

BANGLA HANDWRITING RECOGNITION

BY

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This Report Presented in Partial Fulfillment of the Requirements for the
Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled “**Bangla Handwriting Recognition**”, submitted by MD. Asif Hasan, ID: 151-15-5425 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering (BSc) and approved as to its style and contents. The presentation has been held on 24th November, 2018

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DECLARATION

I hereby declare that, this project has been done by me under the supervision of MD. Azizul Hakim, Lecturer, Daffodil International University, Dhaka. I also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

Bangla Hand Writing Recognition System is a system that can recognize the bangla handwriting. In this project I am working with the dataset that I collect personally from different place in Bangladesh. This dataset contains approximately 700 students handwriting sample. In this dataset I collect 44 simple alphabets and 109 compound alphabets. Main purpose of this project is to make a system that can recognize the bangla handwriting and with the help of this we can change the data collection system of this country. This system can be use in the Bangladesh Land Office to make all previous records digital. I used python OpenCV library to prepare this dataset and use Convolutional Neural Network model to recognize the handwriting.

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CHAPTER 1

Introduction

1.1 Introduction:

In recent time handwriting recognition system is a very popular concept because of it's used. If we look closely, we can find that in recent mobiles are recognize our English handwriting very well and can perform according to the instruction but for Bangla alphabet there are no features for recent mobile phones and this mobile cannot recognize the Bangla alphabets. This happens because not have proper recognize system and not have the proper alphabet dataset. Not only in the mobile phones if you look today many features are available with the help of handwriting recognize system but still, we are not able to get the benefit of our language. Now a day we can translate from the image, automatically control the traffic and can note down the vehicle numbers. But lack of the proper recognize system and proper dataset we are not able to use these features in our routine life. So, handwriting recognize system is very interesting and popular topic now a day.



Fig:1.1.1 All Bangla Alphabets

1.2 Motivation:

I notice that in other languages there is enough recognize system available but in our Bangla language, there is no proper recognize system. This thing touches my heart and I thought to make a proper recognize system for Bangla handwriting. Also, recently I found a application in google play that can read doctors handwriting, and can give result properly. But I do not find any application that read our handwriting and give result properly. For this goal, I collect almost seven hundred set samples from different places. My goal is very clear and straight that to make a proper recognize system that gives best accuracy in recognition. So, in initially I want to make a model that can recognize then after I want to work with it.

