REAL TIME BANGLA SIGN LANGUAGE DETECTION WITH TENSORFLOW OBJECT DETECTION USING DEEP LEARNING SSD

BY

OVIJIT SHINHA

ID: 191-15-12753

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

Supervised By

Tapasy Rabeya
Lecturer (Senior Scale)
Department of CSE
Daffodil International University

Co-Supervised By

Abu Kaisar Mohammad Masum
Lecturer
Department of CSE
Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY

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APPROVAL

This Project/internship titled **"Real Time Bangla Sign Language Detection with TensorFlow Object Detection Using Deep Learning SSD"**, submitted by Ovijit Shinha, ID No: 191-15-12753 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 23/01/23.

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_____

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Professor and Head
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

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Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

External Examiner

_____

Dr. Ahmed Wasif Reza
Associate Professor
Department of Computer Science and Engineering
East West University

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We hereby declare that, this project has been done by us under the supervision of **Tapasy Rabeya, Lecturer (Senior Scale), 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:

Tapasy Rabeya
Lecturer (Senior Scale)
Department of CSE
Daffodil International University

Co-Supervised by:

Abu Kaisar Mohammad Masum
Lecturer
Department of CSE
Daffodil International University

Submitted by:

Ovijit Shinha
ID: -191-15-12753
Department of CSE
Daffodil International University

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ABSTRACT

The Image detection system has revolutionized the way modern technology work due to its multipurpose use. Detecting Bangla sign language is nothing but detecting visual data which uses an image detection system to predict the sign and show the possible output. Our research shows that the Bangla sign language detection system work by collecting user data to match those data with previously trained data to show the result. After going through different research papers on this field we have found that there is a lot of existing work in this field, especially the in English language and other major language in the world. However, there are very few papers that have worked on Bangla sign language detection and it is mandatory to put emphasis on the Bangla sign language detection system. In this preliminary research paper, we have proposed a Bangla sign language detection model to detect the visual data and predict the sign with percentage to display the result. In order to detect Bangla sign language, we have used the 36 standard Bangla sign alphabet such as (অ-o, ক-k). The model we have proposed detects the visual data using an image recognition system and matches that information with the 36 Bangla sign alphabets that we have trained then it shows the result with matching percentage and expected possible result. To achieve the result, we have used a deep learning approach that uses a convolutional neural network (CNN) to detect the image and match the information with the Bangla sign alphabet to recognize the Bangla sign language. The approach we took showed average accuracy of 90.30 percent.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Deaf people consist of a very small proportion of the Bengali community and because of that, they have to face major drawbacks in their daily life and career. Although there's some established sign language in Bengali the main problem is most normal people do not understand sign language. However, technology might play a major role to fill the gap between those people who do not have the capability to understand sign language and those who can by implementing a modern solution using deep learning that will be saviors for this minority deaf community.

Sign language is one of the hardest forms of communication because there are lot of things to notice at the same time to understand the language like facial expression, hand movement, head movement, and arm movement. Bengali sign language is no exception from others and it is also very complex in nature. There's very little research has been done to recognize Bangla sign language. Although all of them had done best with what they had the technology they used had some drawbacks to delivering a certain type of results. In this research, I am going to demonstrate how to detect real time Bangla sign language detection with TensorFlow object detection using deep learning.

Applying the OpenCV library, I easily captured the required Bangla sign images using my webcam. After getting all the required images then labeled this dataset as per demanded. In this process, I utilized the MobilieNet-v2 model which is 53 layers deep. MobileNet-v2 outsails MobileNet-v1 and Shuffle-Net with proportionate size and computational cost. Besides, it can load a pre-trained version of the network trained on more than a million images from the database and the pre-trained network can classify images into 1000 object categories. I trained 36 Bangla signs [6 vowels and 30 consonants]. Using a webcam easily detected the sign and provided accuracy of the detected sign. For this process, I used TensorFlow Object Detection API and I got a 90.30% average accuracy.

1.2 Motivation

For centuries sign language was one of the best ways to communicate for hunting, deaf people, in war. However nowadays sign language is only used for minority deaf people and as previously mentioned that deaf people consist of a very small proportion of the Bengali community. Deaf people in the Bengali community face problems in their day-to-day life with basic thinking because most people do not understand sign language. Although much research has been done to detect sign language somehow, they don't have practical use that's why we were going to develop a sign language detection program that can be used for practical purposes in the future. In the military, they also use sign language for their emergencies.

1.3 Rationale of the Study

Object detection is one of the most complex by nature. There are two elegant ways to predict object which is the machine learning approach and the deep learning approach but we are going to use the deep learning approach because this use modern convolutional neural networks (CNN) which is unsupervised and that helps to identify an object as well as area of an object. First, we will input the Bangla sign into the program using OpenCV. After that program will takes three steps such as creating a small component and drawing block around segment to process the image to train the program. After training all possible Bangla sign language the program will be able to detect the sign provided by the client and the program will automatically show the percentage of match signs.

