International Journal of Scientific Research in Computer Science, Engineering and Information Technology

ISSN : 2456-3307

OPEN ACCESS

Available Online at : www.ijsrcseit.com

doi : https://doi.org/10.32628/IJSRCSEIT

Pen Stroke Digit Recognition Using CNN

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ARTICLEINFO

Article History:

Accepted: 10 April 2024

Published: 22 April 2024

Publication Issue

Volume 10, Issue 2

March-April-2024

Page Number

721-728

ABSTRACT

Hand-written character and digit recognition have been one of the most exigent and engrossing field of pattern recognition and image processing. The main aim of this paper is to demonstrate and represent the work which is related to hand-written digit recognition. The hand-written digit recognition is a very exigent task. In this recognition task, the numbers are not accurately written or scripted as they differ in shape or size; due to which the feature extraction and segmentation of hand-written numerical script is arduous. The vertical and horizontal projections methods are used for the purpose of segmentation in the proposed work. KNN is applied for recognition and classification. The digit recognition is a very exigent task. In this recognition task, the numbers are not accurately written or scripted as they differ in shape or size; due to which the feature extraction and segmentation of numerical script is arduous. The vertical and horizontal projections methods are used for the purpose of segmentation in the proposed work. CNN is applied for recognition, classification and we are also getting nice accuracy while doing prediction.

Keywords : CNN, KNN, OCR, Naïve Bayes, Neural Networks, Feature Extraction, Optical Character Recognition, Segmentation, Handwritten Digit Classification.

I. INTRODUCTION

Optimal Character Recognition (OCR), can be defined as the method which is capable to recognize and identify the digits by the conversion of typed images.The pixel representation of a digit is obtained after the conversion from equivalent digit representation. The process is a simulation by the machine of human reading. Digit recognition can be stated as the research of how observation of the environment by the machines is able to distinguish the digit of interest and predicts the accurate decision related to the digits. OCR, (Optimal Character Recognition) can be defined as the device which is capable of translating the images into machine recognizable formats which could be in the form of ASCII or Unicode. The process of digit recognition of text which is manually-written is more difficult than text generated by machines, as the digits in hand-written text are non-uniform and due to which it is

variable in shape and size; while the machine printed text are simple and uniformly spaced which are aligned fixed. The process contributes in the automation process, as it increases the necessary interaction among the machines and humans. In OCR, there are two types of OCR Datasets: Offline and Online. In 'Offline' dataset, the datasets are loaded and provided to the classifier or training model as an input, but in 'Online' dataset, the co-ordinates of the detection of drawing the digit is recorded to instantiate the prediction. The OCR technique involves numerous benefits as the manually-written digit involves conversion process which is aimed for generation of machine generated and machine recognizable digit due which it is space efficient.

The main aim of this paper is to demonstrate and represent the work which is related to digit recognition. The digit recognition is a very exigent task. In this recognition task, the numbers are not accurately written or scripted as they differ in shape or size; due to which the feature extraction and segmentation of hand-written numerical script is arduous. The vertical and horizontal projections methods are used for the purpose of segmentation in the proposed work. CNN is applied for recognition, classification and we are also getting nice accuracy while doing prediction.

II.RELATED WORK

The digit classification or recognition, for the cursive hand-written document, the study demonstrated that off-line manually-written analysis of the document occurs through skew recognition, writing pressure detection and segmentation. The segmentation method which was proposed, was based on modified vertical and horizontal projections; moreover, in the existence of multi-skewed and over-lapped text lines these projections are capable to segment the text lines and the words accurately. The testing of the method was executed on more than 550 images of text which were of IAM database and sample images of handwriting of different writers on different back-grounds. This proposed method was capable of performing correct segmentation and prediction with of around 92.56% words and 95.65% lines from the IAM dataset. Moreover, around 96% are perfectly normalized with a minute error correction. The method of skew normalization demonstrates the skew angle accurately and compares it to different hands on techniques efficiently. The segmentation of lines, of the text is processed on the basis of information energy targeted individually for the calculation of every pixel and "Artificial Neural Network" recognized the characters and digits. The accuracy of recognition was around 98% above. The execution of feature set which is hull based and of convex form which implies, 125 features to be computed according to the consideration of diverse attributes of bays of a pattern of the convex hull, isolated Bangla basic characters and digits were also recognized and this technique was also included in this field of study. The accuracy rate of recognition of manually-written Bangla characters was 76.86% and for Bangla numerals it was 90-97%.

