THE FIRST OPEN ACCESS DATASET FOR BANGLA SIGN LANGUAGE AND AN ARROWHEAD DETECTION TECHNIQUE WITH CNN MODEL

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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/internship titled "**The First Open Access Dataset for Bangla Sign Language and an Arrowhead Detection Technique with CNN Model**", submitted by Md. Sanzidul Islam and Sadia Sultana Sharmin and Nazmul Ahsan, ID No: 151-15-5223 and 151-15-5191 and 151-15-4668, 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 and approved as to its style and contents. The presentation has been held on 11th December 2018.

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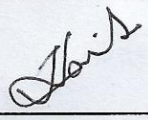

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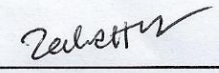

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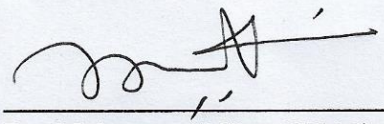

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Dr. Syed Akhter Hossain, Professor and Head, Department of CSE** Daffodil International University. We 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

Sign Language is the method of interaction between the hearing-impaired people and the general people. It is the only way to decrease the communication gap of deaf community and the normal people. A machine translator could be potent solution for solving this problem. But collecting hand sign data of sign language from reliable source is too much difficult to researchers. This project is conceived from the above scenario. In this project, we made two open access isolated datasets- Ishara-Bochon and Ishara-Lipi and its recognition model. Ishara-Bochon contains 100 sets of 10 different classes for Bangla Sign Language digits. And Ishara-Lipi contains 50 sets of 36 classes for Bangla Sign Language characters. The image data are collected from different deaf and general volunteers from different institutes. Our datasets could be used to build computer vision based or any other type of system that allows users to search the meaning of BdSL signs. We attempted to represent a BdSL recognizer model which will help hearing impaired people to remove communication gap with generals. In proposed method we used multi-layered Convolutional Neural Network (CNN). CNNs have capability to learn structures automatically from raw data. Our model gained 92% accuracy on our digits datasets and 86% accuracy on our characters dataset. In the future, further AI and data analytics will add values to the services delivered to the end users.

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Introduction

1.1 Introduction

As an independent country 16 million people living in Bangladesh, among them 2.6 million people are dumb and deaf. That means they can't talk and hear from general people. But Bangla is the mother tongue of everyone. Deaf and dumb people use different types of gesture to communicate with each other. This is called sign language. There are almost 137 sign language exists in this world. One of the soonest composed records of a communication via gestures is from the fifth century BC. Deaf and dumb people used different types of hand gestures, movement of body, sign to communicate with each other. By using different types of signs they express their feelings and emotion with each other. Disable people use their hand to make different types of shape and express different meaningful word. In Bangladesh there is few school for dead and dumb children where they learn through sign language. The Bangla sign language characters and digits picture are shown in figure 1.1 and figure 1.2 accordingly-

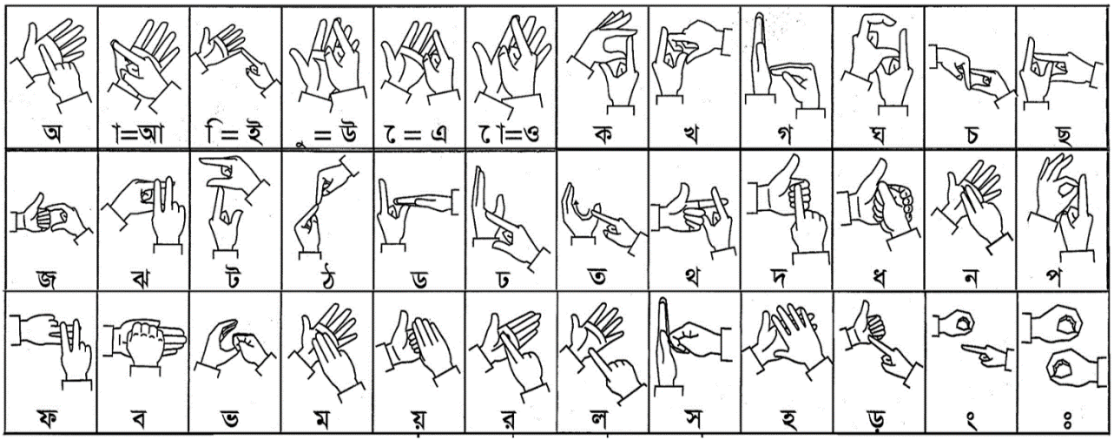

Figure 1.1(i) - Bangla sign language characters

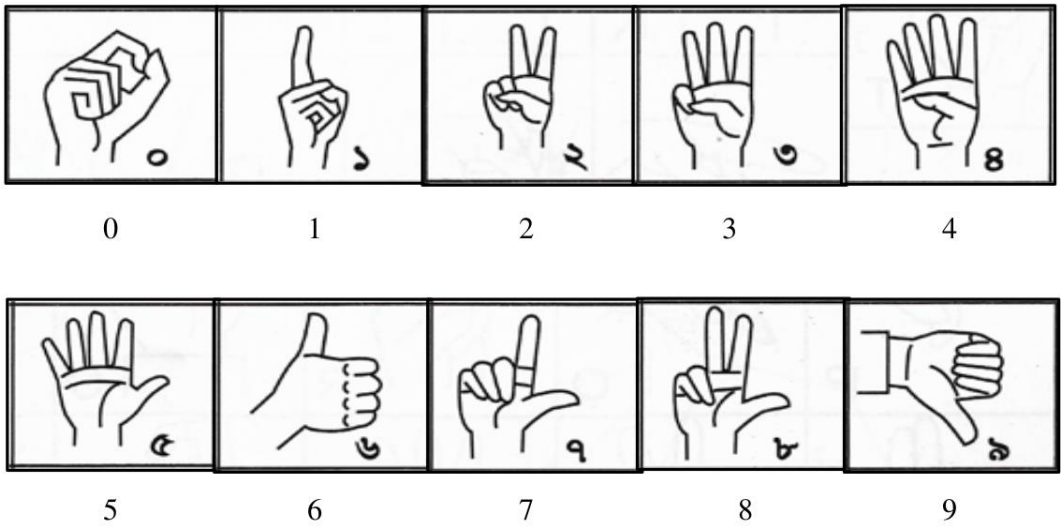

Figure 1.1 (ii) - Bangla sign digits

But sign language is not universal. General people don't understand those sign and what those sign means. For this reason, there is always a communication gap between general and disable people. It is not easy for general people to communicate with deaf and dumb people because they can't hear from us. When a child born in a family he or she learn first word from the environment but as a deaf people don't hear anything he or she can't learn from surrounding. Till now there is no specific pattern of Bangla sign language in our country. General people can easily communicate with disable people if there is a model of Bangla sign language recognizer. This will decrease the gap between disable and general people. And deaf and dumb people can take all types from opportunity from our society. There will be no discrimination between general and disable people. So Bangla sign language recognizer can create a great impact on our society. In every sector deaf and dumb people will get same type of opportunity as general people get. Bangla sign language recognizer model will help general people and disable people as a universal medium. Disable people can easily express their emotion as like as general people. It will be developed in deep learning approach. Deep learning is part of machine learning. It is also known as deep structured learning.

There are different types of deep learning architectures .Such as deep belief network, deep neural network, recurrent neural network etc. Those architectures are used in different field. Such as audio recognition, computer vision, speech recognition, natural language processing, social network filtering, drug design, medical image analysis, machine translation etc. This model is developed with the help of deep learning. This model will work as a universal model for both disable and general people. General people can easily express their emotion with disable people, on the other hand disable people can also express their feelings with general people. This model will increase the dignity of Bangla language. As we achieved Bangla as our mother tongue with lots of blood, we have to work for increasing dignity of Bangla language. This is possible when everyone expressing their feelings in Bangla. And this model can work as a medium. By using this everyone can easily expressing their feelings with anyone they want. Moreover it will be matter of pride for every Bangladeshi that we have an established complete open access Bangla sign language data set.

1.2 Motivation

Sign language is only medium for deaf and dump people to express their emotion and communication. Hard of hearing is a lack of ability that castrate their hearing and build up them handicap to tune in. And dumb is a lack of ability that undermine their talking and set up them cripple to talk.2.4 million People use sign language in Bangladesh but rest general people don't understand those sign language. For this there should be a universal medium, by using this everyone will understand their language. As Bangla is mother tongue for both general and disable people there should be a universal medium for all. By using this everyone can communicate with anyone. In many sector disable people are lagging behind general people for communication problem. A universal medium can reduce this problem. On the other side, United State has their own sign language pattern that is called American Sign Language (ASL) which is very developed. As Bangladesh is a developing country, Bangladesh should have their own sign language pattern which is called Bangla Sign Language (BDSL). Very few developers worked with Bangla sign

language model. But they worked only few number or characters. But we should have our own dataset of all Bangla number and characters. This model will increase the accuracy. Other model has less accuracy. ASL recognizer model have 94% accuracy but on the other hand BDSL have only 84% accuracy so it has to be increased.

Figure 1.2 - A deaf children using hand sign

We achieved Bangla as our mother tongue with lot of blood. Bangla is also mother tongue for deaf and dumb people. So Bangla sign language model have to be establish for deaf and dumb people so that they can participate in every occasion for the betterment of Bangla language and Bangladesh. In Bangladesh there are few institutions for deaf and dumb children where they learn about sign language. Disable people use different gesture and body movement to communicate with each other. Static signs are for the most part utilized for letter sets and numbers where hand shapes characterize each sign. Then again, words and sentences are representing through mix of hand shape, introduction and development of hands and arms. Sometimes facial expressions express different emotion. But those expressions can hardly understand by any general people. A formal sign language is established by Centre for disability development (CDD) for deaf and dumb people. A

model for sign language recognizer can help both disable and general people to communicate with each other.

1.3 Rational of the study

In Bangladesh there is always a communication gap happen between general and disable people. Moreover, People with disabilities are lagging. They don't get all opportunity like general people. Bangla sign language model can solve this problem. We know that communication is very important part in our life. This model will help general people to turn sign language in normal language. And on other hand disable people will also be beneficial. They can convert general people's language into sing language. Bangladesh is developing day by day. Its development cannot be possible without participation of every citizen of the country. In others developing county disable people are also taking part in development of their country. So Bangla sign language recognizer model can also help disable people to take place in development of country. Moreover, there will be a standard pattern for Bangla sign language data set. That will help developers for further development of the model. Both general people and disable people will be beneficial through the Bangla sign language recognizer model. For Digital Bangladesh this type of model is compulsory. With this model whole country will be beneficial. Disable people can perform any task as a general people with using this system. In Bangladesh people have lack of knowledge about sign language. They don't know which gesture means what. Disable people can participate in any type of government work by using this model.

1.4 Research Questions

- How disable people can connect with this model?
- How can this model decrease communication gap between general and disable people?
- How this model can play role in developing Bangladesh?
- What will be future work of Bangla sign Language recognizer model?

- How can general people can communicate with deaf and dumb people with this model?

1.5 Expected Output

As it is a research based project, result will be publishing a research paper dependent on another way to deal with perceive Bangla gesture based communication. It will help other people to know about the project. Few developers work with Bangla sign language but their data set is not open for all. So if anyone wants to develop Bangla sign language related anything he or she has to start work from the start. So will make a dataset that will be open for all, and using those data set which model is created it will be open source. It will help developers for further development. Developers will add more features in future. Communication will be easier. A system will be developing for general people that can convert input text or voice in sign language. It will help general people to communicate with deaf and dumb people. General people can easily express their feelings and emotions with any deaf and dumb people. On the other side, a system will develop for disable people that can convert sign language to text or voice. This will cooperate deaf and dumb people to communicate with general people. A full data set of Bangla sing language will be establishing. There is some data set of Bangla sign language, those are not fully establishing. A full dataset of Bangla number and character will come from research. There will be 0-9 total ten set of number data.

