in a paragraph. The results gathered through this data analysis were documented and these were used for the experimental research method. While conducting the literature review, towards recognition of handwritten digits a critical analysis is taken for the methods used solving this problem.

Automatic handwritten digits extracts from images is a crucial role for creating documents and processing the systems. The main purpose is to find out the rules to be used in the AHDR for document images using machine learning methods. The field studied in this work is to recognize the corrupted handwritten digits and increase the reliability of the result of the recognition process and to speed up the collecting training and test data from handwritten digit strings. The overall recognition process consists of preprocessing, segmentation, classification and finally recognition of given input data.

The results from the literature review give us a lot of existing research area on preprocessing, segmentation, feature extraction with specific techniques and classification to recognize the digits. In the paper, the authors have conducted research related to “Handwritten Word Recognition Using Multi-view Analysis”. The major contribution of this research is a solution to the problem of efficiently recognizing handwritten words from a limited size lexicon.

The authors of another paper have conducted research related to “Handwriting Recognition On Form Document”. The author used Freeman Chain Code, with the division of a region into nine sub-regions, histogram normalization of chain code as feature extraction and Artificial Neural Networks, to classify the characters on the form document.

PROPOSED SOLUTION:

Artificial Neural Networks:

Neural networks can be known as a set of algorithms, loosely modeled after the brain of humans that are designed in a way to recognize patterns. They are capable of interpreting data using a type of machine perception, clustering or labeling raw input. The patterns recognized by them are contained in vectors, numerical, into which all the data of the real-world, be it text, sound, time series, or images, are supposed to be translated. Along with various advantages of neural networks, the most common ones are that they help us classify and cluster. They can be considered as a classification of the clustering layer maintained above the data that you store and manage. They allow you to group the data that is unlabeled based on similarities between example inputs, and they are responsible for the classification of data when the dataset is labeled by them to train on. To be more precise, neural networks can be considered as components of larger applications of machine learning as a service that involve algorithms for classification, regression, and reinforcement learning.

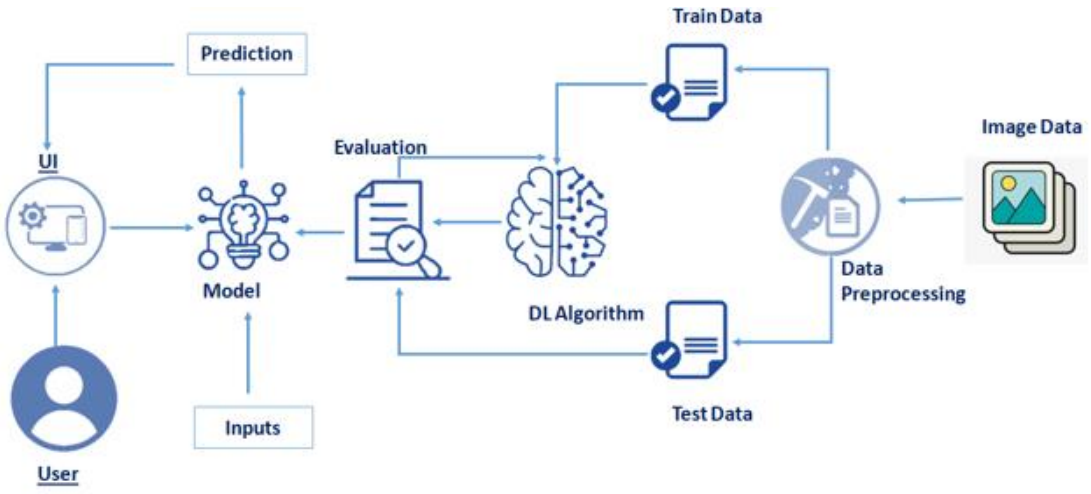
Convolutional Neural Networks :

The field of machine learning has taken a dramatic twist in recent times, with the rise of the Artificial Neural Network (ANN). These biologically inspired

computational models are able to far exceed the performance of previous forms of artificial intelligence in common machine learning tasks. One of the most impressive forms of ANN architecture is that of the Convolutional Neural Network (CNN). CNNs are primarily used to solve difficult image-driven pattern recognition tasks and with their precise yet simple architecture, offers a simplified method of getting started with ANNs.