III.PROPOSED SYSTEM

The main aim of this paper is to demonstrate and represent the work which is related to digit recognition. The digit recognition is a very exigent task. In this recognition task, the numbers are not accurately written or scripted as they differ in shape or size; due to which the feature extraction and segmentation of manually-written numerical script is arduous. The vertical and horizontal projections methods are used for the purpose of segmentation in the proposed work. CNN is applied for recognition and classification to get High Accuracy rate.So we are using CNN algorithm to get high accuracy and efficiency when compared to the existing system.

Advantages:

- It is giving higher accuracies .
- Better prediction rate when compared to existing.

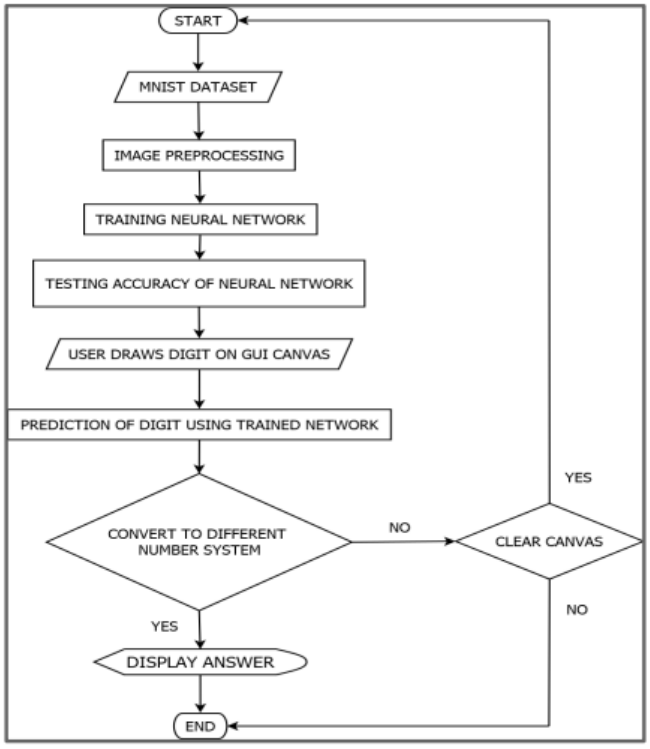


Fig 1: Proposed Workflow

3.1 CNN APPROACH

Convolutional Neural Network (ConvNet or CNN) well known neural network for specially image recognition and classification. CNN is highly excellent in extracting complex features for classifications. CNN consist of neurons where weight and bias can be learned. Each neuron receives some input; weighted sum is taken then given to the activation function. CNN uses successive convolution layer and nonlinear ReLU function to extract valuable feature with specific dimension [7] [8] [11]. Maxpooling layer is used to downsize the feature map. In Fully connected layer, each neuron is connected to every other neuron of previous dense layer. Back- propagation and gradient descent are used while training the network. Softmax function is probability distribution to limit all class output value between 0 and 1. CNN provides feature maps which helps neural network to learn small features of the image depending on the depth of hidden layers. Proposed architecture is as shown in Figure 2.