Final outcome will be an open Data Set & open source model, so that developers can work in future. And a system that can convert voice r text into sign and hand gestures or sign into voice or text.

1.6 Report Layout

There are total 5 chapter in this report. In Chapter 1 which focusses on the introduction, motivation and goals behind the thesis. Chapter 1 consists of 6 portions. 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6, section includes introduction, motivation, rational of the study, research

questions, expected output and report layout. Chapter 2, consists of background, fundamentals information relevant to the thesis and is divided in 5 portions. Section 2.1, 2.2, 2.3, 2.4 and 2.5, consists of introduction, related work, research summary, scope of the problem and challenges individually.

Chapter 3 explains the facts of our thesis experiment extend over 5 subsections. 3.1, 3.2, 3.3, 3.4 and 3.5 section describes every phase of the recognition, i.e. Introduction, research subject and instrumentation, data collection procedure, statistical analysis and implementation requirements. Chapter 4 mentioned the experimental results and discussion of that result. It has 4 portions. Section 4.1, 4.2, 4.3 and 4.4 consists of introduction, experimental results, descriptive analysis and summary. In the end chapter 5 have 4 sections that included summary, conclusion, recommendation and implication for future research.

Follows the five sections and at the conclusion there is a reference of following resources we have mentioned in our research.

CHAPTER 2

Background

2.1 Introduction

A sign Language is a language which is represented by alliance of gesture or movement of the hands. Sign Language is the visual language because of these sign language and spoken language both is different. In real world, people face different gestures. Different country has different sign languages rely on their alphabets and native expression. There are various sign language for example American, Arabic, French, Spanish, Chinese, and Indian etc.

Sign language is a natural language and it is naturally made [1]. General people are not accustomed with sign language. For effective communication deaf and damp people and normal people must have the similar set of knowledge for an individual sign. It is difficult for the deaf and mute people to learn their sign as there is no appropriate model that work as a communication method. So it is essential for create a model which is convert the sign language to text that supported the mute people to communicate with general people and each other.

2.2 Related Work

There are many research and article in sign language recognition. Many researchers have worked in characters and digits sign using datasets.

The American Sign Language Lexicon Video Dataset [2] (Neidle and Vogler, 2012) forms such a lexicon for American Sign Language (ASL), having more than 3000 signs in multiple video views.

The Argentinian Sign Language (LSA) paper is proposing a dataset of 64 signs. (LSA64, Franco and Facundo) This dataset contains 3200 videos of 64 different LSA signs recorded by 10 subjects.

The Arabic Sign Language recognition paper [4] contains 30 manual alphabets signs (Omar Al-Jarrah and Alaa Halawani, 2001).

In Chinese SLR [3] has 120 signs dataset (2012, Yun Li and Xiang Chen).

Byeongkeun Kang et al. take the particularly well-organized major step of automatic finger spelling recognition system using convolutional neural networks (CNNs) from depth maps. In this work, they consider quite larger number of classes related with the forgoing literature. They train CNNs for the classification of 31 alphabets and numbers using a subset of collected depth data from multiple subjects [5]. In Deep Convolutional Neural Networks for Sign Language Recognition paper they proposed a CNN architecture for classifying selfie sign language gestures. A stochastic pooling method is applied which pools the benefits of both max and mean pooling methods. They make the selfie sign language database of 200 ISL sign with 5 signers in 5 user dependent viewing angles for 2 sec each at 30fps generating a total of 300000 sign video frames [6].

Hana Hosoe et al. established a structure for recognition of static finger spellings on images. This recognition of hand gestures is done using a convolutional neural network, which has been trained using physical images. They recorded 5000 images with static finger spellings from Japanese Sign Language [7].

Jie Huang et al. developed a 3D CNN model for sign language recognition that gets and removes temporal structure by performing 3D convolutions. They use multilayer perceptron classifier to categorize these feature demonstrations [8].

A voice/text format architecture is being proposed using the neural networks identification to convert the sign language and introduce the Point of Interest (POI) and trajectory idea delivers creativity and cuts the storage memory condition in Real-time Sign Language Recognition based on Neural Network Architecture paper [9].

Lionel Pigou(B) et al. contribute a recognition system using the Microsoft Kinect, convolutional neural networks (CNNs) and GPU acceleration and making complex

handcrafted features. They were able to recognize 20 Italian gestures with 91.7% accuracy [10]

In Bangladesh, there is some work on sign language. In 2014, Muhammad Aminur Rahaman, Mahmood Jasim, Md. Haider Ali and Md. Hasanuzzaman did a Computer Vision-Based Real-Time Bangla Sign Language Recognizer [11] where they proposed Bengali Hand gesture recognition system focusing on Computer Vision.

In September 2017 Mohammad Mahadi Hasan, Md. Khaliluzzaman, Shabiba Akhtar Hime, and Rukhsat Tasneem Chowdhury proposed a sign language recognizer structure [12] for various Bangla characters using Artificial Neural Network (ANN) and they got a good recognition rate.

In [13], they used scale invariant feature transform (SIFT) for feature extraction in Bangla sign vocabularies and then applied k-means clustering. They also introduced the bag of words model to their hybrid approach.

Rhythm Shahriar, A.G.M. Zaman, Tanvir Ahmed, Saqib Mahtab Khan and H.M. Maruf proposed a communication platform between Bangla and Sign language in 2017 [14]. They worked with Bangla speech which converts speech to sign and show to impaired persons. They mainly focused on speech recognition algorithms.

K. Datta, B. Sarkar, C. Datta et al proposed a framework for Bangla text to Bangla sign language based on translation system [15]. In that method, the input text organize the words in the exact order for Bangla sign language, and show the exact video file related to each word given.

2.3 Research Summary

In this paper, we have represented a BdSL recognition model which is created using of own dataset images. We have created two open access datasets. The name of digits and character dataset is accordingly ‘Ishara-Bachon’ and ‘Ishara-Lipi’. Ishara-Bachon dataset

contains 100 sets of 10 Bangla basic sign digits and Ishara-Lipi dataset contains 50 sets of 36 Bangla basic sign characters.

In Bangladesh, there are many researchers who are working in this field and they are trying to improve this field. For this purpose, they are used different method. In proposed model, we used deep learning method of convolutional neural network (CNNs). Firstly we have collect the image and processed the image. After that, we divided the dataset into two portions- training data and test data using multi-layered Convolutional Neural Network (CNN). CNNs are able to automate the process of structure making. Then finally the whole model architecture could be shown in a picture.

2.4 Scope of the Problem

General people have a mother language learned from the environment. But by birth hearing impaired people, they can't hear something from environment that's why became deaf finally. Sometimes Bangladeshi deaf people use their own local signs because of not having accurate idea of keeping a fixed standard of Bangla sign language. The sign rule is different in country basis. American sign digits picture are given in figure 3.4 (i):

Figure 2.4 (i) - American sign digits

In Bangladesh a formal sign language has been established recently. In the year 2000, Center for Disability in Development (CDD) took the initiative to standardize communication with sign languages in this country [16]. Now the most used signs among the Bangladeshi deaf community are CDD standard Sign Language. Bangla sign digits are shown in figure 2.4 (ii) -

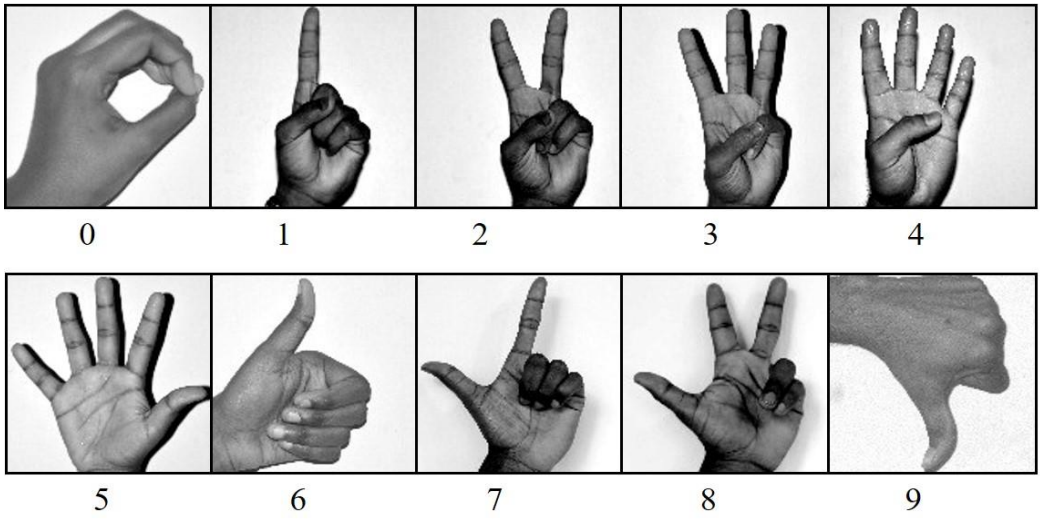

Figure 2.4 (ii) - Bangla sign digits

Bengali Sign Language is architecturally different from sign languages from other countries. A very few research was effectively held on Bangladeshi Sign Language (BdSL) but no dataset is open in web repository to work further for this deaf community. So it is important for create a model which is translate the sign language to text that supported the mute people to communicate with general people and each other. To perform Bengali Sign Language, different kind of rules is used generally but, in this model, we used one hand for digits sign and two hand for characters sign. Now a days, Bangladeshi Sign Language Recognition (BdSL) becomes one of the challenging topics in the area of machine learning and computer vision.

2.5 Challenge

In our project we have to do Process a huge number of image data manually and it is very challenging. Our other challenges are some Bangla Word Signs are not static image and some characters have two hand sign. Such a challenging fact to consider about sign languages is that, same hand shapes or same hand motion can be used to express different signs. For example, in Bangla sign language, some of characters have the near about same hand movement but the hand shape for the two signs are different. So, it is very challenges for every researcher to recognition the hand gesture and getting classified data for Bangla Sign. And there is a big challenge to hardware limitation as having no high configures GPU. The given characters figure 2.5(i) and figure 2.5(ii) is nearly same-

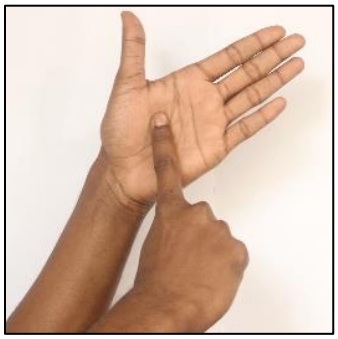

Figure 2.5(i) - Image Character "অ"

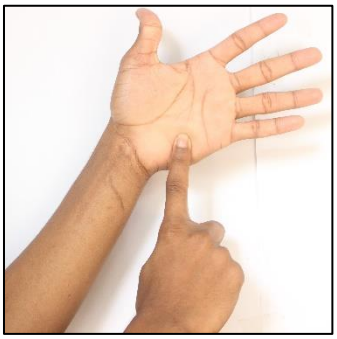

Figure 2.5(ii) - Image Character "ল"

Figure 2.5(iii) and figure 2.5(iv) of characters have the near about same hand movement but the hand shape for the two signs are different. These are given below-

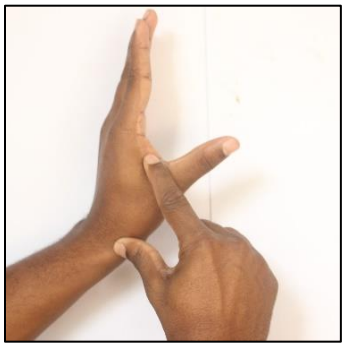

Figure 2.5(iii) - Image Character "ঢ"

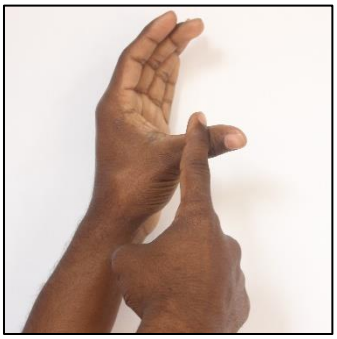

Figure 2.5(iv) - Image Character "ত"

CHAPTER 3

Research Methodology

3.1 Introduction

Different country has different sign language. Any kind of sign language recognition is very difficult, because the computer system can't recognize the sign easily. All researcher efforts hard and apply different method to recognize the sign with the computer system. In proposed system we applied some method to interact with computer system. This system recognizes Bangla sign digits (0-9) and characters.

