A

PROJECT REPORT ON

SIGN LANGUAGE CONVERSION FOR TINY-TOTS

SUBMITTED TO SAVITRIBAI PHULE PUNE UNIVERSITY
FOR PARTIAL FULFILLMENT
OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

BACHELOR OF ENGINEERING
In
Electronics and Telecommunication Engineering

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2018-19

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CERTIFICATE

This is to certify that the Project Report entitled

SIGN LANGUAGE CONVERSION FOR TINY-TOTS

has been successfully completed by

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Ashwini More B150053167

Is a bona fide work carried out by them under the guidance of Dr. Sreemathy and it is approved for the partial fulfillment of the requirement of the Savitribai Phule Pune University, Pune for the award of the degree of the Bachelor of Engineering (Electronics and Telecommunication Engineering). This project work has not been earlier submitted to any other Institute or University for the award of any degree or diploma.

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Place: Pune
Date : 26th March,2019

ACKNOWLEDGEMENTS

We would like to express our sincere gratitude towards Dr.R.Sreemathy, Mr.Akshay Velapure of Electronics and Telecommunications Department and all our friends and colleagues for their support and assistance in the course of the project.

We would like to specially thank our guide Dr.Sreemathy for her invaluable support and guidance provided throughout the project. We consider ourselves very fortunate to have worked under her supervision and guidance.We would also like to thank our Principal Dr. P.T Kulkarni, HOD Y. Ravinder,our project coordinator Jaiswal Sir and Laxmikant Gavhane for their support.

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ABSTRACT

Communication means to share thoughts, messages, knowledge or any information. Ordinary people communicate their thoughts through speech to others, whereas the hearing impaired community the means of communication is the use of sign language.

Computer recognition of sign language is an important research problem for enabling communication with hearing impaired people. This project introduces an efficient and fast algorithm for identification of the number of fingers opened in a gesture representing an alphabet of the Sign Language. The system does not require the hand to be perfectly aligned to the camera. The project uses image processing system to identify, especially English alphabetic sign language used by the deaf people to communicate. The basic objective of this project is to develop a computer based intelligent system that will enable dumb people significantly to communicate with all other people using their natural hand gestures. The idea consisted of designing and building up an intelligent system using image processing, machine learning and artificial intelligence concepts to take visual inputs of sign language's hand gestures and generate easily recognizable form of outputs. Hence the objective of this project is to develop an intelligent system which can act as a translator between the sign language and the spoken language dynamically and can make the communication between people with hearing impairment and normal people both effective and efficient. This system will be the one of efficient tool for the hearing impaired children. These children can be taught the basic English grammar concept through the designed module.

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CHAPTER 1

Introduction

1.1 Background

Dumb people are usually deprived of normal communication with other people in the society. It has been observed that they find it really difficult at times to interact with normal people with their gestures, as only a very few of those are recognized by most people. Since people with hearing impairment or deaf people cannot talk like normal people so they have to depend on some sort of visual communication in most of the time. Sign Language is the primary means of communication in the deaf and dumb community. Around 500,000 to 2,000,000 speech and hearing impaired people express their thought through Sign Language in their daily communication. These numbers may diverge from other sources but it is most popular as mentioned that the ASL is the 3rd most-used sign language in the world.

As like any other language it has also got grammar and vocabulary but uses visual modality for exchanging information. The problem arises when dumb or deaf people try to express themselves to other people with the help of these sign language grammars. This is because normal people are usually unaware of these grammars. As a result it has been seen that communication of a dumb person are only limited within his/her family or the deaf community. The importance of sign language is emphasized by the growing public approval and funds for international project. At this age of Technology the demand for a computer based system is highly demanding for the dumb community. However, researchers have been attacking the problem for quite some time now and the results are showing some promise. Interesting technologies are being developed for speech recognition but no real commercial product for sign recognition is actually there in the current market. The idea is to make computers to understand human language and develop a user friendly human computer interfaces (HCI). Making a computer understand speech, facial expressions and human gestures are some steps towards it. Gestures are the non-verbally exchanged information. A person can perform innumerable gestures at a time. Since human gestures are perceived through vision, it is a subject of great interest for computer vision researchers. The project aims to determine human gestures by creating an HCI. Coding of these gestures into machine language demands a complex programming algorithm.

1.2 Relevance

The project topic includes the digital image processing concepts such as color segmentation, thresholding etc. It also includes the Artificial Intelligence using machine learning algorithms. These are the key concepts of the subjects such as digital image processing and Artificial intelligence which are the part of Electronics and Telecommunication field.

1.3 Literature Survey

There has already been a great deal of work done both in the area of text to- sign language conversion [7-9]. The area of sign language-to-text is less mature, although there have been some recent breakthroughs incorporating data gloves for positional extraction. We are attempting to bridge cultural barriers, with technology as a medium. The incorporation of image processing applied to this challenge is in itself, unique; however, incorporating new breakthroughs in feature extraction promises to further enhance the research and development potential. With our goal being a useful, practical, affordable device operating
in real time, the implementation of these new ideas in feature extraction will result in data reduction, and decrease the signal processing requirements of the system.

- **[1] PAPER- 1**

The students of The ECTAT department of the Rochester institute of Technology, New York has published paper regarding a project for developing a module for translation of American sign language(ASL) into digital audio or text.

Approach of the project:

First milestone is to establish a standardized set of minimal physical measurement criteria for ASL finger-spelling and signing as related to image sampling. Secondly establish a process for capturing measurements that can be generalized for a statistical range of subjects.

Next our unique data processing techniques and correlate this data to our adaptive learning database in order to discriminate letters, words, and eventually, phrases is established. At each milestone there are definable and measurable figures of merit that will determine the state of the research.

The following section describes the components of the proposed Sign2 Conversion System. A typical embodiment of the Sign2 system is a stereo imaging device connected to a storage system that leads to a video/image processor, as shown in figure (1.1)The use of a stereo imaging system is important for phase two and beyond, when depth perception is more important.

Figure (1.2) is a block diagram of the system. Current processing scheme involves the post processing of video captured by the imaging system. Ultimately real-time processing of input video for on-the-spot determination of letters and words is envied.

Then the input subject image is compared to the statistical database. The set of images in the database that correspond to a given letter and has the lowest cumulative error, reveals the highest probability of the correct letter being returned.

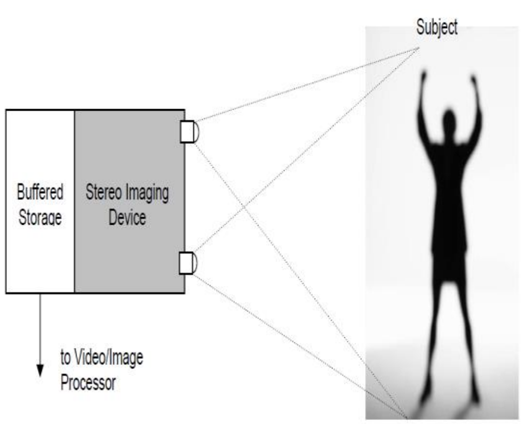


Fig 1.1 Imaging System Illustration

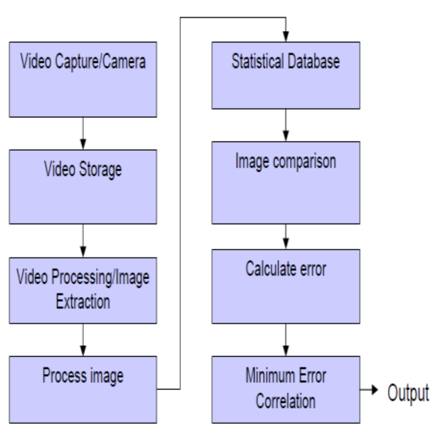


Fig 1.2 System block diagram

Conclusion : The paper set a goal of establishing a firm foundation of research in this important area as a platform for a larger body of work carried out in conjunction with other researchers and institutions.

- **[2] PAPER-2**

The students of IQRA University has designed an application based on MATLAB to recognise hand gesture .

Approach of the research work:

This research work focuses on the problem of gesture recognition in real time that sign language used by the community of deaf people. Research problem identified is based on Digital Image Processing using Color Segmentation, Skin Detection, Image Segmentation, Image Filtering, and Template Matching techniques. This system recognizes gestures of ASL including the alphabet and a subset of its words.

The main goal of this research paper is to demonstrate that how a good performance can be achieved without using any special hardware equipment, so that such a system can be implemented and easily used in real life.