1.4 Research Question

Research Question 1: How will this system help the deaf and others?

Research Question 2: How to detect Bangla sign language through a webcam?

Research Question 3: Does it beneficial for our minority people in Bangladesh?

Research Question 4: Is it really compatible with other sign language detection processes?

1.5 Expected Outcome

There is very little research to detect Bangla sign language because of its rare use case and that's why we chose to work with that. The system will use previous train data to detect

arm movement. After that, it will use that data to predict the sign and will show the percentage of accuracy of the arm gesture.

1.6 Report Layout

This research paper consists of five segments. The first part mainly consists of an introduction and motivation. In the second part, we will discuss similar research, brief discussion, challenge of this program from a technical perspective. In the third part, we will focus on the instruments we are going to use and how we will collect data and statistical analysis. In the fourth part, we are going to show the experimental result, a brief discussion of the methodology we used, and a brief analysis. In the fifth part, I discussed the impact on society and the environment when the proposed system will be implemented. In the final section, I will discuss everything, in short, further study and implications of further research.

CHAPTER 2

BACKGROUND

2.1 Introduction

Deep learning (DP) is an important field of Machine learning (ML) which is essentially a neural network with three or more layers. This neural network attempt to simulate the behavior of the human brain. Object detection is a core part of this field. Bangla sign language detection helps the Bengali deaf minority people. Easily communicate with the general people using real time Bangla sign language detection system. First trained the machine using a pre-captured label image. After completing the training process, the machine will have the detection ability when we will provide the still image or videos then the machine easily detects the object. Only this system is not for deaf people. It also uses the military for its secret mission and other purpose.

Bangla language is the fifth most popular language in the world and is spoken by a population of over 300 million native speakers and 37 million second language speakers. It is the sweetest language in the world. It is said to be the mother language of Bangladesh and the second-language of India. Nevertheless, few researchers have worked on this topic over the past few years because of the lacking of resource and its complexity. Also, have major drawbacks in their methods. Nowadays every researcher's intention is to research the trending topic.

Numerous types of research have been done from different methods or platforms on ASL (American Sign Language) or other Sign Language. They have established different types of approaches to sort out sign language detection problems. Currently, I observe all the approaches in this field and finally, I have worked with real time Bangla sign language system. Caring for the minority deaf people in Bangladesh, this field requires a lot of consideration.

2.2 Related Works

Oishee Bintey Hoque and other group members proposed a method that uses a Convolutional Neural Network based object detection technique to detect the presence of signs in the image region and to recognize their class. For this intention, they used Faster Region-based Convolutional Network approach [1].

In 2018, a group of people collected hand gesture data with the help of different deaf and general volunteers. They made a full dataset that contains 36(6 vowels and 30 consonants) Bangla sign alphabets out of 50 sets. In the final state, they were including 1800-character images of Bangla Sign Language [2]. I have completed my process based on this research paper.

In [3], Rahman, Fatema, and Rokonuzzaman proposed a system that can only detect signs of Bengali numerals from 1 to 10 and used gloves containing dots at each finger position to track the action of signs. They collected the dots and mapped the result of the clustered dots to a predefined chart.

Applying a leap motion controller (LMC) to capture hand gestures and implementing a Convolutional Neural Network (CNN) for detection signs which an approach proposed by Yasir, Prasad, Alsadoon, and Sreedharan [4]. However, their implemented system is not real-time.

Contour analysis is a great approach to computer vision. A Haar-like feature-based cascaded classifier is used to locate the predefined hand posture from the captured image and is bounded by a rectangular box that is initialized as a region of interest (ROI). Aminur, Jasim, Haider, and Hasannuzzaman introduced a contour analysis system for Bangla sign language detection [5]. They got 90.11% accuracy and a computational cost of 26.063 milliseconds per frame.

2.3 Research Summary

Every day we are facing some kind of problem. Research is a methodized way to find solutions of a previous problems or problems that nobody ever has worked on before and it can be tried to solve an old and new problems in an efficient way. My Research is on recognizing Bangla sign language that is related to Deep Learning (DP). There are a few works done on Bangla sign language detection. I have worked with 36(6 vowels and 30 consonants) Bangla sign alphabets. Many researchers have done their work using the previously published dataset but I used my own make dataset which is captured through a computer webcam using the OpenCV library. After got all the images then I used labelimg.py for labeling images. Images labeling is a difficult job for every researcher. Here I have labeled images according to the sign and labeled 720 images. I divided the images into a two-part training set and a test set. 80% of images belong to a training set and 20% of images belong to the test set. For the training purpose, I used MobileNet-v2 which is 53 layers deep. This model is better because of its model size and computation cost. Afterward, I used TensorFlow Object Detection API that can easily recognize the Bangla sign based on the train data and show the accuracy level of the shown Bangla sign.