3.2 Research Subject and Instrumentation

Our research topic is “The First Open Access Dataset for Bangla Sign Language and an Arrowhead Detection Technique with CNN Model.” It is the field of image processing system.

Up to now we have discussed the theoretical concepts and methods. Now a list of requirements of instruments are given below-

Hardware and Software instruments which we use-

- 7^{th} generation core i5, 3.2 GHz with 8 GB RAM.
- 2GB GPU with 384 CUDA core supported PC.
- 1 TB HDD
- 256 GB SSD for system boot
- Canon 600 D (18/55 Lens)

Developing Tools-

- Linux Kernel (Ubuntu 18.04)
- Python 3
- Keras & Tensorflow

- Python OpenCV

3.3 Data collection procedure

Our model has applied some procedure for implementation. All the procedures have discussed in this section. The whole data collection process has been divided into five different states. All those states are described in figure 3.3

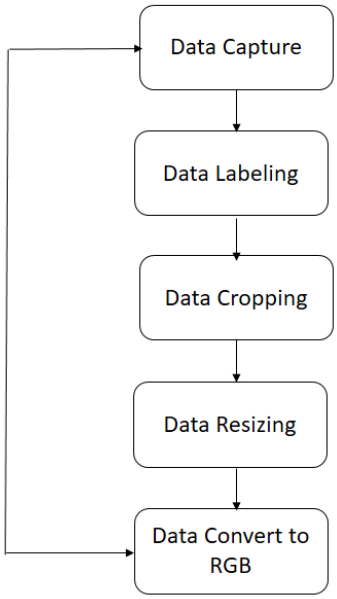

Figure 3.3- Flow of working procedures

a) Capturing image

Data are collect from general volunteers and many Deaf School Community and we took images of uncovered hands. The white background was choose as background color and then captured images one by one. DSLR camera was used for taking hand signs images because of conducive resolution. While capturing images white spaces were removed from hands edge as much as possible.

b) Labeling data

Labeling data is important to minimize the noise get in the capturing process for improve the images quality. After data collection labeling developed our script. For example some of BdSL sign vary little from another. Images of this kind of signs appear familiar and enhance the exception of experiment. For that we categorized the signs individual.

Different signs have different classes/folders. Ten Different directories (named- 0, 1, 2, 3, 4, 5, 6, 7, 8, 9) was built for digits. On the other hand Bangla Language has about 49 characters but in sign language it's not. In Bangla Sign Language there have only 36 characters at all. So we had 36 characters by naming with numeric convention from 1 to 36 (1, 2, 3...9). After that we stored those images into different classes to make more organized. The naming convention of all characters is given below in a chart.

c) Cropping images manually

The taken image cannot be used without cropping for any sign recognition purpose. Cropping is essential to create the image for further experiment. We cropped images manually for making those noise free and it observing the rate of height and width for future processing. Images are cropping to show the hand region. White spaces are removed as well as possible by cropping. Figure 4.3.c (i) is showing the cropping image-

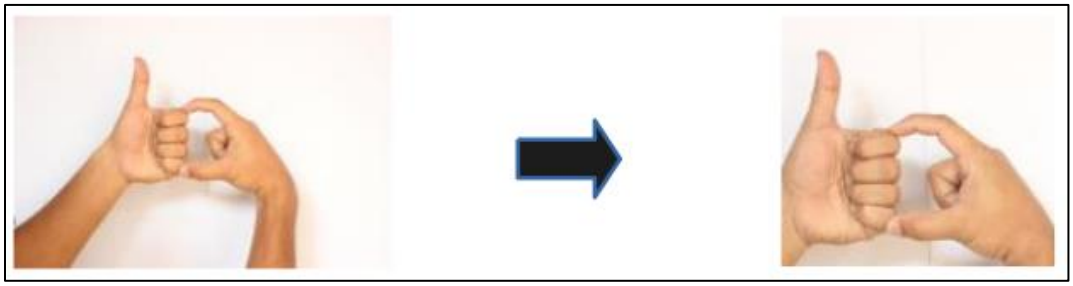

Figure 3.3.c (i) - Cropping Image

The entire cropping characters figure 4.3.c (ii) shown the following -

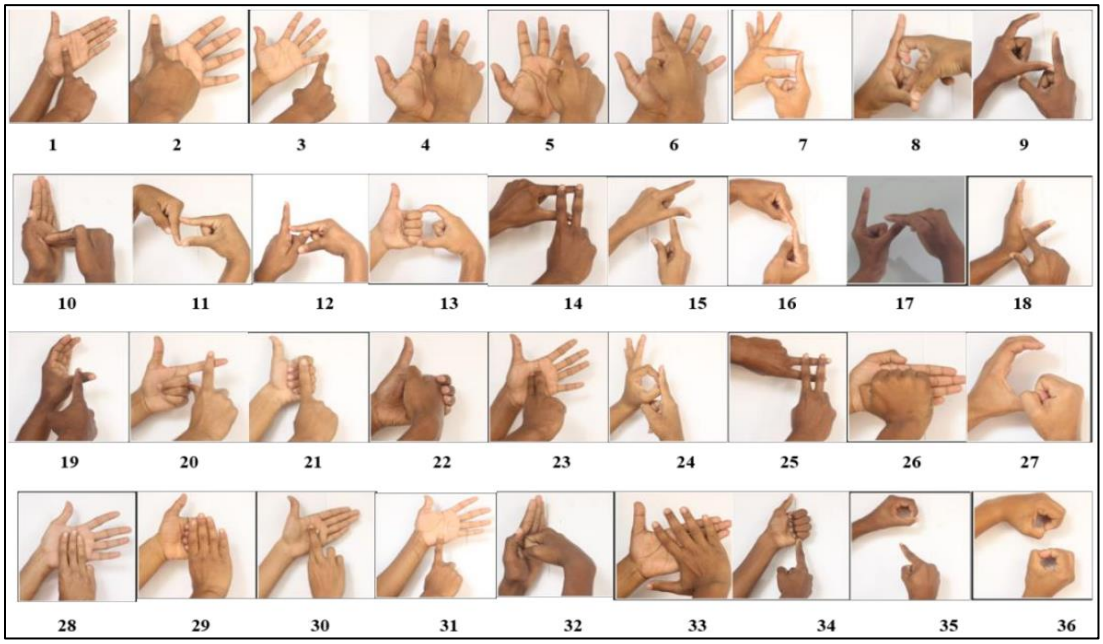

Figure 3.3.c (ii) - Cropped Images

d) Resizing image and convert to gray-scale

All images are resized in a standard format by python cv2 script for create our dataset more usable in any kind of machine learning, deep learning or computer vision based works. We created a script what will go in every folders having images and take the same action in every images. The scripts resize the image by 128 *128 pixels first and then convert RGB to gray -scale. We prepared all images into a standard form and ensuring same pixels in height and width.

Figure 3.3.d is shown entire gray- scale characters picture-

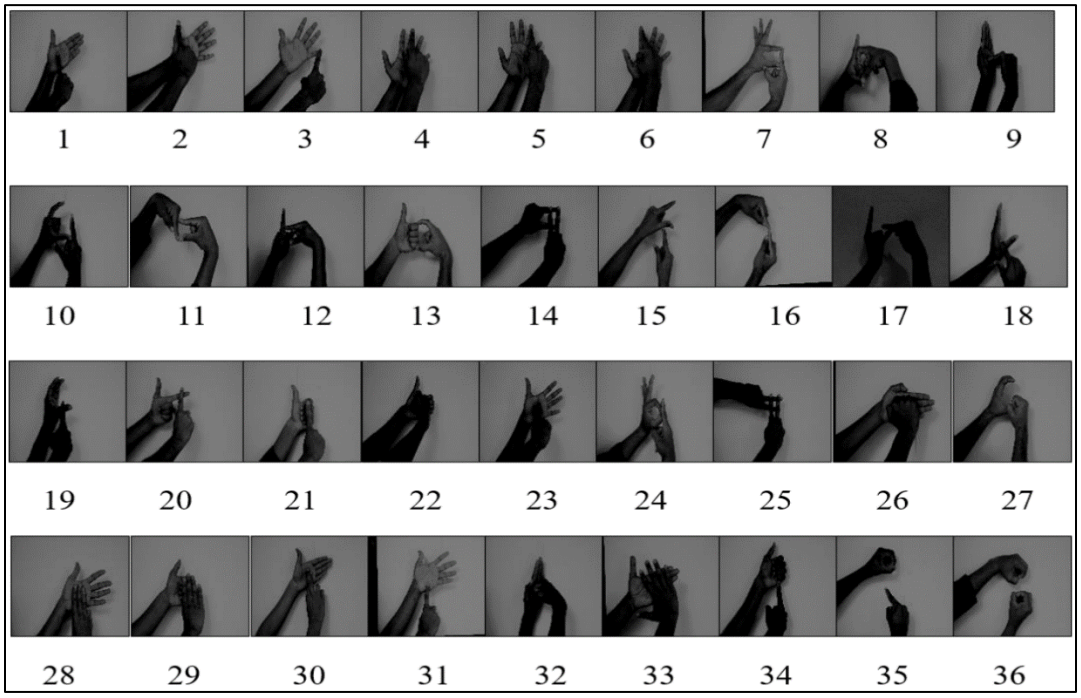

Figure 3.3.d - Final gray scale images

3.4 Statistical Analysis of Datasets

1. Before we mentioned Ishara-Bochon contains sign images of total 10 classes of Bangla sign digits (0, 1, 2, 3 . . . 9) and Ishara-Lipi dataset contains 36 folders of images labeled by numbers (1, 2, 3 . . . 36) as sequentially presented as Bangla sign characters sequence. Figure 3.4 is numeric representation of BdSL characters-

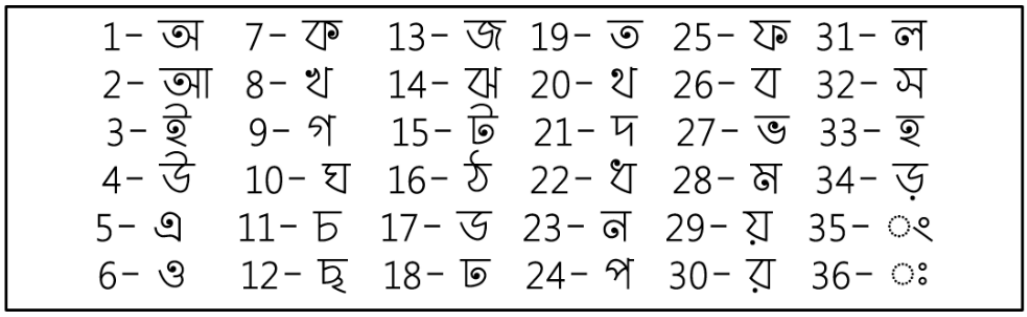

Figure 3.4 - Numeric representation of BdSL characters

2. Ishara-Bochon Dataset has total 1000 (10*100=1000) images and Ishara-Lipi contains total 1800 images (36 * 50 = 1800)
3. All sign images is cropped and resized by 128*128 pixels.
4. Here in 36 characters- 6 Bangla vowels and 30 consonants.
5. All images are kept in .jpg formatted datatype.
6. The images is captured then resized and finally converted to gray scale from RGB.