Proposed methodology:

The idea behind this method is that the software run in a mobile handset having a frontal camera while a disabled person (who is in the front of the mobile handset) makes the signs. This software recognizes these gestures of ASL, including letters and a subset of its words and produces text message for corresponding word or letter for normal people to understand.

In this sign language interpreter system, mobile frontal camera is the input device for observing the information of hands or fingers of the user and then these inputs presents to the system to produce the text message for normal people to understand the gestures. The development of such a visual gesture recognition system is not an easy task. There are a numerous environmental concerns and issues are associated with this Sign Language Interpreter System from real world. Such as visibility, this is the key issue in the performance of such system, since it determines the quality of the input images and hence affects the performance.

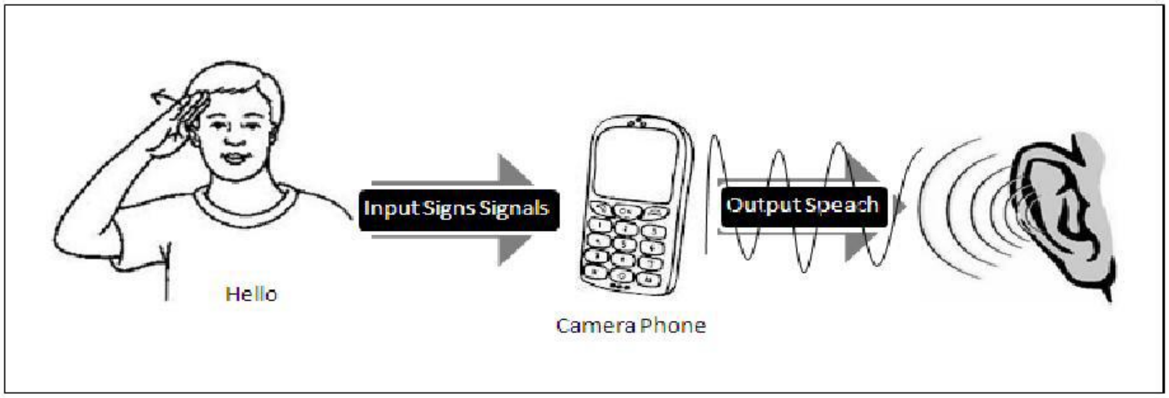


Fig 1.3 Sign language Interpreter

Conclusion:

The statistic of result of the implementation, it is therefore, concluded that the method is used for template matching and colour segmentation work with high accuracy with hand gesture recognition. The results obtained are applicable, and can be implemented in a mobile device smart phone having frontal camera. However, only issue was found for alphabets involve motion like J and Z, which are recommended to be handled through multiple secondary templates.

- **[3] PAPER-3**

Students of Machine vision lab CSIR-CEERI Pilani has implemented android based portable hand recognition system. Computer Vision based techniques were used for image analysis and PCA was used after image tokenizer for recognition. This method was tested with webcam results to make system more robust.

Proposed Methodology:

In this project, an application for the disable people has been discussed which has been developed on Android device. Android device brings the long-expected technology to interact with graphical interfaces to the masses. Android device captures the user's movements without the need of a controller. The basic block diagram of a hand gesture recognition system is given in Figure 1.4. The video sequences captured by an android camera are processed to make it suitable for extracting useful information about user. In this work, a real time object selection and recognition method is proposed for the application for disabled people.

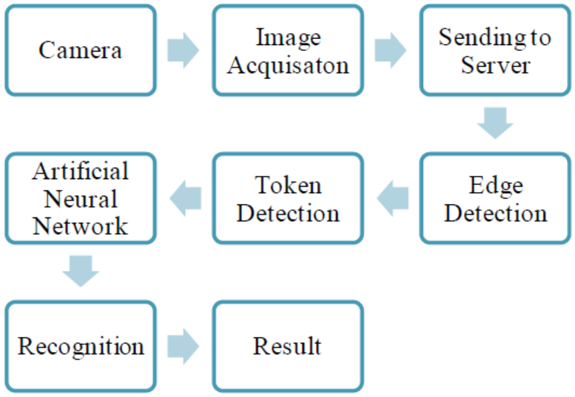


Fig 1.4 Proposed Method

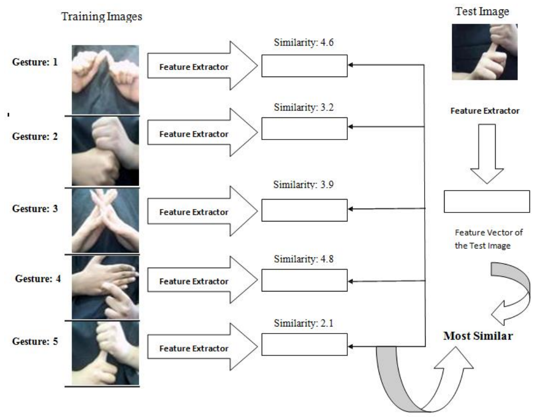


Fig 1.5 Recognition process

Conclusion:

This chapter discuss a hand sign recogntion system which would be deployed on an Android device. The system is developed and tested successfully with webcam and an android device. This system is useful for a deaf and dumb person carrying an android device or a system connected with webcam. All gestures have recognition rate in between 70-100% which is an acceptable range. Overall accuracy of this system is 90% (approximate) while 77% with Android.

The performance of the algorithm used for detecting sign gestures can be severely decreased due to varying lighting conditions and noises in the background. In future, a custom camera instead of the IpWebCam app which will further enhance the success rate of the system. Other different type of gestures can also be made part of the database.

- **[4] PAPER-4**

Computer recognition of sign language is an important research problem for enabling communication with hearing impaired people. This project introduces an efficient and fast algorithm for identification of the number of fingers opened in a gesture representing an alphabet of the Binary Sign Language.

Proposed method:

Fig 1.6 shows the overall idea of proposed system. The system consists of 4 modules. Image is captured through the webcam. The camera is mounted on top of system facing towards the wall with neutral background. Firstly, the captured Colored image is converted into the gray scale image which intern converted into the binary form. Coordinates of captured image is calculated with respect to X and Y coordinates. The calculated coordinates are then stored into the database in the form of template. The templates of newly created coordinates are compared with the existing one. If comparison leads to success then the same will be converted into audio and textual form. The system works in two different mode i.e. training mode and operational mode. Training mode is part of machine learning where we are training our system to accomplish the task for which it is implemented i.e. Alphabet Recognition.

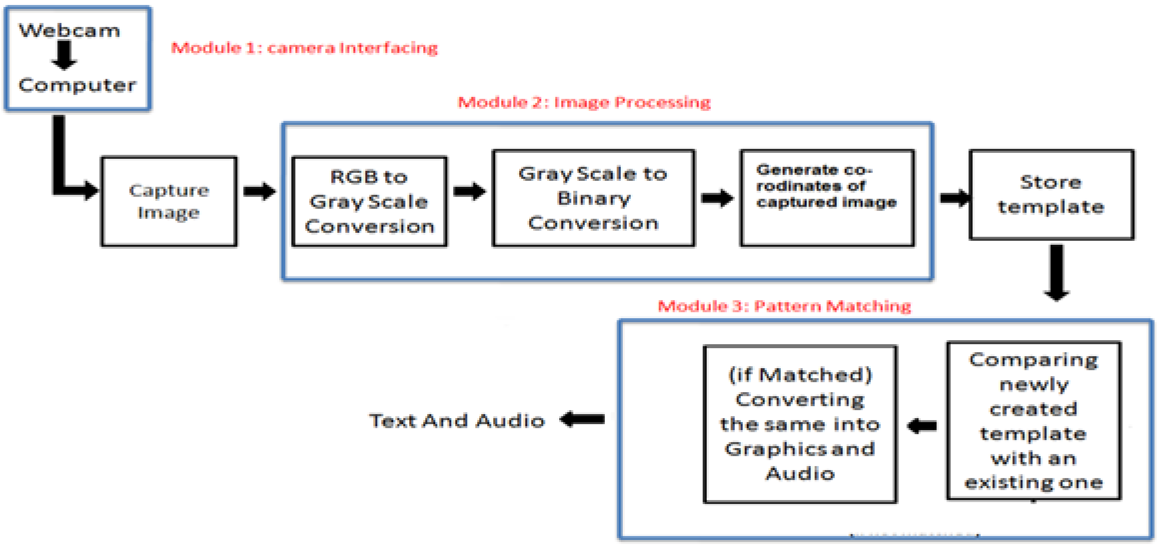


Fig 1.6 System Architecture Diagram

<u>Conclusion:</u>

This project aims to bridge the gap by introducing an inexpensive computer in the communication path so that the sign language can be automatically captured, recognized and translated to speech for the benefit of blind people. In the other direction, speech must be analyzed and converted to either sign or textual display on the screen for the benefit of the hearing impaired.