2.4 Scope of the problem

Object detection is to recognize or locate a telling target from still images and videos. It is one of the finest applications of Machine Learning (ML) and Deep Learning (DP). The target of this field is to teach machines to perceive the content of an image just like humans do. Object detection is a trending field because of we have got the result easily and the accuracy level of the result is pretty good than other fields. Nowadays object detection has been assembling values to the industry as because recognizing target object bases their results on factors that is so inherently humane. In this research, I tried to detect Bangla sign language based on pre-trained images using TensorFlow and detect the accuracy level of the target image.

2.5 Challenges

Some sign is very difficult to take input. The following table 2.5 shows the difficult signs.

Table 2.5: Complex Sign which is difficult to take input

	ক	k
	খ	kh
	প	p
	ছ	ch

Training images on the computer took too much time and heat was generated during processes. External GPU is required for this type of work. There are a lot of images in the dataset. Hence, labeling 720 images is a tenacious job. When trained images, there created checkpoints in the model folder. Three checkpoints are enough for this system. However, I completed six checkpoints that's why it took so much time.

This full process, have a major drawback which is the background interface. When I have opened my computer webcam then there is a clear background required. I preferred to use a white background when creating datasets and detecting signs.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides information about how can be data collected, the data collection procedure. Also provides information about requirements for this system and gives a layout of the research method. Sign language is a very kind topic for minority deaf people. In the developed country, they are working on sign language detection techniques but in Bangladesh, few researchers are working on this topic. The research model is introduced here and the reason behind choosing it. Also introduced the architecture of the chosen model. Lastly, discussed the accomplishment issues and the requirements that were followed in the process.

3.2 Research Subject and Instrumentation

My research subject is real time Bangla sign language system which is detected the sign will show through the webcam and the system detect it and show the accuracy level. Here I mainly worked for deaf people. Converted the Bangla sign letter into English letters and label the sign images using English alphabetic order. I observed that this technique is a very helpful and lite weight for use. There is less code than other techniques that's why it is lite weight.

For this research purpose, I have collected 720 images which is captured using my computer webcam. My work is to detect the Bangla sign using deep learning. For this working purpose, I used the MobileNet-v2 TensorFlow Object Detection model. This is a suitable model for real-time object detection.

3.3 Data Collection and Procedure

Data collection for sign language is very difficult in Bangladesh and all over the world. Because only minority talented people are using sign language for their day-to-day life. Good-quality of images is required for this field and it is very difficult to collect. There are many datasets on the internet related to Bangla sign language. However, I used OpenCV (Open-Source Computer Vision Library) for collecting images. OpenCV is an open-source

computer vision and machine learning library and has more than 2500 revised algorithms. I captured 36 Bangla letters sign and each sign had 20 images. So, I worked with total of 720 images.

```
In [78]: IMAGES_PATH = 'Tensorflow\workspace\images\collectedimages'
```

```
In [79]: IMAGES_PATH = 'Tensorflow\workspace\images\collectedimages'
         labels = ['qq']
         number_imgs = 20
```

```
In [ ]: for label in labels:
            !mkdir {'Tensorflow\workspace\images\collectedimages\\'+label}
            cap = cv2.VideoCapture(0)
            print('Collecting images for {}'.format(label))
            time.sleep(2)
            for imgnum in range(20):
                print('Collecting image {}'.format(imgnum))
                ret, frame = cap.read()
                imgname = os.path.join(IMAGES_PATH,label,label+'.'+'{}.jpg'.format(str(uuid.uuid1())))
                cv2.imwrite(imgname, frame)
                cv2.imshow('frame', frame)
                time.sleep(4)

                if cv2.waitKey(1) & 0xFF == ord('q'):
                    break
            cap.release()
```

```
Collecting images for qq
Collecting image 0
Collecting image 1
Collecting image 2
Collecting image 3
Collecting image 4
Collecting image 5
Collecting image 6
Collecting image 7
Collecting image 8
Collecting image 9
Collecting image 10
```

Figure 3.3: Data Collection Process (Using OpenCV)

