A Major Project Final Report on

Alpha-Numeric Sign Character Recognition

Submitted in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Engineering in Information Technology

under Pokhara University

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We take this opportunity to thank all the lecturers who have directly or indirectly helped for our project accomplishment. We are highly obliged to them for providing us this opportunity to carry out their ideas and work during the project period and helping us to gain the successful completion of the project. We pay the respect and love to our guardians and all other family members for their love and encouragement throughout our project development period. Last but not the least, we express our thanks to all our beloved friends for their cooperation and support.

ABSTRACT

Communication is a way through which people exchange meaningful information. There are different ways of communication such as written communication, oral communication or physical communication. Written communication includes emails or social media, Oral communication means communication through speech, video conferencing and Physical communication is communication via body language. A language through which communication is possible without means of acoustic sounds is known as sign language. Normal hearing people use speech to communicate whereas hearing impaired people use signs.

Sign language plays a great role as communication media for people with hearing difficulties. The communication between normal people and deaf people is challenging. They need a mediator person to communicate. But a mediator should know the sign language used by deaf person. Hence, the project entitled **"Alpha-Numeric Sign Character Recognition"** is a system that facilitate communication between these people. This project helps to identify alphabets in Sign Language from the corresponding images having different hand gestures. It can interpret 26 English letters and 0-9 Decimals numbers by taking image as an input. The project focused on the development of neural network using back propagation algorithm by using MATLAB software. The code is written in MATLAB with the usage of Graphical User Interface (GUI).

In this project, the idea is to take a large number of images of different signs as datasets. Images are processed by feature extraction methods. Then, the neural network toolbox of MATLAB is used to train the datasets. Further image will be given as input and then there will be preprocessing of given input which will goes for feature extraction. At last, classification and recognition will be carried out.

Keywords:

Sign Language Alphabets, Sign Language Numbers, Datasets, Image Processing, Feature Extraction, Text Recognition, Text Extraction, MATLAB, Artificial Neural Network

LIST OF ABBREVIATION

ANN	Artificial Neural Network
BP	Back Propagation
MATLAB	Matrix Laboratory
GUI	Graphical User Interface

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1. INTRODUCTION

In this emerging world of technology, various software system has been developed that make human life easier and beneficial. Among them, one is sign language recognition. Sign language is a language that helps to communicate using hand gestures and symbols for words or letters of the alphabet, often used by those who are hard-of-hearing. Sign language plays a vital role as communication media between normal people and hearing impaired people. With the help of sign language recognition system, the computer will be capable to receive and interpret the input from images. These systems implement machine learning mechanisms like neural networks.

Neural networks are learning models that works on a system of hardware and software patterned after the operation of neurons in the human brains. They are one of the most powerful learning models used in machine learning mechanisms that helps in automation of tasks. It can be very fast and may detect connections between seen instances of data that human cannot see.

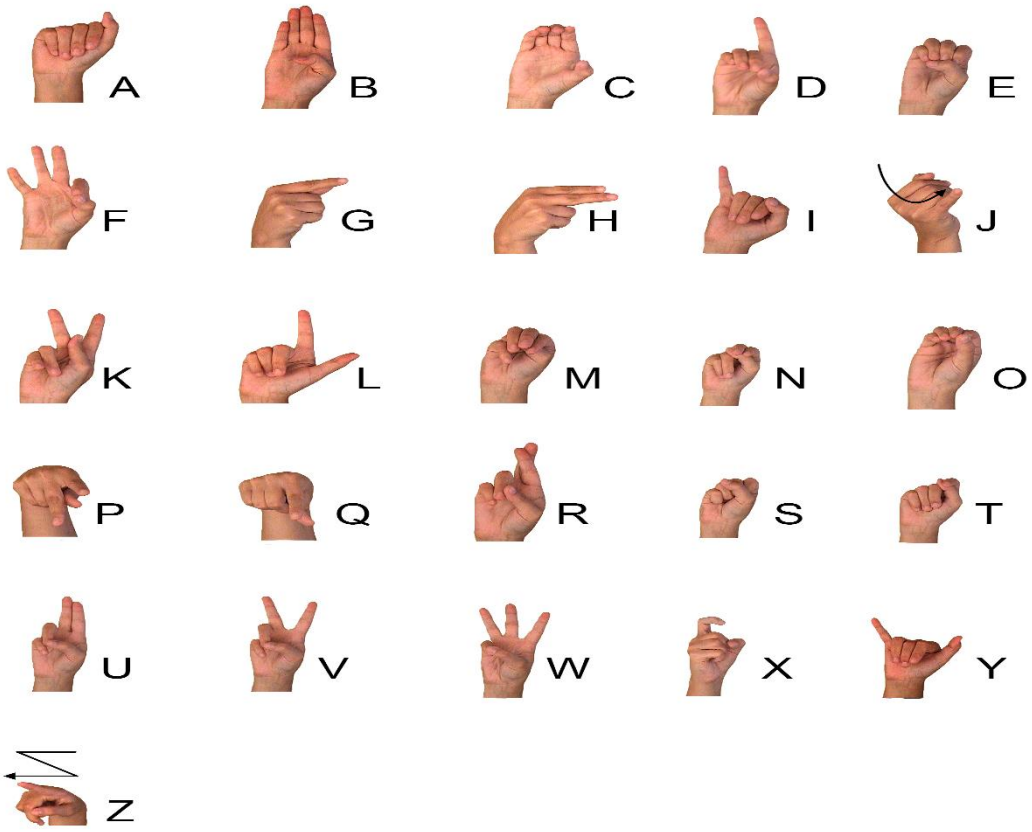


Figure 1: Sign Language Alphabets

1.1 Project Overview

The project **'Alpha-Numeric Sign Character Recognition"** is a system software to recognize alphabets and numbers of sign language from hand gestures on computer where the input will be an image having various hand gestures. It is established for the translation of sign language alphabets in image that are captured and converted into text. Thus, the converted text can be extracted further. The system recognizes the English alphabets as well as numbers. The project will be designed using MATLAB software with a back propagation Neural network.

At first, the project will take a large number of images of different sign language alphabets as datasets. These datasets are preprocessed and features are extracted. Then, the neural network toolbox of MATLAB is used to train them. Further, the work will be done by taking signs from an image as an input and the image is preprocessed. Then, the system takes out the features of input and compared it with the trained data provided by neural network. Next, classification and recognition of sign language alphabets will be carried out.

2. PROBLEM STATEMENT

Language is defined as the method of human communication. Among of various means of communication, there is sign language which helps to communicate using hand gestures for words or letters of the alphabet, often used by those who are hard-of-hearing. It works as a communication media between those people and normal people. It is easier to make communication between them with the use of signs. But somewhere, it can be difficult for both people. The people who used sign have difficulties in communication with the speaking persons. Generally, normal people do not know about different signs and their meanings. So, it can create difficulties in communication between them. Due to this, it has seen that communication of these persons are only limited within their family or the deaf community. Also, there will be lack of interactions and complications on sharing feelings between normal people and hearing impaired people.

By analyzing such problems, our system helps people to understand different sign languages and make it recognizable. The dumb people can easily interact with normal people. They don't need a mediator person to communicate. Also, normal people can have an idea about different signs and understands deaf/dumb people. Due to proper communication, the people will not have to be upset on not understanding the languages. Hence, our system will recognize different signs, hand gestures and can be beneficial for both normal as well as hearing impaired people.

3. OBJECTIVES

The objectives of this project are:

- To study Neural Network algorithm and develop a system that is able to recognize characters in sign languages using MATLAB.
- To study about sign language alphabets and numbers.
- To detect and recognize alphabets and numbers.

4. SCOPE AND IMPORTANCE

This project has following scope and importance:

- The system recognizes sign language alphabets and numbers.
- The system uses hand gestures used by deaf people to communicate.
- The system makes communication of the hearing and speech impaired people more easy.
- The project has use of Neural Network for classification.
- The system helps to study about different sign alphabets.