THEORITICAL ANALYSIS :

ARCHITECTURE :



REQUIREMENTS :

To complete this project , you should have the following software and packages :

- **Anaconda Navigator**: Anaconda comes with so very nice tools like JupyterLab, Jupyter Notebook, QtConsole, Spyder, Glueviz, Orange, Rstudio, Visual Studio Code. For this project, we will be using Jupiter notebook and spyder.
- To build Deep learning models you must require the following packages:
  - Tensor flow
  - Keras

EXPERIMENTAL INVESTIGATIONS :

The result of this recognizes the digit. Recognizing handwritten numbers is a piece of cake for humans, but it's a non-trivial task for machines. Nowadays, with the advancement of machine learning, people have made machines more and more capable of performing this task. The handwritten digit recognition is the ability of computers to recognize human handwritten digits. It is a hard task for the machine because handwritten digits are not perfect and can be made with many different flavors. The handwritten digit recognition is the solution to this problem which uses the image of a digit and recognizes the digit present in the image.

CONTROL FLOW OF THE SOLUTION :

Project Flow:

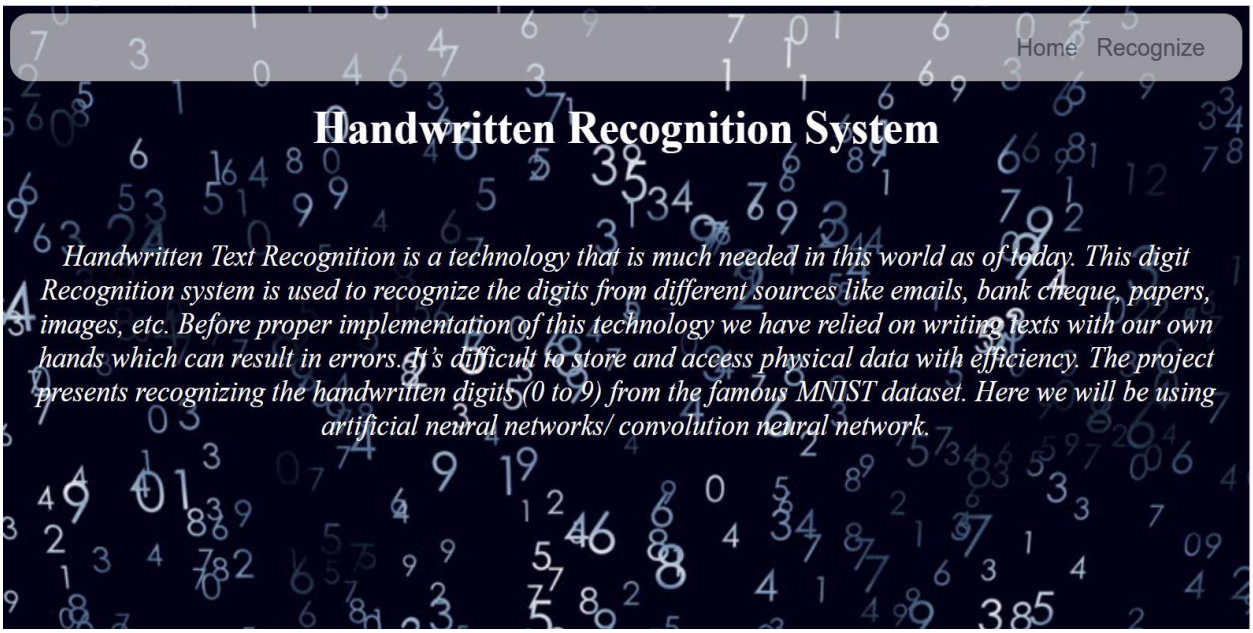
- The user interacts with the UI (User Interface) to upload the image as input
- The uploaded image is analyzed by the model which is integrated
- Once the model analyses the uploaded image, the prediction is showcased on the UI

To accomplish this, we have to complete all the activities and tasks listed below:

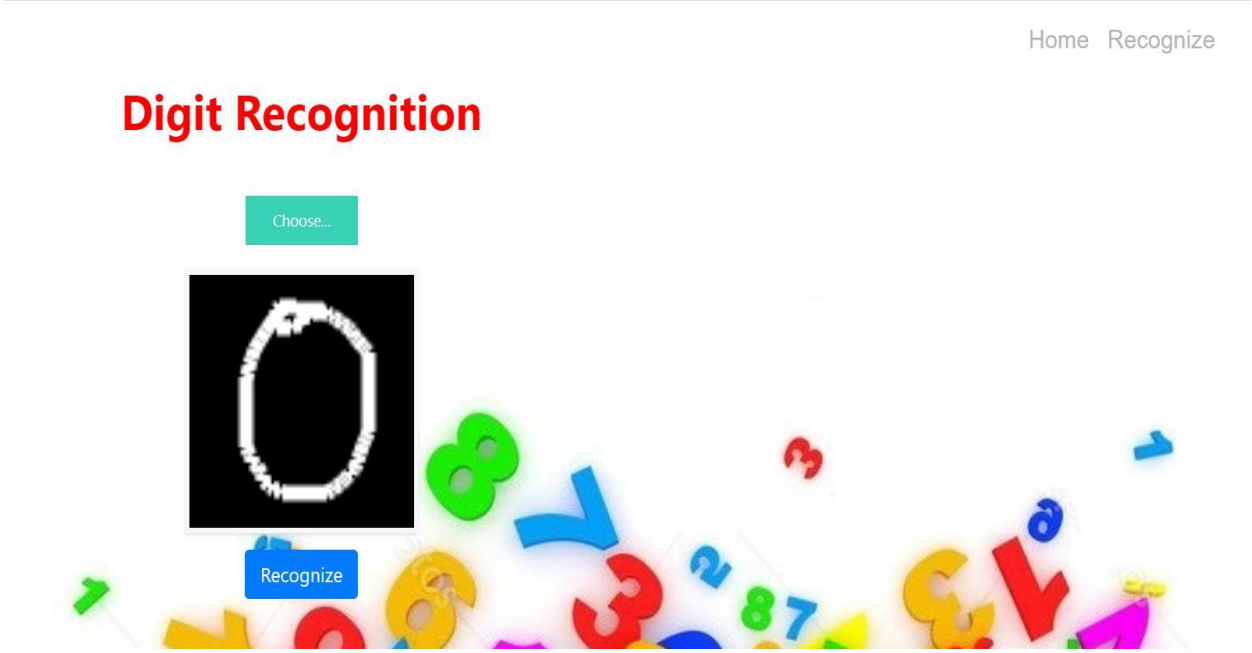
- Understanding the data.
    - Importing the required libraries
    - Loading the data
    - Analyzing the data
    - Reshaping the data.
    - Applying One Hot Encoding
- Model Building
    - Creating the model and adding the input, hidden and output layers to it
    - Compiling the model
    - Training the model
    - Predicting the result
    - Testing the model by taking image inputs
    - Saving the model
- Application Building
    - Create an HTML file
    - Build Python Code

RESULT :

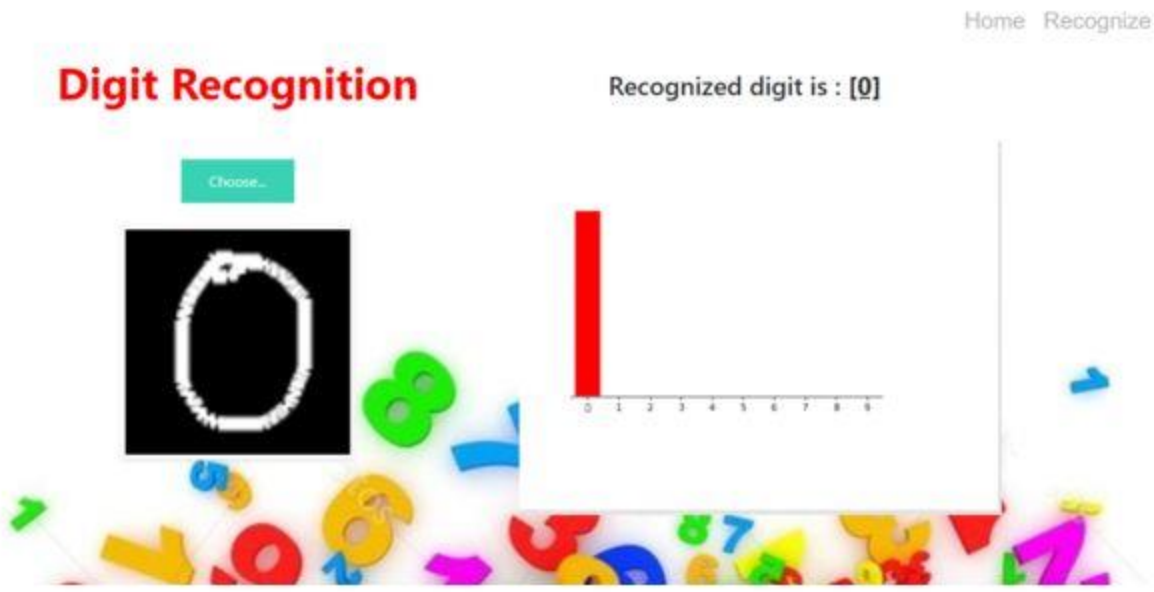
There comes a need for handwritten digit recognition in many real-time applications. MNIST data set is widely used for this recognition process and it has 70000 handwritten digits. We use Artificial neural networks to train these images and build a deep learning model. Web application is created where the user can upload an image of a handwritten digit. this image is analyzed by the model and the detected result is returned on to UI.



When we click on recognize option, we can upload the image which has to be recognized.



