E-LEARNING SYSTEM FOR HEARING IMPAIRED STUDENTS

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Specializing in Software Engineering

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DECLARATION

We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	**Registration No.**	**Signature**
Pirathikaran Vadiveswaran	IT18068610	

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

…….. Date ……

Signature of the supervisor:

(Dr. Kalpani Manathunga)

…….. Date ……

Signature of the co-supervisor:

(Mrs. Samanthi Erang Siriwardene)

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Firstly, I want to express my gratitude to God Almighty for blessing me during my studies. I might have had a better experience and, moreover, enhanced my abilities in many disciplines in the field of information technology if I had taken the final year research module. Because this is a completely new scenario for us, we require advice and assistance from our professors. First and foremost, I would want to express my gratitude to our supervisor, Dr. Kalpani Manathunga and co-supervisor Mrs. Samanthi Erang Siriwardene for providing outstanding leadership and motivation to my team. Even at the most difficult moments of the project's completion, I and my team were urged not to panic and to work hard to ensure the project's success. They steered us in the correct direction and showed us how to attain our own objectives. I'm also appreciative for their generosity in sharing their time with me this year. I also want to express my thanks to everyone who helped make this endeavour a success. I'd want to express my gratitude to the Sri Lanka Institute of Information Technology for providing the necessary knowledge. They also introduced the requirement for a fourth-year plan to finish the course. I would like to express my gratitude to Dr. Janaka Wijekoon, the lecturer in charge, for his assistance at one point in the curriculum. To make the project a success, he helped us through difficult periods, encouraging and correcting our faults. Nonetheless, I'd want to express my deepest thanks to my parents for believing in me and for their continuous support and encouragement of colleagues and coworkers.

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ABSTRACT

During this pandemic due to COVID-19, most of the people have transferred to digital life especially education system from learning to e-learning. According to survey and research the better way of communicate with the hearing impaired people is sign language. The current pandemic situation gave more challenges to the deaf and dumb students to learn. In the past decades most of the researchers mainly focusing to ensure hearing impaired people without help from others can use an automatic interpretation of sign languages. The hearing impaired people can communicate themselves but cannot communicate with ordinary people, this is the barrier for both the community. The proposed system aims to make dual-way communication between hearing impaired and ordinary civilians.

The suggested system could create a video in sign language using machine language, video processing and Natural language processing. Pre-processing, skin segmentation, feature extracting, classification for recognizing the hand gestures. First students uploads doubt and question videos on particular forums system check the quality of the video and allow them to upload. The next step is, system convert video into the frame by frame image and detect the hand gestures and according to the hand, gestures make text format and fine-tune and make it meaning full sentence vice versa. It will make two-way communication and break the barriers between deaf-dumb and normal people.

Keywords: *Machine Learning, Video Processing, American sign language, deaf and dumb.*

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LIST OF ABBREVIATION

Abbreviations	Description
LMS	Learning Management System
WHO	World Health Organization
ASL	American Sign Language
ISL	Indian Sign Language
BSL	British sign language
HOG	Histogram of oriented gradients
SGD	Stochastic Gradient Descent

1. INTRODUCTION

1.1. Background Study

Deaf and dumb people should only communicate by sign language. Deaf and dumb community can have communication between themselves but, when communicating with ordinary people, it is challenging for them. Each country has unique sign languages. The most popular languages are ISL, ASL, and BSL. Sign language using hand gestures and facial expression. ASL uses both hand gestures and the face to recognize the sign language. WHO conducted a survey, in that survey above 6% of the world's population are hearing impaired persons. In March 2018 hearing impaired persons were around 466 million, and it will increase to about 900 million by 2050 [8].

Sign language recognition is one of the most popular research topics nowadays. Many new innovations have been implemented in this field. We have developed a proper system to use by the deaf and dumb community. It is more user-friendly and straightforward. When comes to E-learning concept for the deaf and dumb student it is necessary to have a good system to educated their studies. Only a few institutions have e-learning method for deaf and dumb student because it will cost them. However, we have taken the responsibility to create a standard e-learning platform for them [6]. In common techniques are used to detect sign language vision-based and sensor-based glove approaches are main [4, 9]. The user should wear gloves to the hand when using the sensor-based technique. Gloves are used to transport cables and sensors that are connected to the computer. However, gloves are still expensive, difficult to use, and not a portable system. In a vision-based approach work on taking images by the camera. It is common for users can have this facility to use the system. This approach overcomes the glove based problem. The acquisition, segmentation, filtering, representation, and classification of hand gestures are all part of the vision-based system [9].

In our research, we provided LMS try to solve all issue on the existing system for the deaf and dumb students' community. Common LMS always allow making two-way communication. Therefore in the deaf and dumb LMS also we should provide two-way communication. In our system student can ask a question through sign language and it will convert into text format also tutor can teach the lectures it will convert into sign language. Above the method, the deaf and dumb student can communicate with a tutor. The tutor also directly communicate with the deaf and dumb student without any interpreter.

In our research, we have developed an ASL e-learning platform. Figure 1 represents the alphabet letters of ASL and this is mostly to use one hand gestures to do communication. All hand gestures are unique possess. Our goal is for deaf and dumb students can be asking questions through our system and get a reply, then they can clarify their doubts.

Figure 1 - ASL Dataset

1.2. Literature Survey

Essentially conducting the literature survey for finding out existing researches have any similar functionalities and techniques, through that we can get clear understanding our system and find out research gaps and research problem. Here some most vital researches are analyzed.

In 2016, A. Mishra and A. Sood, in their paper “AAWAAZ: A communication system for deaf and dumb.” [1] In their paper, a proposal a framework to reduce the gap between hearing impaired community and us using recognizing hand gestures. Their approaches were first to take an image applying skin segmentation using Hue-Saturation-value (HSV) histogram and finding edges detection. The other component is to feature extracting with help of Harris algorithm. By the following step feature matching and recognition, here calculating the minimum value of the matrix. In our research field, we can use the skin segmentation method to find a skin region on the image. It detects hand gestures.

In 2015, K. Raju K , S. A. Swamy B , K. Dutta, and S A. Kumar G.S, in their paper "Double-handed Indian Sign Language to speech and text" [2] proposed a system that detects both hands sign language gestures into written and spoken language. Here they used MATLAB to process image. In this paper, the Min Eigenvalue algorithm applied to extracting the interesting points, the extracted features are stored because it utilizes less space and computational will be smaller. Here, using a web camera of 5mp for reducing noise and artifacts. After analyzed, we can use the extracted feature for consuming limited space and using a quality web camera to decrease the level of noise and artifacts.

In 2012, S. Khupase, A. S. Ghotkar, R. Khatal, S. Asati and M. Hadap, in their paper "Hand gesture recognition for Indian Sign Language" [3]. The proposed system focusing on recognize ASL alphabets and double-handed gestures for deaf and dumb people. The four main components of their system are hand gesture component, hands segmentation component, real time hands track component, and features extract component. For their major four components, they used algorithms and methods. The hand tracking gestures and segmentation were identified using the camshift (camelcase) method, and the saturation and hue, and intensity-HSV colour model.

Then they have used a Genetic Algorithm to do the gesture recognition. Through this research paper, I can modify and use the Genetic algorithm to do gestures recognition.

In 2017, U. Gawande and S. Rathi in their paper “Development of full duplex intelligent communication system for deaf and dumb people” [4]. The suggested system aims to enable dual way communication among deaf-mutes & hearing persons. But this research identify some issues on dynamic hand gestures that give the same meaning. It is also challenging on this researches. Pre-processing, division, feature extraction, and classification are the techniques they used. Video pre-processing used Gaussian low for avoiding high-frequency noise from input images. Segmentation applied because of finding hand gestures regions from the image area. Feature extraction purpose they used Eigenvalues and Eigenvectors. Classification is used to recognize hand gestures using the Eigenvalue and Eigenvector. Through this research, we can use the classification stage to use it on our system.

In 2015, P. B. Warale, P. G. Ahire, K. B. Tilekar and T. A. Jawake "Two Way Communicator between Deaf and Dumb People and Normal People" [10]. The suggested system aims to enable hearing impaired and the general public should communicate in two directions. Here two different component were used. The first one was getting input from the native language and it mapping with relevant sign gestures image and it will convert as animated gestures. The second component was a real-time video of sign language that would be mapped to related text and converted into human-understandable speech. Using google text-to-speech API to translate text from speech in my future work, I can use the text to speech conversion method

1.3. Research Gap

Students who are deaf and dumb have not yet fully utilized ways to voice their doubts. The existing system developed this feature but not a proper development and not user friendly. Still in the LMS, this feature is lacking. Only if students ask questions then only they can understand the lectures and clarify their doubts. In my part of the

research, I'm mainly focusing on it and make a proper feature for the ask question scenario.

Two-way communication is not yet in use in the e-learning platform. The existing system developed this feature but, it should improve a lot. In our search, we are mainly considering the two-way communication between deaf-dumb and tutor. Then only we can provide a better solution for the deaf and dumb community to use this LMS. Deaf and dumb students should ask a question in sign language, which will be converted into text for the tutor to understand, and the tutor's response will be converted back into sign language. These systems allow for two-way communication on our LMS.

Table 1 - Research Gap

Paper	Tasks	Limitation	Our system
[12]	Using Two-way hand gesture	Developed but Not accuracy	Yes Accuracy level High
[2]	Sign language gestures detect word	Only detect Letters and Numbers	Yes Detect word and letters also
[3]	Make Two way communication	Developed but Cannot used in e-Learning Platform	Yes We using two way Communication
[11]	Easy to use	Only using glove can detect sign language	Yes Without glove using video only

1.4. Research Problem

My research first problem is the tutor cannot understand sign language. In our LMS's tutors cannot understand any sign languages. However, tutors should understand the deaf and dumb students question and doubts. Then the tutor can explain it. Otherwise, there is a barrier between student and tutor. We overcome this issue by convert sign

language into text and make a meaningful sentence. Figure 1.4.1 represents our survey, it shows the majority of responses want to clarifying doubts using sign language.