5. LIMITATIONS

There are some limitations of the project and they are:

- Detection of alphabets or numbers from poor lighting, shadowing images can’t be done.
- Inefficient capture due to improper placement of camera angle.
- The system is not applicable for blur images.
- The system is based on American Sign Language.

6 LITERATURE REVIEW

6.1 Review

After our research, we came to know that there are various kind of software for text recognition like ‘Glove-based Gesture Recognition’, ‘Motionsavvy’, ‘ASL Coach’, ‘Marlee Signs’, ‘Glove-TalkII’ etc. But however there are certain limitations which we are trying to overcome through our project.

6.2 Related Task

6.2.1 Domain

The project **‘Alpha-Numeric Sign Character Recognition”** helps to recognize sign language alphabets as well as numbers. It makes easy to communicate between all kind of people.

6.2.2 Existing System

6.2.2.1 Glove-based Gesture Recognition

Christopher Lee and Yang sheng Xu developed a glove-based gesture recognition system that was able to recognize 14 of the letters from the hand alphabets. It learns new gestures and able to update the model of each gesture in the system in online mode. Over the years advanced glove devices have been designed such as the Sayre Glove, Dexterous Hand Master and Power Glove.

Limitations:

- Recognize 14 letters only.
- Required hand gloves for recognition.
- The new gestures are updated in online mode.

6.2.2.2 Motionsavvy

The Motionsavvy is all about teaching users on different signs. It has easy navigation and features with different signers. It is based on human hand gestures. But it has certain limitations.

Limitations:

- The users have to make payments to recognize the input.
- It is online based system.

6.2.2.3. ASL Coach

ASL Coach is an application which supports on apple product. The application helps to learn on different sign language alphabets from videos. But the users have to download those videos. Following are some limitations of this application.

Limitations:

- Compatible with IOS device only.
- It will help to recognize numbers only.
- For every recognition, users have to download the data first.

6.2.2.4 Marlee Signs

Marlee Matlin developed Marlee Signs, an app to learn sign language. It has different lessons with videos to learn. It has following limitations.

Limitations:

- Compatible with IOS device only.
- Users have to make payment for recognition.

6.2.2.5 Glove-TalkII

Glove-TalkII is a system that translates hand gestures to speech through an adaptive interface. Glove-TalkII uses several input devices, a parallel formant speech synthesizer and neural networks.

Limitations:

- Used for translation.
- Requires Cyberglove, Contactglove for translation.

6.2.3 Comparison with Existing System

After studying the existing system, we realized that the users need different input devices for the recognition of sign languages. Many of the systems are online based or user need to pay some amount for detection of sign characters. But our system doesn't need internet and user don't have to purchase. It is offline and available for free. Glove-TalkII, Glove-based Gesture Recognition requires gloves for the detection of the signs. Also Glove-based Gesture Recognition recognizes 14 letters only.

7 REQUIREMENT ANALYSIS

7.1. System Requirements

- OS Compatibility:

Our system supports the following platforms:

- Microsoft Windows XP (SP2 or SP3)/Vista/7/8/10
- Apple Mac OS

7.2. Input Requirements

The input requirement for this project is as follows:

- Image (JPG file)

7.3. Output Requirements

The output requirement for this project is as follows:

- Sign Characters (Including Numbers and Alphabets)

8 METHODOLOGY

8.1 Method

It is a system software based on Neural Network Algorithm using MATLAB. The proposed method comprises the following methods:

A. Preprocessing
B. Feature Extraction
C. Classification and Recognition

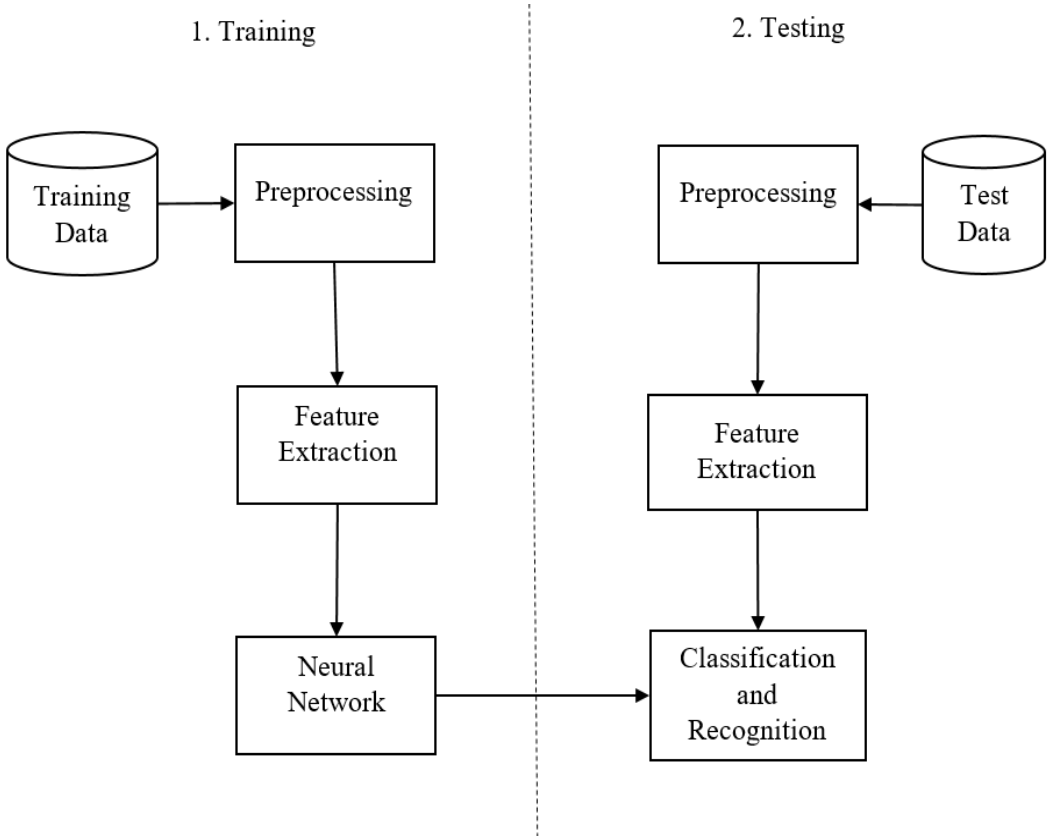


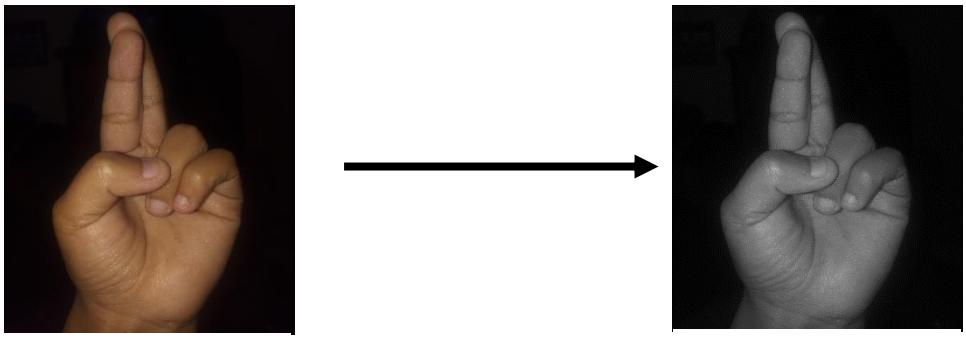
Figure 2: Process Flow

8.1.1 Preprocessing

It is the first steps to perform on input image. In this step, the input will be resized and sent to other preprocessing methods for further processing. Some of those methods are:

8.1.1.1 Gray-scaling of RGB image

The RGB image is converted into black and white image. This process is called Gray-scaling. It is done by eliminating the hue and saturation information while retaining the luminance.



RGB Color Image Grayscale Image

Figure 3:Converting RGB Image to Grayscale Image

8.1.1.2 Edge Detection

After gray-scaling image, the image edge detection is carried out. Edge detection is used for detecting forefront of the image by reducing the amount of data and filtering unimportant information to highlight important ones. There are different algorithms for edge detection. We choose to use canny edge detection algorithm.