3.4 Methodology and Data Analysis

My methodology is to detect the Bangla sign alphabets. At first, I captured all the images then labeled it. Using TensorFlow object detection API updated the labelmap and trained the images. Afterward, Detect the sign by using computer webcam. The following figure 3.4 shows the methodology of my Bangla sign language detection process.
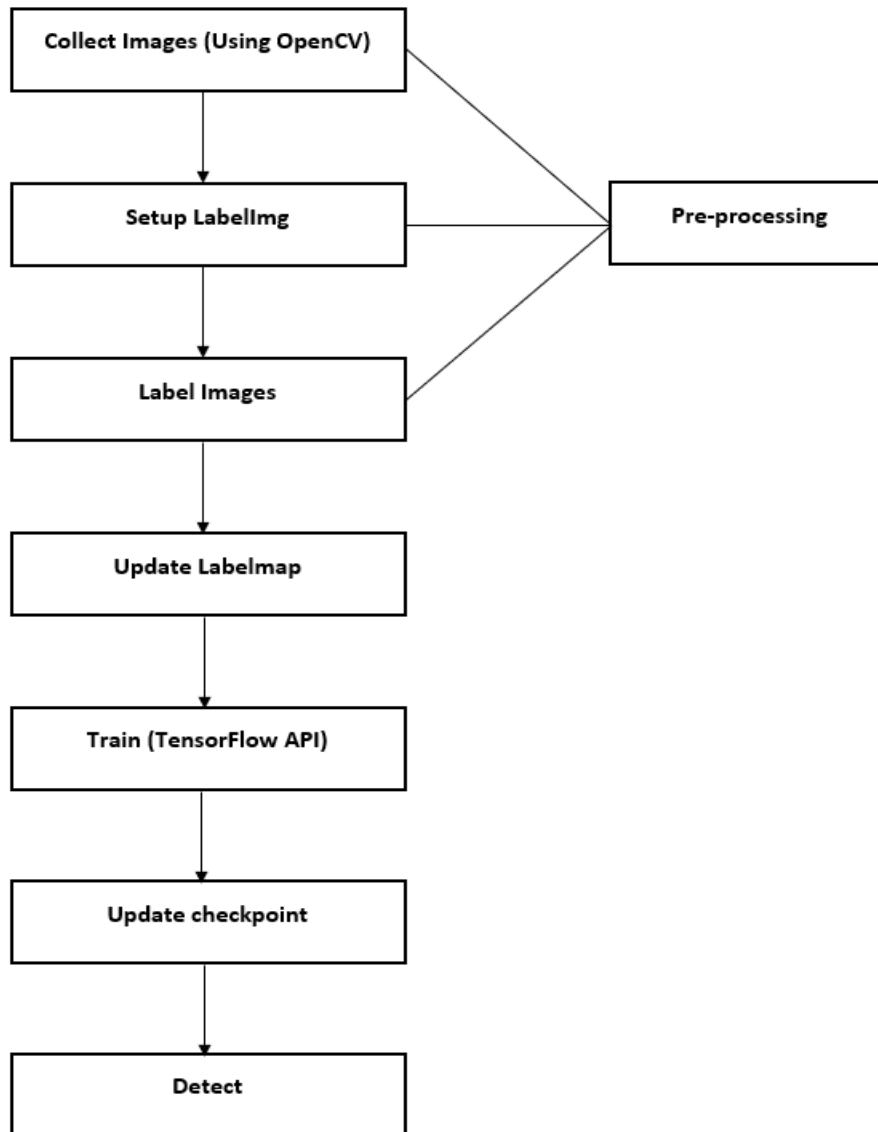

Figure 3.4: Methodology Flowchart

3.4.1 Convert Letter

Firstly, I converted the Bangla 36(6 vowel and 30 consonants) letter into English letter. The following table 3.4.1 shows the converting process.

Table 3.4.1: Convert Bangla Letters into English Letter

Bangla Sign Image	Bangla Letter	English letter
	অ	**o**
	আ	**a**
	ই	**i**
	উ	**u**
	এ	**e**
	ও	**O**
	ক	**k**
	খ	**kh**
	গ	**g**
	ঘ	**gh**
	চ	**c**
	ছ	**ch**