All around the world, each country has unique sign languages and own action also. It differs from each country. The main problem is when we creating LMS it is very difficult to develop all sign languages are out there. We can be focusing on one sign language. In our LMS we use the ASL.

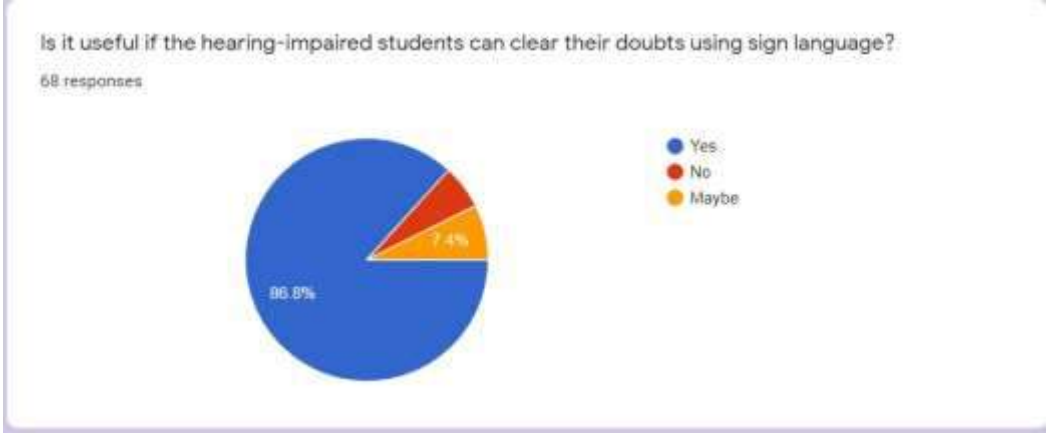


Figure 2 - Survey result

1.5. Research Question

- How can deaf and dumb student ask questions and clarify their doubts?
- How a teacher who does not know sign language can understand the question of deaf and dumb students?
- What is the best way for deaf and dumb students to ask questions?

1.6. Research Objective

1.6.1. Main Objective

The goal of this proposed system is to find a better solution to the hearing impaired community to communicate with a normal persons without the use of an interpreter. Mostly e-learning platform deaf and mute students want to interact, ask questions and

clarify the doubt using sign language. The goal is to students' sign language video recognize, convert them into text and fine-tune to the native language. It makes tutors can understand the students' requirements.

1.6.2. Specific Objective

The following sub-goals are the first step in achieving the principal objectives.

1. Do the preprocessing video and get frame by frame.
2. Removal of background and objects
3. Convert Image in binary form.
4. Feature Extraction
5. Recognize text and fine tune to native language.

2. METHODOLOGY

In our research, my basic functionality is to convert sign language into text and make a meaningful sentence. Deaf and dumb student can ask questions by uploading their questions as a video file. Then the system saves the video and does the relevant steps. The first system does video pre-processing. In the video pre-processing has three steps. The first step is converting the video into a frame by frame image, the second step is to adjust the contrast and the final step is to resize the image. After video pre-processing image background removal, the next step is to convert the image in binary form, the following step is the feature extraction, and the later step is to do the gesture recognition and finally taking output text, fine-tune and save it into the database.

2.1 System Overview Diagram

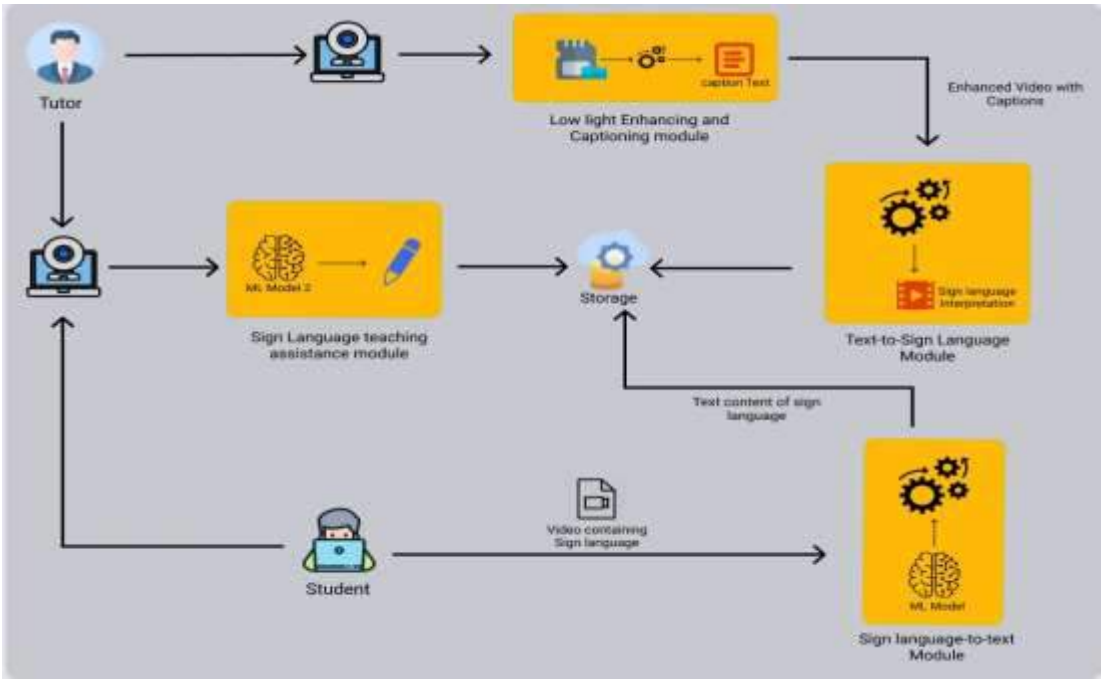


Figure 3- System overview diagram

Figure 3 shows the system overview diagram. According to the system diagram the video will be recorded by the lecturer using his/her webcam. Then it will be uploaded to the system. Once the video is uploaded the Low light enhancing and captioning

module will enhance the video and produce captions to the enhanced video using proposed algorithms. The output of this module will contain both the enhanced video and the captioned text for the video. The captioned text will be sent to the Text-to-Sign language module and produces the sign language interpretation for the captioned text. This output will be stored in a storage/ database. Sign Language teaching assistance module and the Sign language to text module takes user recorded videos as its input for its modules and produce Sign to text interpretation for sign language teaching functionality and hearing-impaired student question forum functionality respectively.

2.2 Function Overview Diagram

This functionality is to convert sign language into text and make a meaningful sentence. Deaf and dumb student can ask questions by uploading their questions as a video file. Then the system saves the video and does the relevant steps. The first system does video pre-processing. In the video pre-processing has three steps. The first step is converting the video into a frame by frame image, the second step is to adjust the contrast and the final step is to resize the image. After video pre-processing image background removal, the next step is to convert the image in binary form, the following step is the feature extraction, and the later step is to do the gesture recognition and finally taking output text, fine-tune and save it into the database.