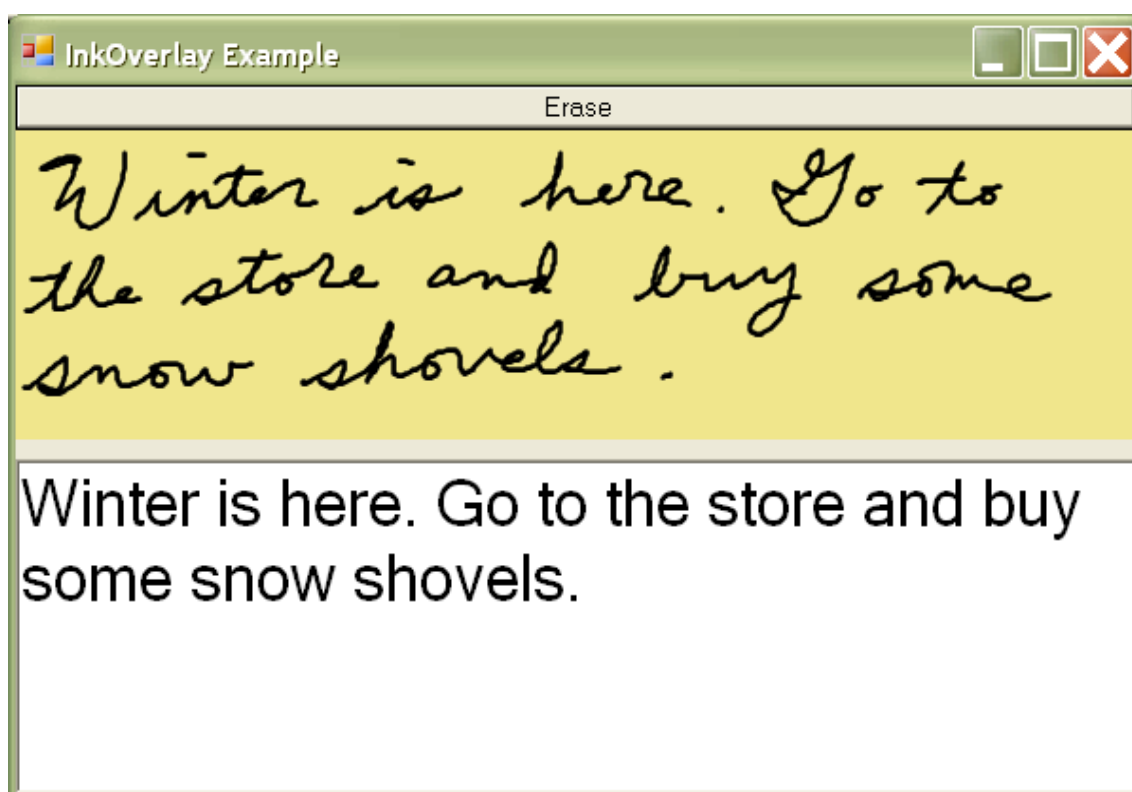


Fig: 1.2.1 English Handwriting Recognizer

1.3 Rationale of the study:

In Bangladesh, most of the people can type English in the computer but they failed to type in Bangla because of the complexity of Bangla typing process. This is one of the sides that I bring to change. If anyone gives his or her scan handwriting in this proposed system then he gets the type form of that hardwiring. If this can be done in a proper way and with the great accuracy then it will be a big change in the sector of Bangla typing. By this project, the people who live in the countryside then can be beneficial most.

1.4 Objectives:

- Make dataset for Bangla handwriting recognizer.
- Create compound alphabets character dataset.
- Achieve the best accuracy for recognition.

1.5 Expected Outcome:

- Make a dataset for compound character in Bangla language.
- Make the biggest dataset for compound character.
- Acceptable recognition accuracy for compound character.

All created dataset of this project will be open source in the future. All over the world, it can be used for education purpose. After completing this project, I will upload this dataset on GitHub for further research purpose.

1.6 Report Layout:

Chapter 1- This is the introduction of this project. In this chapter I talk about the motivation behind this project, the expected outcome of this project and the objective of this project.

Chapter 2- Here I talk about the previous works related to my project. I also talk about the eligibility of this project. I describe the problems that I faced by this time I also mention them in this part.

Chapter 3- This is very important part of this report. I talk about the data collection process and the process of data cropping.

Chapter 4- This chapter is about my used model for recognize the handwriting. Here I talk about all the basic concept of CNN and describe the basic definition of CNN.

Chapter 5- Result of the project and the final outcome

Chapter 6- Here I mention the future possibilities of this project and the limitations.

CHAPTER 2

Literature Review

2.1 Literature Review:

In Shape Decomposition-based Handwritten Compound Character Recognition for Bangla OCR of Rahul Pramanik, Soumen Bag, they have used the ICDAR 2013 Segmentation Dataset and Cmaterdb 240 dataset (version 3.1.3.1 for compound characters and version 3.1.2 for basic characters) for their experimental purpose. Both these datasets are unbiased with varied elements and are used by most researchers working in this particular domain. A total of 10240 sample images of compound characters are used to carry out the experiment. They have used 12300 basic character images for 245 training purpose. All modules used for implementation are written in MATLAB on the Windows 10 platform

In A COMPLETE PRINTED BANGLA OCR SYSTEM of B. B. CHAUDHURI and U. PAL, We have noted that error correction module can correct 74.22% of single character error generated by the OCR system [2][3]. As a result, the overall accuracy of the OCR system is about 95.50% in word level which is equivalent to about 99.10% in character level (assuming a word to consist of an average of 5 characters)

In Diacritical Language OCR based on neural network: Case of Amazigh language of Khadija EL GAJOUÏ, To train there system, they created images containing a text line. The training corpus is composed of 10,000 images and the test corpus of 1,000 images. Learning is run in more than 20,000 iterations and gives birth to 20 different neural network models. The test phase shows that the best model gives a percentage of 97%.

In Recognition of Handwritten Bangla Numerals using Adaptive Coefficient Matching Technique of Amitava Choudhurya, Alok Negib and Sanhita Dasc, Experimentations are performed on a dataset of Bengali numeral images [4]. The dataset consists of 300 images divided into 100 training images and 200 test images on randomly basis. 10 different numbers 0 to 9 are used each having 10 training instances and 20 test instances

2.2 Why I Choose This Project?

Bangla is one of the popular languages in this universe. We feel very proud that we talk in Bangla but we do not want to work to improve this language. I know that in time to time many people work or sacrifice their valuable time to make it better but I think this is not sufficient for this community. So, I took this challenge to make a recognition system also want to make a dataset for the complex letter of Bangla language and also the simple letter as well. End of this project I can make one of the biggest Bangla handwritten complex letter datasets. These things inspire me a lot to take this project.

2.3 Eligibility Requirements:

To make this dataset I choose the people who at least can write Bangla. But most of his data collected from universities and from the schools. But in future if anyone wants to contribute you must have the basic knowledge of Bangla letters this is the only requirement for contribute on it.