3.5 Implementation Requirements

a) Convolutional Neural Network (CNNs)

Convolutional Neural Networks is a class of deep neural network and also called CNNs or ConvNets. CNNs are compare the images piece by piece. The pieces are called features. Convolutional networks are powerful visual models that yield hierarchies of features and driving advances in recognition [17]. Convolutional Neural Networks have been really effective in image recognition and classification problems, and have been effectively executed for human sign recognition in recent years [18].CNNs advances in bounding box object detection, part and key point prediction, and local correspondence [17]. Convolutional neural network is able to fulfil a real time and appropriate sign language recognition system. It is mentioning that CNN can eliminate the obstacle of moving hands from background for hands because CNNs have the ability to learn structures automatically from raw data without any prior knowledge [19]. The model used to recognize these sign

here used multi-layer convolutional neural networks which are connected each other. The model is represented by total eight layers. Figure 3.5.a is shown the eight layers of model architecture-

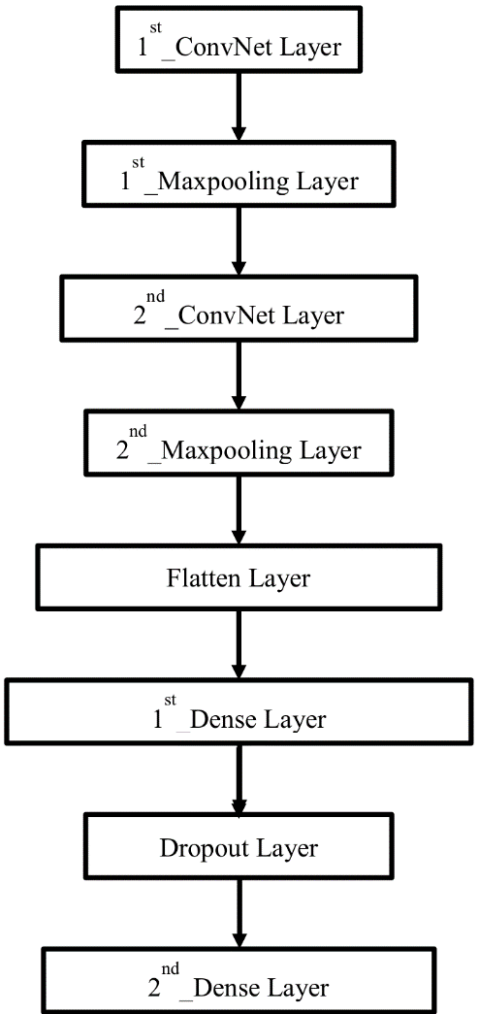

Figure 3.5.a - Model architecture

b) Methodology (Working Algorithm)

Dataset provides 128*128 pixels grayscale images. For making this model did some reprocessing works like- convert grayscale image to binary and threshold. The method we used determines the threshold automatically from the image using Otsu's method.

Algorithm 1:

1: ADAM (Learning Rate)
2: For 30 iterations in all batch do:
3: Convolution 1 (Filter, Kernel Size, Stride, Padding, Activation)
4: Convolution 2 (Filter, Kernel Size, Stride, Padding, Activation)
5: MaxPool 1 (Pool Size)
6: Dropout (Rate)
7: Convolution 3 (Filter, Kernel Size, Stride, Padding, Activation)
8: Convolution 4 (Filter, Kernel Size, Stride, Padding, Activation)
9: MaxPool 2 (Pool Size)
10: Dropout (Rate)
11: Dense (Units, Activation, Kernel initializer, Bias Initializer)
12: Dropout (Rate)
13: Dense (Units, Activation, Kernel initializer, Bias Initializer)
14: end for

Proposed model in this paper use ADAM optimizer with a learning rate of 0.001. The model has 9-layer CNN. For convolution 1 and 2, where filter size is 32, kernel size is (5x5), Stride is (1x1), same padding with ReLU (1) activation.

Followed by a 5 x 5 max pooling layer. Then use 25% dropout to reduce over fitting.

$$ReLu(x) = Max(0, x)| \qquad (1)$$

For convolution 3 and 4, the filter is 64, kernel size is (3x3), Stride is (1x1), same padding with ReLU activation. Followed by a 2 x 2 max-pooling layer. Then used 25% dropout.

Then flatten the layer and use a Dense layer with 256 units with ReLU activation and 50 % dropout. At final output layer, used 36 units with SoftMax (2) activation. Figure showing the neural network architecture.

$$S(y_i) = \frac{e^{y_i}}{\sum_j e^{y_i}} \qquad (2)$$

Proposed Bangla sign language processed data is given below figure 3.5.b-

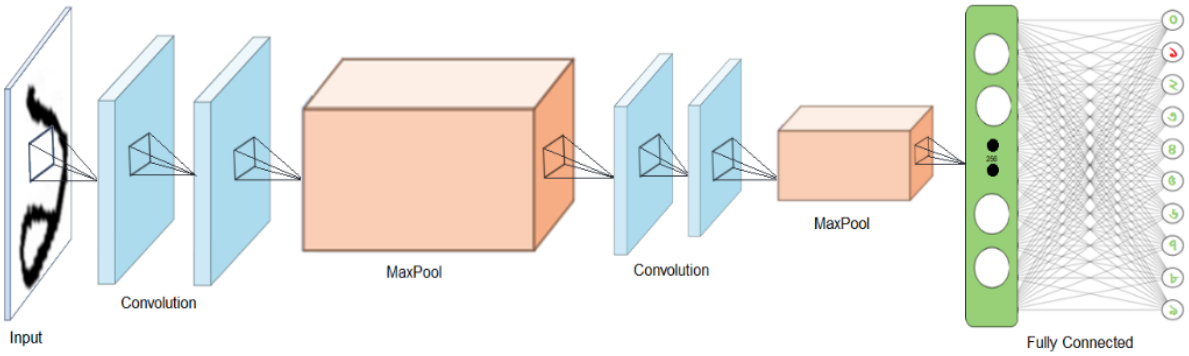

Figure 3.5.b – Proposed Bangla sign language processed data

c) Working Procedure

Convolutional neural network is work the step by step. In this section it has briefly discuss. Densed layer is in fact the linear operation on the layers input vector. It works as below in figure 3.5.c (i)-

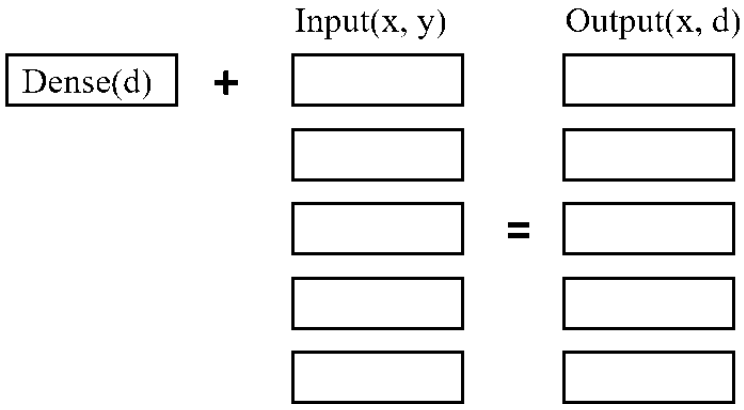

Figure 3.5.c (i) - Densed layer working method

The flattening step is required so that we can create use of completely connected layers after some convolutional layers.

Flattening layer working method is shown in figure 3.5.c (ii)-

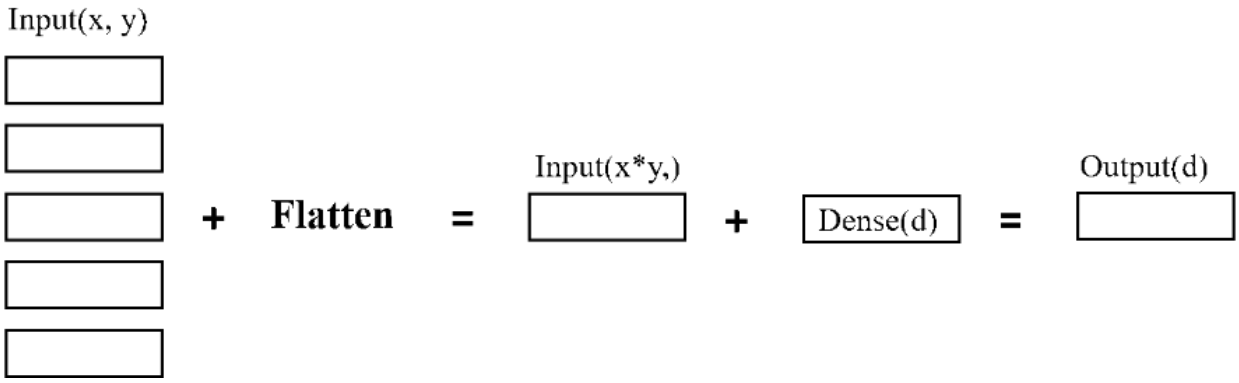

Figure 3.5.c (ii) - Flattening layer working method

Now finally the whole model architecture could be shown in a picture. Figure 3.5.c (iii) is showing the neural network architecture.