1.4 Motivation

The main motivation behind this project is to improve the lives of mute and deaf people. These children find it difficult to express themselves and learn different things. In-order to make it easy for them we are going to develop a module, wherein these children can learn English-grammar easily .Also, these students can learn effectively through hand gestures, hence we are going to develop the module which is developed through hand gestures. Hence in order to make communication easy for these children we are going to develop the module .The other main motivation behind this project is, the current educative modules which are there contain a very small dataset and hence the accuracy is also very low. We attempt to make a comparatively large dataset and hence improve the accuracy. The currently used modules are not that interactive and hence we make an attempt to improve its interactivity and make it more user-friendly. Hence the main motive behind this project is to provide a good and interactive medium of communication for deaf and mute children.

1.5 Problem Definition

- To improve the lives of deaf and mute children by making communication easy for them.
- To design and develop the learning module for the deaf and dumb children through digital image processing and machine learning algorithms.

1.6 Scope and Objectives

- Scope of the project is designing and implementing Graphical User Interface for the deaf and dumb children and use this GUI for teaching basic English grammar concept.

  Objectives:
- Real time scanning of Sign language inputs and recognizing it intelligently.
- Using recognized image designing the learning module which includes concepts such as Match the pair and Rhyming words.
- Design of Graphical User Interface for the same.

1.7 Technical Approach

- Use of the Digital Image processing concepts such as color segmentation thresholding for skin detection.
- Use of digital filtering concepts to remove noise and unwanted part.
- Use of machine learning algorithms for accurate recognition of input.
- Designing Graphical User Interface(GUI) using Java/Python to display the result.

CHAPTER 2

Image processing and training of Database

2.1 Introduction

The first step towards creation of Sign language Database is acquisition of Image and its preprocessing. The Camera Interface block is the hardware block that interfaces and provides a standard output that can be used for subsequent image processing. To satisfy and reduce the computational effort needed for the processing, pre-processing of the image taken from the camera is highly important. Apart from that, numerous factors such as lights, environment, background of the image, hand and body position and orientation of the signer, parameters and focus the of camera impact the result dramatically

2.2 Model Workflow

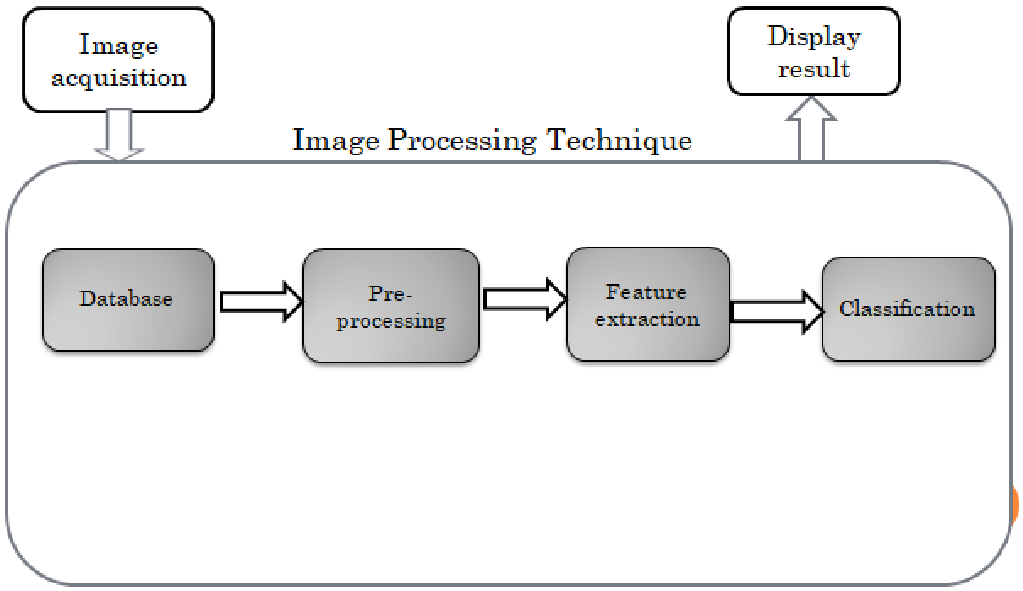
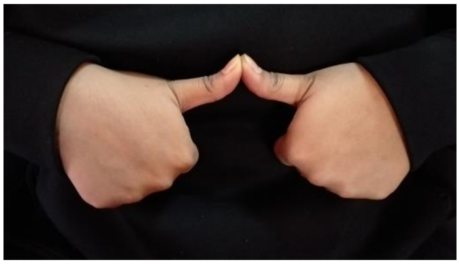


Fig. 2.1 Modelflow

2.3 Implementation part 1: Creation of Database

Our first task was to create database. We gathered the images of A-Z with different backgrounds and different combinations of the alphabets. The background, different angles ,light factor were taken into consideration.The images were blur, rotated, flipped. Such 6000 images were collected for training and validation.

A.

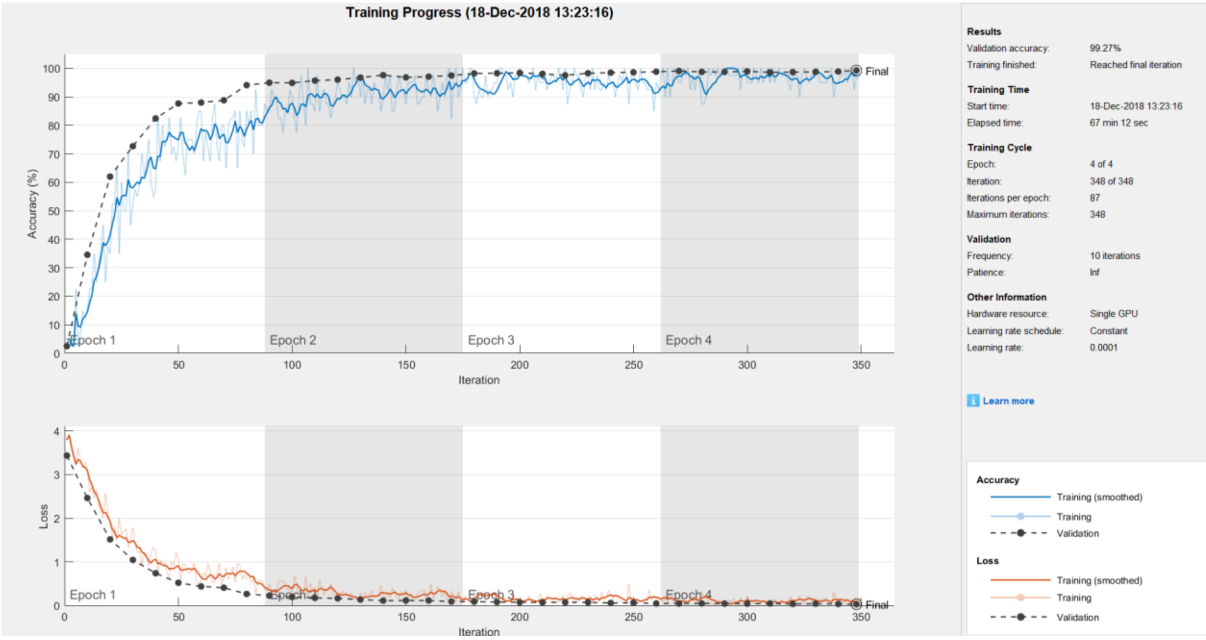


B.

2.4 Implementation part 2: Development of algorithm and code

With the help of Matlab 2018 Neural Network Toolbox we understood the needful functions and developed the algorithm. We constructed the Matlab code accordingly for training and validation of database. We developed the code using Neural Network Toolbox and the various sources available on the Internet. The final algorithm developed is used for the training and validation using Alex-net,Vgg16.

Training and Validation using Alex-net:



Introduction to Alexnet:

- **Transfer Learning Using AlexNet:**

AlexNet has been trained on over a million images and can classify images into 1000 object categories (such as keyboard, coffee mug, pencil, and many animals). The network has learned rich feature representations for a wide range of images. The network takes an image as input and outputs a label for the object in the image together with the probabilities for each of the object categories.

Transfer learning is commonly used in deep learning applications. You can take a pretrained network and use it as a starting point to learn a new task. Fine-tuning a network with transfer learning is usually much faster and easier than training a network with randomly initialized weights from scratch. You can quickly transfer learned features to a new task using a smaller number of training images.