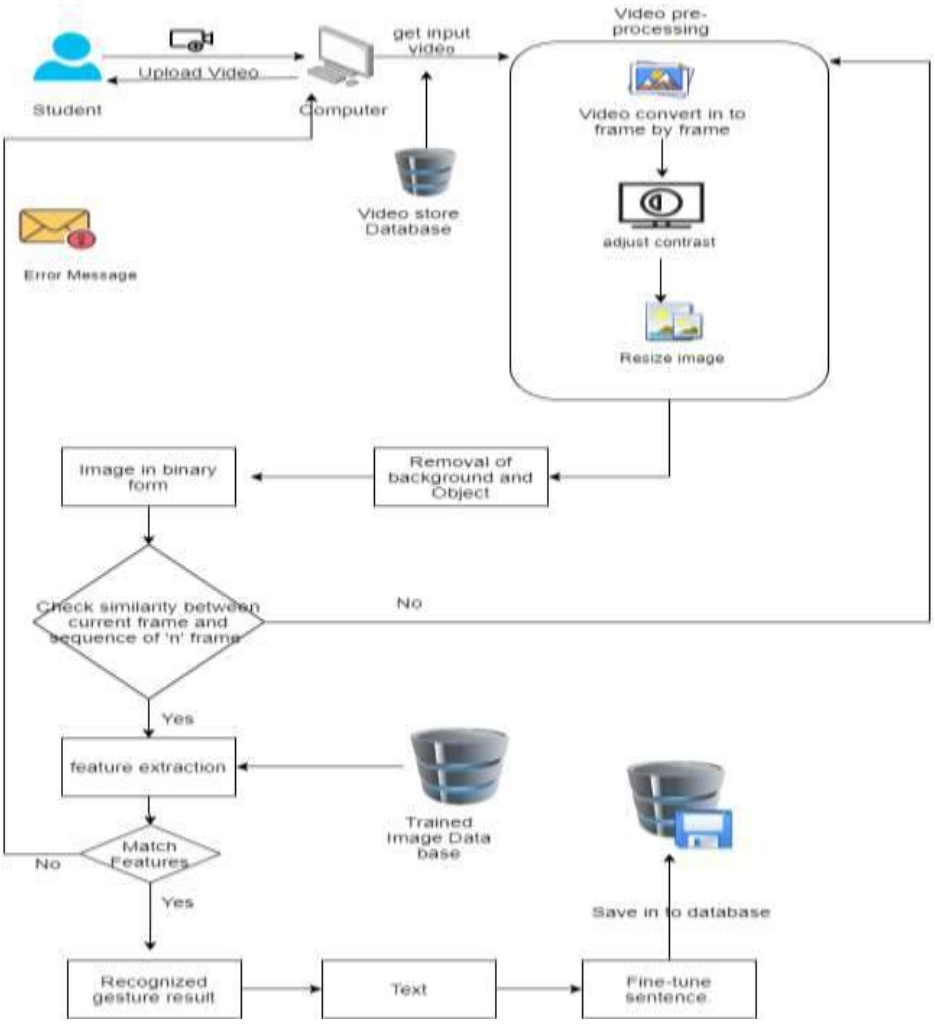


Figure 5 -Function overview diagram

2.3 Use case diagram

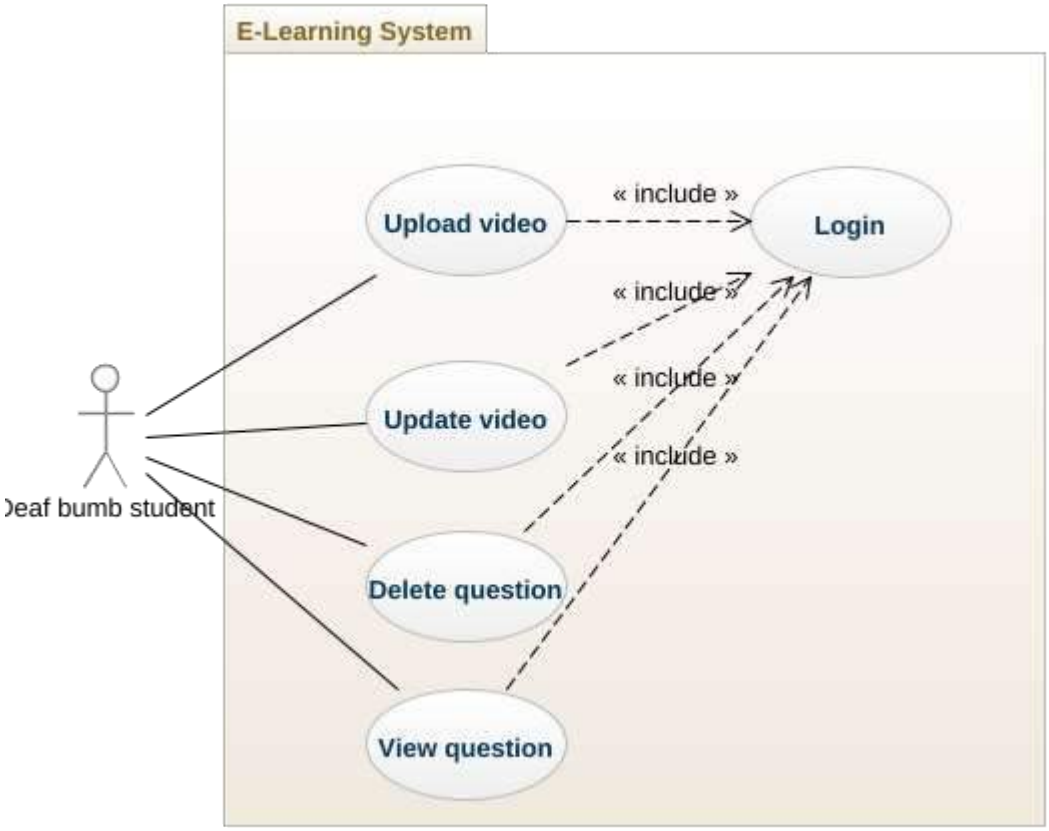


Figure 6- Use case diagram

2.4 Flow chart

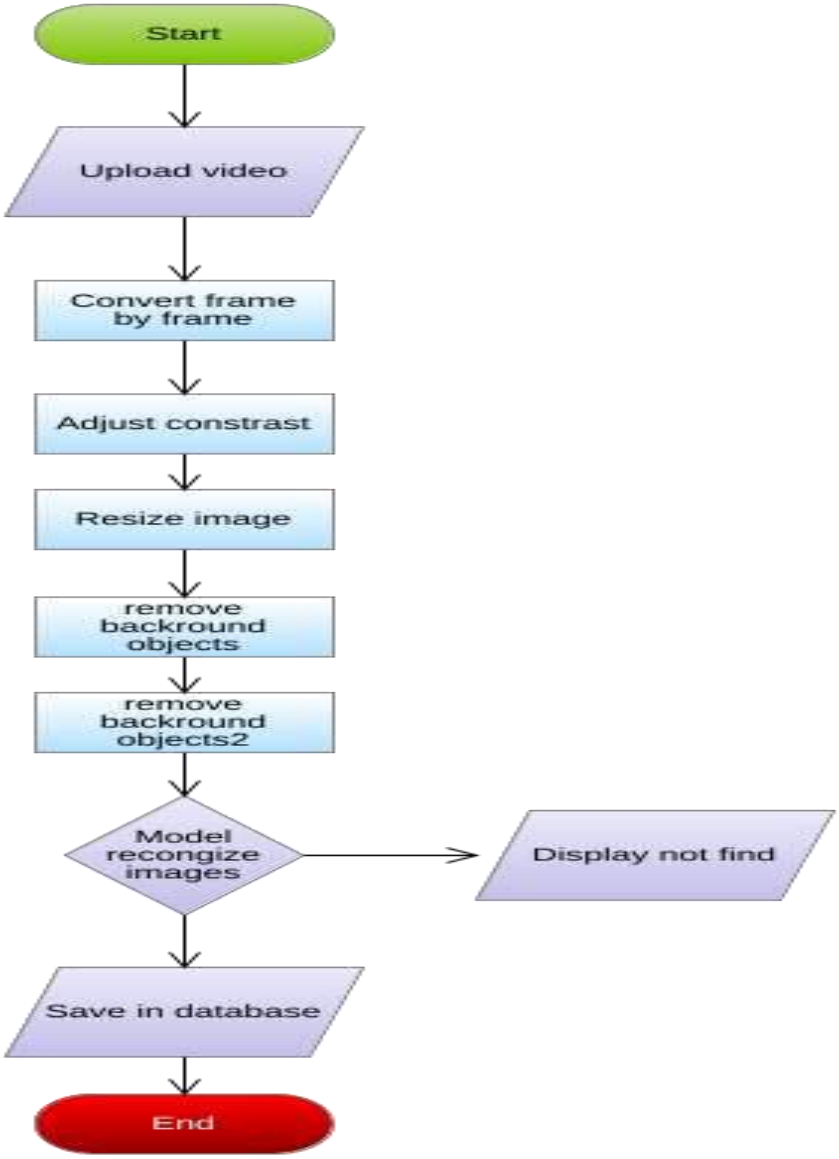


Figure 7- Flow chart

2.5 Development Process

At the beginning of a research project requirements may be unclear or undefined due to presence of various sign language and will be subjected to lot of changes throughout the development cycle. The Agile Scrum model Figure 7 represents the scrum process is an ideal methodology for this kind of a project because it adds more flexibility to the software development life cycle and encourages requirement changes throughout the process of development. Agile follows an incremental and iterative development approach, and each iteration will focus on delivering a working product by adding more dataset. Because our team consists of four people, having daily scrum meetings will allow each member to gain a broad understanding of the project and be aware of issues that other members are experiencing, as all of the functionalities are interdependent. Also, this will improve the collaboration between team members encouraging better team work.

According to the above statement we have chosen this model for our system development.

Figure 8- Agile Scrum model diagram

2.6 Feasibility Study

The project's technical resources must be identified and addressed in order to conduct a feasibility study. In our research project video pre-processing, image background removal, image binary form and machine learning model creation are mainly used technologies. Also feature extraction algorithms and classification algorithms are already used in many pieces of research about hand recognize the technique. In the system video pre-processing I used flask and OpenCV, feature extraction I have used hog transformation algorithms, machine learning model I have used sklearn, pandas, numpy, skimage libraries.

Below list mentioning tools and technologies have been used in our system.

- Opencv
- Flask
- Pandas
- Sklearn
- Sk image
- Numpy
- Scipy

Through all relevant technologies, we can complete this research project.

2.7 Requirement Gathering

This stage is one of the most important steps to take before implementing each system. To understand what procedures must be carried out and what technologies are being utilized, it is important to examine and read a large number of prior research works linked to this Plan. What research gaps have been identified in prior studies and published works. The best source for gathering needs is research documents. In addition, needs were gathered from Google and others who used comparable systems.

Also, we got a survey from the deaf and dumb community and analysed various factors on their requirements which are needed on e-learning platforms for their study purpose and do the communication easier.

2.8 Resources Used

2.8.1 Soft Boundaries

- Visual Studio code

  I have chosen a visual studio code editor for the development tool. It is very easy to use and there are plenty of plugins are available for our research requirements. It works on Windows, Linux, Mac os also.

- GitLab

  We have chosen a version control system as GitLab to maintain our codes and easy to test and maintain our versions of code with consistency and also using Continuous Integration and Continuous Delivery(CI/CD) pipeline through this.

- Microsoft planner

  This is a project management tool from Microsoft. We have used to maintain our progress and monitor our improvement through this. Also, we can schedule our deadline and work accordingly make easy and this tool is very user friendly also.

2.8.2 Hardware Boundaries

- Data storage capacity should more than 1 GB.
- RAM should be over 8GB is good.
- Processor speed should more than 1.0GHz is good.

2.9 Commercialization aspect of the product

The web-based nature of the platform we propose has several advantages when considering its potential LMS value.

- It can be hosted on a cloud platform and provided as a *Software as a Service* (SaaS) product, where the customer will pay a one-time fee or a subscription to use it.
- It can be developed as a website and advertisements can be incorporated into the system.
- It can be developed as a Freemium model, where services are provided free of charge and certain premium services can be provided for a fee such downloading feature, certification and etc.