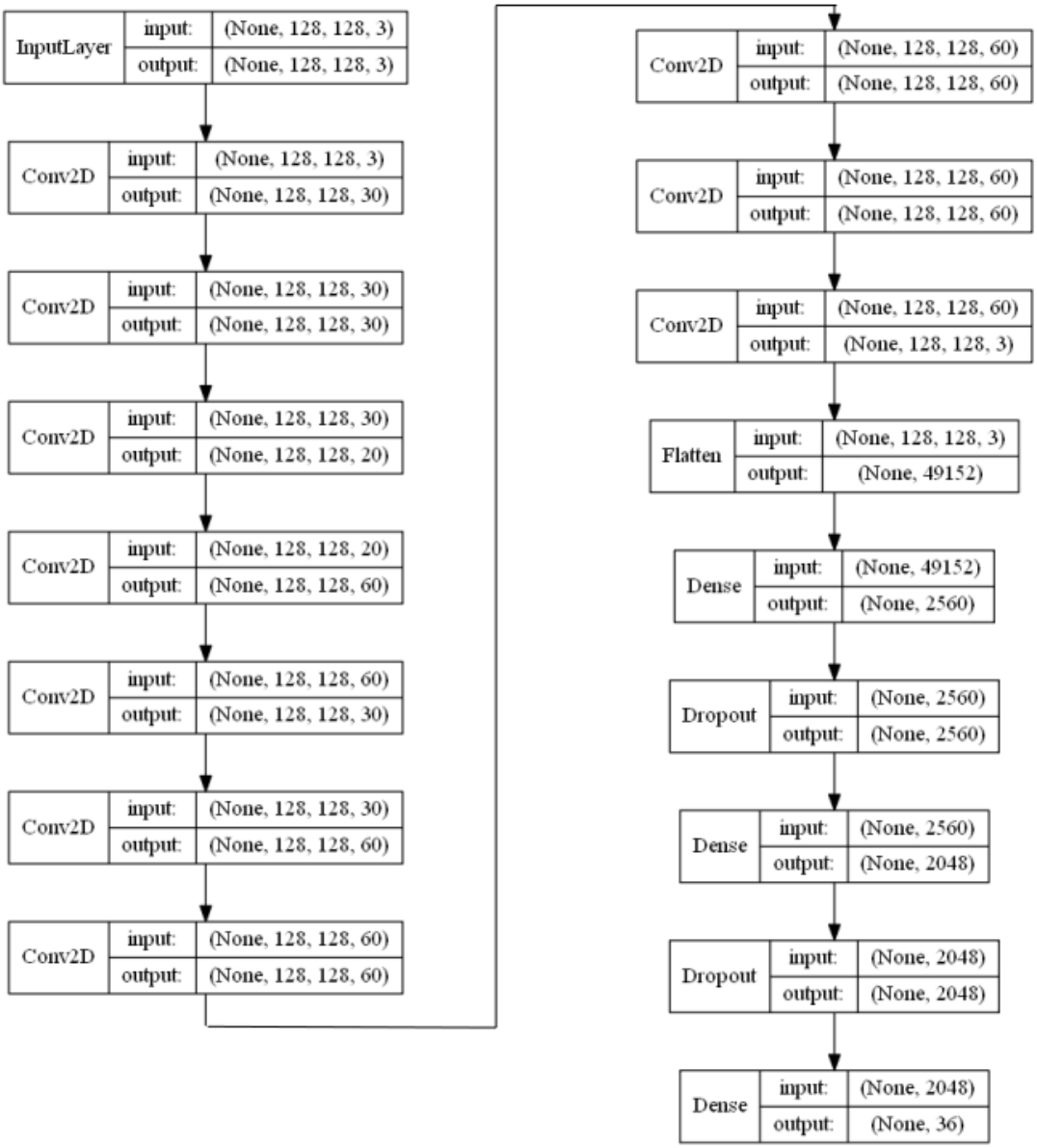

Figure 3.5.c (iii) - The whole model architecture

d) Model Optimization and Learning Rate

The choice of optimization algorithm can make a sufficient change for the result in Deep Learning and computer vision work. The Adam paper says, "Many objective functions

are composed of a sum of sub functions evaluated at different subsamples of data; in this case, optimization can be made more efficient by taking gradient steps w.r.t. individual sub-functions ...". The Adam optimization algorithm is an extension to stochastic gradient descent that recently adopting most of the computer vision and natural language processing application. The method computes individual adaptive learning rates for different parameters from estimates of first and second moments of the gradients. Proposed method used ADAM Optimizer with learning rate = 0.001.

When using a neural network to perform classification and prediction task. A recent study shows that cross entropy function performs better than classification error and mean square error. Cross-entropy error, the weight changes don't get smaller and smaller and so training isn't s likely to stall out. Proposed method used categorical cross entropy (3) as loss function.

$$L_i = \sum_j t_{i,j} \log(p_{i,j}) \qquad (3)$$

To make the optimizer converge faster and closer to the global minimum of the loss function, using an automatic Learning Rate reduction method. Learning rate is the step by which walks through the minimum loss. If higher learning rate use it will quickly converge and stuck in a local minimum instead of global minima. To keep the advantage of the fast computation time with a high Learning Rate, after each epoch model dynamically decreases the learning rate by monitoring validation accuracy.

CHAPTER 4

Experimental Results and Discussion

4.1 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-

4.2 Experimental Results

Our project where we calculated accuracy using the following variables:

Precision:

The precision is defined by the ratio of the numbers of correct recognition to the total numbers of recognition for each hand signs.

Recall:

The recall rate is defined by the ratio of the numbers of correct hand sign identification to the total number of hand signs.

Recall and Precision can be defined using the following variables:

TP (True Positive): True positive means number of correct results we are looking for.

TN (True Negative): Means number of correct detections of the incorrect input data.

FP (False Positive): Means wrong result in the system's output (Unexpected output).

FN (False Negative): Means missing expected outputs, i.e. the result should be included in system output but is not there.

As recall and precision are defined as follows:

$$\text{Precision} = \frac{tp}{tp+fp}$$

$$\text{Recall} = \frac{tp}{tp+fn}$$

Accuracy and True Negative rate are calculated as given below

$$\text{True negative rate} = \frac{tn}{tn+fp}$$

$$\text{Accuracy} = \frac{tp+tn}{tp+tn+fp+fn}$$

TABLE 1: EXPERIMENTAL RESULT SUMMERY.

Experiment	Training Accuracy	Validation Accuracy	Epoch Used	Dataset Used
Digits	95.35%	94.88%	50	100 Sets
Characters	92.74%	92.65%	100	50 Sets

4.3 Descriptive Analysis

As we know our model dataset divided into two portions- training data and test data. The model was trained with the training data and then validated with the validation data.

TABLE 2: DATASET DISTINGUISHING FOR TEST AND TRAINING.

Experiment	Total Data	Training Data	Test Data
Digits	1000	850	150
Characters	1800	1440	360

For our database, after 30 epoch model gets 92.65% accuracy on the training set and 92.74% accuracy on the validation set in characters and after 100 epoch model gets 95.35% accuracy on the training set and 94.88% accuracy on the validation set in digits. Fig 4.3(i) shows the loss value and accuracy of the training set and the validation of digits. Finally, the proposed system accuracy is 92.74% for characters and 94.88% for digits.

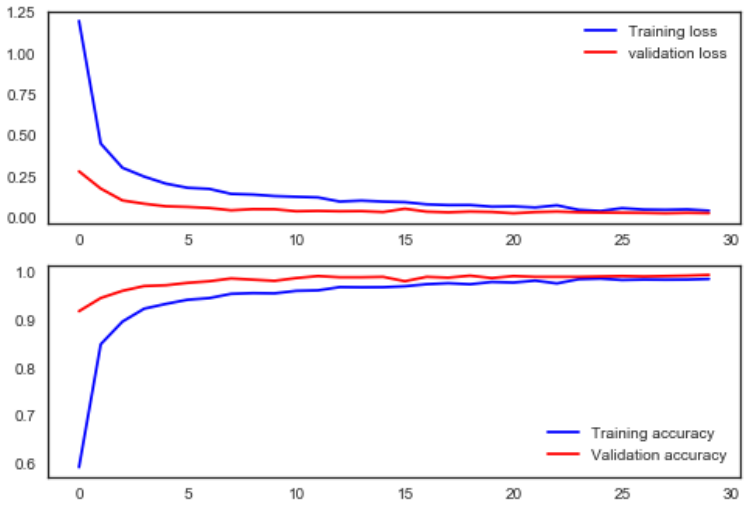

Figure 4.3(i) – Test and Training Accuracy Graph of BdSL Digits

Fig 4.3(ii) shows the loss value and accuracy of the training set and the validation of characters.

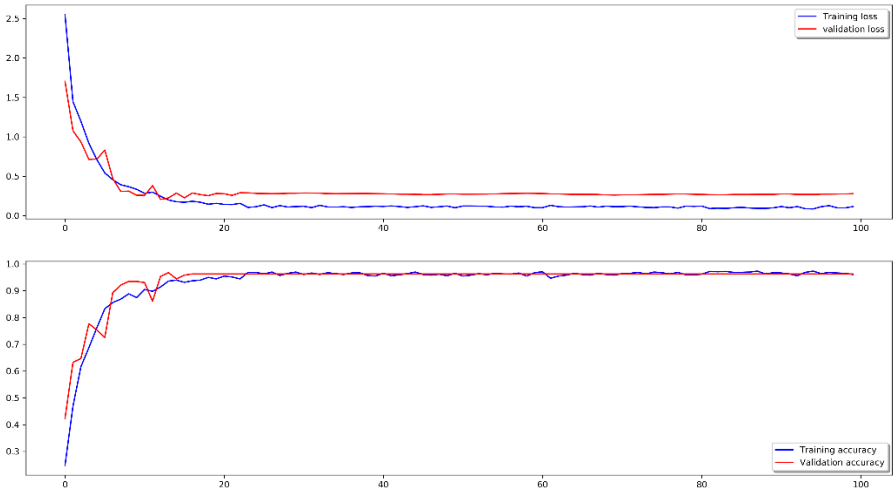

Figure 4.3(ii) – Test and Training Accuracy Graph of BdSL Characters.

4.4 Summary

In this section I have discussed the accuracy calculation and accuracy figure of the sign of our project. And discussed the result briefly and give descriptive analysis.

CHAPTER 5

Conclusion and Future Work

5.1 Summary of the Study

We have implemented the Computer Vision-Based Bangla Sign Language Recognizer Model successfully. The whole project short summary is given below-

Step1-

- Data collection
- Data Pre-processing

Step2-

- Divided data into train, validation and test set
- Transfer learning.

Step3-

- Recognize the sign using CNN

Step4-

- Calculate the accuracy to get better result

These model improve our hearing impaired community upgrading the system further more. In this section we will like to describe the conclusion, recommendations and further improvement ideas of this research.

5.2 Conclusion

Opportunities and resources for working on disable communities are too much difficult in Bangladesh perspective of other countries. Recognizing sign from images is a challenging task to developing models. The ability of automatically recognize sign language could have a great impression on the lives of deaf and dump people. This will relief them in their daily life communication.

In our project, we represented a convolutional neural network (CNN) approach for a classification algorithm of Bangla Sign Language. CNN can create outcome in real-time manner and able to recognizing static sign language gesture. Here, we introduced a self-made two large datasets for digits and characters. Those dataset includes accordingly 1000 images of 10 digits and 1800 images of 36 characters. Both dataset will help other researchers to work further for deaf and hearing impaired people because both dataset are publicly obtainable. We believe that this dataset will be a great resource for researchers in Bangla Sign Language recognition and also hope that the compatibility of the BdSL dataset will motivate and aid other researchers to study the difficulty of sign language recognition, gesture recognition. We were capable of get an accuracy of 92% for our CNN classifier. By giving to the arena of automatic sign language recognition the purpose of our model is to decrease the difficulty of communication between hearing impaired people and normal people.

5.3 Recommendations

In next stage we will be increase the number of training samples and trying to apply other methods than compare neural network to analyze which one makes the best result for Bangla Sign Language recognition.

This project has the possibility of enhancements like:

· As an interpreter it helps hearing impaired people.

· It also helps to robotics system.

· Any kind of Disability Development Organization can worked with our dataset and model as a standard platform.

5.4 Implication for Further Study

This model has been developed with future improvement possibilities. In data science project here data is the most important fact for working and making applicable model. For this project increasing the dataset size will be the future work. Learning the edge of this

completed method like structure classification, a more exact sign recognition system can be displayed. We will try to establish our model more efficient in future. We try for 10 digits and 36 Bengali alphabets and we will extent the accuracy for all the Bengali alphabets. In future, extra feature like body movements and facial expressions will proposed in BdSL. Develop the vocabulary can also be figured as a future work. Our final goal, to make model for classify sign of the BdSL and to interpret them to Bangla text. We would like to development this model as a standard platform any disability development organization.