- **Load Data:**

Unzip and load the new images as an image datastore. `imageDatastore` automatically labels the images based on folder names and stores the data as an`ImageDatastore` object. An image datastore enables you to store large image data, including data that does not fit in memory, and efficiently read batches of images during training of a convolutional neural network.

Divide the data into training and validation data sets. Use 70% of the images for training and 30% for validation. `splitEachLabel` splits the `images` datastore into two new datastores.

- **Load Pretrained Network:**

Load the pretrained AlexNet neural network. If Deep Learning Toolbox™ Model *for AlexNet Network* is not installed, then the software provides a download link. AlexNet is trained on more than one million images and can classify images into 1000 object categories, such as keyboard, mouse, pencil, and many animals. As a result, the model has learned rich feature representations for a wide range of images.

```
net = alexnet;
```

Use `analyzeNetwork` to display an interactive visualization of the network architecture and detailed information about the network layers.

```
analyzeNetwork(net)
```

The first layer, the image input layer, requires input images of size 227-by-227-by-3, where 3 is the number of color channels.

- **Replace Final Layers:**

The last three layers of the pretrained network `net` are configured for 1000 classes. These three layers must be fine-tuned for the new classification problem. Extract all layers, except the last three, from the pretrained network.

```
layersTransfer = net.Layers(1:end-3);
```

Transfer the layers to the new classification task by replacing the last three layers with a fully connected layer, a softmax layer, and a classification output layer. Specify the options of the new fully connected layer according to the new data. Set the fully connected layer to have the same size as the number of classes in the new data. To learn faster in the new layers than in the transferred layers, increase the `WeightLearnRateFactor` and `BiasLearnRateFactor` values of the fully connected layer.

- **Train Network:**

The network requires input images of size 227-by-227-by-3, but the images in the image datastores have different sizes. Use an augmented image datastore to automatically resize the training images. Specify additional augmentation operations to perform on the training images: randomly flip the training images along the vertical axis, and randomly translate them up to 30 pixels horizontally and vertically. Data augmentation helps prevent the network from overfitting and memorizing the exact details of the training images.

```
pixelRange = [-30 30];
imageAugmenter = imageDataAugmenter( ...
    'RandXReflection',true, ...
    'RandXTranslation',pixelRange, ...
    'RandYTranslation',pixelRange);
augimdsTrain = augmentedImageDatastore(inputSize(1:2),imdsTrain, ...
    'DataAugmentation',imageAugmenter);
```

To automatically resize the validation images without performing further data augmentation, use an augmented image datastore without specifying any additional preprocessing operations.

```
augimdsValidation = augmentedImageDatastore(inputSize(1:2),imdsValidation);
```

Specify the training options. For transfer learning, keep the features from the early layers of the pretrained network (the transferred layer weights). To slow down learning in the transferred layers, set the initial learning rate to a small value. In the previous step, you increased the learning rate factors for the fully connected layer to speed up learning in the new final layers. This combination of learning rate settings results in fast learning only in the new layers and slower learning in the other layers. When performing transfer learning, you do not need to train for as many epochs. An epoch is a full training cycle on the entire training data set. Specify the mini-batch size and validation data. The software validates the network every `ValidationFrequency` iterations during training.

Train the network that consists of the transferred and new layers. By default, `trainNetwork` uses a GPU if one is available (requires Parallel Computing Toolbox™ and a CUDA® enabled GPU with compute capability 3.0 or higher). Otherwise, it uses a CPU. You can also specify the execution environment by using the `'ExecutionEnvironment'` name-value pair argument of `trainingOptions`.

netTransfer = trainNetwork(augimdsTrain,layers,options);

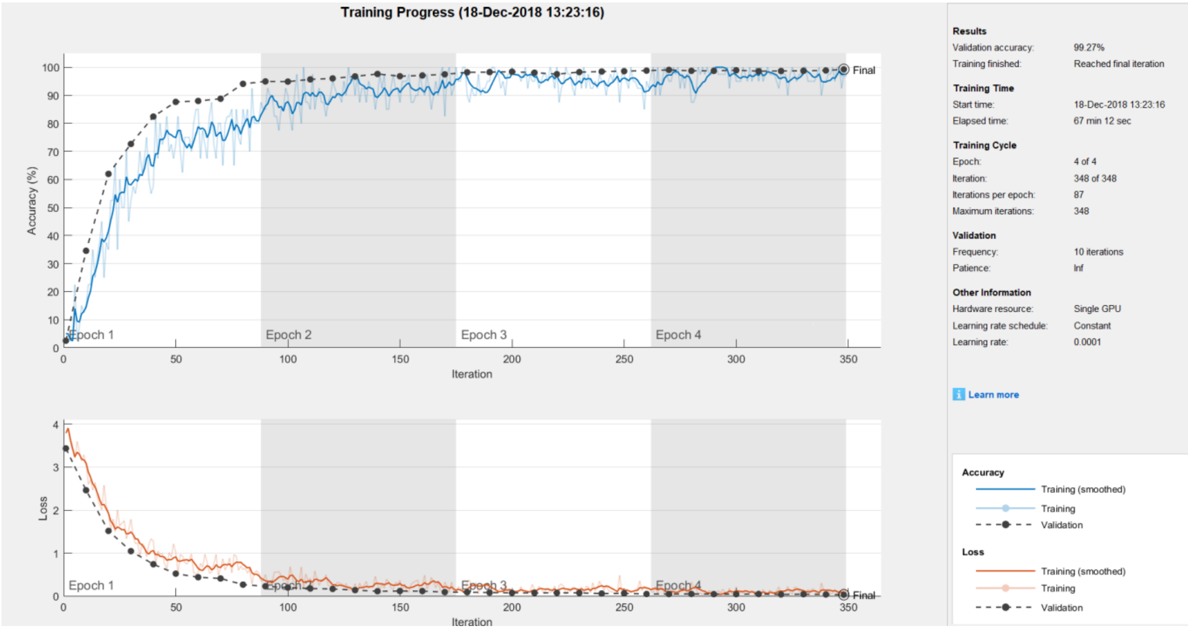
- **Classify Validation Images:**

Classify the validation images using the fine-tuned network.

Calculate the classification accuracy on the validation set. Accuracy is the fraction of labels that the network predicts correctly.

YValidation = imdsValidation.Labels;
accuracy = mean(YPred == YValidation)
accuracy = 1
This trained network has high accuracy.

Training and Validation using Vgg16:



<u>Introduction to vgg16:</u>

- **Pretrained VGG-16 convolutional neural network:**

VGG-16 is a convolutional neural network that is trained on more than a million images from the ImageNet database [1]. The network is 16 layers deep and can classify images into 1000 object categories, such as keyboard, mouse, pencil, and many animals. As a result, the network has learned rich feature representations for a wide range of images. The network has an image input size of 224-by-224. For more pretrained networks in MATLAB®, see Pretrained Convolutional Neural Networks.

You can use classify to classify new images using the VGG-16 network. Follow the steps of Classify Image Using GoogLeNet and replace GoogLeNet with VGG-16.

- **Syntax:**

net = vgg16

- **Description:**

net = vgg16 returns a pretrained VGG-16 network.

2.5 Implementation part 3: Training of database

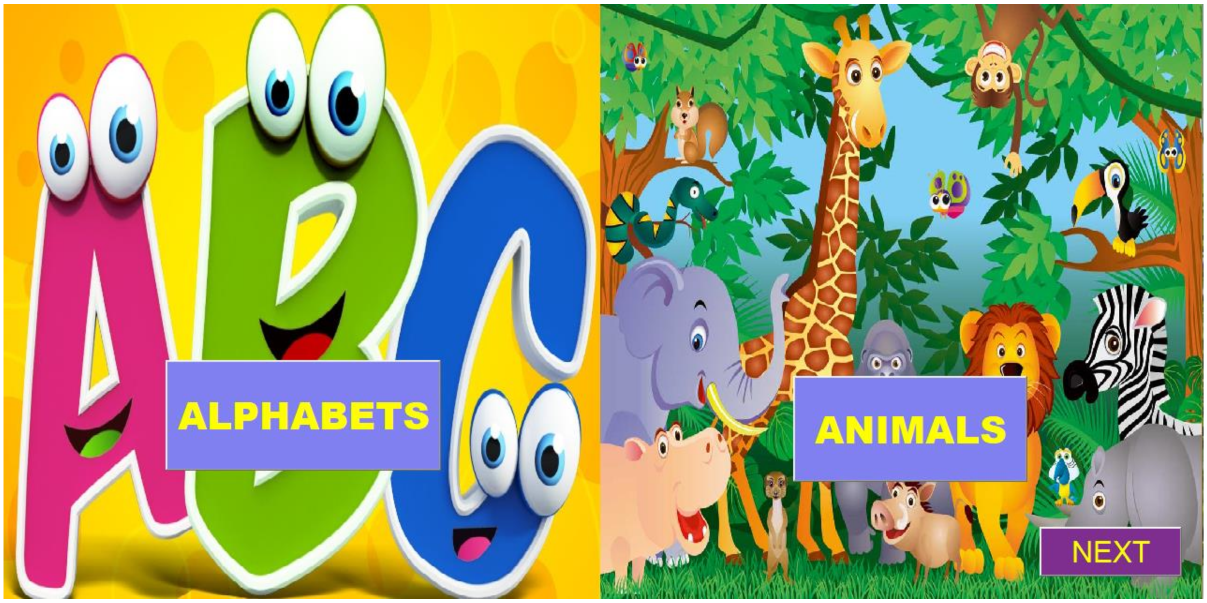
Our database consists of 6000 images of A–Z with different backgrounds and versions of the alphabets. Hence we decided to train small modules of database first in order to increase the accuracy of image detection. In the first stage of our project we have our database from A-M with different accuracies. Later we trained our database with Alex-net,Vgg16.