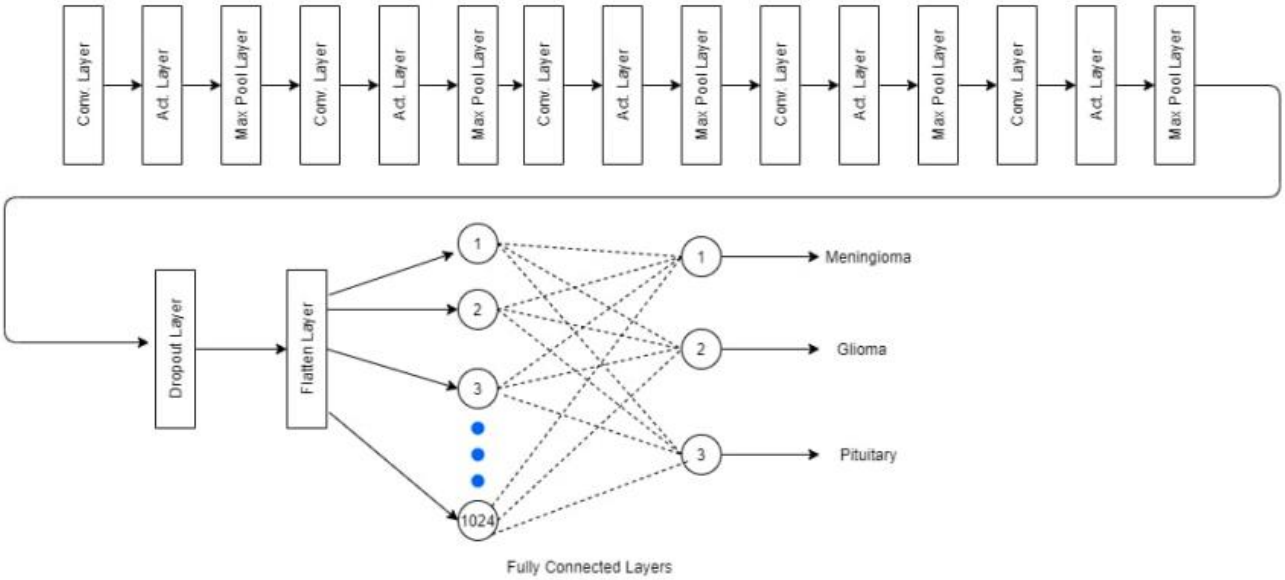


Fig 2: CNN Architecture

IV.RESULTS AND DISCUSSION

```
import cv2

# loop over a few random digits

for i in np.random.randint(0, high=len(testLabels), size=(5,)):
          # grab the image and classify it
          image = testData[i]
          prediction = model.predict([image])[0]

          imgdata = np.array(image, dtype='float')
          pixels = imgdata.reshape((8,8))
          plt.imshow(pixels,cmap='gray')
          plt.annotate(prediction,(3,3),bbox={'facecolor':'white'},fontsize=16)
          print("i think tha digit is : {}".format(prediction))
          #cv2.imshow("image", image)
          plt.show()
          cv2.waitKey(0)
```

```
i think tha digit is : 2
```

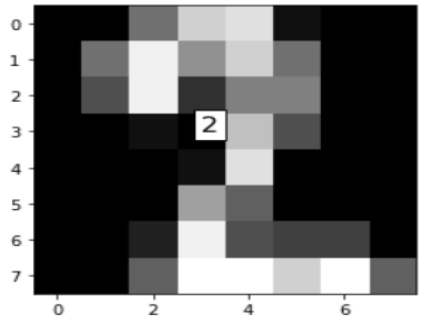


Fig 3. KNN OUTPUT

```
fig, ax = plt.subplots(2,1, figsize=(18, 10))
ax[0].plot(history.history['loss'], color='b', label="Training loss")
ax[0].plot(history.history['val_loss'], color='r', label="validation loss",axes =ax[0])
legend = ax[0].legend(loc='best', shadow=True)

ax[1].plot(history.history['accuracy'], color='b', label="Training accuracy")
ax[1].plot(history.history['val_accuracy'], color='r',label="Validation accuracy")
legend = ax[1].legend(loc='best', shadow=True)
```