2.4 Challenges I Faced:

When I am started to collect handwriting data from people many of them refused to give his/ her handwriting sample because they thought this is a bogus work. But when we explain the whole scenario, they changed their mind and co-operate with us by giving their handwriting. The second challenge is when I am going to prepare the dataset, I faced a huge problem because each of the data sheets contains 154 samples that mean 154 different images. If I crop this image manually it will become almost impossible for me to finish this project on time. So, dataset preparation is one of the biggest challenges in this project. Then one major problem is to classified the labels. Many alphabets are similar in look in Bangla language. As a example we I can say the alphabets অ and আ, ব and ঝ, ড and ঙ. This is one of the biggest challenges in labeling of this model. Noise reduction is one of the basic problems of this project. People who contribute on this dataset there writing style is definitely not similar so

sometimes the touch the side line of the data form. This will become another headache for me when I prepare this dataset. Because in Open CV the detect the pixel variation and when the found the pixel variation outside given box it understands that this is the place where it need to crop. So, for this silly mistake data loss might be happen here, but fortunately somehow I managed to solve this problem and decrees the data loss by bring some minor changes in the code.



Fig:2.4.1 Example of some similar characters

CHAPTER 3

Requirement Specification

3.1 Introduction:

Language is the main way to express our emotions and our thought in front of all and handwriting is one of the best ways to express our emotions. Handwriting is played a very important role in any language because by this way you can store your works and your emotions for the future. In Bangla language, it has totally forty-nine alphabets. In this project, I collect one hundred and fifty-four alphabets in total. In this dataset, it has eleven vowel and thirty-six consonant words and one hundred and four complex words.

3.2 Data Collection Process:

To make this dataset first I create a form in MS Word. This form page is A4 in size. Total dimension of this data form is 2085*2928 pixel. I collect my all data form three different districts in Bangladesh. I collected this data from Rangpur, Nilphamari and Dhaka. But most of the data collected form my university. Here I collect almost four hundred set data and the very interesting part is here I got almost all district people. I collect this data form my department of CSE and for this I took the permission from the head of this department.

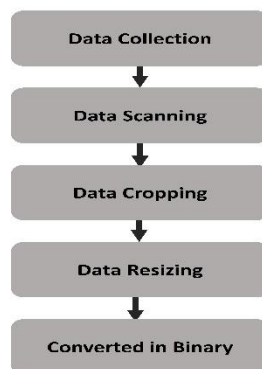


Fig. 3.2.1 Data Collection Process

a. Data Collection:

Data collection one of the challenging steps in this project. People does not eagerly want to contribute or giving their handwriting data sample easily. For this I need to explain why I want this samples from them and what is the main purpose of this project. After my explanation everyone became very excited to contribute on this project and eagerly give their handwriting samples. I collect these data from four different district in Bangladesh. But most of my data samples are collected from our Daffodil International university, Dhanmondi campus. I collect data form my department and almost every batch student contribute on this project.

b. Data Scanning:

All the data that I collect is now in raw format. This data form is now useless because this is not process yet. To make it useful first I need to scan this data form for further uses and for this I scan this data sets in 300 dpi. Then rename this scan files in order.

c. Image Cropping:

Now we have our data in readable form for next process. This time I crop this data set manually for my next step of this. I crop the side borders of this data form manually for next step. Then I crop my data form in the size of the square box.

d. Data Resizing:

In this step every image now not in same size. For this I need to resize all images in same size. I resize this square box into 50*50 dimension.

e. Converted into Binary:

To convert this resized image into binary form first I need to convert this image into gray scale. Then convert all

জেলা:		বয়স:				লিঙ্গ: ছেলে / মেয়ে (√ দিন)										
অ	আ	ই	ঈ	উ	ঊ	ঋ	এ	ঐ	ও	ঔ	ক	খ	গ	ঘ	ঙ	চ
ছ	জ	ঝ	ঞ	ট	ঠ	ড	ঢ	ণ	ত	থ	দ	ধ	ন	প	ফ	ব
ভ	ম	য	র	ল	শ	ষ	স	হ	ড়	ঢ়	য়	ৎ	ৱ	৳	ত্য	ত্র
ড্র	থ্য	থ্র	দ	ক্র	প্র	ক্ক	ক্ষ	ফ	ব	ক্ক	ব	ত্র	ৱ	ভ্য	প্র	ম
ক্ক	স্ত	ম্য	ম্র	য্য	ক্ক	ক্য	গ্য	ঘ্য	চ্য	জ্য	ণ্য	ভ্য	থ্য	ব্য	ম্য	শ্য
ষ্য	হ্য	খ্য	গ্য	গ্র্য	ঘ্য	ট্র	ট্র	র্জ	র্জ	ষ্য	র্ভ	ষ্য	র্ভ	র্ভ	র্ভ	র্ভ
র্দ্ব	র্দ্র	র্ধ	র্ধ	র্ন	র্প	র্ফ	র্ভ	র্ম	র্য	র্ল	র্শ	র্ষ	র্ষ	র্স	র্ই	র্চ্য
র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল	র্ল
র্ষ্য	র্ক	র্স	র্স	র্স	র্স	র্স	র্স	র্স	র্স	র্স	র্স	র্স	র্স	র্স	র্স	র্স