2.10 Implementation

2.10.1 Video pre-processing

This is contains three sub processing. Converting video to a frame-by-frame format, adjusting contrast, and resizing images are all examples of sub processing. First of all, the system taking video from the database and start video-processing. In the first step of video pre-processing video input will convert frame by frame and store as sequences of images [4][13]. The second step is taking images one by one and analysis the contrast and adjust the contrast according to the requirement. The last step is to resize the image. This step is maintaining a unique size of image and resolution for all images. It will deduce the analysis time for the calculations.

2.10.2 Removal background object

1. After the video pre-processing image will take it for the next step. In this step image's background and objects will remove from here. It makes the image more definition to identify the hand region.

2. I have used techniques to remove the background using skin color detection. Through a maximum and minimum range of skin color, cv2 do the process and find the region on specific pixels areas.

3. The second step is to remove the face from the images. I have used the face detection technique to remove from the images.

4. The next part is to remove unwanted small are of skin color regions. I have used a finding big region technique to remove the small part of the match with skin color areas.

Figure 9- Removal background object image

2.10.3 Convert Image in binary form

The image will be converted to a binary form in this step. The image segmentation approach is used to recognize the hand gesture area in this step [5]. Because of when a change to the binary form of image it will easy to identify the hand region on the image.

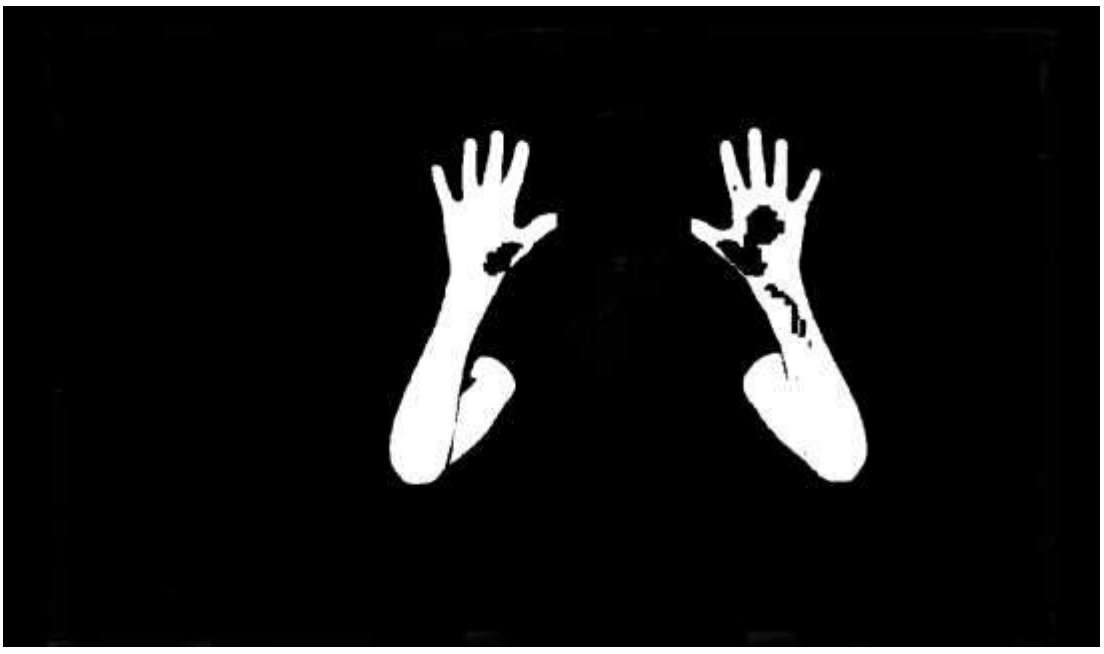


Figure 10- Convert Image in binary form

2.10.4 Feature Extraction and Classification

Feature extraction is used to extract specific characteristics from each identity's distinctive hand picture. The existing frame and the trained picture will be identical. If the hand gestures match each other, then Eigenvectors and Eigen values will extract from the trained image [4].

I have used the hog transformation algorithm for feature extraction. The histogram of oriented gradients (HOG) is a feature description used to detect objects in image processing.

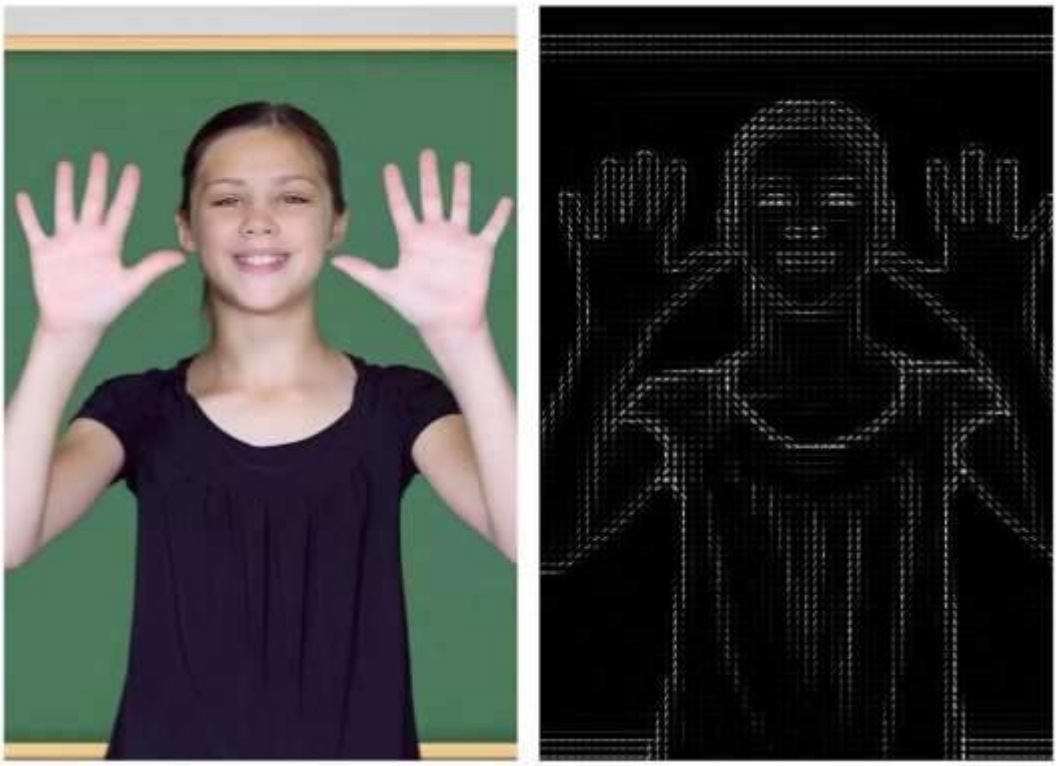


Figure 11 - Feature Extraction (HOG) image

Classification is a method after feature extraction that recognize hand gestures with various hand gestures images. I used here SGD classifier. The Stochastic Gradient Descent (SGD) optimization technique is used to determine the values of parameters/coefficients of functions that minimize a cost function. After the classification outputs will save into the specific database location.

2.10.5 Recognize text and fine tune to native language.

In this step, the feature extraction result will use to find the relevant image's text and gives the text output. It is not a meaningful sentence. Then fine-tune will occur. It will convert raw text result into the meaningful sentences and save into the database.

2.10.6 Dataset Collection

In our research mainly focus on the American sign langue. Therefore I'm using the American Sign Language data set from Kaggle and Microsoft-ASL. Also I have used own data from different people. I have taught and Collect all data sets from them.

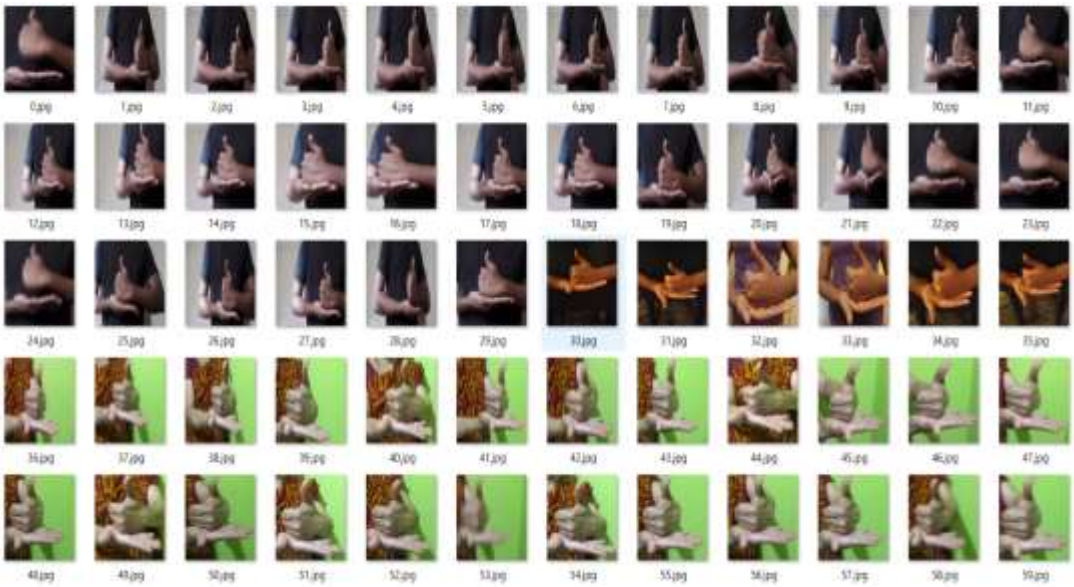


Figure 12- Own dataset

2.11 Testing

In our research project system needs various sorts of testing techniques in various periods of the advancement life cycle. These tests help to distinguish any flimsy parts of the system. Testing is both a perplexing and basic part of the improvement of the application. Application testing incorporates convenience, execution, security, utilitarian and non-practical angles. The testing will upgrade the nature of the item. Distinguish the shortcoming of the system in the beginning phase to stay away from

certain issues. By composing experiments for every activity, bugs and issues can be fixed. Unit testing, module testing, reconciliation testing, and framework testing ought to be accomplished for this candidate positioning application.