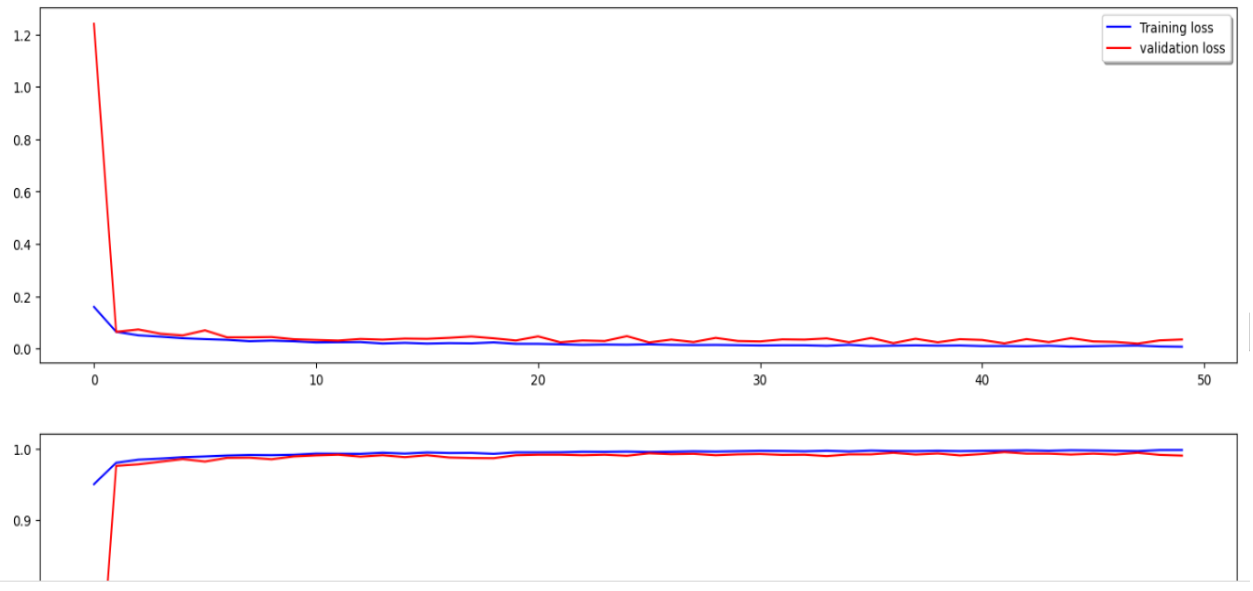
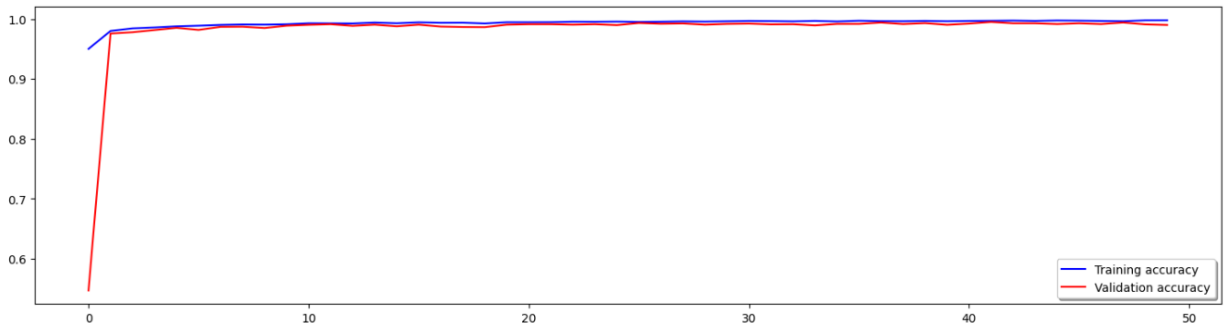


Fig 4. Training and Testing Loss




```
fig = plt.figure(figsize=(10, 10)) # Set Figure

y_pred = model.predict(X_test) # Predict class probabilities as 2 => [0.1, 0, 0.9, 0, 0, 0, 0, 0, 0, 0]

Y_pred = np.argmax(y_pred, 1) # Decode Predicted labels
Y_test = np.argmax(y_test, 1) # Decode labels

mat = confusion_matrix(Y_test, Y_pred) # Confusion matrix

# Plot Confusion matrix
sns.heatmap(mat.T, square=True, annot=True, cbar=False, cmap=plt.cm.Blues, fmt='.0f')
plt.xlabel('Predicted Values')
plt.ylabel('True Values');
plt.show();
```