8.1.1.2.1 Canny Edge Detection

Canny Edge Detection is a multi-step algorithm that can detect edges with noise suppressed at the same time. The Canny method finds edges by looking for local maxima of the gradient of image. The gradient is calculated using the derivative of a Gaussian filter. The method uses two thresholds, to detect strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges. In our project, we have used canny edge detection algorithm. It works on a principle of blurring images to remove noise, and then the local maxima of the edges are marked on the large magnitudes of image. Next step is to detect final edges by smothering the edges that are not connected to a certain edge.

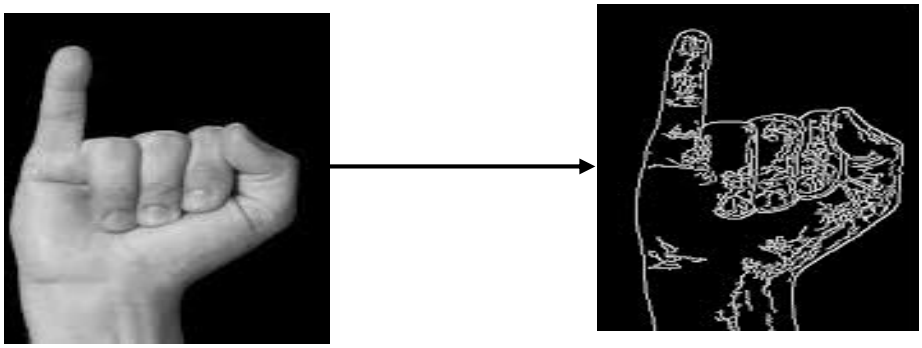


Figure 4: Canny Edge Detection

8.1.2 Feature Extraction

The next step is feature extraction. It is a special form of reduction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from

the input data in order to perform the desired. After preprocessing of an image, image masking is carried out.

8.1.2.1 Image Masking

The mask image for every quadrant is produced misusing the attributes of array and the edge esteem, so the mask image is used like an image filter. Accordingly, the mask image ought to be such that the wanted quadrant ought to be white and all other quadrants ought to be black The mask era for the distinctive quadrants are composed manually in excel document, and by creating codes in MATLAB, the image array is analyzed by these masks. There are 15 separate masks such that some of quadrants are binary 1s and the rest are binary 0. For the image features to be segmented into the mask quadrants, the feature image must be multiplied with the quadrant that fits to the mask image.

8.1.3 Classification and Recognition

This is the step where the characters are classified and recognize to give the desired result. For this, back propagation algorithm is used on the neural network.

8.1.3.1 Neural Network

Neural networks are learning models works on a system of hardware and software patterned after the operation of neurons in the human brains. They are one of the most powerful learning models used in machine learning mechanisms that helps in automation of tasks. It can be very fast and may detect connections between seen instances of data that human cannot see.

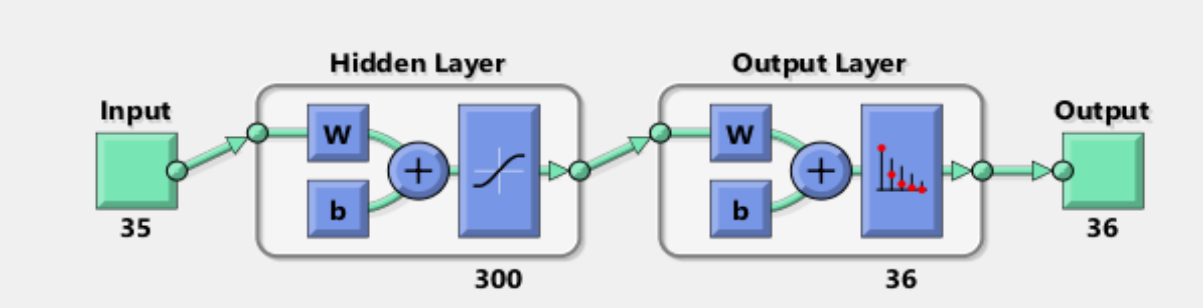


Figure 5: Neural Network

For the project, the neural network has a hidden layer where size of neuron is 300 and the classification is done in two phases. First, the features of the images are being extracted by feature extractor. And the next is classifier, which can be used to train the datasets in neural network using **Back Propagation Algorithm (BP).** The Back propagation algorithm starts with calculating the output layer, which is the only one where preferred outputs are available.

The error rate in the output layer is calculated based on the difference between the desired output and the actual output. In this project, the outcome of Back Propagation neural network is a matrix of 36*7198. The output from the Back Propagation neural network can be used to obtain English Alphabets(A-Z) and decimal numbers (0-9) in sign language.

8.2 Model

8.2.1. Incremental Model

The framework we will be using for developing this project is Incremental Model. This model combines linear sequential model with the iterative prototype model. New functionalities will be added as each increment is developed. The phases of linear sequential model are: Analysis, Design, Coding and Testing. The software repeatedly passes through these phase in iteration and an increment is delivered with progressive changes.

For the development of this project, there are three increments.

Increment-1: In increment-1, the study of existing projects as well as analysis of project was done. Here, datasets for alphabets (A-Z) in sign language were created.

Increment-2: In increment-2, the created datasets were trained and recognized.

Increment-3: In increment-3, the datasets for numbers were created, trained and recognized.

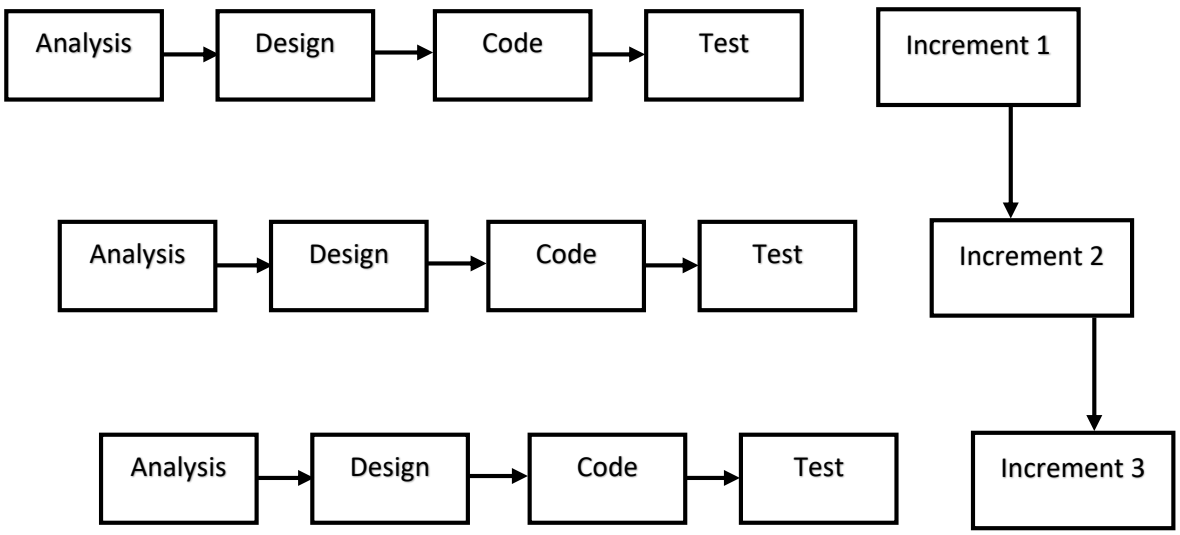


Figure 6: Incremental Model

8.2.1.1. Analysis Phase

In this phase, analysis will be performed in order to find out the requirements of the system. The outcome of this phase is a SRS which is an acronym for “System Requirement Specifications”.

8.2.1.2. Design phase

In this phase, the System Requirement Specification is translated into the system’s design. The flowcharts, Use Case Diagram, Sequence diagrams had been developed.

8.2.1.3. Coding Phase

In this phase, coding has been done according to the design and a working system will be developed by the end of this process.

8.2.1.4. Testing Phase

In this phase, the system is tested. With each testing, a list of changes to the system developed, is suggested and the changes will be applied to the software and the software would be delivered as a successive increment until a satisfying system is achieved.