Fig. 3.1.1 Data collection form

জেলা: ঢাকা		বয়স: ২০				লিঙ্গ: ছেলে/মেয়ে (✓ দিন)										
অ	আ	ই	ঈ	উ	ঊ	ঋ	এ	ঐ	ও	ঔ	ক	খ	গ	ঘ	ঙ	চ
অ	আ	ই	ঈ	উ	ঊ	ঋ	এ	ঐ	ও	ঔ	ক	খ	গ	ঘ	ঙ	চ
ছ	জ	ঝ	ঞ	ট	ঠ	ড	ঢ	ণ	ত	থ	দ	ধ	ন	প	ফ	ব
ছ	জ	ঝ	ঞ	ট	ঠ	ড	ঢ	ণ	ত	থ	দ	ধ	ন	প	ফ	ব
ভ	ম	য	র	ল	শ	ষ	স	হ	ড়	ঢ়	য়	ৎ	ক্ক	ক্ক	ক্ক	ক্ক
ভ	ম	য	র	ল	শ	ষ	স	হ	ড়	ঢ়	য়	ৎ	ক্ক	ক্ক	ক্ক	ক্ক
ক্র	ক্ক	ফ	ক্ক	ধ	ক্ক	গ	ধ	গ্র	গ	গ	ঘ	চ্	চ্	জ্জ	জ্জ	জ্জ
ক্র	ক্ক	ফ	ক্ক	ধ	ক্ক	গ	ধ	গ্র	গ	গ	ঘ	চ্	চ্	জ্জ	জ্জ	জ্জ
জ্জ	উ	ই	টা	ট্ট	ড	ড	ঢ	ঢ	ট	ট	ড	ঢ	গ	ধ	ত	
জ্জ	উ	ই	টা	ট্ট	ড	ড	ঢ	ঢ	ট	ট	ড	ঢ	গ	ধ	ত	
দ্র	দ্র	ত্যা	ত্র	ধ	ধ	দ	দ	দ	দ	দ	দ	দ	ধ	ধ	ট	
দ্র	দ্র	ত্যা	ত্র	ধ	ধ	দ	দ	দ	দ	দ	দ	দ	ধ	ধ	ট	
ঠ	ভ	ভ	হ	ল	দ্র	ম	ব	প	প	প	প	প	ফ	ফ	ব	ব
ঠ	ভ	ভ	হ	ল	দ্র	ম	ব	প	প	প	প	প	ফ	ফ	ব	ব
ব্র	ব্র	ব	ল	শ	ম	ধ	ব্য	ড	ত্র	শ্য	শ্র	ভ	ধ	ঠ	ফ	দ
ব্র	ব্র	ব	ল	শ	ম	ধ	ব্য	ড	ত্র	শ্য	শ্র	ভ	ধ	ঠ	ফ	দ
ষা	ক	স	স্ট	ভ	হ	ম	স্প	ফ	ব	স্যা	স্র	স্র	হ	ট	ই	ধ
ষা	ক	স	স্ট	ভ	হ	ম	স্প	ফ	ব	স্যা	স্র	স্র	হ	ট	ই	ধ

Fig. 3.1.2 Collected Data

3.2 Data Processing:

To use this collected data, I need to process it for make it usable. I used python OpenCV library to process this data. First step is converting this data form into gray scale. This is the sample of one dataset. All images are in 50 * 50-dimension.

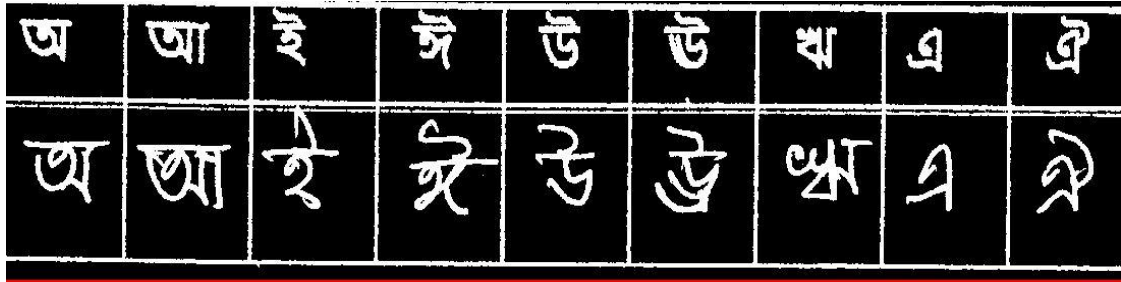


Fig. 3.2.1 Binary image

The second step is, crop all letters separately and make a class for a different letter. Basically, in this project, I work with 154 letters so in 700 data sheet it is more one hindered thousand images. So manually if I try to do this it will take almost three to four months to finish. To overcome this problem, I again take the help of OpenCV library to crop these images.