2.11.1 Unit Testing

Every single module is tried exclusively and ensure that every one of the functionalities is working effectively as indicated by the prerequisites. Only if each of individual functions are working fine and there is no error then we can easily to integrate with other components. In our research my induvial functions are video pre-processing, background removal, checking the model accuracy and detecting the hand gesture.

2.11.2 Module Testing

During this testing technique, every component, file, class and subsystem is examined. It is completed by a member of the group and also the author is not required to test their modules.

2.11.3 Integration Testing

Integration testing is happening when we integrate our whole system and all functionalities. It is must need testing after integration. Because after the integration sometimes errors will occur or some functionalities not working. This is the purpose to ensure our system working fine and the expected output we are getting.

2.11.4 System Testing

System testing happening after all integration is finished. This stage will check the actual output and expected out. Through that, we can decide test is pass or fail. This stage helps to improve the accuracy of the system and find out any bugs in our system.

I have tested my each functionality below way of approach.

Table 2 - Testing the video-pre processing

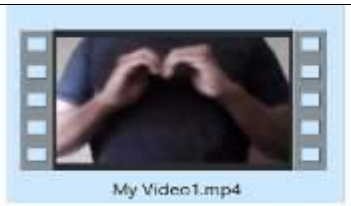
Test case 01	
Description	Testing the video-pre processing
Test Procedure	1.Write pre-processing code 2.Run the Script 3. Save the pre-processing file.
Input	
Expected output	Same size of image and N number of frames.
Actual output	
Pass/ Fail	Pass

Table 3 - Testing the removal background

Test case 02	
Description	Testing the removal background
Test Procedure	1.Write removal background code 2.Run the Script 3. Save the removal background file.
Input	

Expected output	Only detect Skin color other parts should be black
Actual output	
Pass/ Fail	Pass

Table 4 - Testing the removal face area

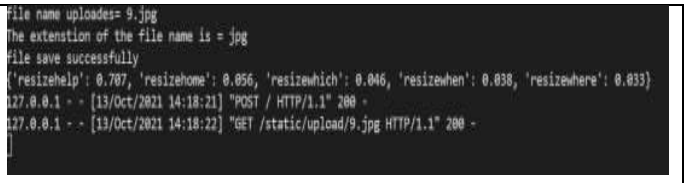
Test case 03	
Description	Testing the removal face area
Test Procedure	1.Write removal face area code 2.Run the Script 3. Save the removal face area file.
Input	
Expected output	Remove face area skin and mask should black color
Actual output	
Pass/ Fail	Pass

Table 5 - Testing the create binary image

Test case 04	
Description	Testing the create binary image
Test Procedure	1.Write binary image code 2.Run the Script 3. Save the removal face area file.
Input	
Expected output	Image appearance should black and white color
Actual output	
Pass/ Fail	Pass

Table 6 - Testing the create binary image

Test case 05	
Description	Testing the model accuracy of hand gesture
Test Procedure	1.Write model accuracy code 2.Run the Script
Input	
Expected output	Detect the particular hand gesture and display name

Actual output	
Pass/ Fail	Pass

3. RESULTS & DISCUSSION

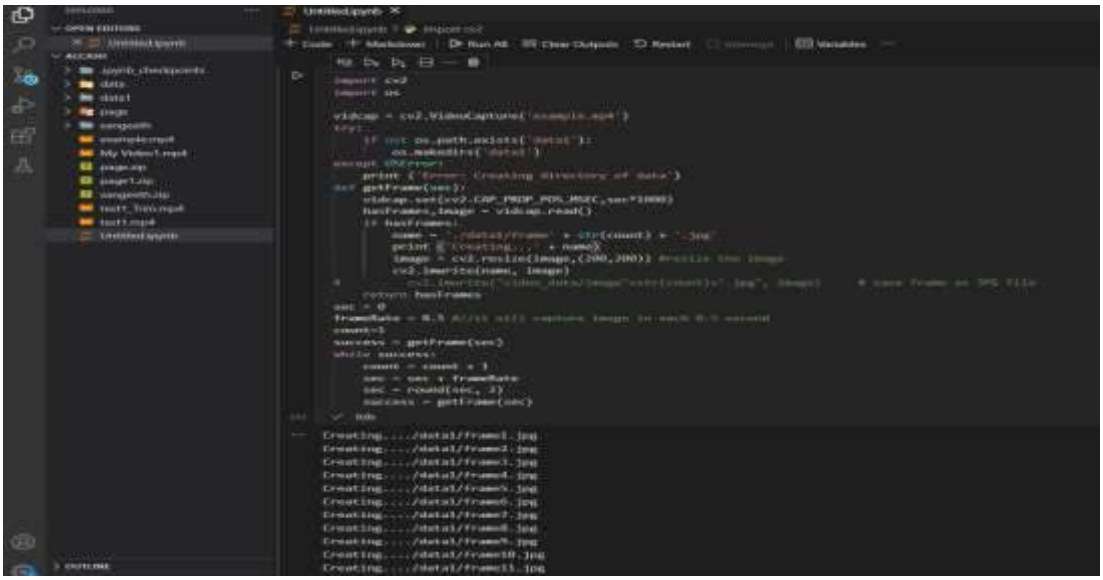
3.1 Results

Here we will discuss the results of our research application. Deaf and a dumb student ask questions and clarify their doubts through the system are very important of this research. It is easy for students are able to discuss with tutors and makes a better understanding of subjects. When comes to e-learning platform especially deaf and dumb students' ability is different from others. Through our system easy way to access the questionaries' sessions and be able to understand both sides.

The major issue is the accuracy of the outputs. When students asking questions through uploading videos should the system give more accurate results. Because they even cannot understand the English language. Our system is fully dependent on more accuracy. We consider the above requirements and came up with good accuracy of the results of each individual and integrated function. In the below scenario, we will discuss more.

3.1.1 Video pre processing

This is the stage of starting my function when the student uploaded a video file after it will do the processing on the video and save it into a database. In the pre-processing video file convert into frame by frame and images are the same size. Each image has a different unique name to make processing easier. The below images show the result of the video pre-processing.



3.1.2 Removal background object and convert into binary form

This is stage two of my research project. I need to remove background objects from the images which are stored in the database after the pre-processing. This very important stage because when we recognize hand gestures image contain only the hand gesture region then easy to detect the gestures.

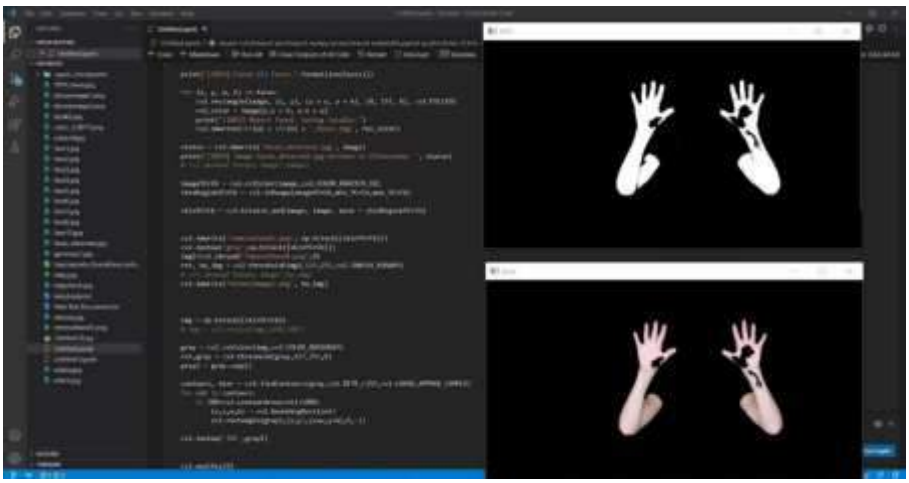


Figure 14 - Removal background object and convert into binary form result

Face detection code and make remove it - code

```python
import cv2
import sys
import numpy as np
import matplotlib.pyplot as plt

min_YCrCb = np.array([0,133,77],np.uint8)
max_YCrCb = np.array([235,173,127],np.uint8)
imagePath = sys.argv[1]

image = cv2.imread('face5.jpg')
image=cv2.resize(image,(640,360))

gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
cv2.imshow("original Image",image)
faceCascade = cv2.CascadeClassifier(cv2.data.haarcascades + "haarcascade_frontalface_default.xml")
faces = faceCascade.detectMultiScale(
    gray,
    scaleFactor=1.3,
    minNeighbors=3,
    minSize=(30, 30)
)

print("[INFO] Found {0} Faces.".format(len(faces)))

for (x, y, w, h) in faces:
    cv2.rectangle(image, (x, y), (x + w, y + h), (0, 255, 0), cv2.FILLED)
    roi_color = image[y:y + h, x:x + w]
    print("[INFO] Object found. Saving locally.")
    cv2.imwrite(str(w) + str(h) + '_faces.jpg', roi_color)

status = cv2.imwrite('faces_detected.jpg', image)
print("[INFO] Image faces_detected.jpg written to filesystem: ", status)
# cv2.imshow("Binary Image",image)
```