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THE FIRST OPEN ACCESS DATASET FOR BANGLA SIGN LANGUAGE AND AN ARROWHEAD DETECTION TECHNIQUE WITH CNN MODEL BY MD. SANZIDUL ISLAM ID: 151-15-5223 SADIA SULTANA SHARMIN ID: 151-15-5191 AND NAZMUL AHSAN ID: 151-15-4668 This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering Supervised By DR. SYED AKHTER HOSSAIN Professor and Head Department of CSE Daffodil International University DAFFODIL INTERNATIONAL UNIVERSITY DHAKA, BANGLADESH DECEMBER 2018 APPROVAL i This Project titled “The First Open Access Dataset for Bangla Sign Language and an Arrowhead Detection Technique with CNN Model” submitted by Md. Sanzidul Islam and Sadia Sultana Sharmin and Nazmul Ahsan 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 and approved as to its style and contents. The presentation has been held on December 2018 BOARD OF EXAMINERS Dr. Syed Akhter Hossain Professor and Head Department of CSE Faculty of Science & Information Technology Daffodil International University Chairman Dr. Sheak Rashed Haider Noori Assistant Professor Department of CSE Faculty of Science & Information Technology Daffodil International University Internal Examiner Dr. Mohammad Shorif Uddin Professor Department of Computer Science and Engineering Jahangirnagar University External Examiner ii DECLARATION We hereby declare that, this project has been

done by us under the supervision of Dr. Syed Akhter Hossain, Professor and Head, Department of CSE Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma. Supervised by: Dr. Syed Akhter Hossain Professor and Head Department of CSE Daffodil International University Submitted by: Md. Sanzidul Islam ID: 151 -15- 5223 Department of CSE Daffodil International University Sadia Sultana Sharmin ID: 151 -15- 5191 Department of CSE Daffodil International University Nazmul Ahsan ID: 151 -15- 4668 Department of CSE Daffodil International University iii ACKNOWLEDGEMENT First we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year project/internship successfully. We really grateful and wish our profound our indebtedness to Supervisor Dr. Syed Akhter Hossain, Professor and Head, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of "Data Mining, Pattern Recognition, Topic Modeling" to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting them at all stage have made it possible to complete this project. We would like to express our heartiest gratitude to the Almighty Allah and Head, Department of CSE, for his kind help to finish our project and also to other faculty member and the staff of CSE department of Daffodil International University. We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.Finally, we must acknowledge with due respect the constant support and patients of our parents. iv ABSTRACT Sign Language is the method of interaction between the hearing-impaired people and the general people. It is the only way to decrease the communication gap of deaf community and the normal people. A machine translator could be potent solution for solving this problem. But collecting hand sign data of sign language from reliable source is too much difficult to researchers. This project is conceived from the above scenario. In this project, we made two open access isolated datasets- Ishara-Bochon and Ishara-Lipi and its recognition model. Ishara-Bochon contains 100 sets of 10 different classes for Bangla Sign Language digits. And Ishara-Lipi contains 50 sets of 36 classes for Bangla Sign Language characters. The image data are collected from different deaf and general volunteers from different institutes. Our datasets could be used to build computer vision based or any other type of system that allows users to search the meaning of BdSL signs. We attempted to represent a BdSL recognizer model which will help hearing impaired people to remove communication gap with generals. In proposed method we used multi-layered Convolutional Neural Network (CNN). CNNs have capability to learn structures automatically from raw data. Our model gained 92% accuracy on our digits datasets and 86% accuracy on our characters dataset. In the future, further AI and data analytics will add values to the services delivered to the end users. . v TABLE OF CONTENTS CONTENS PAGE Board of examiners ii Declaration iii Acknowledgements iv Abstract v List of Figure viii List of Tables ix Chapter 1 : Introduction 1.1 Introduction 1.2 Motivation 1.3 Rational of the study 1. 4 Research Questions 1. 5 Expected Output 1. 6 Report Layout 1-7 1 3 5 5 6 6 vi Chapter 2 : Background 2.1 Introduction 2.2 Related Works 2.3 Research Summary 2.4 Scope of the Problem 2.5 Challenges Chapter 3 : Research Methodology 3.1 Introduction 3.2 Research Subject and Instrumentation 3.3 Data Collection Procedure 3.3.a Capturing Image 3.3.b Labeling Image 3.3.c Cropping Image Manually 3.3.d Resizing Image and Convert to Gray Scale 3.4 Statistical Analysis 3.5 Implementation Requirements 3.5.a Convolutional Neural Network 3.5.b Methodology (Working Algorithm) 3.5.c Working Procedure 3.5.d Model Optimization and

Learning Rate 8-13 8 8 10 11 12 14-25 14 14 15 15 16 16 17 18 19 19 20 22 24 vii Chapter 4 : Experimental Results and Discussion 4.1 Introduction 4.2 Experimental Results 4.3 Descriptive Analysis 4.4 Summary Chapter 5 : Summary, Conclusion, Recommendation and Future Research 5.1 Summary of the Study 5.2 Conclusions 5.3 Recommendations 5.4 Implication for Further Study 26-29 26 26 27 29 30-31 30 30 31 31 REFERENCES 30-31 LIST OF FIGURES FIGURES PAGE NO Figure 1.1 (i): Bangla sign language characters 1 viii Figure 1.1 (ii): Figure 1.2: Figure 2.4 (i): Figure 2.4 (ii): Figure 2.5 (i): Figure 2.5 (ii): Figure 2.5 (iii): Figure 2.5 (iv): Figure 3.3: Figure 3.3.c (i): Figure 3.3.c (ii): Figure 3.3.d: Figure 3.4: Figure 3.5.a: Figure 3.5.b: Figure 3.5.c (i): Figure 3.5.c (ii): Figure 3.5.c (iii): Figure 4.3(i): Figure 4.3(i): Bangla sign digits Deaf children using sign language American sign digits Bangla sign digits Image character "অ" Image character "ল" Image character "ট" Image character "ত" Flow of working procedures Cropping image Cropped image Final gray scale image Numerical representation of BdSL characters Model architecture Bangla sign language processed data Densed layer working model Flattening layer working madel The whole model architecture Test and training graph of BdSL digits Test and training graph of BdSL characters 2 4 11 12 13 13 13 13 15 16 17 18 18 20 22 22 23 24 28 28 LIST OF TABLES TABLES PAGE NO Table 1 Experimental Result Summery 27-27 Table 2 Dataset Distinguishing for 27 Test and Training 27 ix CHAPTER 1 Introduction 1.1 Introduction As an independent country 16 million people living in Bangladesh, among them 2.6 million people are dumb and deaf. That means they can't talk and hear from general people. But Bangla is the mother tongue of everyone. Deaf and dumb people use different types of gesture to communicate with each other. This is called sign language. There are almost 137 sign language exists in this world. One of the soonest composed records of a communication via gestures is from the fifth century BC. Deaf and dumb people used different types of hand gestures, movement of body, sign to communicate with each other. By using different types of signs they express their feelings and emotion with each other. Disable people use their hand to make different types of shape and express different meaningful word. In Bangladesh there is few school for dead and dumb children where they learn through sign language. The Bangla sign language characters and digits picture are shown in figure 1.1 and figure 1.2 accordingly- Figure 1.1(i) - Bangla sign language characters Figure 1.1 (ii) - Bangla sign digits But sign language is not universal. General people don't understand those sign and what those sign means. For this reason, there is always a communication gap between general and disable people. It is not easy for general people to communicate with deaf and dumb people because they can't hear from us. When a child born in a family he or she learn first word from the environment but as a deaf people don't hear anything he or she can't learn from surrounding. Till now there is no specific pattern of Bangla sign language in our country. General people can easily communicate with disable people if there is a model of Bangla sign language recognizer. This will decrease the gap between disable and general people. And deaf and dumb people can take all types from opportunity from our society. There will be no discrimination between general and disable people. So Bangla sign language recognizer can create a great impact on our society. In every sector deaf and dumb people will get same type of opportunity as general people get. Bangla sign language recognizer model will help general people and disable people as a universal medium. Disable people can easily express their emotion as like as general people. It will be developed in deep learning approach. Deep learning is part of machine learning. It is also known as deep structured learning. There are different types of deep learning architectures .Such as deep belief network, deep neural network, recurrent neural network etc. Those architectures are used in different field. Such as audio recognition,

computer vision, speech recognition, natural language processing, social network filtering, drug design, medical image analysis, machine translation etc. This model is developed with the help of deep learning. This model will work as a universal model for both disable and general people. General people can easily express their emotion with disable people, on the other hand disable people can also express their feelings with general people. This model will increase the dignity of Bangla language. As we achieved Bangla as our mother tongue with lots of blood, we have to work for increasing dignity of Bangla language. This is possible when everyone expressing their feelings in Bangla. And this model can work as a medium. By using this everyone can easily expressing their feelings with anyone they want. Moreover it will be matter of pride for every Bangladeshi that we have an established complete open access Bangla sign language data set. 1.2 Motivation Sign language is only medium for deaf and dump people to express their emotion and communication. Hard of hearing is a lack of ability that castrate their hearing and build up them handicap to tune in. And dumb is a lack of ability that undermine their talking and set up them cripple to talk.2.4 million People use sign language in Bangladesh but rest general people don't understand those sign language. For this there should be a universal medium, by using this everyone will understand their language. As Bangla is mother tongue for both general and disable people there should be a universal medium for all. By using this everyone can communicate with anyone. In many sector disable people are lagging behind general people for communication problem. A universal medium can reduce this problem. On the other side, United State has their own sign language pattern that is called American Sign Language (ASL) which is very developed. As Bangladesh is a developing country, Bangladesh should have their own sign language pattern which is called Bangla Sign Language (BDSL). Very few developers worked with Bangla sign language model. But they worked only few number or characters. But we should have our own dataset of all Bangla number and characters. This model will increase the accuracy. Other model has less accuracy. ASL recognizer model have 94% accuracy but on the other hand BDSL have only 84% accuracy so it has to be increased. Figure 1.2 - A deaf children using hand sign We achieved Bangla as our mother tongue with lot of blood. Bangla is also mother tongue for deaf and dumb people. So Bangla sign language model have to be establish for deaf and dumb people so that they can participate in every occasion for the betterment of Bangla language and Bangladesh. In Bangladesh there are few institutions for deaf and dumb children where they learn about sign language. Disable people use different gesture and body movement to communicate with each other. Static signs are for the most part utilized for letter sets and numbers where hand shapes characterize each sign. Then again, words and sentences are representing through mix of hand shape, introduction and development of hands and arms. Sometimes facial expressions express different emotion. But those expressions can hardly understand by any general people. A formal sign language is established by Centre for disability development (CDD) for deaf and dumb people. A model for sign language recognizer can help both disable and general people to communicate with each other. 1.3 Rational of the study In Bangladesh there is always a communication gap happen between general and disable people. Moreover, People with disabilities are lagging. They don't get all opportunity like general people. Bangla sign language model can solve this problem. We know that communication is very important part in our life. This model will help general people to turn sign language in normal language. And on other hand disable people will also be beneficial. They can convert general people's language into sing language. Bangladesh is developing day by day. Its development cannot be possible without participation of every citizen of the country. In others developing county disable people are also