2.6 Implementation part 4: Graphical User Interface

Opening page of GUI:

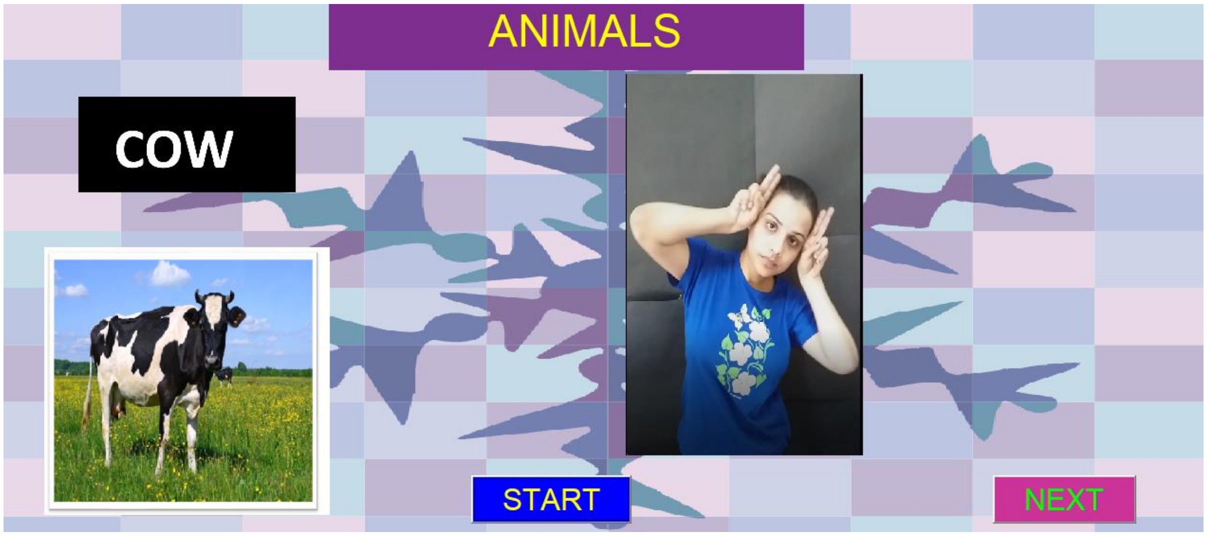
Menu page of GUI:

Teaching module-1:



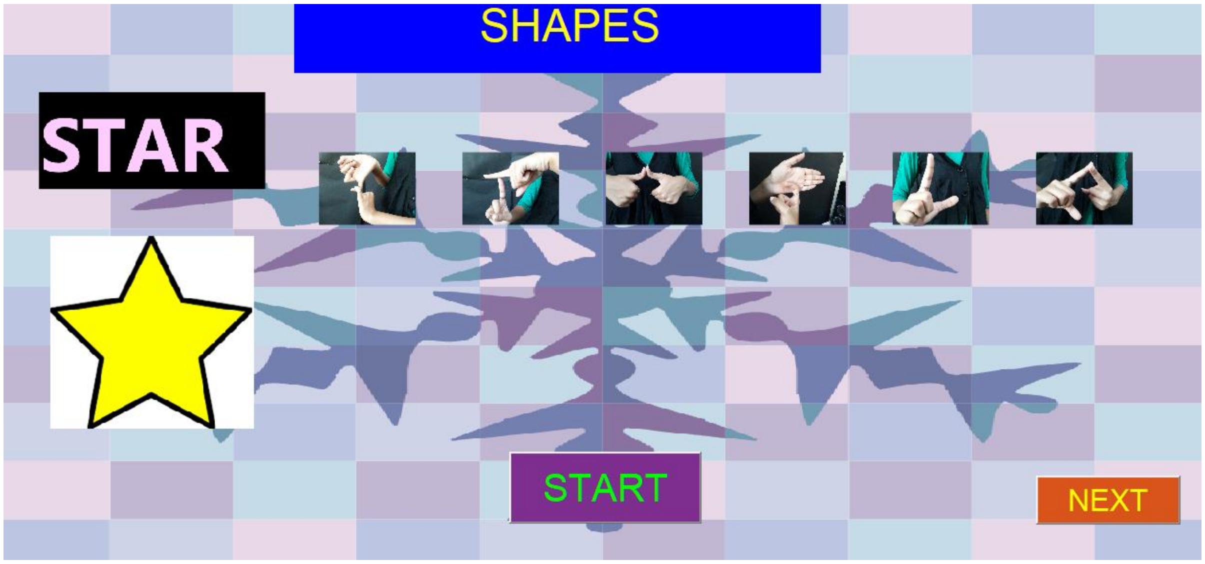
Teaching module-2:

Teaching module for Animals:

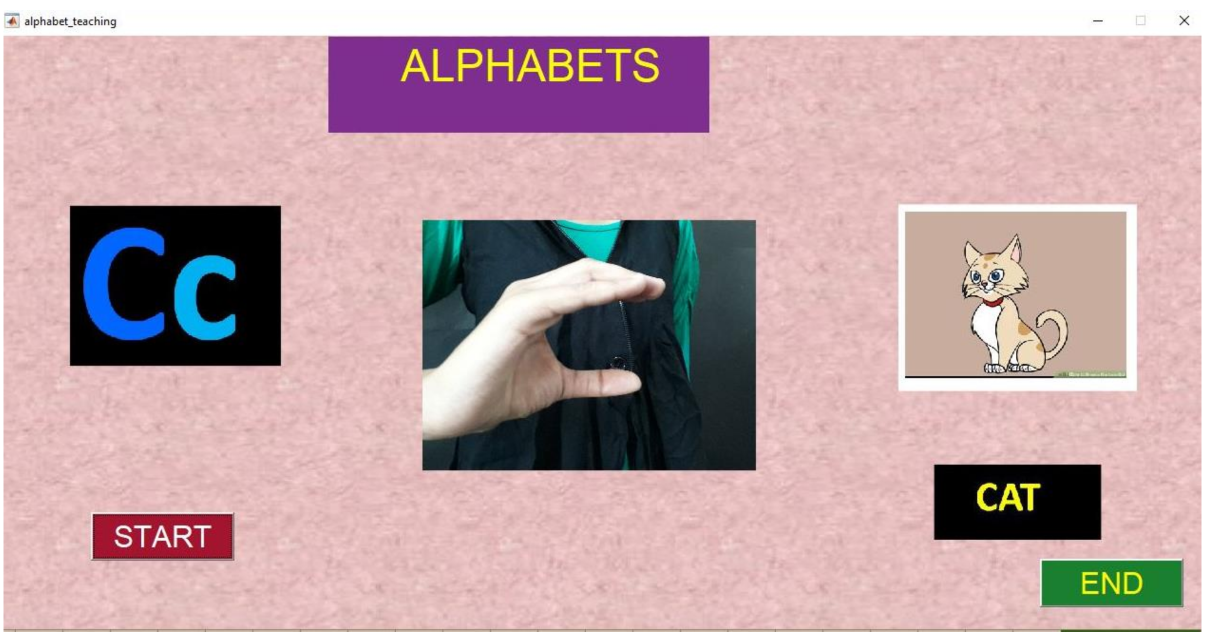


Teaching module for Fruits:

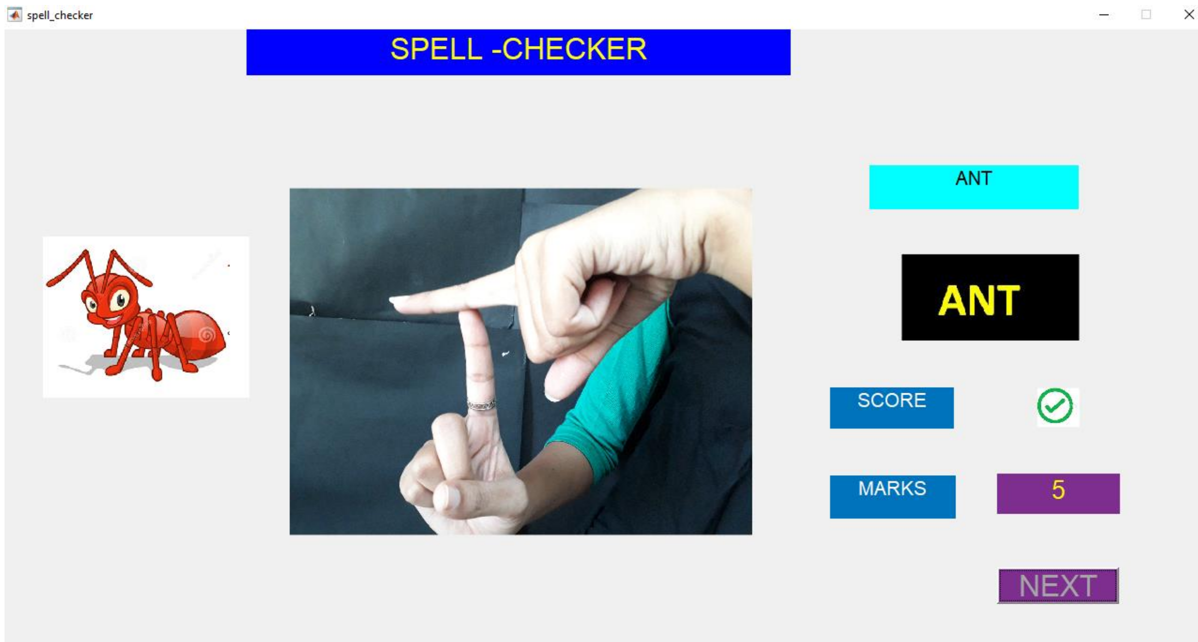
Teaching module for Shapes:



Teaching module for Alphabet:



Assessement module:



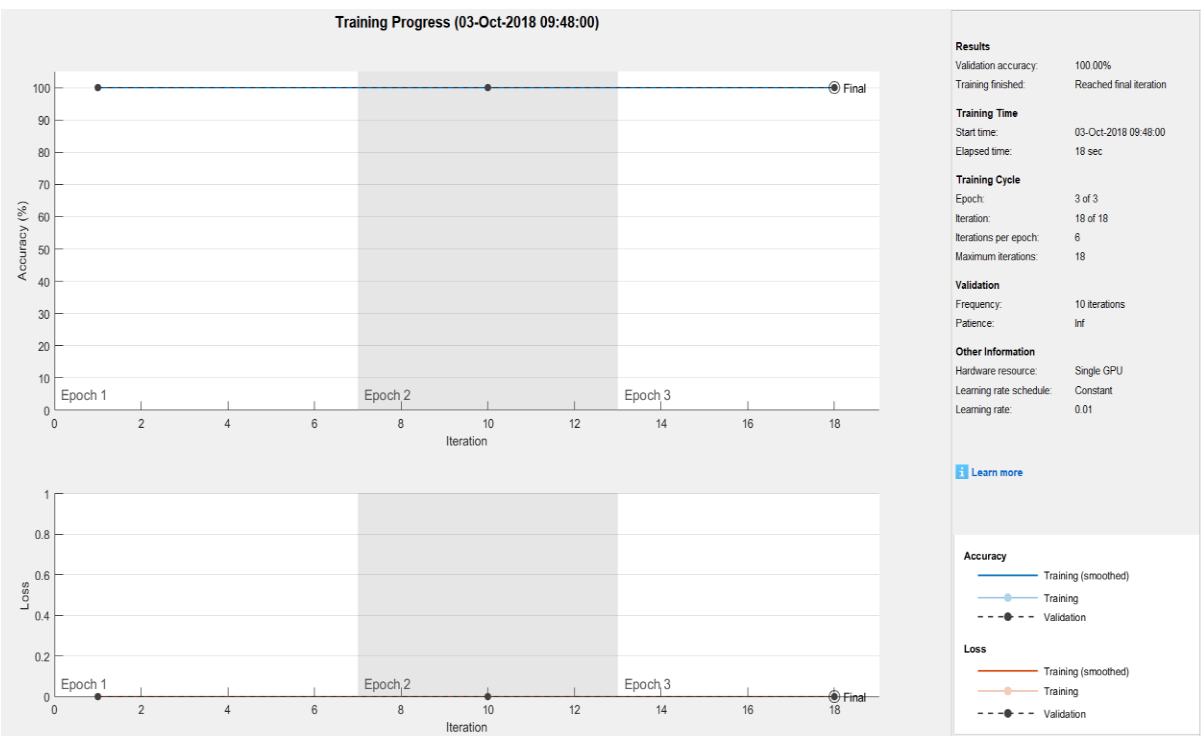
CHAPTER 3

Observations, Results and Issues faced

3.1 Observations

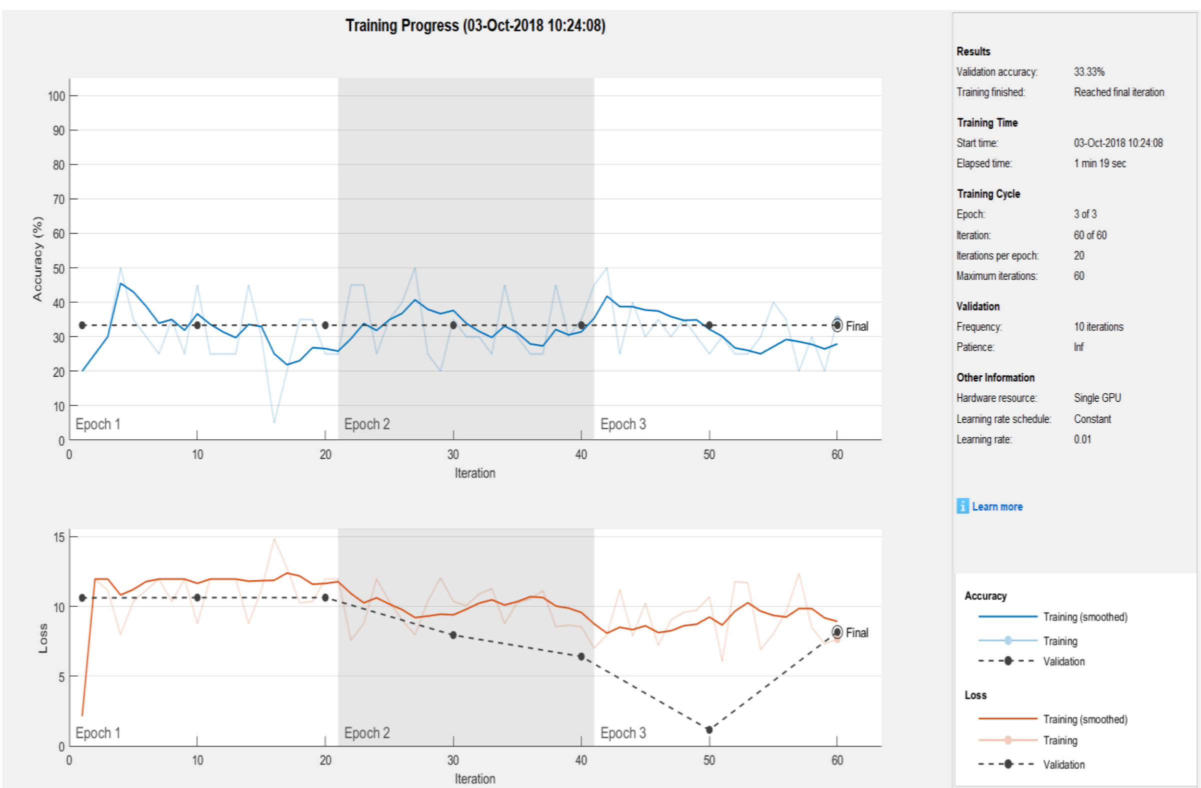
<u>Dataset containing images of alphabet A:</u>

- Accuracy-100%
- Epoch-3
- Learning rate-0.01
- Elapsed time-18 sec
- Validation frequency-10