8.3 System Design

8.3.1 System Architecture

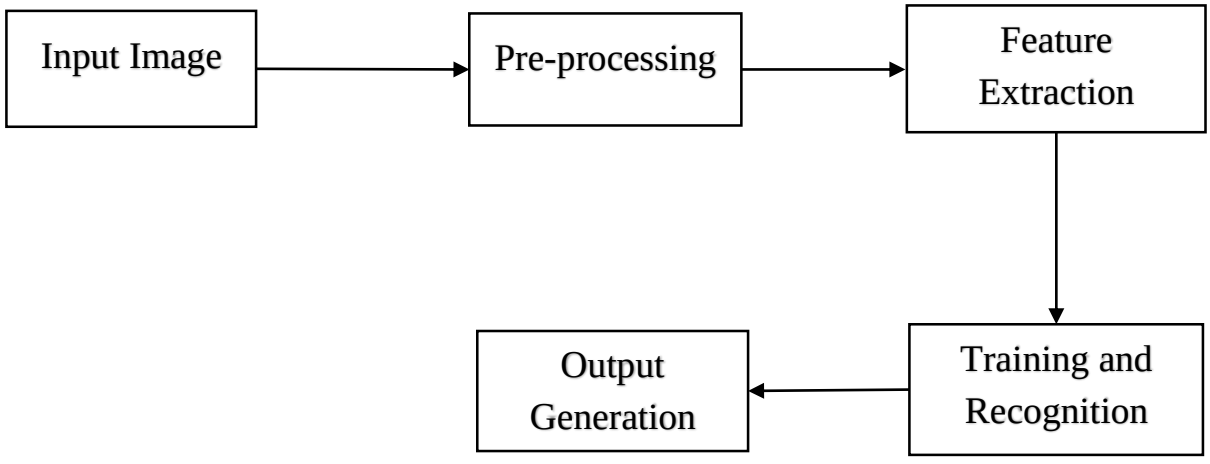


Figure 7: System Architecture

8.3.2 Use Case Diagram

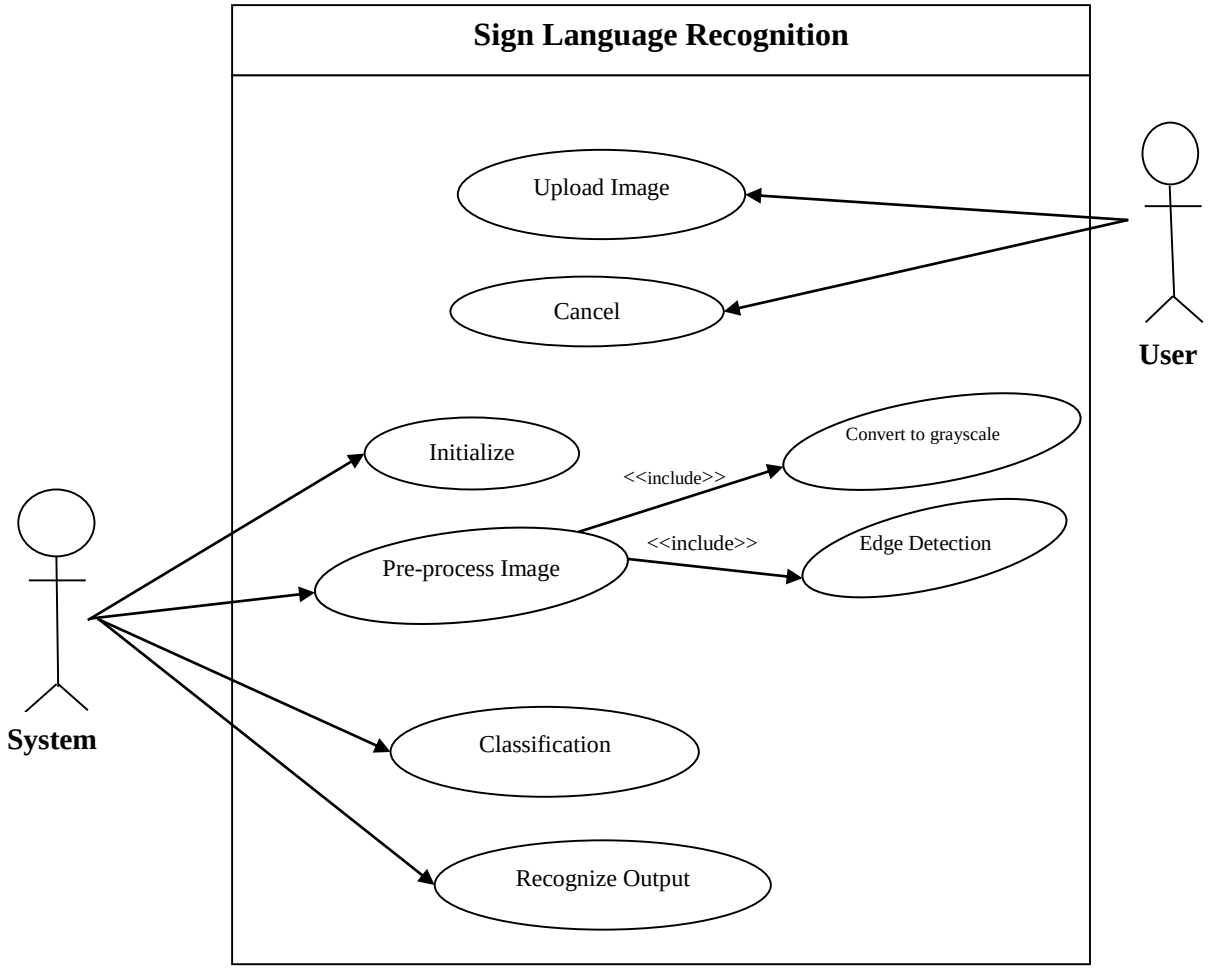


Figure 8:Use Case Diagram

8.3.3 Flow Chart

The flowchart of our project is shown below:

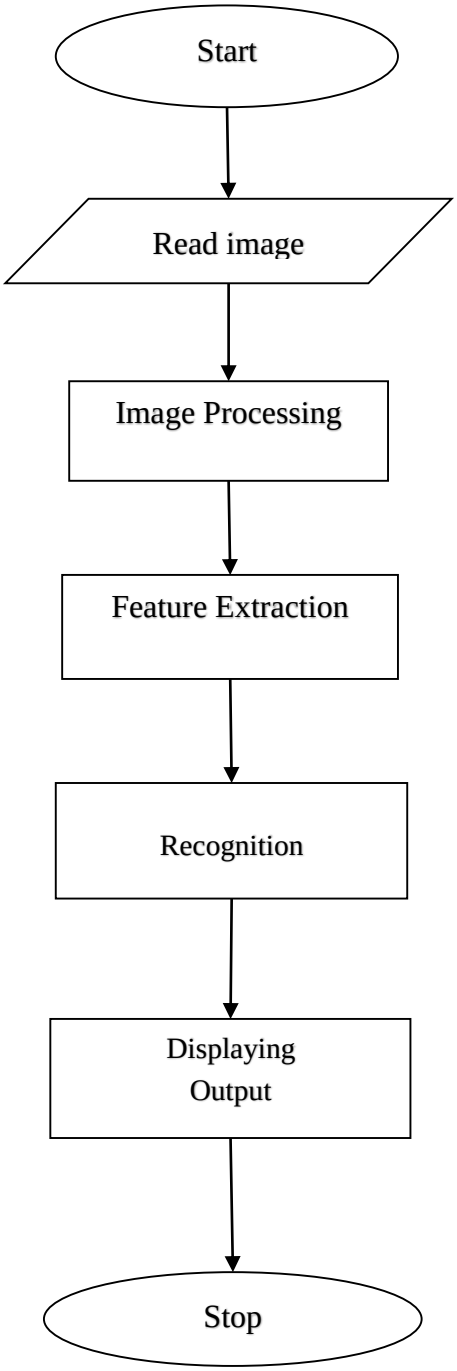


Figure 9: Flow Chart

8.3.4 Sequence Diagram

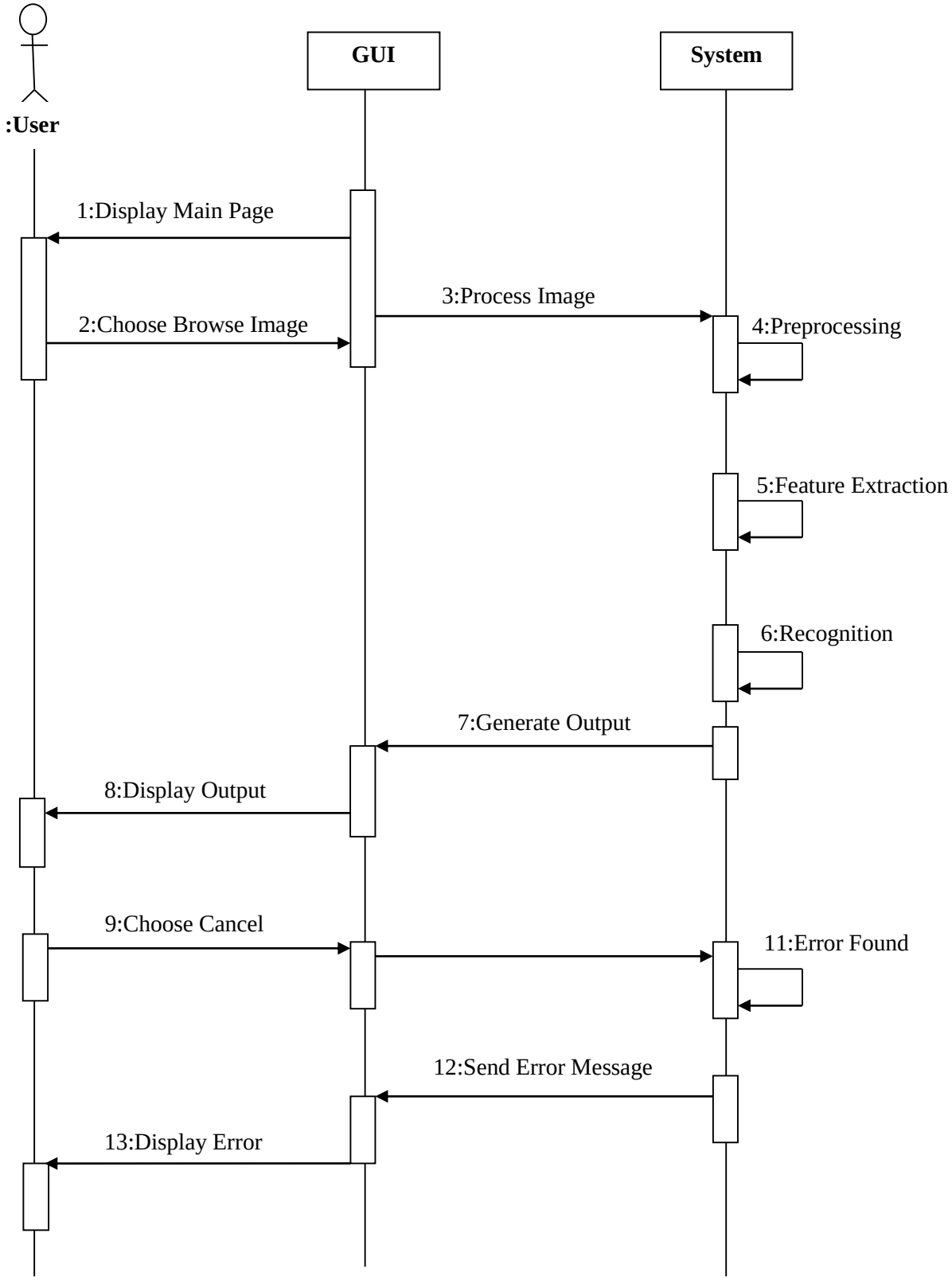


Figure 10: Sequence Diagram

8.4 TOOLS AND TECHNIQUE

This system is using the following tools:

8.4.1 MATLAB

- MATLAB is a high-level programming language with an interactive environment for visualization, numerical computation and programming function. It's basic data element is the matrix. A simple integer is considered a matrix of one row and one column.
- Matlab's functionality can be greatly expanded by the addition of toolboxes
- Matlab in not only a programming language, but a programming environment as well. We can perform operations from the command line, as a sophisticated calculator or create programs and functions that perform repetitive tasks.
- So, we used Matlab as a platform for the development of the project.

8.4.2 NEURAL NETWORK

- A neural network is a connection of many very tiny processing elements called as neurons. Neural Network is best domain which can give research platform for many students due to its wide applications and budding demand. Neural networks are learning models works on a system of hardware and software patterned after the operation of neurons in the human brains.
- Neural networks are one of the most powerful learning models used in machine learning mechanisms that helps in automation of tasks. It can be very fast and may detect connections between seen instances of data that human cannot see.
- For the implementation of our project, we have used neural network toolbox 9.0 that helps on training and simulating neural networks. It contains different applications and we have used neural net pattern recognition with feed-forward and back propagation algorithm.

9. PROJECT WORK DETAILS

9.1 DETAILS

9.1.1 Datasets

Figure 11: Samples of Datasets

9.1.2 Training Neural Networks

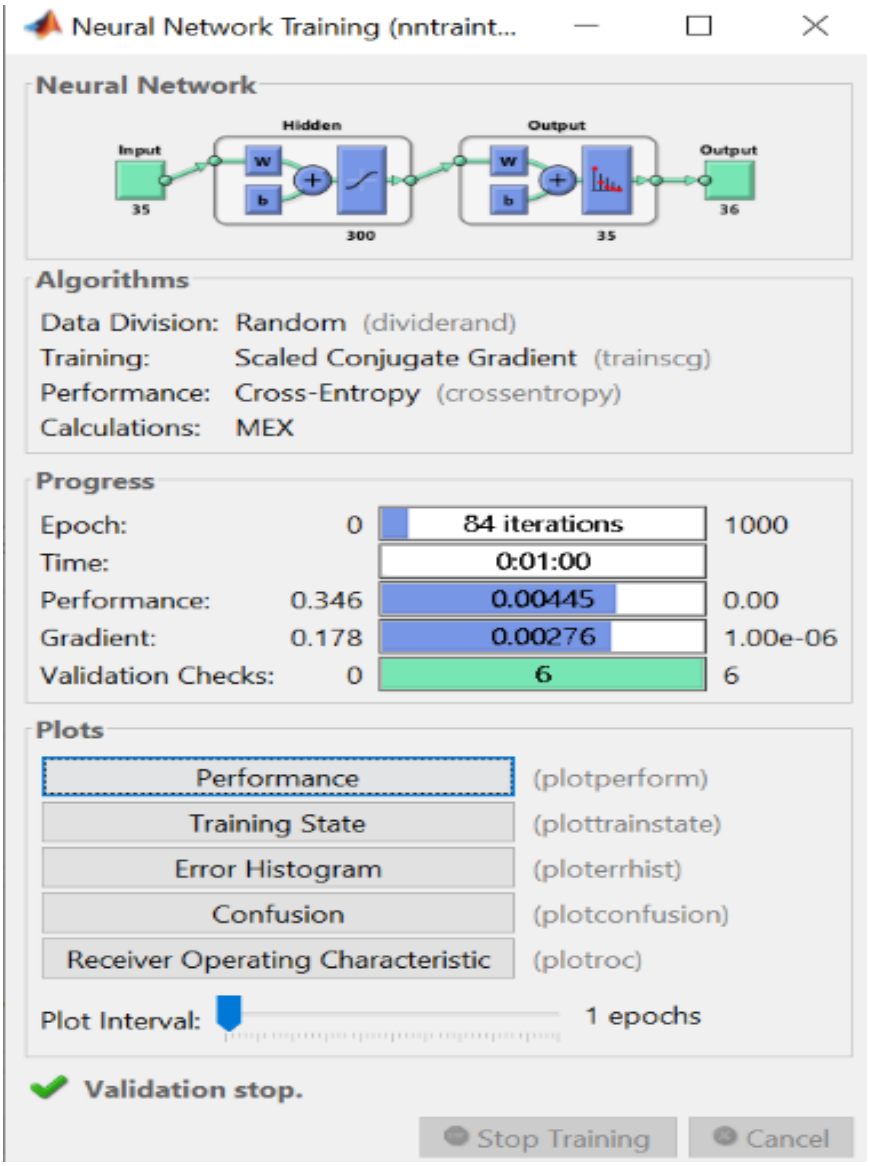


Figure 12: Training Neural Network

9.1.3 Main Page

This will be the first page when we run our project.