Figure 15 - Face detection code and make remove code

Convert image into binary form - code

```
imageYCrCb = cv2.cvtColor(image,cv2.COLOR_BGR2YCR_CB)
skinRegionYCrCb = cv2.inRange(imageYCrCb,min_YCrCb,max_YCrCb)

skinYCrCb = cv2.bitwise_and(image, image, mask = skinRegionYCrCb)


cv2.imwrite("removalhand1.png", np.hstack([skinYCrCb]))
cv2.imshow("gray",np.hstack([skinYCrCb]))
img2=cv2.imread("removalhand1.png",0)
ret, bw_img = cv2.threshold(img2,127,255,cv2.THRESH_BINARY)
# cv2.imshow("Binary Image",bw_img)
cv2.imwrite("binaryimage1.png", bw_img)



img = np.hstack([skinYCrCb])
# img = cv2.resize(img,(640,360))

gray = cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)
ret,gray = cv2.threshold(gray,127,255,0)
gray2 = gray.copy()

contours, hier = cv2.findContours(gray,cv2.RETR_LIST,cv2.CHAIN_APPROX_SIMPLE)
for cnt in contours:
    if 200<cv2.contourArea(cnt)<5000:
        (x,y,w,h) = cv2.boundingRect(cnt)
        cv2.rectangle(gray2,(x,y),(x+w,y+h),0,-1)

cv2.imshow('IMG',gray2)


cv2.waitKey(0)
cv2.destroyAllWindows()
```

```
[INFO] Found 1 Faces.
[INFO] Object found. Saving locally.
[INFO] Image faces_detected.jpg written to filesystem:  True
```

Figure 16 - Convert image into binary form - code

3.1.3 Feature Extraction

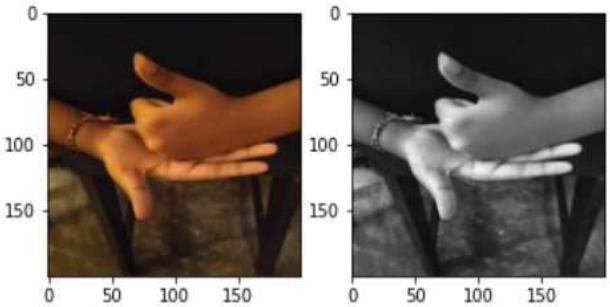
The method of distributing and reducing the initial set of source data into more manageable categories is called feature extraction. Below images show the result of feature extraction.

Preprocessing

- Grayscale
- Hog (histogram oriented gradient) tranformer

```
In [23]: from sklearn.base import BaseEstimator, TransformerMixin

In [24]: from skimage.color import rgb2gray

In [25]: class rgb2gray_transform(BaseEstimator,TransformerMixin):
             import skimage.color
             def __init__(self):
                 pass

             def fit(self,X,y=None):
                 return self

             def transform(self,X,y=None):
                 return np.array([skimage.color.rgb2gray(x) for x in X])

In [26]: x_train.shape
Out[26]: (388, 200, 200, 3)

In [27]: rgb2grayobj = rgb2gray_transform()
         x_train_gray = rgb2grayobj.fit_transform(x_train)

In [28]: x_train_gray.shape
Out[28]: (388, 200, 200)
```

```
In [29]: plt.subplot(1,2,1)
         plt.imshow(x_train[12])
         plt.subplot(1,2,2)
         plt.imshow(x_train_gray[12],cmap='gray')
Out[29]: <matplotlib.image.AxesImage at 0x1efb4ceceb0>
```



```
In [30]: class hogtransformer(BaseEstimator,TransformerMixin):
             import skimage.feature
             def __init__(self,orientations=9,pixels_per_cell=(8, 8),cells_per_block=(3, 3),):
                 self.orientations = orientations
                 self.pixels_per_cell = pixels_per_cell
                 self.cells_per_block = cells_per_block


             def fit(self,X,y=None):
                 return self

             def transform(self,X,y=None):
                 def local_hog(img):
                     hog_features= skimage.feature.hog(img,orientations=self.orientations,
                                         pixels_per_cell=self.pixels_per_cell,
                                         cells_per_block=self.cells_per_block)

                     return hog_features

                 hfeatures = np.array([local_hog(x) for x in X])
                 return hfeatures

In [31]: hogt = hogtransformer()

In [32]: x_train_hog = hogt.fit_transform(x_train_gray)

In [33]: x_train_hog.shape

Out[33]: (388, 42849)
```

Figure 17 - Feature Extraction result

3.1.4 Model Results

Finally I have tested this functionality with a machine learning model and Figure 18 shows the Cohen kappa score accuracy of 0.803 and it predicted 80% of images according to the relevant label and I have used this model for my function on the project.

Model Evaluation

```
In [41]: cr = sklearn.metrics.classification_report(y_test,y_pred_test,output_dict=True)
         pd.DataFrame(cr).T
```

Out[41]:

	precision	recall	f1-score	support
resizedrink	1.000000	1.000000	1.000000	5.000000
resizehelp	1.000000	1.000000	1.000000	15.000000
resizehome	0.500000	0.200000	0.285714	5.000000
resizehow	0.750000	1.000000	0.857143	6.000000
resizeno	0.636364	0.700000	0.666667	10.000000
resizewhat	0.857143	0.923077	0.888889	13.000000
resizewhen	0.928571	0.866667	0.896552	15.000000
resizewhere	0.800000	0.800000	0.800000	10.000000
resizewhich	0.800000	0.923077	0.857143	13.000000
resizeyes	0.500000	0.333333	0.400000	6.000000
accuracy	0.826531	0.826531	0.826531	0.826531
macro avg	0.777208	0.774615	0.765211	98.000000
weighted avg	0.814644	0.826531	0.814130	98.000000

```
In [42]: metrics.cohen_kappa_score(y_test,y_pred_test)
Out[42]: 0.8034218289085546
```

Figure 18 - Model Cohen kappa score

3.1.5 Rest API (Flask) Results

I have used flask for my back API creation. The below code shows the results of rest API for the sign language to convert into text.

```
File name uploades= 9.jpg
The extenstion of the file name is = jpg
File save successfully
{'resizehelp': 0.707, 'resizehome': 0.056, 'resizewhich': 0.046, 'resizewhen': 0.038, 'resizewhere': 0.033}
127.0.0.1 - - [13/Oct/2021 14:18:21] "POST / HTTP/1.1" 200 -
127.0.0.1 - - [13/Oct/2021 14:18:22] "GET /static/upload/9.jpg HTTP/1.1" 200 -
```

3.2 Model Evaluation

Here we will look into the model evaluation. This phase is a subset of the model creation process. It is during this phase that the model's performance is determined. As a result, it's important to think about the model's outputs through every potential

assessment technique. Using a variety of approaches can result in a variety of viewpoints.

In the model evaluation, we can measure the accuracy level of the machine learning model using Cohen's kappa score. Cohen's kappa is a popular measure for determining how well two raters agree. It may also be used to judge a classification model's effectiveness. According to Cohen, values of ≤ 0 indicate no agreement, 0.01–0.20 indicate none to the sparse agreement, 0.21–0.40 indicate fair agreement, 0.41– 0.60 indicate moderate agreement, 0.61–0.80 indicate significant agreement and 0.81–1.00 indicate virtually perfect agreement.

Out[180]:

	precision	recall	f1-score	support
book	1.0	1.0	1.0	20.0
boring	1.0	1.0	1.0	17.0
easter	1.0	1.0	1.0	26.0
fail	1.0	1.0	1.0	21.0
germany	1.0	1.0	1.0	12.0
library	1.0	1.0	1.0	33.0
like	1.0	1.0	1.0	14.0
phone	1.0	1.0	1.0	31.0
signlanguage	1.0	1.0	1.0	23.0
accuracy	1.0	1.0	1.0	1.0
macro avg	1.0	1.0	1.0	197.0
weighted avg	1.0	1.0	1.0	197.0

```
In [179]: metrics.cohen_kappa_score(y_test,y_pred_test)
Out[179]: 1.0
```

On the second run I got better result than the previous result.

Out[25]:

	precision	recall	f1-score	support
resizedrink	1.000000	0.600000	0.750000	5.000000
resizehelp	0.866667	0.866667	0.866667	15.000000
resizehome	0.750000	0.600000	0.666667	5.000000
resizehow	0.444444	0.666667	0.533333	6.000000
resizeno	0.400000	0.600000	0.480000	10.000000
resizewhat	0.800000	0.923077	0.857143	13.000000
resizewhen	0.833333	0.666667	0.740741	15.000000
resizewhere	0.692308	0.900000	0.782609	10.000000
resizewhich	0.857143	0.461538	0.600000	13.000000
resizeyes	0.600000	0.500000	0.545455	6.000000
accuracy	0.704082	0.704082	0.704082	0.704082
macro avg	0.724389	0.678462	0.682261	98.000000
weighted avg	0.744720	0.704082	0.706491	98.000000

In [27]:
```
metrics.cohen_kappa_score(y_test,y_pred_test)
```

Out[27]:
```
0.6661968522433639
```

Finally I have tested this functionality with a machine learning model and Fig (17) shows the Cohen kappa score accuracy of 0.803 and it predicted 80% of images according to the relevant label and I have used this model for my function on the project.

Model Evaluation

```
In [41]: cr = sklearn.metrics.classification_report(y_test,y_pred_test,output_dict=True)
         pd.DataFrame(cr).T
```

Out[41]:

	precision	recall	f1-score	support
resizedrink	1.000000	1.000000	1.000000	5.000000
resizehelp	1.000000	1.000000	1.000000	15.000000
resizehome	0.500000	0.200000	0.285714	5.000000
resizehow	0.750000	1.000000	0.857143	6.000000
resizeno	0.636364	0.700000	0.666667	10.000000
resizewhat	0.857143	0.923077	0.888889	13.000000
resizewhen	0.928571	0.866667	0.896552	15.000000
resizewhere	0.800000	0.800000	0.800000	10.000000
resizewhich	0.800000	0.923077	0.857143	13.000000
resizeyes	0.500000	0.333333	0.400000	6.000000
accuracy	0.826531	0.826531	0.826531	0.826531
macro avg	0.777208	0.774615	0.765211	98.000000
weighted avg	0.814644	0.826531	0.814130	98.000000

```
In [42]: metrics.cohen_kappa_score(y_test,y_pred_test)
```

```
Out[42]: 0.8034218289085546
```

Figure 19 - Cohen kappa score accuracy

3.3 Research Findings

The ultimate intention of this research project was to develop a system that would allow hearing-impaired students to learn independently via online platforms, without the need for support from others. The test show that it was about 100% of the results.