taking part in development of their country. So Bangla sign language recognizer model can also help disable people to take place in development of country. Moreover, there will be a standard pattern for Bangla sign language data set. That will help developers for further development of the model. Both general people and disable people will be beneficial through the Bangla sign language recognizer model. For Digital Bangladesh this type of model is compulsory. With this model whole country will be beneficial. Disable people can perform any task as a general people with using this system. In Bangladesh people have lack of knowledge about sign language. They don't know which gesture means what. Disable people can participate in any type of government work by using this model. 1.4 Research Questions • How disable people can connect with this model? • How can this model decrease communication gap between general and disable people? • How this model can play role in developing Bangladesh? • What will be future work of Bangla sign Language recognizer model? model? • How can general people can communicate with deaf and dumb people with this 1.5 Expected Output As it is a research based project, result will be publishing a research paper dependent on another way to deal with perceive Bangla gesture based communication. It will help other people to know about the project. Few developers work with Bangla sign language but their data set is not open for all. So if anyone wants to develop Bangla sign language related anything he or she has to start work from the start. So will make a dataset that will be open for all, and using those data set which model is created it will be open source. It will help developers for further development. Developers will add more features in future. Communication will be easier. A system will be developing for general people that can convert input text or voice in sign language. It will help general people to communicate with deaf and dumb people. General people can easily express their feelings and emotions with any deaf and dumb people. On the other side, a system will develop for disable people that can convert sign language to text or voice. This will cooperate deaf and dumb people to communicate with general people. A full data set of Bangla sing language will be establishing. There is some data set of Bangla sign language, those are not fully establishing. A full dataset of Bangla number and character will come from research. There will be 0-9 total ten set of number data. Final outcome will be an open Data Set & open source model, so that developers can work in future. And a system that can convert voice r text into sign and hand gestures or sign into voice or text. 1.6 Report Layout There are total 5 chapter in this report. In Chapter 1 which focusses on the introduction, motivation and goals behind the thesis. Chapter 1 consists of 6 portions. 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6, section includes introduction, motivation, rational of the study, research questions, expected output and report layout. Chapter 2, consists of background, fundamentals information relevant to the thesis and is divided in 5 portions. Section 2.1, 2.2, 2.3, 2.4 and 2.5, consists of introduction, related work, research summary, scope of the problem and challenges individually. Chapter 3 explains the facts of our thesis experiment extend over 5 subsections. 3.1, 3.2, 3.3, 3.4 and 3.5 section describes every phase of the recognition, i.e. Introduction, research subject and instrumentation, data collection procedure, statistical analysis and implementation requirements. Chapter 4 mentioned the experimental results and discussion of that result. It has 4 portions. Section 4.1, 4.2, 4.3 and 4.4 consists of introduction, experimental results, descriptive analysis and summary. In the end chapter 5 have 4 sections that included summary, conclusion, recommendation and implication for future research. Follows the five sections and at the conclusion there is a reference of following resources we have mentioned in our research. CHAPTER 2 Background 2.1 Introduction A sign Language is a language which is represented by alliance of gesture or movement of the hands. Sign

Language is the visual language because of these sign language and spoken language both is different. In real world, people face different gestures. Different country has different sign languages rely on their alphabets and native expression. There are various sign language for example American, Arabic, French, Spanish, Chinese, and Indian etc. Sign language is a natural language and it is naturally made [1]. General people are not accustomed with sign language. For effective communication deaf and damp people and normal people must have the similar set of knowledge for an individual sign. It is difficult for the deaf and mute people to learn their sign as there is no appropriate model that work as a communication method. So it is essential for create a model which is convert the sign language to text that supported the mute people to communicate with general people and each other. 2.2 Related Work There are many research and article in sign language recognition. Many researchers have worked in characters and digits sign using datasets. The American Sign Language Lexicon Video Dataset [2] (Neidle and Vogler, 2012) forms such a lexicon for American Sign Language (ASL), having more than 3000 signs in multiple video views. The Argentinian Sign Language (LSA) paper is proposing a dataset of 64 signs. (LSA64, Franco and Facundo) This dataset contains 3200 videos of 64 different LSA signs recorded by 10 subjects. The Arabic Sign Language recognition paper [4] contains 30 manual alphabets signs (Omar Al-Jarrah and Alaa Halawani, 2001). In Chinese SLR [3] has 120 signs dataset (2012, Yun Li and Xiang Chen). Byeongkeun Kang et al. take the particularly well-organized major step of automatic finger spelling recognition system using convolutional neural networks (CNNs) from depth maps. In this work, they consider quite larger number of classes related with the forgoing literature. They train CNNs for the classification of 31 alphabets and numbers using a subset of collected depth data from multiple subjects [5]. In Deep Convolutional Neural Networks for Sign Language Recognition paper they proposed a CNN architecture for classifying selfie sign language gestures. A stochastic pooling method is applied which pools the benefits of both max and mean pooling methods. They make the selfie sign language database of 200 ISL sign with 5 signers in 5 user dependent viewing angles for 2 sec each at 30fps generating a total of 300000 sign video frames [6]. Hana Hosoe et al. established a structure for recognition of static finger spellings on images. This recognition of hand gestures is done using a convolutional neural network, which has been trained using physical images. They recorded 5000 images with static finger spellings from Japanese Sign Language [7]. Jie Huang et al. developed a 3D CNN model for sign language recognition that gets and removes temporal structure by performing 3D convolutions. They use multilayer perceptron classifier to categorize these feature demonstrations [8]. A voice/text format architecture is being proposed using the neural networks identification to convert the sign language and introduce the Point of Interest (POI) and trajectory idea delivers creativity and cuts the storage memory condition in Real-time Sign Language Recognition based on Neural Network Architecture paper [9]. Lionel Pigou(B) et al. contribute a recognition system using the Microsoft Kinect, convolutional neural networks (CNNs) and GPU acceleration and making complex handcrafted features. They were able to recognize 20 Italian gestures with 91.7% accuracy [10] In Bangladesh, there is some work on sign language. In 2014, Muhammad Aminur Rahaman, Mahmood Jasim, Md. Haider Ali and Md. Hasanuzzaman did a Computer Vision-Based Real-Time Bangla Sign Language Recognizer [11] where they proposed Bengali Hand gesture recognition system focusing on Computer Vision. In September 2017 Mohammad Mahadi Hasan, Md. Khaliluzzaman, Shabiba Akhtar Hime, and Rukhsat Tasneem Chowdhury proposed a sign language recognizer structure [12] for various Bangla characters using Artificial Neural Network (ANN) and they got a good

recognition rate. In [13], they used scale invariant feature transform (SIFT) for feature extraction in Bangla sign vocabularies and then applied k-means clustering. They also introduced the bag of words model to their hybrid approach. Rhythm Shahriar, A.G.M. Zaman, Tanvir Ahmed, Saqib Mahtab Khan and H.M. Maruf proposed a communication platform between Bangla and Sign language in 2017 [14]. They worked with Bangla speech which converts speech to sign and show to impaired persons. They mainly focused on speech recognition algorithms. K. Datta, B. Sarkar, C. Datta et al proposed a framework for Bangla text to Bangla sign language based on translation system [15]. In that method, the input text organize the words in the exact order for Bangla sign language, and show the exact video file related to each word given. 2.3 Research Summary In this paper, we have represented a BdSL recognition model which is created using of own dataset images. We have created two open access datasets. The name of digits and character dataset is accordingly 'Ishara-Bachon' and 'Ishara-Lipi'. Ishara-Bachon dataset contains 100 sets of 10 Bangla basic sign digits and Ishara-Lipi dataset contains 50 sets of 36 Bangla basic sign characters. In Bangladesh, there are many researchers who are working in this field and they are trying to improve this field. For this purpose, they are used different method. In proposed model, we used deep learning method of convolutional neural network (CNNs). Firstly we have collect the image and processed the image. After that, we divided the dataset into two portions- training data and test data using multi-layered Convolutional Neural Network (CNN). CNNs are able to automate the process of structure making. Then finally the whole model architecture could be shown in a picture. 2.4 Scope of the Problem General people have a mother language learned from the environment. But by birth hearing impaired people, they can't hear something from environment that's why became deaf finally. Sometimes Bangladeshi deaf people use their own local signs because of not having accurate idea of keeping a fixed standard of Bangla sign language. The sign rule is different in country basis. American sign digits picture are given in figure 3.4 (i): Figure 2.4 (i) - American sign digits In Bangladesh a formal sign language has been established recently. In the year 2000, Center for Disability in Development (CDD) took the initiative to standardize communication with sign languages in this country [16]. Now the most used signs among the Bangladeshi deaf community are CDD standard Sign Language. Bangla sign digits are shown in figure 2.4 (ii) - Figure 2.4 (ii) - Bangla sign digits Bengali Sign Language is architecturally different from sign languages from other countries. A very few research was effectively held on Bangladeshi Sign Language (BdSL) but no dataset is open in web repository to work further for this deaf community. So it is important for create a model which is translate the sign language to text that supported the mute people to communicate with general people and each other. To perform Bengali Sign Language, different kind of rules is used generally but, in this model, we used one hand for digits sign and two hand for characters sign. Now a days, Bangladeshi Sign Language Recognition (BdSL) becomes one of the challenging topics in the area of machine learning and computer vision. 2.5 Challenge In our project we have to do Process a huge number of image data manually and it is very challenging. Our other challenges are some Bangla Word Signs are not static image and some characters have two hand sign. Such a challenging fact to consider about sign languages is that, same hand shapes or same hand motion can be used to express different signs. For example, in Bangla sign language, some of characters have the near about same hand movement but the hand shape for the two signs are different. So, it is very challenges for every researcher to recognition the hand gesture and getting classified data for Bangla Sign. And there is a big challenge to hardware limitation as having no high configures GPU. The given characters figure 2.5(i) and figure 2.5(ii) is nearly same-

Figure 2.5(i) - Image Character "অ" Figure 2.5(ii) - Image Character "ল" Figure 2.5(iii) and figure 2.5(iv) of characters have the near about same hand movement but the hand shape for the two signs are different. These are given below- Figure 2.5(iii) - Image Character "ট" Figure 2.5(iv) - Image Character "ত" CHAPTER 3 Research Methodology 3.1 Introduction Different country has different sign language. Any kind of sign language recognition is very difficult, because the computer system can't recognize the sign easily. All researcher efforts hard and apply different method to recognize the sign with the computer system. In proposed system we applied some method to interact with computer system. This system recognizes Bangla sign digits (0-9) and characters. 3.2 Research Subject and Instrumentation Our research topic is "The First Open Access Dataset for Bangla Sign Language and an Arrowhead Detection Technique with CNN Model." It is the field of image processing system. Up to now we have discussed the theoretical concepts and methods. Now a list of requirements of instruments are given below- Hardware and Software instruments which we use- ? 7th generation core i5, 3.2 GHz with 8 GB RAM. ? 2GB GPU with 384 CUDA core supported PC. ? 1 TB HDD ? 256 GB SSD for system boot ? Canon 600 D (18/55 Lens) Developing Tools- ? Linux Kernel (Ubuntu 18.04) ? Python 3 ? Keras & Tensorflow ? Python OpenCV 3.3 Data collection procedure Our model has applied some procedure for implementation. All the procedures have discussed in this section. The whole data collection process has been divided into five different states. All those states are described in figure 3.3 Figure 3.3- Flow of working procedures a) Capturing image Data are collect from general volunteers and many Deaf School Community and we took images of uncovered hands. The white background was choose as background color and then captured images one by one. DSLR camera was used for taking hand signs images because of conducive resolution. While capturing images white spaces were removed from hands edge as much as possible. b) Labeling data Labeling data is important to minimize the noise get in the capturing process for improve the images quality. After data collection labeling developed our script. For example some of BdSL sign vary little from another. Images of this kind of signs appear familiar and enhance the exception of experiment. For that we categorized the signs individual. Different signs have different classes/folders. Ten Different directories (named- 0, 1, 2, 3, 4, 5, 6, 7, 8, 9) was built for digits. On the other hand Bangla Language has about 49 characters but in sign language it's not. In Bangla Sign Language there have only 36 characters at all. So we had 36 characters by naming with numeric convention from 1 to 36 (1, 2, 3...9). After that we stored those images into different classes to make more organized. The naming convention of all characters is given below in a chart. c) Cropping images manually The taken image cannot be used without cropping for any sign recognition purpose. Cropping is essential to create the image for further experiment. We cropped images manually for making those noise free and it observing the rate of height and width for future processing. Images are cropping to show the hand region. White spaces are removed as well as possible by cropping. Figure 4.3.c (i) is showing the cropping image- Figure 3.3.c (i) - Cropping Image The entire cropping characters figure 4.3.c (ii) shown the following - Figure 3.3.c (ii) - Cropped Images d) Resizing image and convert to gray-scale All images are resized in a standard format by python cv2 script for create our dataset more usable in any kind of machine learning, deep learning or computer vision based works. We created a script what will go in every folders having images and take the same action in every images. The scripts resize the image by 128 *128 pixels first and then convert RGB to gray -scale. We prepared all images into a standard form and ensuring same pixels in height and width. Figure 3.3.d is shown entire gray- scale characters picture- Figure 3.3.d - Final gray scale images 3.4 Statistical Analysis of