	জ	j
	ঝ	jh
	ট	T
	ঠ	Th
	ড	D
	ঢ	Dh
	ত	t
	থ	th
	দ	d
	ধ	dh
	ন	n
	প	p
	ফ	f
	ব	b
	ভ	v

	ম	m
	য়	y
	র	r
	ল	l
	স	s
	হ	h
	ড়	R
	০ং	ng
	০ঃ	qq

3.4.2 Label Image

Labelimg is now a section of the Label Studio community. The exoteric image annotation tool created by Tzutalin is no longer activity being developed, but you can check out label Studio, the open-source data labeling tool for images, text, hypertext, audio, video, and time-series data. The following figure 3.4.2 shows the data labeling process. In this process everyone got an extra XML file based on the label image.
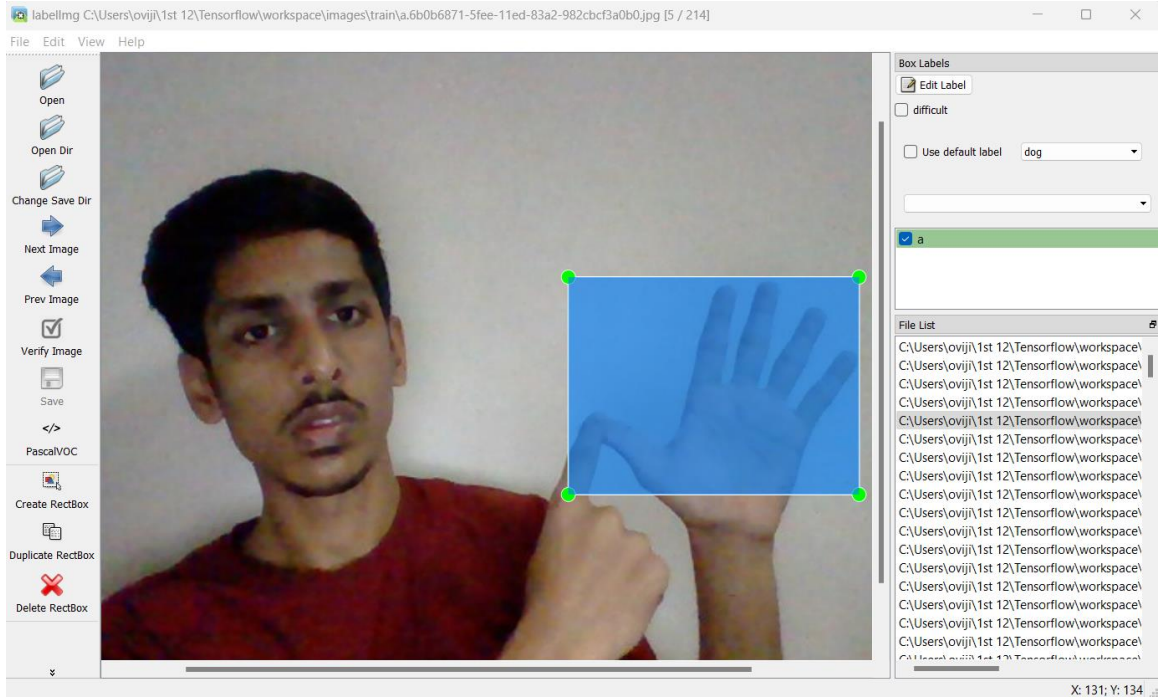
Figure 3.4.2: Data Labeling Process (labelimg.py)

3.4.3 Model Architecture

In this system, I used the MobileNet-v2 model which was 53 layers. The following figure 3.4.3 shows the architecture of the MobileNet-v2 model. MobileNet-v2 is a form of convolutional Neural Network that is much faster as well as a smaller model that makes use of a new kind of convolutional layer known as Depth wise Separable convolution. Because of the small size of the model, these models are considered very useful to be implemented on an embedded system.
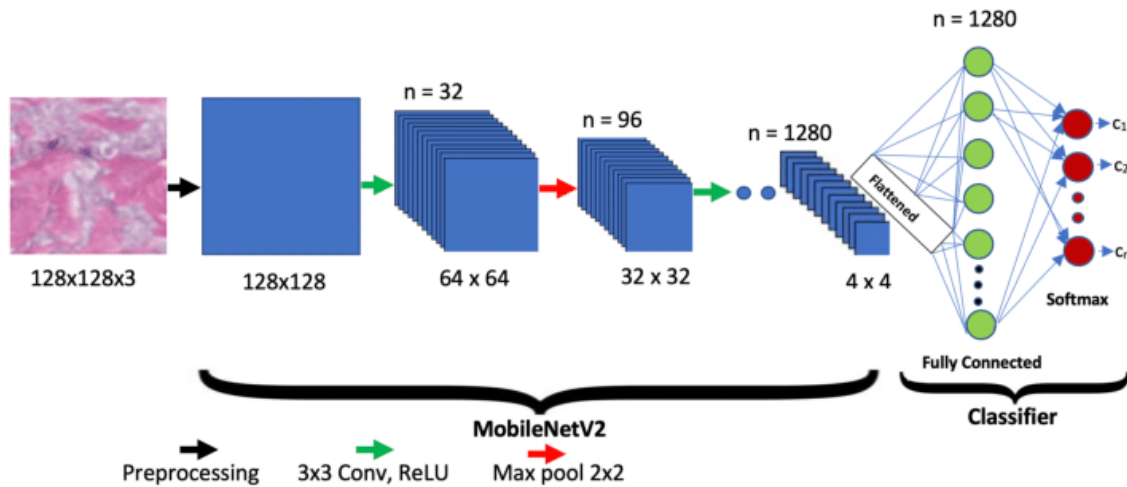
Figure 3.4.3: MobileNet-v2 Architecture