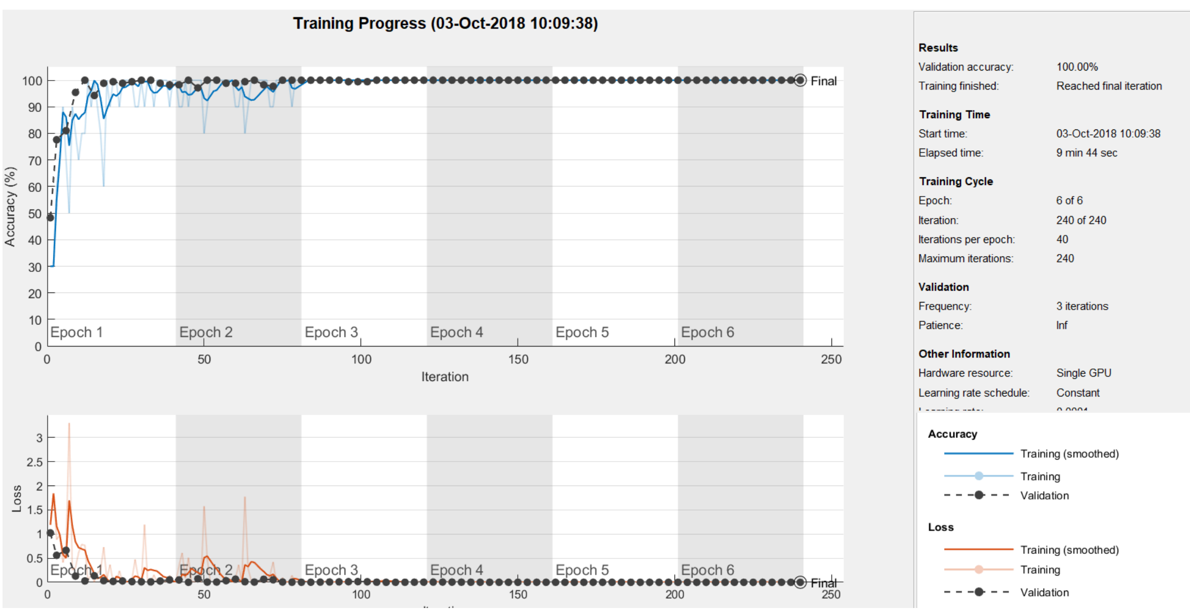
Dataset containing images of alphabet A to C:

- Accuracy-33.33%
- Epoch-3
- Learning rate-0.01
- Elapsed time-1min 19sec
- Validation frequency-10



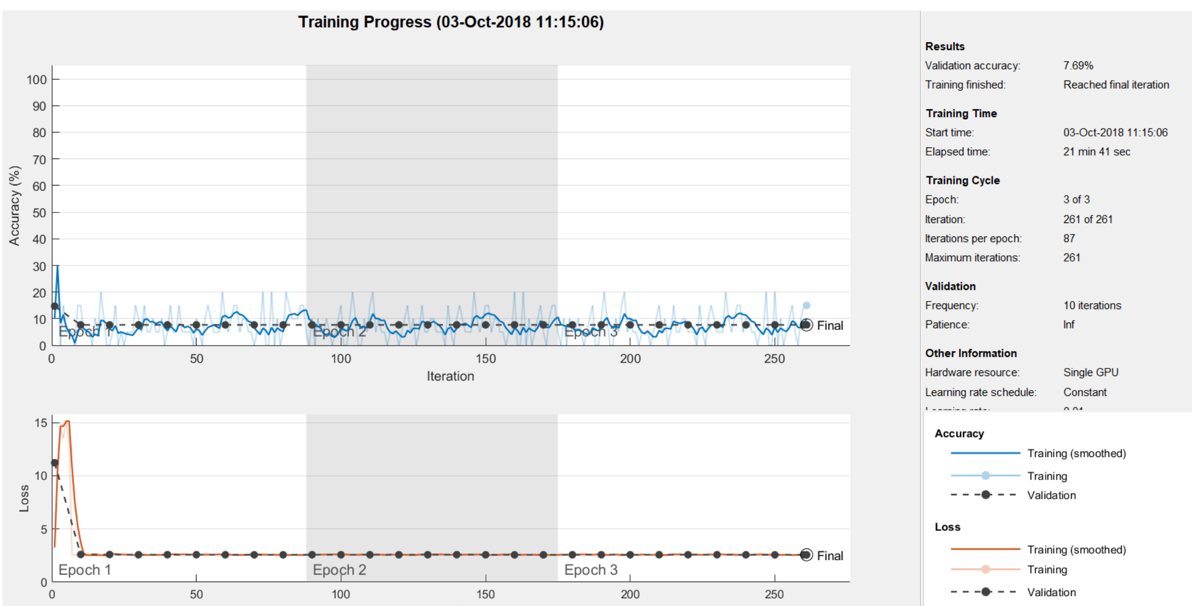
Dataset containing images of alphabets A to C:

- Accuracy-100%
- Epoch-6
- Learning rate-1e-4
- Elapsed time-9 min 44 sec
- Validation frequency-3



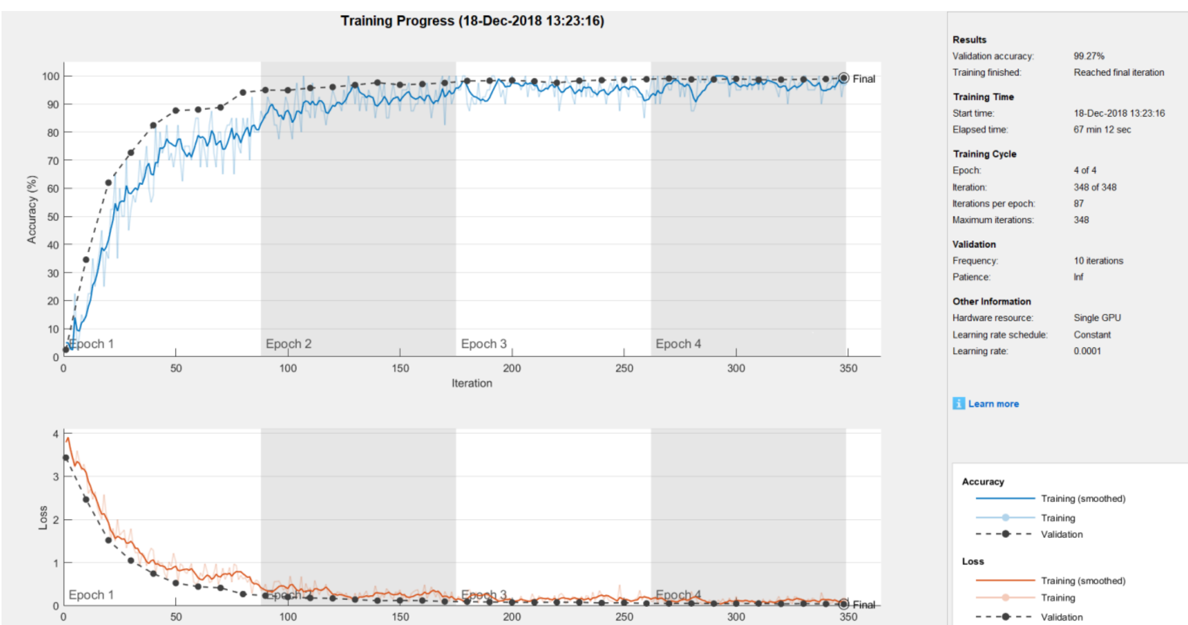
Dataset containing images of alphabets A to M:

- Accuracy-7.69%
- Epoch-3
- Learning rate-0.01
- Elapsed time-21 min 41 sec
- Validation frequency-10