Hence, our developed system is found to consist of the following features.

1. Accurate and Reliable

As the translations of the captions are tested by many test cases, it was found they were very accurate, that the meaning of the sentences was not collapsed. Therefore, it will be useful for students to learn without any doubts about the conversion system.

2. User-friendly interface

Since the development was done to minimize the difficulties faced during the online learning, it was made sure all the things in the application should be simple enough and must have a user-friendly interface.

3. High speed

The conversions take place very rapidly since the data has been already put into the system's database. The process is to find the matching words with the same labels as the videos.

Although our system has the good features mentioned above, there is a con to it. The output that is generated from the system relies on the vocabulary scale which is fed to the system database. Therefore, some words might be missed, but very rarely.

3.4 Discussion

This chapter discusses the results obtained from the development of the application. We have achieved an accuracy of 85% accuracy for the system. Most of the accuracy level is depends on the conversion between sign language into ASL with the proof of test cases our system archived 85% of accuracy by developing the system.

When comparing the sign language to text functionality with other existing systems it is proofed that there is no existing LMS system for hearing impaired students is available by doing this research. Since there is no existing LMS for hearing impaired students out system with 85% accuracy is considered as the best success rate by developing this system.

3.5 Future Works

In my future work, I should consider the accuracy level. Now I have got only more than 80% I should increase the level of accuracy level more than 90%. After we can fully consider our model more suitable for this solution. In the future, I need to collect more data sets for the words because on the internet and outsources there is a lack of data sets available for the sign language words. Some sign languages are motion-based that also need to use other technologies to identify the words. I need to find the best NLB to rearrange the sentence according to ASL's grammar. In the future also we need to create multiple language recognizing systems and it could use full for all around the world's deaf and dumb students.

The next point is I need to test different complex backgrounds and colors also. Then it is easy for the student when taking a question video. Another point is I have made this solution for a small length of videos. In future, I try to increase the length of video conversion with a very quick processing time and also in the future UI perspective view also should improve for user-friendliness to deaf and dumb students.

4. CONCLUSION

In conclusion, this research work is about developing a learning management system for hearing impaired students. Since technology is growing very fast in every sector the education sector also rapidly moving into an online-based education system. When it comes to normal people it is very convenient for them to learn and interact with the tutors through the learning management system especially during the pandemic situation but when it comes to hearing-impaired students they are facing many difficulties while the education sector is migrating into online platform because of this problem we came up with a solution to solve the communication barrier between the tutor and hearing-impaired students and the education barrier. Therefore, in this function, deaf and dumb students ask a question through uploading videos to the system once it is uploaded the system will do the pre procession and detect the sign language frame by frame and convert into a meaning full sentence and save it on the database. After the relevant forum page can retrieve the question.

The sign to text conversion module in the research has been successfully developed and tested that it accommodates the hearing disabled students to fulfil their requirements and eliminate struggles in shifting to the e-learning platform. The system flawlessly converts sign language into text and fine-tunes the question sentence. Therefore, it is hoped that they benefit from this and more users will find this enlightening for their studies.

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APPENDICES

Flask API code

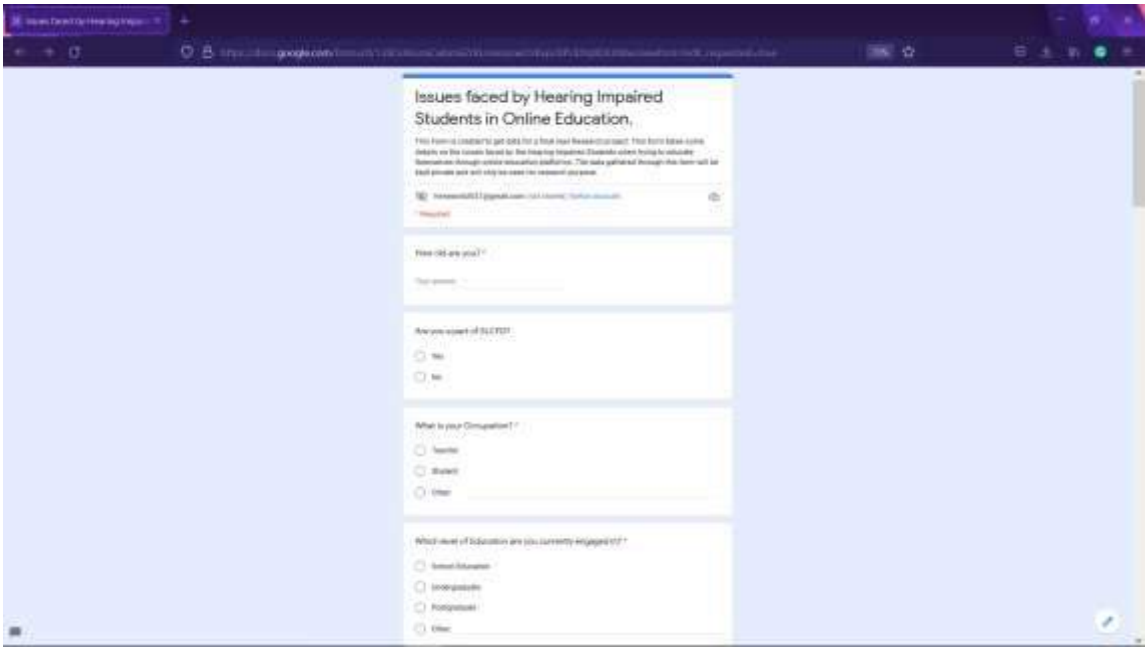
```
from flask import Flask , render_template
from flask import request
from werkzeug.utils import html
import os
import pickle
import numpy as np
import pandas as pd
import scipy
# import sklearn
from sklearn.pipeline import make_pipeline
# import os
import json

# skimage
import skimage
import skimage.color
import skimage.transform
import skimage.feature
import skimage.io

app = Flask(__name__)
```

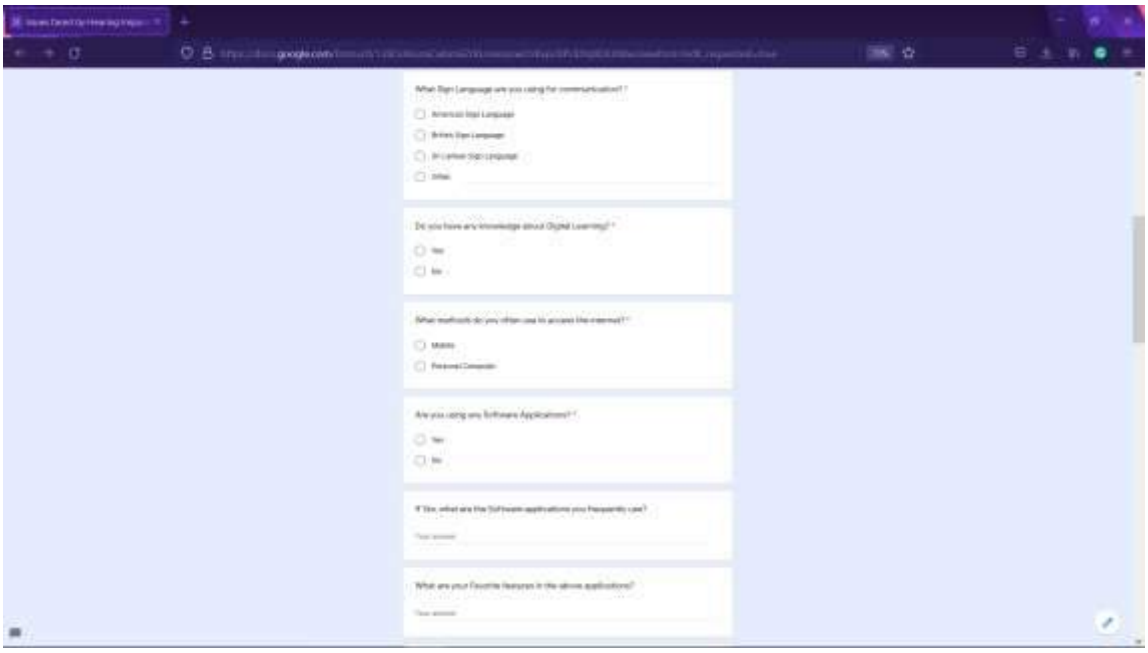
```
            results=pipeline_model(path_save,scaler,model_sgd)
            # hei=getheight(path_save)
            print(results)


            return render_template('index.html' ,fileupload=True,data=results, image_filename=filename)

        else:
            print('use only valite extensions')
            return render_template('index.html')



    else:
        return render_template('index.html ')

def pipeline_model(path,scaler_transform,model_sgd):
    # pipeline model
    image = skimage.io.imread(path)
    # transform image into 80 x 80
    image_resize = skimage.transform.resize(image,(200,200))
    image_scale = 255*image_resize
    image_transform = image_scale.astype(np.uint8)
    # rgb to gray
    gray = skimage.color.rgb2gray(image_transform)
    # hog feature
    feature_vector = skimage.feature.hog(gray,
                                         orientations=10,
                                         pixels_per_cell=(8,8),cells_per_block=(2,2))
    # scaling
```