3.5 Statistical Analysis

MobileNet-v2 is better accuracy and less latency than MobileNet-v1.
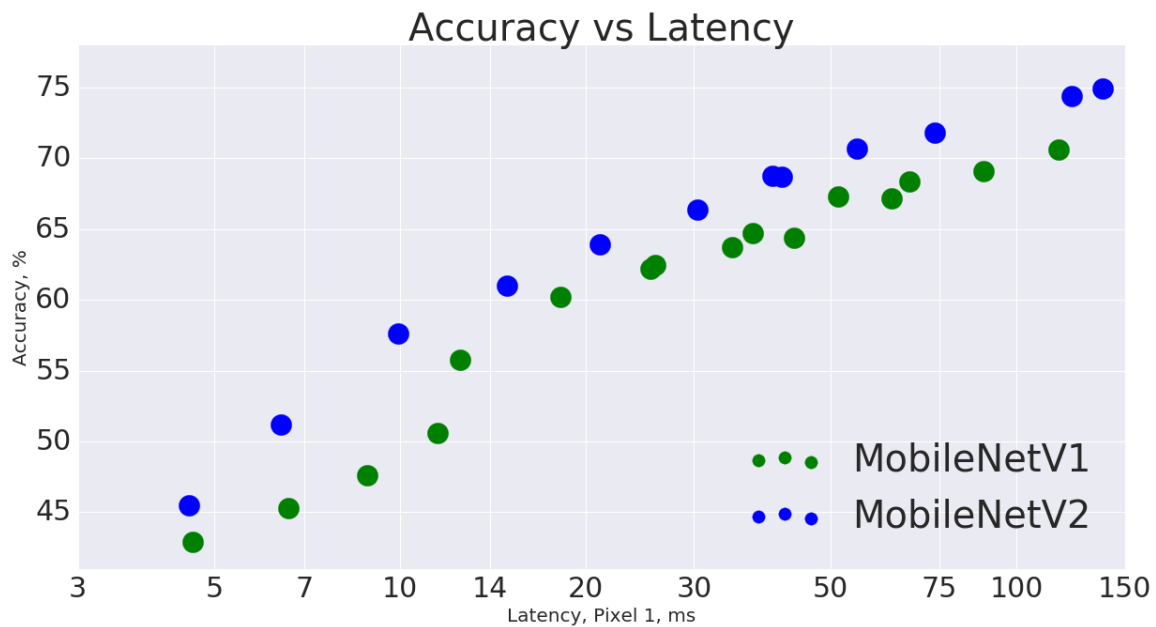
Figure 3.5: Accuracy vs Latency between MobileNet-v2 and MobileNet-v1

3.6 Implementation Requirements

There are a lot of implementation requirements. The dataset was divided into testing and training sets. The training set contains 80 percent and the testing set contains 20 percent of the images. For training, the dataset required an external GPU and I used NVIDIA GeForce MX250. My technique is implemented in TensorFlow-GPU, CUDA 10.1, and Cudnn 10.1. I have used python programming language for implementation where the platform is Jupyter Notebook.

CHAPTER 4

EXPERIMENTAL RESEULT AND ANALYSIS

4.1 Introduction

In this chapter, the research conclusion we have reached is totally preliminary. This section shows the outcome of Bangla sign language in form of a percentage basis. I have captured 720 images using the OpenCV library. After collecting the data from an image, I used mobile net v2 the model to train the data to identify the Bangla sign language and assigned them their value to show the meaning of that sign. After detecting the sign, the program will automatically show the accuracy of that sign in percentage and show the most meaningful result that it matches. After testing the program with multiple data, I have come to the conclusion the result showed by the program is an acceptable level.

4.2 Experimental Analysis

I found individually accuracy for the sign. Then did summation of every sign and the average accuracy level is 90.30 percent.

Table 4.2: Accuracy Prediction

Bangla Letter	English letter	Accuracy
অ	o	69%
আ	a	97%
ই	i	94%
উ	u	93%
এ	e	99%
ও	O	85%

ক	k	88%
খ	kh	89%
গ	g	97%
ঘ	gh	99%
চ	c	90%
ছ	ch	96%
জ	j	88%
ঝ	jh	86%
ট	T	90%
ঠ	Th	92%
ড	D	92%
ঢ	Dh	87%
ত	t	91%
থ	th	97%
দ	d	98%

ধ	dh	95%
ন	n	94%
প	p	94%
ফ	f	95%
ব	b	96%
ভ	v	90%
ম	m	94%
য	y	75%
র	r	90%
ল	l	87%
স	s	87%
হ	h	97%
ড়	R	72%
◌ং	ng	86%
◌ঃ	qq	82%

4.2.1 Experimental Output

Individually, I have detected 36 Bangla signs by using my computer webcam. Here, sign e and gh showed the highest accuracy and o showed the lowest accuracy and the following figure 4.2.1 shows the highest and lowest accuracy.