Fig 5. Training and Testing Accuracy

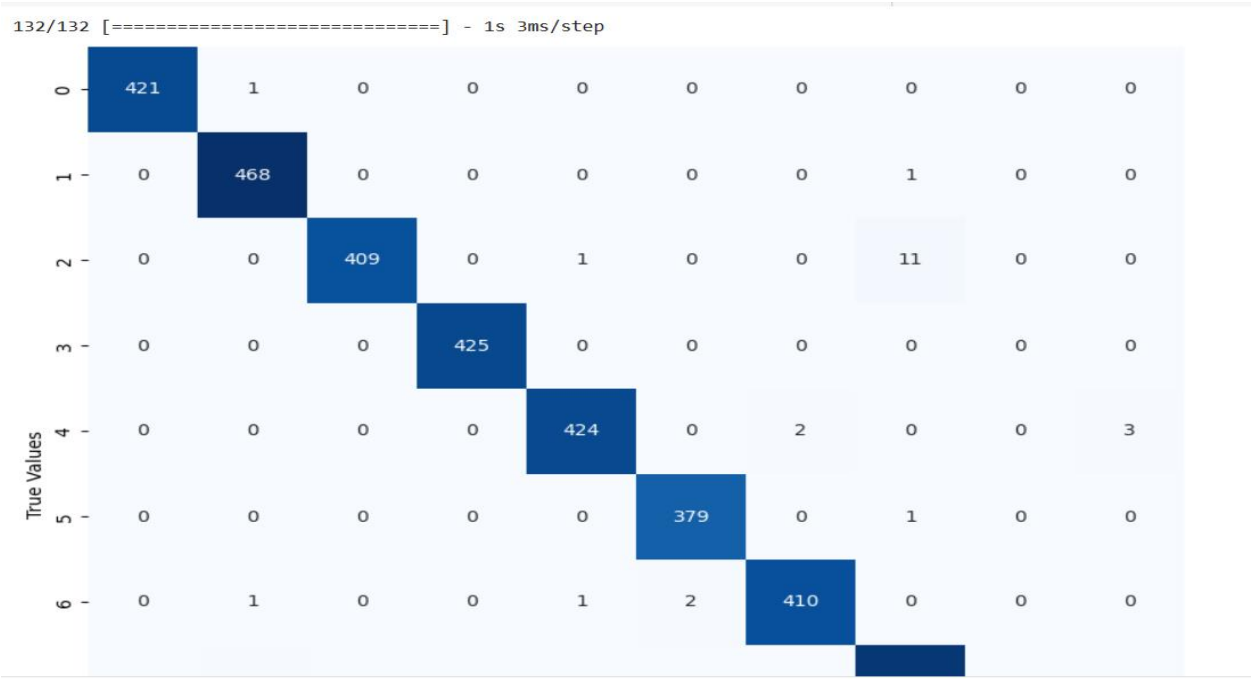
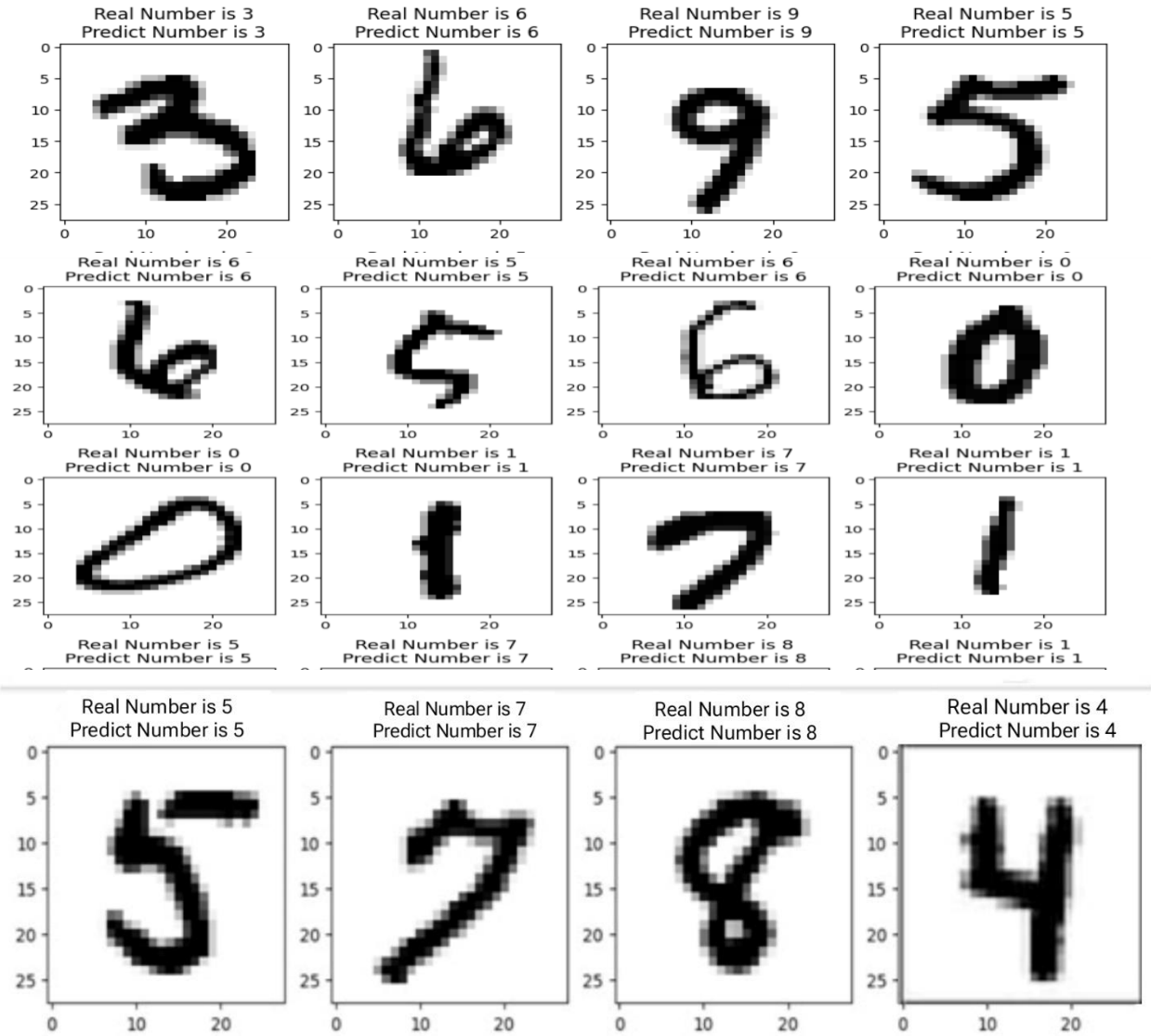