Datasets 1. Before we mentioned Ishara-Bochon contains sign images of total 10 classes of Bangla sign digits (0, 1, 2, 3 . . . 9) and Ishara-Lipi dataset contains 36 folders of images labeled by numbers (1, 2, 3 . . . 36) as sequentially presented as Bangla sign characters sequence. Figure 3.4 is numeric representation of BdSL characters- Figure 3.4 - Numeric representation of BdSL characters 2. Ishara-Bochon Dataset has total 1000 (10*100=1000) images and Ishara-Lipi contains total 1800 images (36 * 50 = 1800) 3. All sign images is cropped and resized by 128*128 pixels. 4. Here in 36 characters- 6 Bangla vowels and 30 consonants. 5. All images are kept in .jpg formatted datatype. 6. The images is captured then resized and finally converted to gray scale from RGB. 3.5 Implementation Requirements a) Convolutional Neural Network (CNNs) Convolutional Neural Networks is a class of deep neural network and also called CNNs or ConvNets. CNNs are compare the images piece by piece. The pieces are called features. Convolutional networks are powerful visual models that yield hierarchies of features and driving advances in recognition [17]. Convolutional Neural Networks have been really effective in image recognition and classification problems, and have been effectively executed for human sign recognition in recent years [18].CNNs advances in bounding box object detection, part and key point prediction, and local correspondence [17]. Convolutional neural network is able to fulfil a real time and appropriate sign language recognition system. It is mentioning that CNN can eliminate the obstacle of moving hands from background for hands because CNNs have the ability to learn structures automatically from raw data without any prior knowledge [19]. The model used to recognize these sign here used multi-layer convolutional neural networks which are connected each other. The model is represented by total eight layers. Figure 3.5.a is shown the eight layers of model architecture- Figure 3.5.a - Model architecture b) Methodology (Working Algorithm) Dataset provides 128*128 pixels grayscale images. For making this model did some reprocessing works like- convert grayscale image to binary and threshold. The method we used determines the threshold automatically from the image using Otsu's method. Algorithm 1: 1: ADAM (Learning Rate) 2: For 30 iterations in all batch do: 3: Convolution 1 (Filter, Kernel Size, Stride, Padding, Activation) 4: Convolution 2 (Filter, Kernel Size, Stride, Padding, Activation) 5: MaxPool 1 (Pool Size) 6: Dropout (Rate) 7: Convolution 3 (Filter, Kernel Size, Stride, Padding, Activation) 8: Convolution 4 (Filter, Kernel Size, Stride, Padding, Activation) 9: MaxPool 2 (Pool Size) 10: Dropout (Rate) 11: Dense (Units, Activation, Kernel initializer, Bias Initializer) 12: Dropout (Rate) 13: Dense (Units, Activation, Kernel initializer, Bias Initializer) 14: end for Proposed model in this paper use ADAM optimizer with a learning rate of 0. 001. The model has 9-layer CNN. For convolution 1 and 2, where filter size is 32, kernel size is (5x5), Stride is (1x1), same padding with ReLU (1) activation. Followed by a 5 x 5 max pooling layer. Then use 25% dropout to reduce over fitting. For convolution 3 and 4, the filter is 64, kernel size is (3x3), Stride is (1x1), same padding with ReLU activation. Followed by a 2 x 2 max-pooling layer. Then used 25% dropout. Then flatten the layer and use a Dense layer with 256 units with ReLU activation and 50 % dropout. At final output layer, used 36 units with SoftMax (2) activation. Figure showing the neural network architecture. Proposed Bangla sign language processed data is given below figure 3.5.b- Figure 3.5.b – Proposed Bangla sign language processed data c) Working Procedure Convolutional neural network is work the step by step. In this section it has briefly discuss. Densed layer is in fact the linear operation on the layers input vector. It works as below in figure 3.5.c (i)- Figure 3.5.c (i) - Densed layer working method The flattening step is required so that we can create use of completely connected layers after some convolutional layers. Flattening layer working method is shown in figure 3.5.c (ii)- Figure 3.5.c (ii) - Flattening layer working method Now finally the

whole model architecture could be shown in a picture. Figure 3.5.c (iii) is showing the neural network architecture. Figure 3.5.c (iii) - The whole model architecture d) Model Optimization and Learning Rate The choice of optimization algorithm can make a sufficient change for the result in Deep Learning and computer vision work. The Adam paper says,"Many objective functions are composed of a sum of sub functions evaluated at different subsamples of data; in this case, optimization can be made more efficient by taking gradient steps w.r.t. individual sub-functions ...". The Adam optimization algorithm is an extension to stochastic gradient descent that recently adopting most of the computer vision and natural language processing application. The method computes individual adaptive learning rates for different parameters from estimates of first and second moments of the gradients. Proposed method used ADAM Optimizer with learning rate = 0.001. When using a neural network to perform classification and prediction task. A recent study shows that cross entropy function performs better than classification error and mean square error. Cross-entropy error, the weight changes don't get smaller and smaller and so training isn't s likely to stall out. Proposed method used categorical cross entropy (3) as loss function. To make the optimizer converge faster and closer to the global minimum of the loss function, using an automatic Learning Rate reduction method. Learning rate is the step by which walks through the minimum loss. If higher learning rate use it will quickly converge and stuck in a local minimum instead of global minima. To keep the advantage of the fast computation time with a high Learning Rate, after each epoch model dynamically decreases the learning rate by monitoring validation accuracy. CHAPTER 4 Experimental Results and Discussion 4.1 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- 4.2 Experimental Results Our project where we calculated accuracy using the following variables: Precision: The precision is defined by the ratio of the numbers of correct recognition to the total numbers of recognition for each hand signs. Recall: The recall rate is defined by the ratio of the numbers of correct hand sign identification to the total number of hand signs. Recall and Precision can be defined using the following variables: TP (True Positive): True positive means number of correct results we are looking for. TN (True Negative): Means number of correct detections of the incorrect input data. FP (False Positive): Means wrong result in the system's output (Unexpected output). FN (False Negative): Means missing expected outputs, i.e. the result should be included in system output but is not there. As recall and precision are defined as follows: Accuracy and True Negative rate are calculated as given below Experiment Digits Characters TABLE 1: EXPERIMENTAL RESULT SUMMERY. Training Accuracy Validation Accuracy Epoch Used Dataset Used 95.35% 94.88% 50 100 Sets 92.74% 92.65% 100 50 Sets 4.3 Descriptive Analysis As we know our model dataset divided into two portions- training data and test data. The model was trained with the training data and then validated with the validation data. TABLE 2: DATASET DISTINGUISHING FOR TEST AND TRAINING. Experiment Total Data Training Data Test Data Digits 1000 850 150 Characters 1800 1440 360 For our database, after 30 epoch model gets 92.65% accuracy on the training set and 92.74% accuracy on the validation set in characters and after 100 epoch model gets 95.35% accuracy on the training set and 94.88% accuracy on the validation set in digits. Fig 4.3(i) shows the loss value and accuracy of the training set and the validation of digits. Finally, the proposed system accuracy is 92.74% for characters and 94.88% for digits. Figure 4.3(i) – Test and Training Accuracy Graph of BdSL Digits Fig 4.3(ii) shows the loss value and accuracy of the training set and the validation of characters. Figure 4.3(ii) – Test and Training Accuracy Graph of BdSL Characters. 4.4 Summary In this

section I have discussed the accuracy calculation and accuracy figure of the sign of our project. And discussed the result briefly and give descriptive analysis. CHAPTER 5 Conclusion and Future Work 5.1 Summary of the Study We have implemented the Computer Vision-Based Bangla Sign Language Recognizer Model successfully. The whole project short summary is given below- Step1- ? Data collection ? Data Pre-processing Step2- ? Divided data into train, validation and test set ? Transfer learning. Step3- ? Recognize the sign using CNN Step4- ? Calculate the accuracy to get better result These model improve our hearing impaired community upgrading the system further more. In this section we will like to describe the conclusion, recommendations and further improvement ideas of this research. 5.2 Conclusion Opportunities and resources for working on disable communities are too much difficult in Bangladesh perspective of other countries. Recognizing sign from images is a challenging task to developing models. The ability of automatically recognize sign language could have a great impression on the lives of deaf and dump people. This will relief them in their daily life communication. In our project, we represented a convolutional neural network (CNN) approach for a classification algorithm of Bangla Sign Language. CNN can create outcome in real-time manner and able to recognizing static sign language gesture. Here, we introduced a self- made two large datasets for digits and characters. Those dataset includes accordingly 1000 images of 10 digits and 1800 images of 36 characters. Both dataset will help other researchers to work further for deaf and hearing impaired people because both dataset are publicly obtainable. We believe that this dataset will be a great resource for researchers in Bangla Sign Language recognition and also hope that the compatibility of the BdSL dataset will motivate and aid other researchers to study the difficulty of sign language recognition, gesture recognition. We were capable of get an accuracy of 92% for our CNN classifier. By giving to the arena of automatic sign language recognition the purpose of our model is to decrease the difficulty of communication between hearing impaired people and normal people. 5.3 Recommendations In next stage we will be increase the number of training samples and trying to apply other methods than compare neural network to analyze which one makes the best result for Bangla Sign Language recognition. This project has the possibility of enhancements like: · As an interpreter it helps hearing impaired people. · It also helps to robotics system. · Any kind of Disability Development Organization can worked with our dataset and model as a standard platform. 5.4 Implication for Further Study This model has been developed with future improvement possibilities. In data science project here data is the most important fact for working and making applicable model. For this project increasing the dataset size will be the future work. Learning the edge of this completed method like structure classification, a more exact sign recognition system can be displayed. We will try to establish our model more efficient in future. We try for 10 digits and 36 Bengali alphabets and we will extent the accuracy for all the Bengali alphabets. In future, extra feature like body movements and facial expressions will proposed in BdSL. Develop the vocabulary can also be figured as a future work. Our final goal, to make model for classify sign of the BdSL and to interpret them to Bangla text. We would like to development this model as a standard platform any disability development organization. Reference [1] Golam Kayas, Sakhawat Hossain Himel, and Mahraj Hasan, "Automatic Recognition of Bangla Sign Language Using Artificial Neural Networks (Anns) for Deaf and Dumb to Bridge the Communication Gap," In: International Journal of Recent Advances in Multidisciplinary Research July, 2016, Vol. 03, Issue 07, pp.1649-1654. [2] Athitsos, Vassilis, et al. "The american sign language lexicon video dataset." Computer Vision and Pattern Recognition Workshops, 2008. CVPRW'08. IEEE Computer Society Conference

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