Figure 4.2.1: Recognized highest and lowest accuracy signs
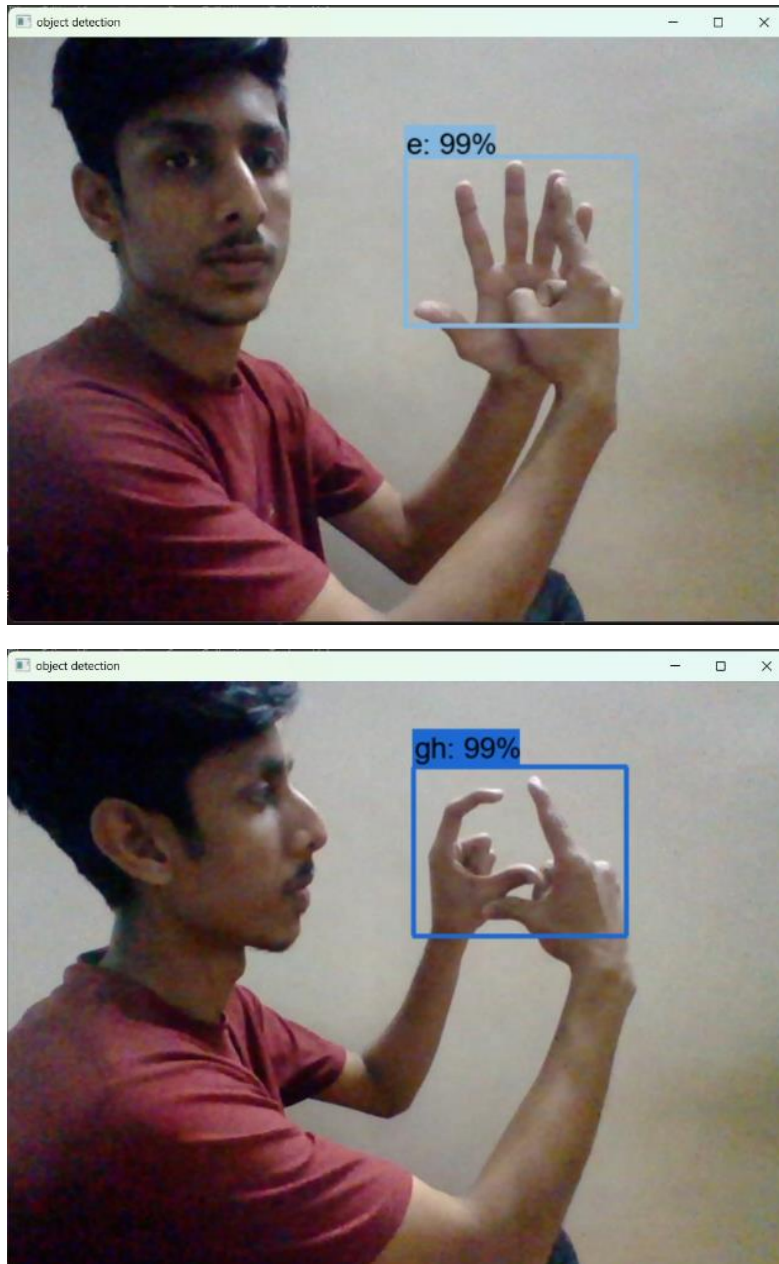
4.3 Summary

In this section visualize the accurate result of research queries. After testing I have come to the conclusion that it identifies 36 Bangla sign language and visualize the accuracy in the percentage of those signs. To develop the system, I chose a deep learning approach that uses CNN rather than a machine learning approach, after testing the system it shows the outcome with 90.30 Percent accuracy. I got the lowest accuracy 69 percent for অ-o and the highest was 99 percent for two signs.

CHAPTER 5

IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY

5.1 Impact on Society

The Bangla sign language detection system will revolutionize the way deaf people communicate with normal people. In this paper, the mode we have proposed shows how to detect the Bangla sign and translate it into sentences using an image detection system. As most of the people who speak Bengali don't know the Bangla sign language and that create difficulties for deaf people to fulfill their daily needs and it became an obstacle to their prosperity in education and business. But using this technology we can easily understand what they are talking about and provide the service they need also it will helpful for them to share their emotion and struggle in their life to normal people and it will help them to be self-sufficient in this community. After considering all this advantage it's clear that after implementing this technology in day-to-day life a part of our community that didn't have the chance to prosper in life because of disability will be a blessing for them. Although deaf people might have been seen as a minority the ability to communicate with people will lead them to do things like business, contribute to scientific research do jobs like normal people. This will not only improve their lives but also create new employment opportunities in the job sector and it will boost the economy of a country. In science, there's lots of work that is not yet solved and we believe once they start to lead a normal life and get proper education, they will contribute in many research fields. To conclude we can say that this technology will not beneficial for them but also beneficial for modern science and society as a whole.