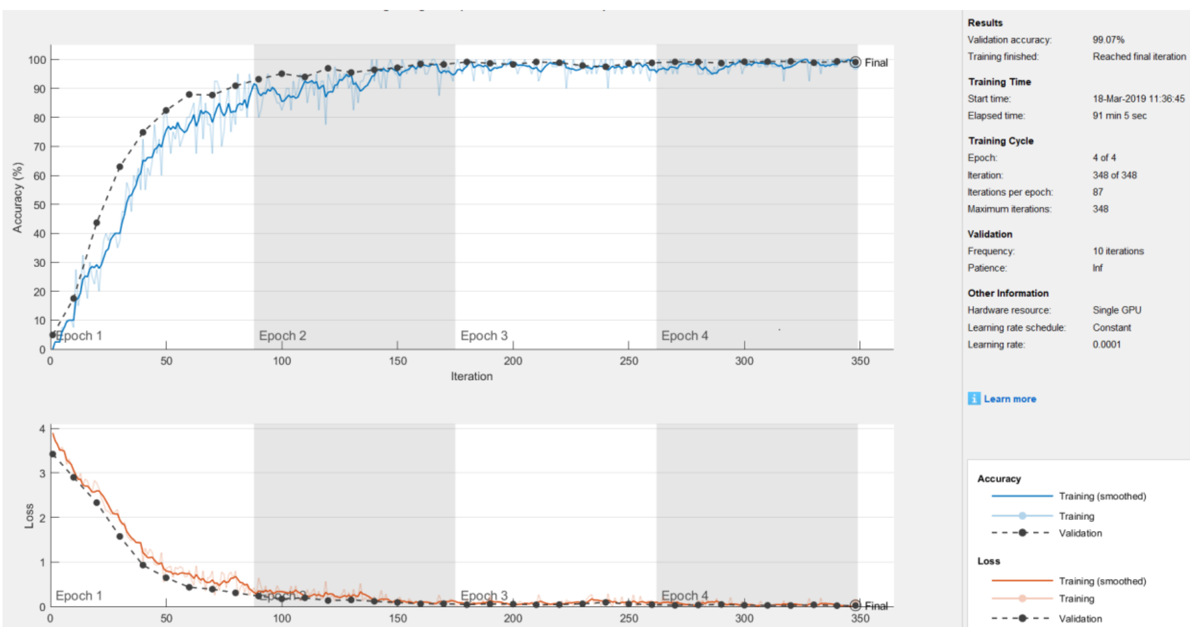
Dataset containing images of alphabets A to Z (Using Alex-net):

- Accuracy-99.27%
- Epoch-4
- Learning rate-0.0001
- Elapsed time-67 min 12 sec
- Validation frequency-10



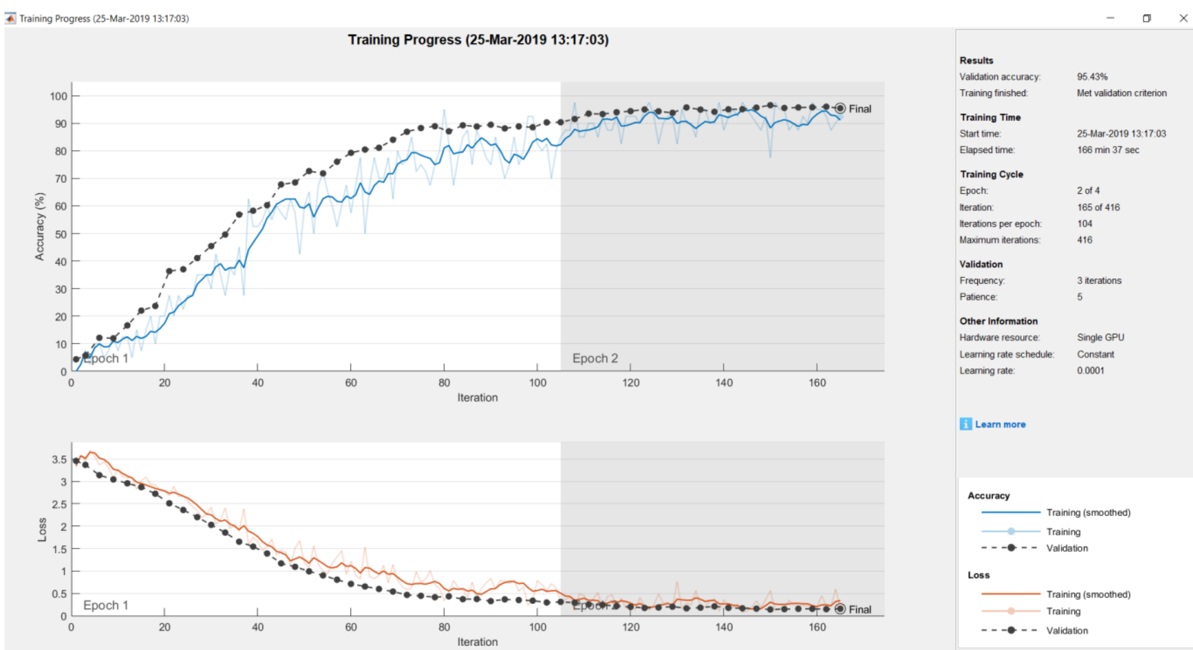
Dataset containing images of alphabets A to Z (Using Vgg16):

- Accuracy-99.07%
- Epoch-4
- Learning rate-0.0001
- Elapsed time-91 min 5 sec
- Validation frequency-10



<u>Dataset containing images of alphabets A to Z (Using Vgg19):</u>

- Accuracy-95.43%
- Epoch-4
- Learning rate-0.0001
- Elapsed time-166 min 37 sec
- Validation frequency-10



3.2 Results

We trained our dataset in three parts first consisting of alphabet A. The accuracy of dataset A is 100%. The next dataset which we took is of A-C. In this dataset we changed the learnrate to change the accuracy. The two accuracies which we got were 33.33% and 100%. The third dataset we took of A-M. Again we changed the learnrate to change the accuracy. The accuracies which we got were 7.69% and .

Thus by changing the learnrate we can change the accuracies.

The comparison of various networks is given below:

NETWORK	TRAINING ACCURACY	REAL-TIME ACCURACY
Alexnet	**99.27%**	**84.16%**
Googlenet	**99.07%**	**75%**
Vgg16	**96.04%**	
Vgg19	**95.43%**	

3.3 Issues faced

- The entire dataset was not available and hence it took a lot of time to collect the dataset.
- The software required was Matlab 2018b version which was not readily available .
- As the dataset is very large ,it consumed a lot of time for training
- The accuracy of different dataset differs according to learnrate ,epoch, matchsize.
- The real time accuracy was not high. Hence we had to append new images to our dataset to increase the real time accuracy.

- There were problems during the making of GUI namely the wallpapers of the pages were not getting retrieved, page coordinates fixation problem, linking of pages, adjusting the resolution of videos required for teaching module.

CHAPTER 4

Progress of Project and Discussion

When our project idea was finalized we looked upon a few research papers for sign language conversion. We decided and came up with the idea of processing the dataset with “Alexnet” Convolutional Neural Network. There are some research papers wherein students have trained the database using Alexnet neural network. Thus as a part of stage 1, we discussed and decided to use Alexnet Neural Network to train our Database.

We discussed and decided to train small parts of the huge database which consists of 4,991 images. Thus our main aim was to increase the accuracy of the image detection. Hence by adjusting the parameters of epoch, batchsize, learnrate and validation frequency we increased our accuracy. We have trained half of the database (A-M) in the first stage of our project. We decided to go with Deep learning because of the easy availability of Neural Network tool-box in Matlab.We observed the results discussed them and made the needful changes. Later we trained our complete dataset (A-Z) using Alexnet,vgg16. After complete training of dataset, our next step was to create a user-friendly and interactive teaching and assessment module for children. The Graphical User Interface for the same is designed which will help students learn the alphabets.

CHAPTER 5

Conclusions

The Sign language is the one of the important form of communication .It is used by deaf and dumb people to convey the message. Since it is visual part of communication it is not easily understandable by other people and thus requires to convert into other form.

The digital image processing concepts are used to extract the important information from the image and removing the unwanted part.

We successfully completed the first part of our project wherein we trained the Database using Deep learning Toolbox. We implemented Deep learning tool-box. We verified the different parameters to improve the accuracy of our database. We also increased the accuracy of our Database. The database was trained using Alexnet,vgg16. We have successfully implemented our teaching and learning module for children.

Applications:

- To design the android application to be used for real time communication.
- Conversion of image into text format.
- Teaching the children through Learning module.

CHAPTER 6

Future Plan

In future the module can be developed into an interactive application through which the physically impaired children can learn. The module can also be transformed into an E-learning website for children.

Different modules can be developed through which students can learn basic English language. The project can be transformed into a website, wherein students can learn different grammar sections in one module.

Since dumb people are usually deprived of normal communication with other people, they have to rely on an interpreter or some visual communication. Now the interpreter can not be available always, so this project can help eliminate the dependency on the interpreter. The system can be extended to incorporate the knowledge of facial expressions and body language too so that there is a complete understanding of the context and tone of the input speech.

A mobile and web based version of the application will increase the reach to more people. Integrating gesture recognition system using computer vision for establishing 2-way communication system.

We look forward to learning new technologies to do the same and research more on this and implement the same.

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