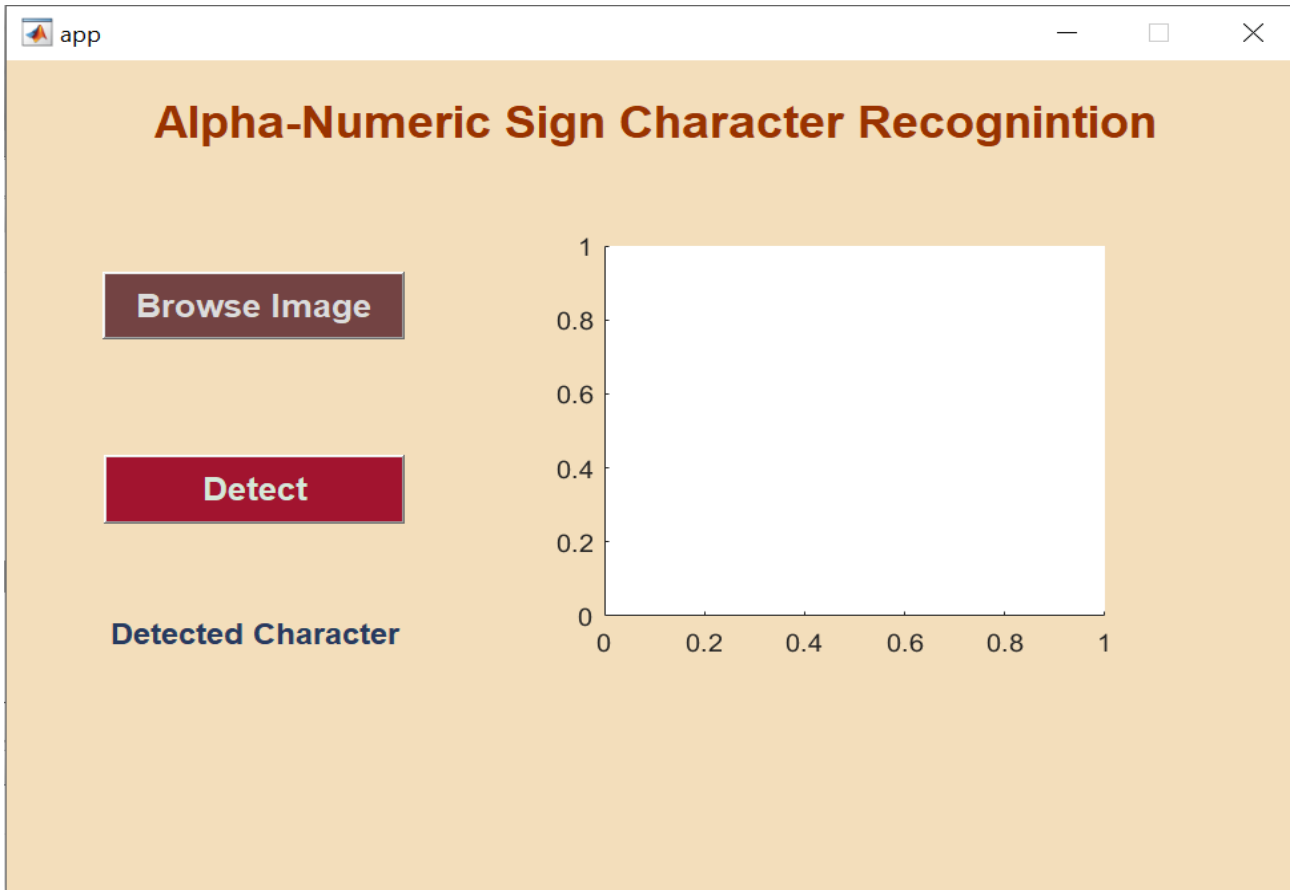


Figure 13: Main Page

9.1.4 Browsing Image

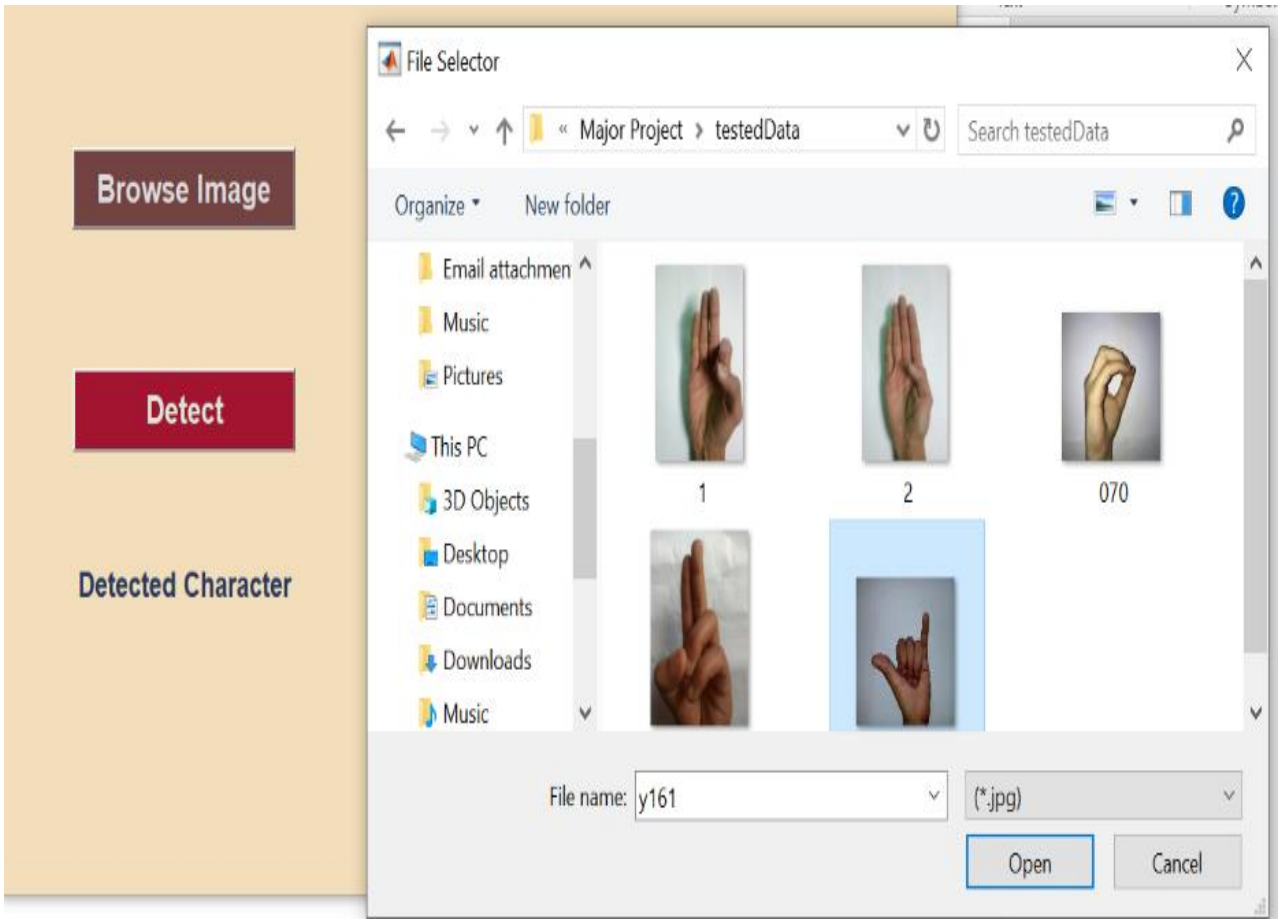


Figure 14: Image Browsing

9.1.5 Loading Input Image

Here, the browsed image will be loaded on the axes.