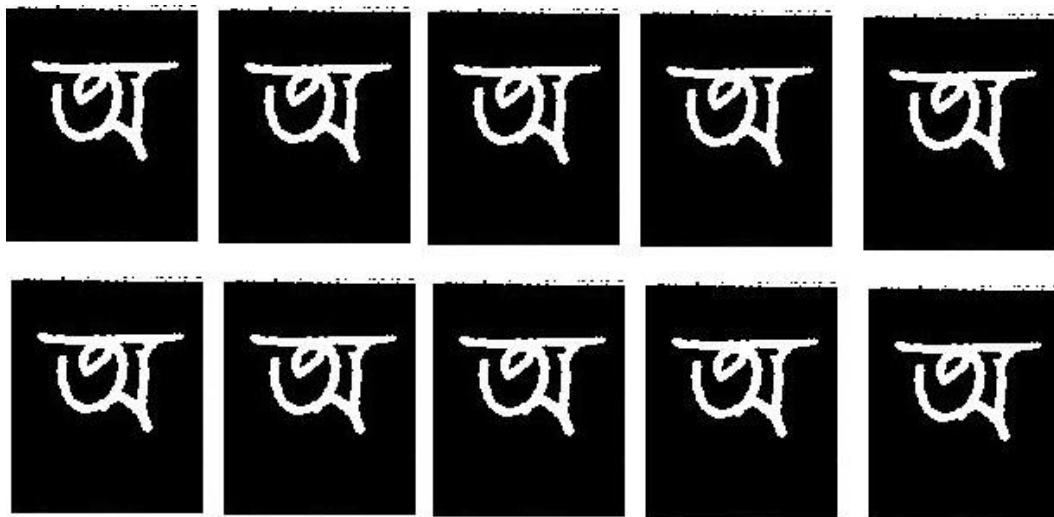


Fig. 3.2.2 Crop images

3.3 Data Classification:

To achieve my desired goal, it is very important to use this data proper way. Because Bangla letters are very different than other languages so it is very important to put all same letters in the same directory because in this way I can train or test my model. So, in this step, I classified all letters properly for my CNN model.

- Image input
- Pre-processing
- Feature Extraction
- Template Matching
- Classification

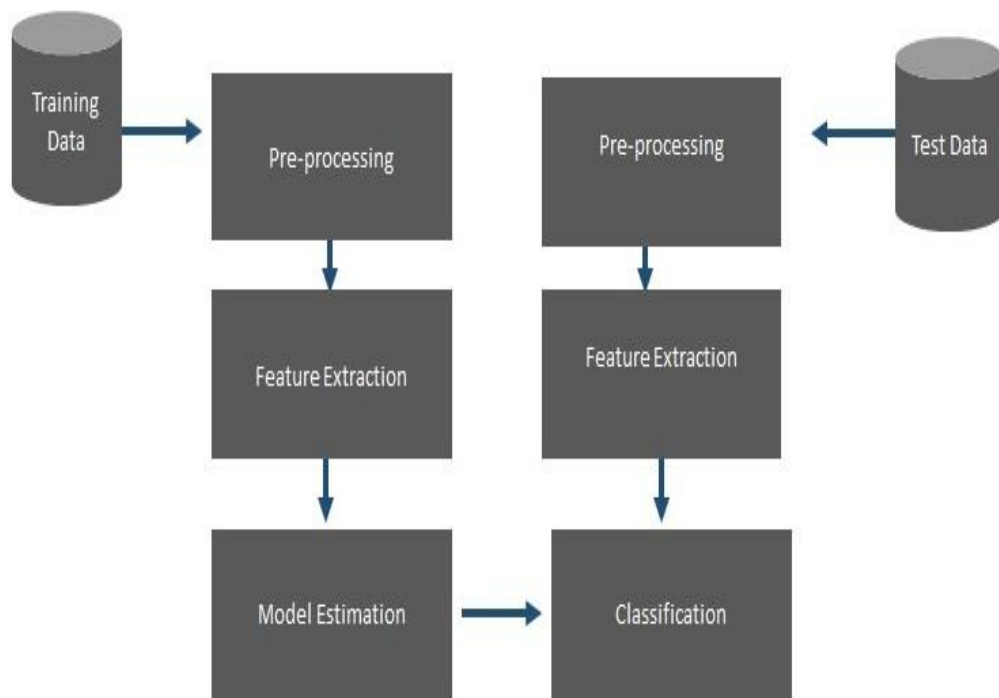


Fig. 3.3.1 Data Classification

3.4 Working Process:

In a very short if I express this project working process, first of all the dataset need to classified properly for train or this model. Then this dataset needs to specified for the training period of this model. Then after its training if we test this model it will then show the output of ask data or image.