Fig 6. Confusion Matrix Plot Diagram

```
y_pred = model.predict(X_test)
X_test__ = X_test.reshape(X_test.shape[0], 28, 28)

fig, axis = plt.subplots(4, 4, figsize=(12, 14))
for i, ax in enumerate(axis.flat):
    ax.imshow(X_test__[i], cmap='binary')
    ax.set(title = f"Real Number is {y_test[i].argmax()}\nPredict Number is {y_pred[i].argmax()}");
```

```
132/132 [==============================] - 0s 2ms/step
```




```
KNN_Acc = accuracies[i % len(accuracies)] * 100
CNN_Acc = max(history.history['accuracy'])
print(len(accuracies))
print(i)
```

```
15
15
```

```
KNN_Acc,CNN_Acc
```

```
(99.25925925925925, 0.9976906180381775)
```

```
Start coding or generate with AI
```

Fig 7. CNN OUTPUT

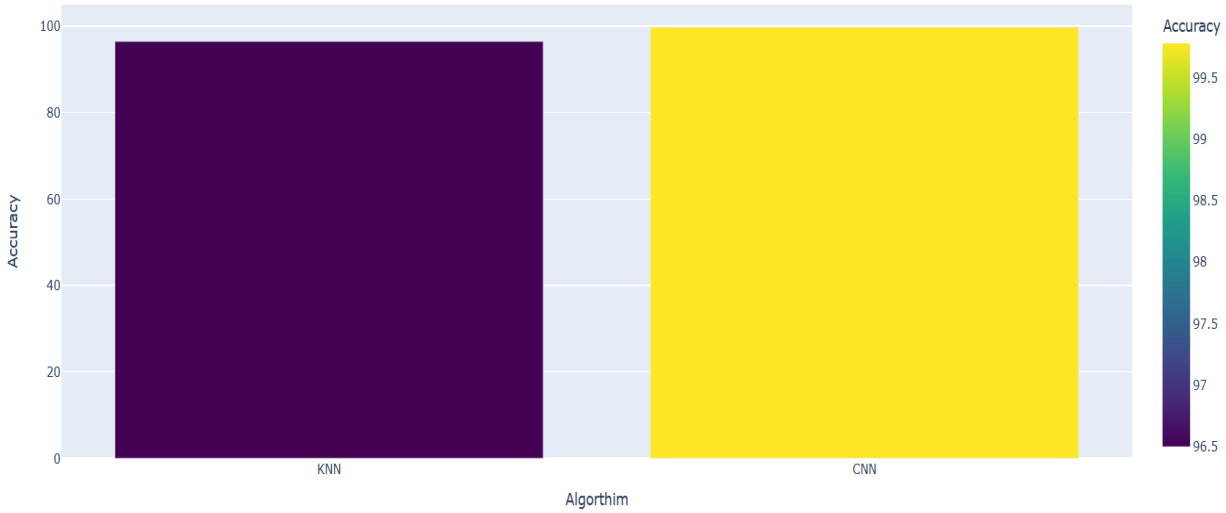


Fig 8. KNN & CNN Accuracy

V.CONCLUSION

The work deals with digit classification, using the efficient CNN deep learning algorithm. For, training supervised classification deep learning model the training dataset is fed to the classifier as input with labelled data and the model after successful training, becomes capable for the classification of digits on the basis of any testing point fed to the classifier, after the involvement of Neural networks which determines the digit recognition and image processing related to the testing data point. For classification, CNN deep learning algorithm was used. The Predicted Accuracy is also High When Compared to KNN.

VI.FUTURE WORK

This work can be proliferated in future to result in rapid computation which would also decrease time and would increase efficiency and target better results. All the experiments were implemented or executed in Jupyter Notebook, a web application which runs on local machine server and is a part of collection of applications in Anaconda software. The datasets used were training and testing MNIST datasets.

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