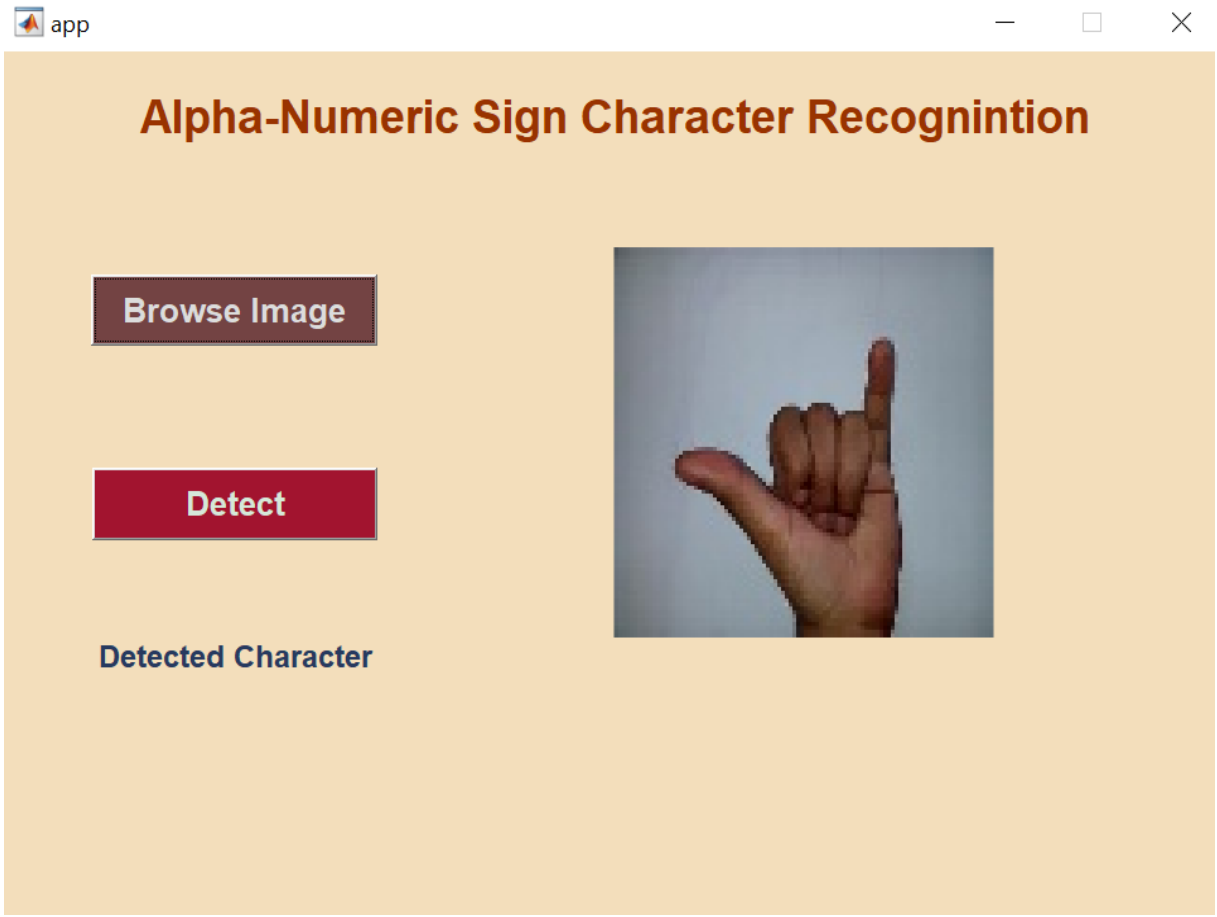


Figure 15:Loading Image

9.1.6 Alphabet Detection

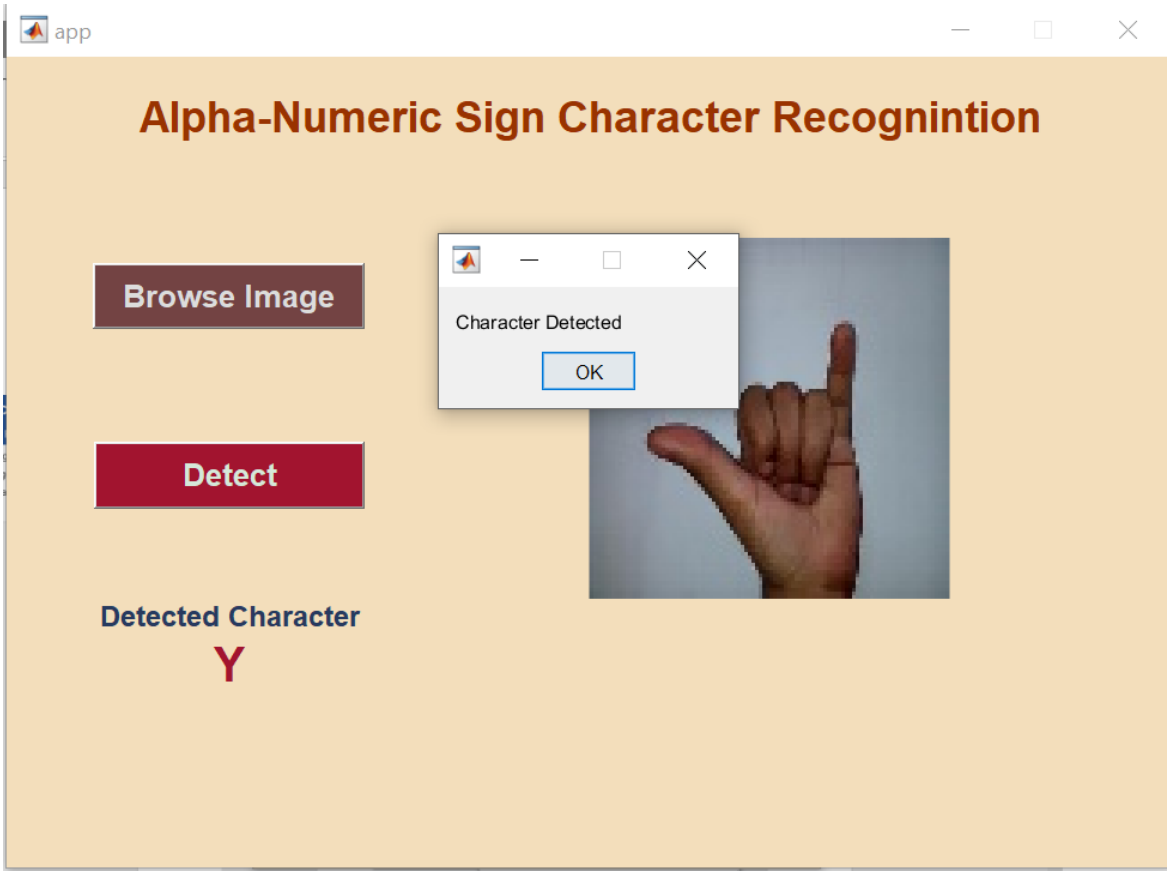


Figure 16: Alphabet Detection

9.1.7 Number Detection

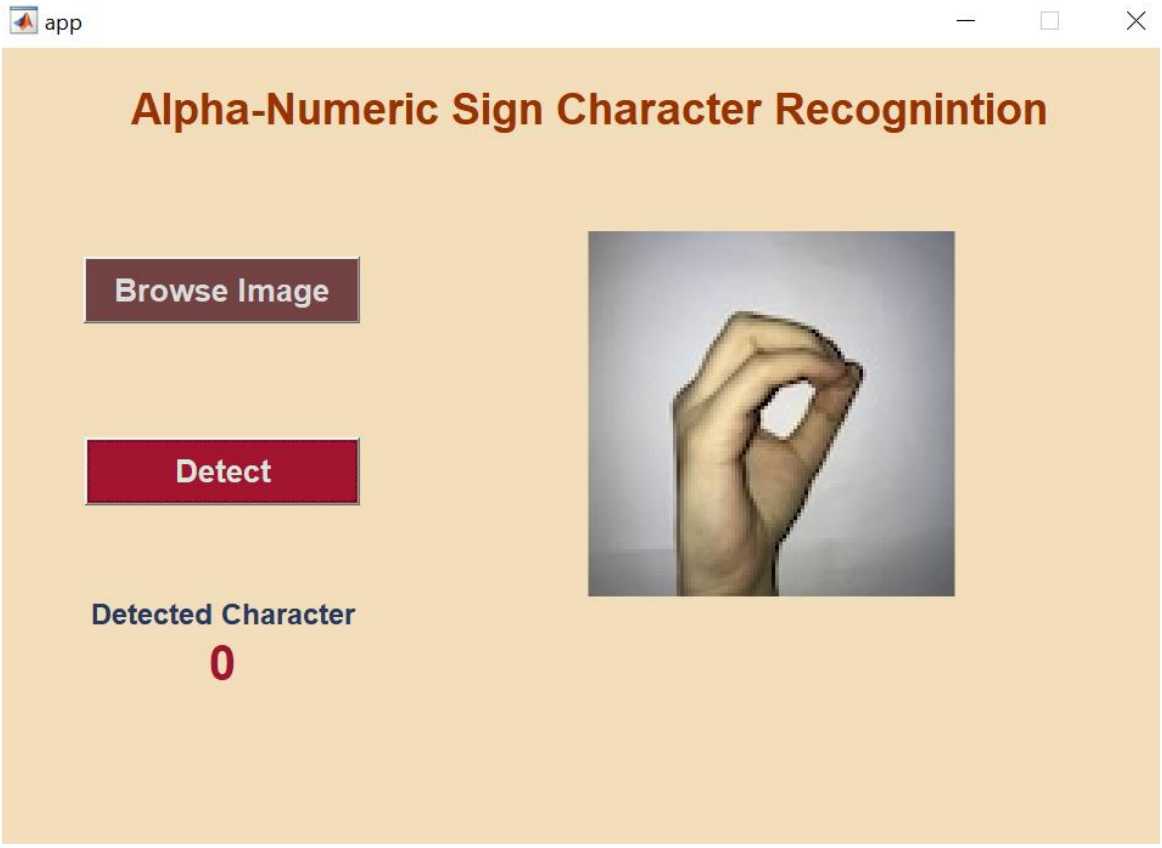


Figure 17:Number Detection

9.2 RESULT AND DISCUSSION

As our work progresses, the result that has been obtained is a system recognizes English alphabets as well as decimal numbers of sign language from the given image. When we first provide the image as an input, it is subjected to preprocessing where the image is converted to grayscale. Then, edge of image is detected. For this project canny edge detection algorithm is used for edge enhancement. After that image masking is done for smoothing image. Finally, with the help of neural network, English alphabets or decimal numbers in sign language is recognized.

10. FUTURE ENHANCEMENT

a. Recognition of British sign language.
b. Recognition of complete sign words.
c. Sign language recognition using facial expressions.

11. DELIVERABLES

At the end, this project will deliver:

- A system recognizes English alphabets as well as decimal numbers in sign language.