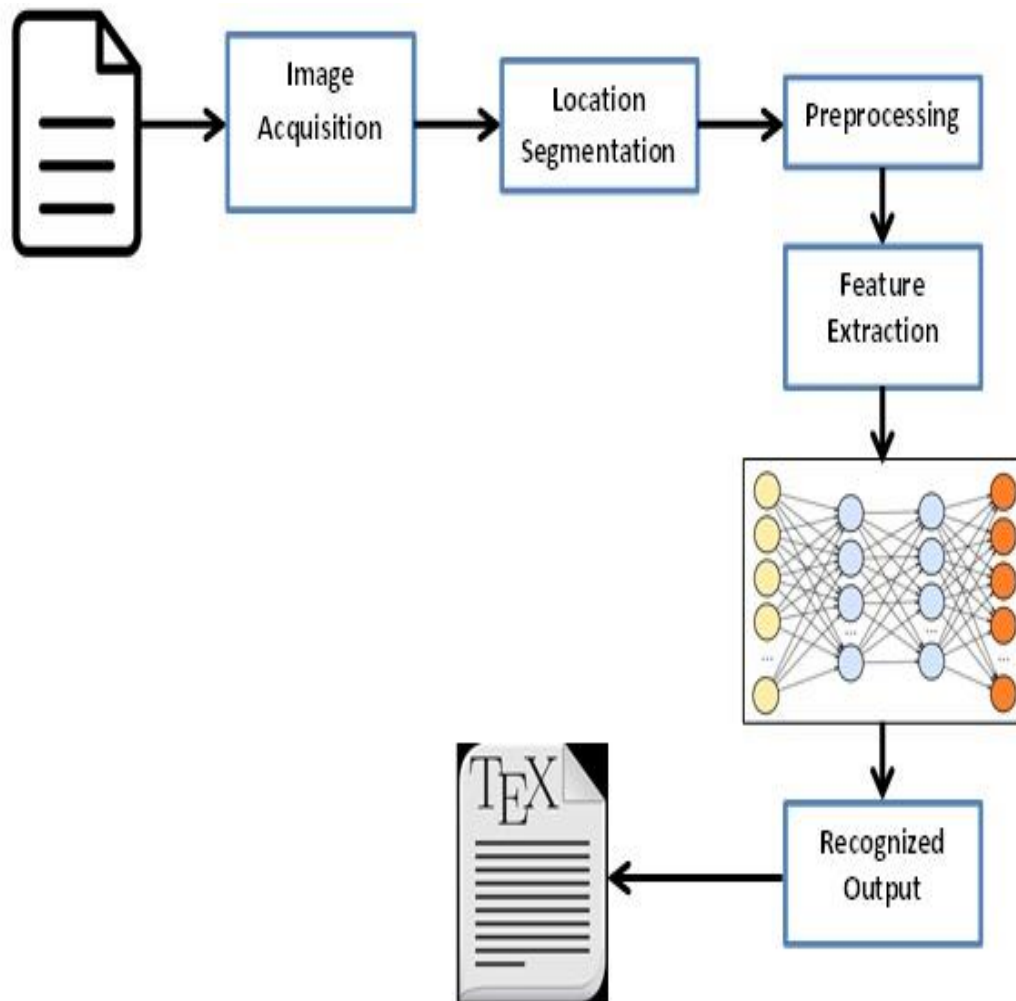


Fig.3.4.1 Working principal

CHAPTER 4

Bangla Handwriting Recognition With CNN

4.1 Introduction:

Bangla is a very different language in compare of other languages. Because in Bangla you can find many similar letters. As an example, ঊ and ঋ these two letters are very similar in structure. So, it is very important to train up our model properly and chose a way that can be efficient and can give the best result. So, get the best possible result I choose Convolutional neural network or CNN model. This model is very popular in the recognition system.

4.2 Convolutional Neural Network:

This is one of the most popular models for pattern or image recognitions. This model has multilayers what makes this model very popular in pattern detection works. In this project this model is also paly big role because it classified the images and connected to all nodes.

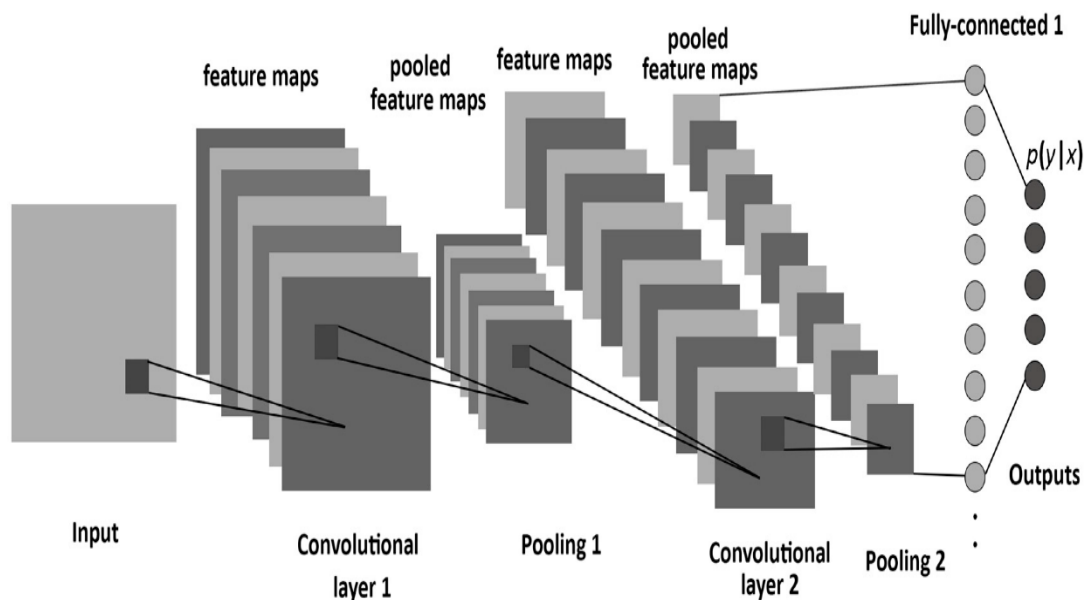


Fig. 4.2.1 CNN in Handwriting recognition

Convolution Layers:

Convolutional layers are basically the hidden layers of CNN model. This layer is actually making the CNN model more useful and more accurate for the pattern recognition or image recognition. Main task of this layers is receiving input and send these inputs to other layers. So, we can say convolutional layers are two kinds. From these One is input channel and other one output channel. It is very simple that input channel is input the data and output channel are given output of these data [1]. In convolutional layer, the transformation that is caused by the convolution operation this is used in Deep learning. Mathematically, cross-correlation are performed by convolutional layers.

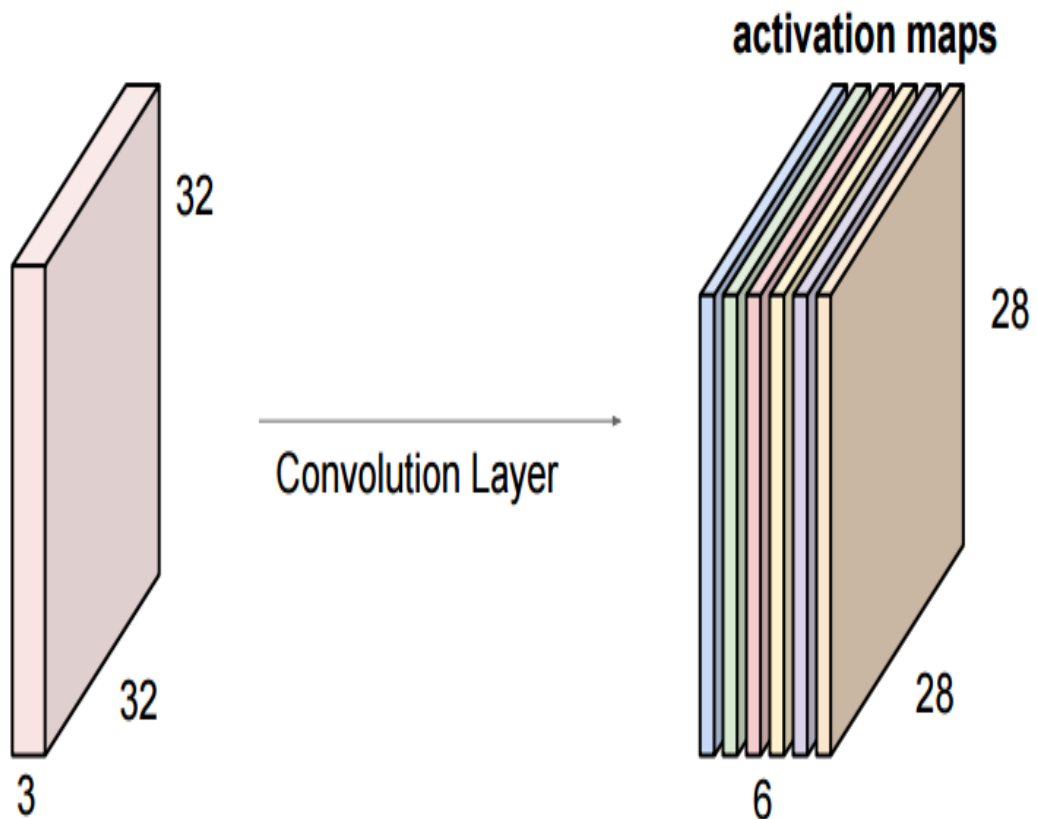


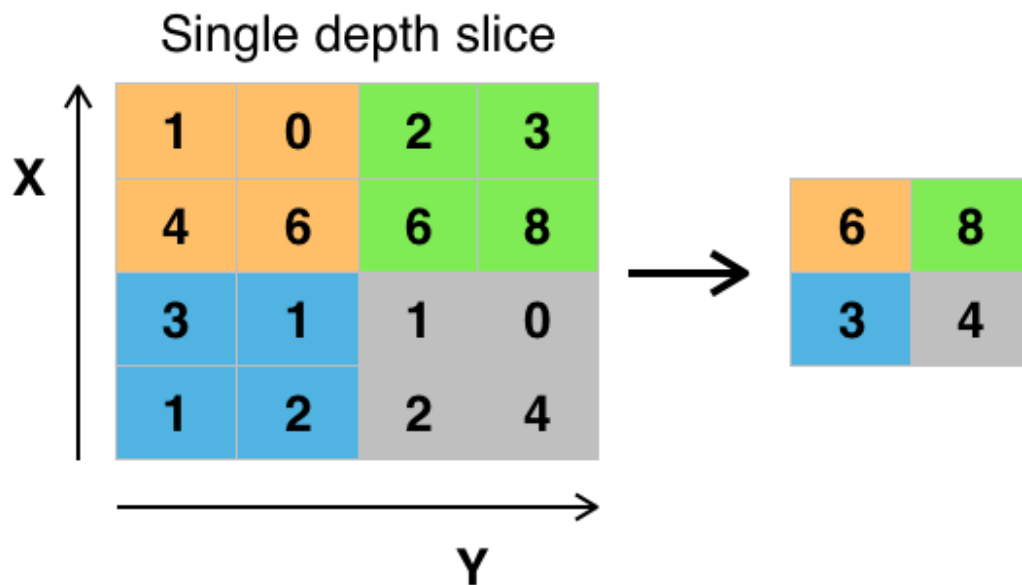
Fig:4.2.2 Convolution layer

ReLU Layer:

ReLU layer applies an elementwise activation function $\max(0, x)$, which turns negative values to zeros. This layer does not change the size of the volume and there are no hyperparameters

Pool Layer:

Pool Layer performs function to reduce the spatial dimension of the input, and the computational complexity of this model. It also controls overfitting. It operates independently on every depth slice of the input. There are different functions such as Max pooling, average pooling or L2- norm pooling.



Patterns:

When we say that the filters are able to detect some patterns. Need to think about how much may be going on in any single image, object, shapes, edges or textures. These are what we mean by patterns. Pattern could be-

- Color
- Object
- Shape
- Edge

When any pattern detector detects the edge of any image is called edge detector pattern. When it detects color, it called color detector pattern. In this project it will detect the edge of the handwriting so this project is edge detector pattern

4.3 Model Architecture:

- Simple (non-convolutional) neural network with 2 hidden ReLU layers
- Network with 2 convolutional layers and 1 fully connected layer
- Network with 2 convolutional layers, max-pooling layers after each and 2 fully connected layers at the end
- Network with 2 convolutional layers, max-pooling after each, an inception module and 2 fully connected layers at the end

CHAPTER 5

Results

5.1 Introduction:

The proposed model has taken CNN technique to improve the sign language recognition field. This system tried hard for makes better accuracy. The accuracy of the model was calculated which describe in given below

5.2 Introduction to Tools and Technologies:

To complete this whole project, I used this –

- Jupiter Notebook