5.2 Impact on Environment

The Bangla sign language recognition system creates a good environment in Bangladesh. Because about 9.6% of the population of Bangladesh is deaf. Deaf people don't get many features for their communication and there are fewer researchers to work with the Bangla sign language detection system. Some researchers have proposed different techniques but their techniques have many drawbacks. My proposed techniques have fewer drawbacks than their techniques. When minority people will use this, they communicate with general

people easily and this system is enough environment friendly. Using this system, the deaf in Bangladesh often do have access to treatment or education and other features. Consequently, this proposed system will create a helpful environment for Bangladeshi minority deaf people.

5.3 Ethical Aspects

In this paper, we have shown how to detect Bangla sign language and show the result with percentages. We did it because after researching the suffering of the deaf that they face in their daily lives is a crisis for humanity in this modern world. Although there is much research on major languages there's little research that has been done to ease the suffering of deaf people in the Bengali community. After observing the difficulties, they are going through in their lives we decided that we will work on a Bangla sign language detection system to help ease their suffering to communicate with normal people. As we all know that communication ability has changed human history and the way we behave and helped the way to build this modern world. Because of that, we should give a life-time opportunity to deaf people to bring their life back in this normal world and we believe once they start to live in this world normally, they will contribute to every aspect of modern science and society beyond our imagination.

5.4 Sustainability Plan

Sustainability refers to meeting our own needs without compromising the ability of future generations to meet their own needs. In this part, trying to find concern for social equity and economic development. In the modern world, everyone gets many necessary features to their day-to-day life but minority people who don't get the opportunity to communicate with others. Therefore, my system is a necessity for this type of minority people and also a necessity for others who intend to use this. Therefore, the proposed system will improve our economic system.

CHAPTER 6

SUMMARY, CONCULATION, RECOMMENDATION, IMPLICATION FOR FUTURE STUDY

6.1 Summary of the Study

I mainly experimented to help the helpless peoples who are deaf and also help those who will try to communicate silently using Bangla sign language. In this research paper, I worked on detecting real time Bangla sign language. I created the dataset myself using the OpenCV library and used my own computer webcam to collect the required sign images. After collecting all the images, I labeled images based on the sign. According to the labeled image updated the label map and trained by MobileNet-v2-based model. In the coding section, I have used TensorFlow Object Detect API. Using my computer webcam easily detect the sign and provided the accuracy level of the sign.

6.2 Conclusion

During the past decade, Bangla sign language recognition is an incriminating topic in Machine Learning. Here, I have developed a system that would recognize 36 Bangla sign letters. Images of different signs from the created dataset were trained by a MobileNet-v2-based model to resolve the problem of detecting Bangla sign language. I got an average accuracy rate of 90.30 Percent.

6.3 Recommendation

If anyone wants to use the system I suggest, will need a good configuration computer system and at least 2GB external GPU. Here you will only detect 36 Bangla sign alphabets. In case, you try to detect other signs or use the wrong sign then the system can't detect it. The proposed system has some drawbacks like if the sign is not similar to the trained image, then the accuracy level of the detection image will show very low. The clear background is required for this type of system and try to use the same color background like green, white, blue, etc.

6.4 Implication for Further Study

In this current era demand for computer vision is on top of technological advancement to make our daily life easier. In order to solve various problems from a large amount of visual data in a fast and reliable way scientists now use computer vision. This technology is used for formatting visual data in different sections using a detection algorithm and also it can used for processing the live visual data in a fraction of a second to assist humans in take decisions in crisis's or to prevent activities that can be harmful for the world. Machine learning and deep learning is one of the main two ways to solve complex visual data using computer vision. The preliminary study in which I have worked on sign language detection that brings out an adequate result will leave a strong impact on similar research. Research has been carried out that shows that the Bangla sign language detection system has a significant impact on deaf people's daily life in Bangladesh and some parts of India.

6.5 Future Work

Sign language may not seem important to a normal people but it is the only way to communicate with people for deaf people and advance military operations where it is only useful way to communicate. However, most people do not have the interest to understand sign language or the capacity to understand sign language because of its complexity. However, the system we will develop will automatically detect the clients' sign language and will deliver the output on the screen in form of sentences that will be easily understandable by a normal people and this will revolutionize the way deaf people communicate with a normal people.

The program we will develop is not going to serve only one purpose which is to detect Bangla sign language. In addition, to detecting Bangla sign language, the program can be trained easily to detect any sign language in the world and it can also use to detect other sign languages that was used for military purposes or any other scientific exploration.

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