- A project report documentation.

12. TASK AND SCHEDULE

12.1 Gantt Chart

The project schedules will be performed as per the requirements and time constraints involved. Numerous informal suggestions, from the supervisors, which had assisted a lot in the development are not included in the chart. This project is scheduled to be completed in about 9 weeks. The figure below provides a better understanding of the tasks and time division.

Figure 18: Gantt Chart

12.2 Project Task

This project will be design as per requirements and constraints involve. Given table clears the schedule of the task and labor division.

Task	**People**
Study of existing systems	Rubin, Sabin, Sandesh
Requirement Analysis	Rubin, Sandesh
Design System	Sandesh, Sabin, Rubin
Coding	Rubin, Sabin
Testing and Debugging	Sandesh, Sabin
Overall System Test	Rubin, Sandesh
Documentation	Rubin, Sandesh, Sabin

Table 1: Work Division

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14. APPENDIX

14.1. Error Message

When user selects cancel button then the error message will be shown as in figure below.

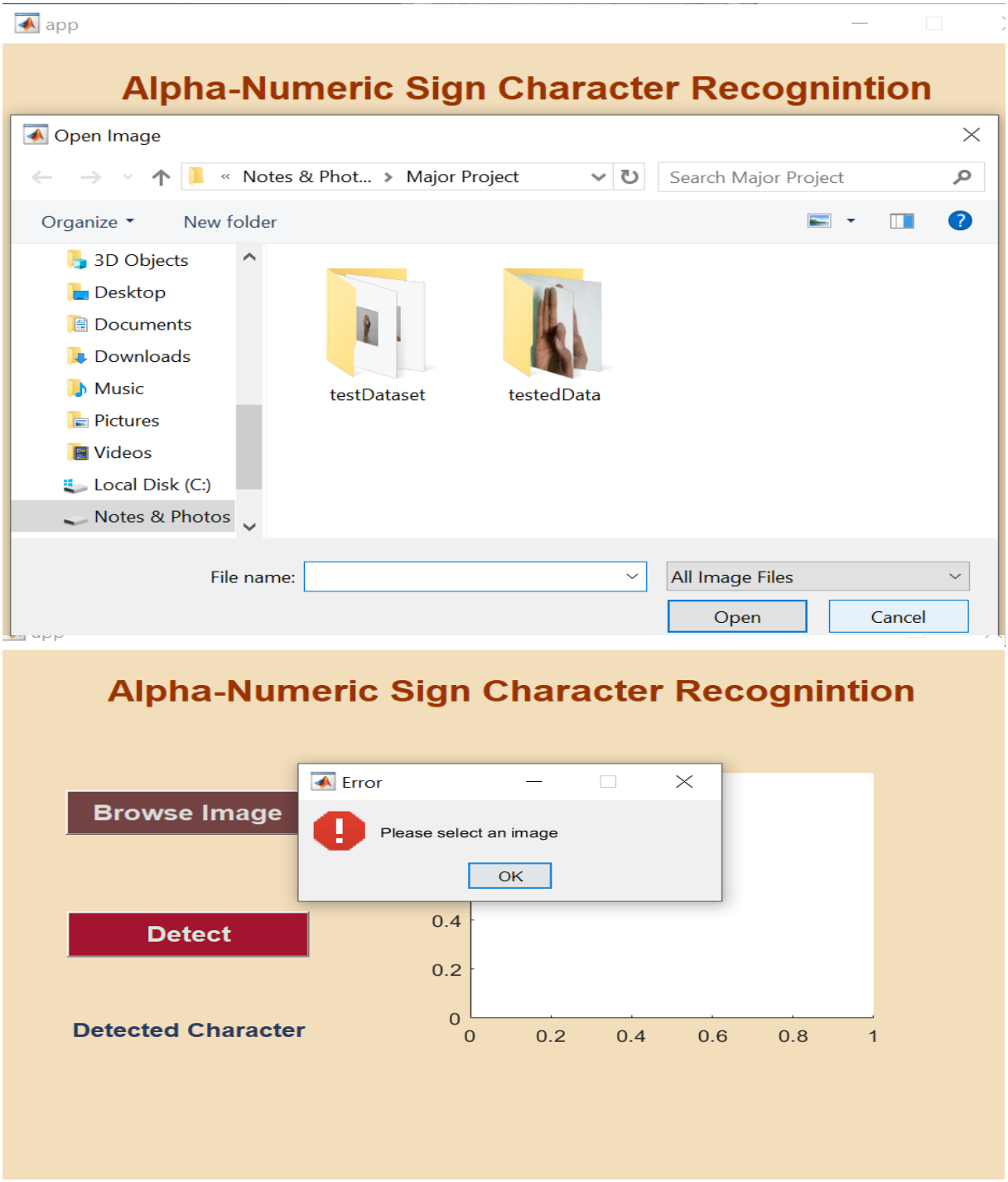

Figure 19: Error Message