- Python OpenCV
- Python
- TensorFlow library

5.2 Key Features of The Proposed System:

In this proposed system it has following main features

5.3 Accuracy:

In the CNN model, I used BanglaLekha-Isolated dataset for just testing the accuracy of my model. I train my model with only vowel letters. The best result was obtained using the final network architecture which includes an inception module. The test set accuracy was at **94.2%** and training set accuracy at **98.9%**.

CHAPTER 6

Conclusion

6.1 Conclusion:

Handwriting detection is one of the most popular topics in the recent world because of its usefulness. So, in this sense, I could say this is the sector that I need to work not only for me but also for the Bangla community. And finally, I have completed this Bangla Handwriting Recognition project successfully. My next goal will be to make sure that, this project will be beneficial for the Bangla community in the future.

6.2 Limitations:

Limitations are something that inspires you to make your work better every day. In this project, I just work with the basic and complex alphabets of Bangla language. This model is not able to read any sentence because I do not train it to do this task. So, this is a limitation of this project. Also, this model is not able to read numeric numbers of Bangla alphabets. Because in my dataset it is not collected by me and I do not try to train it for numeric letters. This model is also not able to recognize the signatures in Bangla language.

6.3 Future Scope to Work:

- Make Mobile application that can translate the Bangla sentence into other language.
- Increase the accuracy of recognition the image.
- Collect more data to make it more accurate.
- Train it for the sentence.
- Train it up for numeric numbers of Bangla language.
- Signatures could be recognizing if you change some technique of recognition.

REFERENCES:

[1] "Convolutional Neural Networks (CNNs) explained - deeplizard." [Online]. Available: http://deeplizard.com/learn/video/YRhxdVk_sIs?fbclid=IwAR1kf3fG5GjkftRPFgAvSi_qnY-tiHVxUmqW_IAaHraE1Ye4GDYvoj3ovXE. [Accessed: 23-Nov-2018].

[2]R. Sarkhel, N. Das, A. Saha and M. Nasipuri, "A multi-objective approach towards cost effective isolated handwritten Bangla character and digit recognition", *Pattern Recognition*, vol. 58, pp. 172-189, 2016.

[3]B. Chaudhuri and U. Pal, "A complete printed Bangla OCR system", *Pattern Recognition*, vol. 31, no. 5, pp. 531-549, 1998

[4] Recognition of Handwritten Bangla Numerals using Adaptive Coefficient Matching Technique
A Choudhury, A Negi, S Das, 2016