Then the output will be recognized as:



ADVANTAGES OF PROPOSED SOLUTION :

There are various advantages of neural networks, some of which are discussed below:

1) Store information on the entire network

Just like it happens in traditional programming where information is stored on the network and not on a database. If a few pieces of information disappear from one place, it does not stop the whole network from functioning.

2) The ability to work with insufficient knowledge:

After the training of ANN, the output produced by the data can be incomplete or insufficient. The importance of that missing information determines the lack of performance.

3) Good falt tolerance:

The output generation is not affected by the corruption of one or more than one cell of artificial neural network. This makes the networks better at tolerating faults.

4) Distributed memory:

For an artificial neural network to become able to learn, it is necessary to outline the examples and to teach it according to the output that is desired by showing those examples to the network. The progress of the network is directly proportional to the instances that are selected.

5) Gradual Corruption:

Indeed a network experiences relative degradation and slows over time. But it does not immediately corrode the network.

6) Ability to train machine:

ANN learn from events and make decisions through commenting on similar events.

7) The ability of parallel processing:

These networks have numerical strength which makes them capable of performing more than one function at a time.

Advantages of Convolutional Neural Networks:

Utilizing intelligent automation in order to boost up the growth process of your business might become your best decision to stay ahead of your competitors.

1) Cost and Time Benefits

Among the three most common neural networks advantages, cost and time benefit remains on the top. Neural networks are considered ad trainable brains. You feed them information about your organization and train them in order to perform tasks such as report generation. These networks will use that new information, training, and work experience to improve and adapt in a similar way that a human worker learns.

2) Quality and Accuracy In Results

The benefits of neural networks involve high quality and accuracy in outputs. Your human workforce, no matter how many times they check for errors, can still leave some flaws unnoticed and that’s what you want to eliminate as the CEO of your company.

3) Job Growth

Jobs growth is also one of the most common neural network advantages. Companies that use machine learning must have to train their workers to use the software. This actually means growth for the right human worker.

These advantages of artificial neural networks are appealing enough for any business to implement machine learning so as to improve their business performance and enhance their growth process. There is a tough competition out there which makes it hard for businesses to survive and strive but with the use of advanced technology and intelligent automation, organizations can easily maintain their place in the industry.

Disadvantages of ANN:

- Hardware Dependence
- Unexplained functioning of the network
- Assurance of proper network structure
- The difficulty of showing the problem to the network
- The duration of the network is unknown

Disadvantages of CNN :

- Classification of Images with different Positions
- Adversarial examples
- Coordinate Frame
- Other minor disadvantages like performance

Applications:

- ✓ Text Classification and Categorization
- ✓ Named Entity Recognition(NER)
- ✓ Part of Speech Tagging

- ✓ Semantic Parsing and Question Answering
- ✓ Paraphrase Detection
- ✓ Language Generation and Multi-document Summarization
- ✓ Machine Translation
- ✓ Speech Recognition
- ✓ Character Recognition
- ✓ Spell Checking

CONCLUSION :

The primary focus of this project is to build an Automatic Handwritten Digit Recognition on document images. So, we used Artificial Neural Networks and Convolutional Neural Networks to recognize the digits. There are also many wide range of applications which can be built using the above model. Although there are some limitations which may arise when certain constraints are involved.

We have found that CNN gave the most accurate results for handwritten digit recognition. So, this makes us conclude that CNN is best suitable for any type of prediction problem including image data as an input. Next, by comparing execution time of the algorithms we have concluded that increasing the number of epochs without changing the configuration of the algorithm is useless because of the limitation of a certain model and we have noticed that after a certain number of epochs the model starts overfitting the dataset and give us the biased prediction.

FUTURE SCOPE :

A new method can be proposed where improvements has to be made. Thus, there is a place for some future work such as:

● To reduce the complexity of the algorithm, it's better to reduce the number of hypothesis to function the algorithm faster.

The future development of the applications based on algorithms of deep and machine learning is practically boundless. In the future, we can work on a denser or hybrid algorithm than the current set of algorithms with more manifold data to achieve the solutions to many problems. In future, the application of these algorithms lies from the public to high-level authorities, as from the differentiation of the algorithms above and with future development we can attain high-level functioning applications which can be used in the classified or government agencies as well as for the common people, we can use these algorithms in hospitals application for detailed medical diagnosis, treatment and monitoring the patients, we can use it in surveillances system to keep tracks of the suspicious activity under the system, in fingerprint and retinal scanners, database filtering applications, Equipment checking for national forces and many more problems of both major and minor category.

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5. “Advancements in Image Classification using Convolutional Neural Network” by Farhana Sultana, Abu Sufian & Paramartha Dutta.

APPENDIX:

SOURCE CODE :