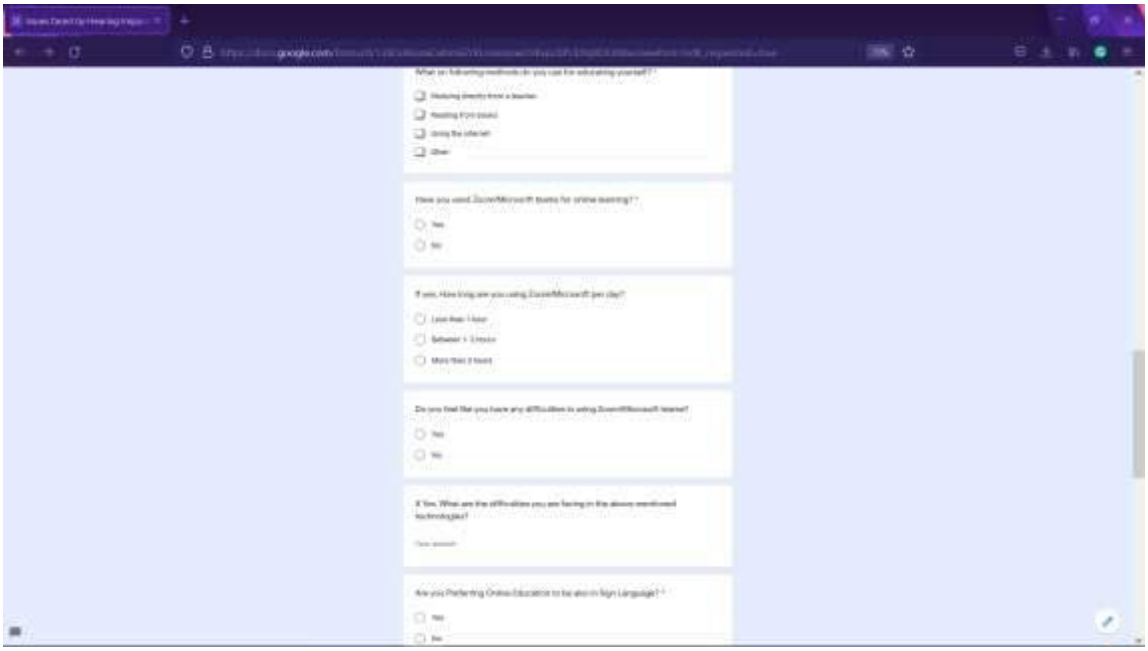
```
BASE_PATH=os.getcwd()
UPLOAD_PATH=os.path.join(BASE_PATH,'static/upload/')
MODEL_PATH=os.path.join(BASE_PATH,'static/models/')

#load model
model_sgd_path=os.path.join(MODEL_PATH,'asl_words_image_classification_sgd.pickle')
scaler_path=os.path.join(MODEL_PATH,'asl_scaler.pickle')
model_sgd = pickle.load(open(model_sgd_path,'rb'))
scaler = pickle.load(open(scaler_path,'rb'))



@app.route('/',methods=['GET','POST'])
def index():
    if request.method == "POST":
        upload_file=request.files['image_name']
        filename=upload_file.filename
        print('file name uploades=',filename)
        #know the extension of the file name
        #allow only some .....

        ext=filename.split('.')[-1]
        print('The extenstion of the file name is =',ext)
        if ext.lower() in ['png','jpg','jpeg']:
            path_save=os.path.join(UPLOAD_PATH,filename)
            upload_file.save(path_save)
            print("file save successfully")
```

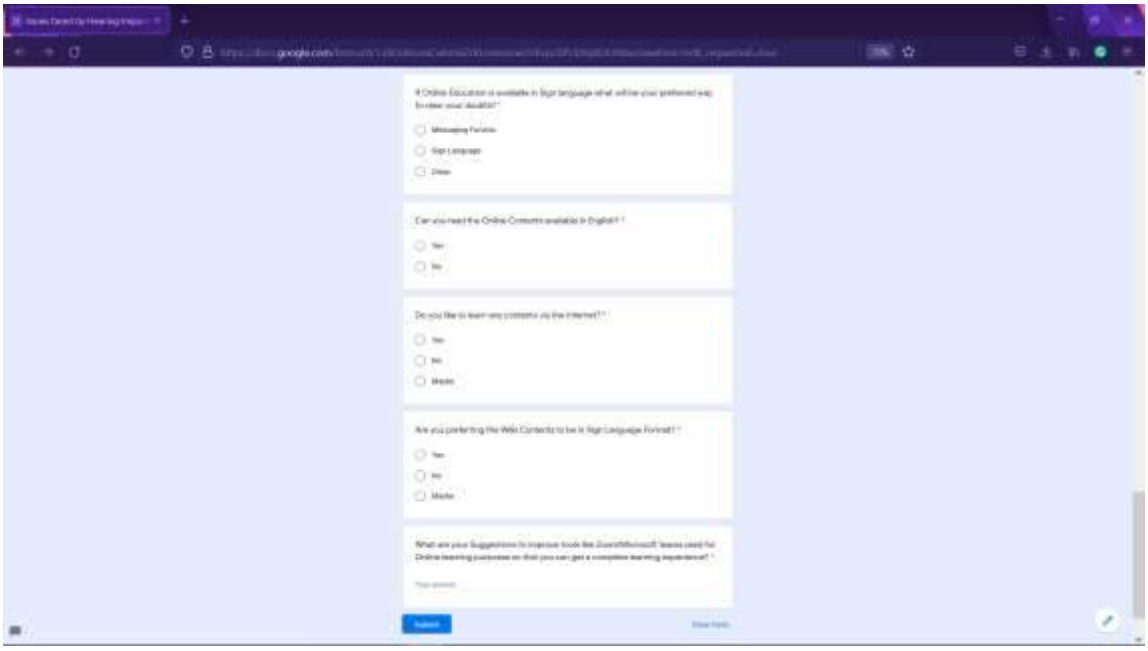
```
    scalex = scaler_transform.transform(feature_vector.reshape(1,-1))
    result = model_sgd.predict(scalex)
    # decision function # confidence
    decision_value = model_sgd.decision_function(scalex).flatten()
    labels = model_sgd.classes_
    # probability
    z = scipy.stats.zscore(decision_value)
    prob_value = scipy.special.softmax(z)

    # top 5
    top_5_prob_ind = prob_value.argsort()[::-1][:5]
    top_labels = labels[top_5_prob_ind]
    top_prob = prob_value[top_5_prob_ind]
    # put in dictornary
    top_dict = dict()
    for key,val in zip(top_labels,top_prob):
        top_dict.update({key:np.round(val,3)})

    return top_dict


if __name__ == "__main__":
    app.run(debug=True)
```

Survey

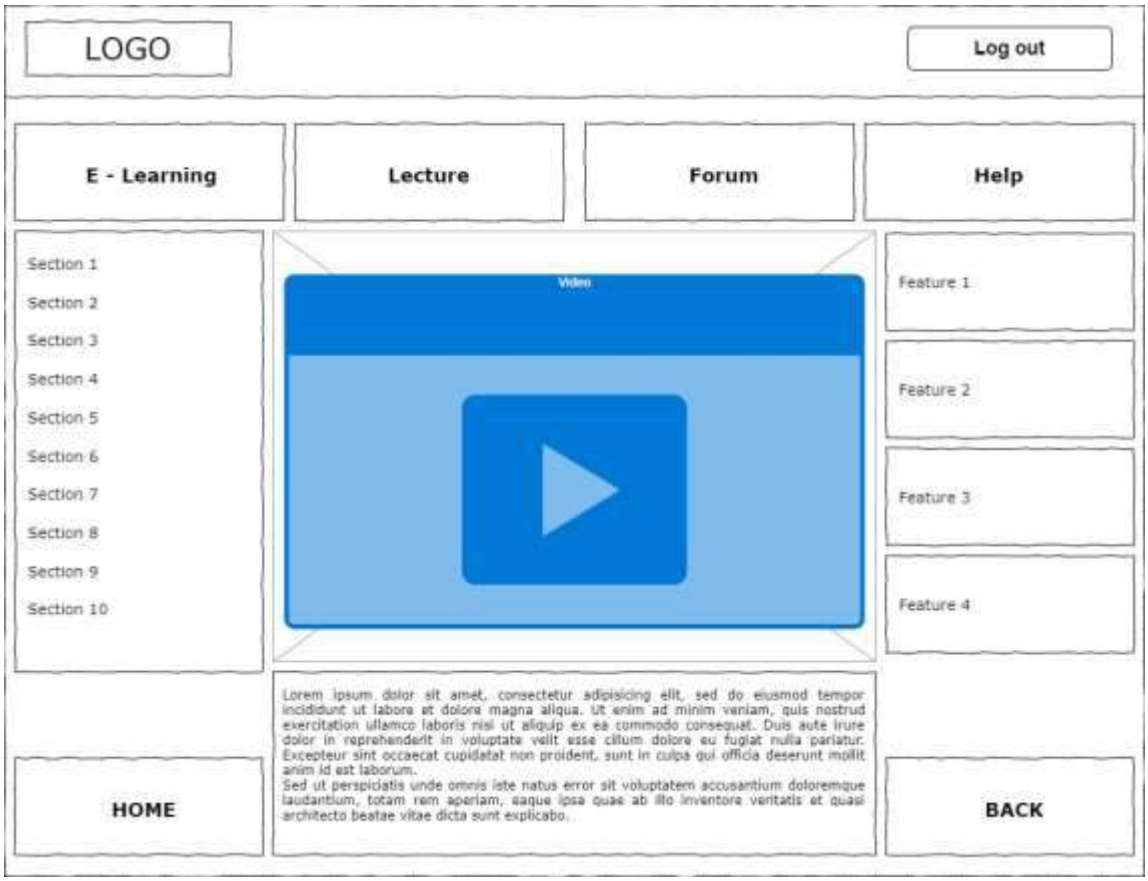

Issues faced by Hearing Impaired Students in Online Education.







Wireframe


LOGO
Log out
E - Learning
Lecture
Forum
Help
Section 1
Section 2
Section 3
Section 4
Section 5
Section 6
Section 7
Section 8
Section 9
Section 10
Video
Feature 1
Feature 2
Feature 3
Feature 4
Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.
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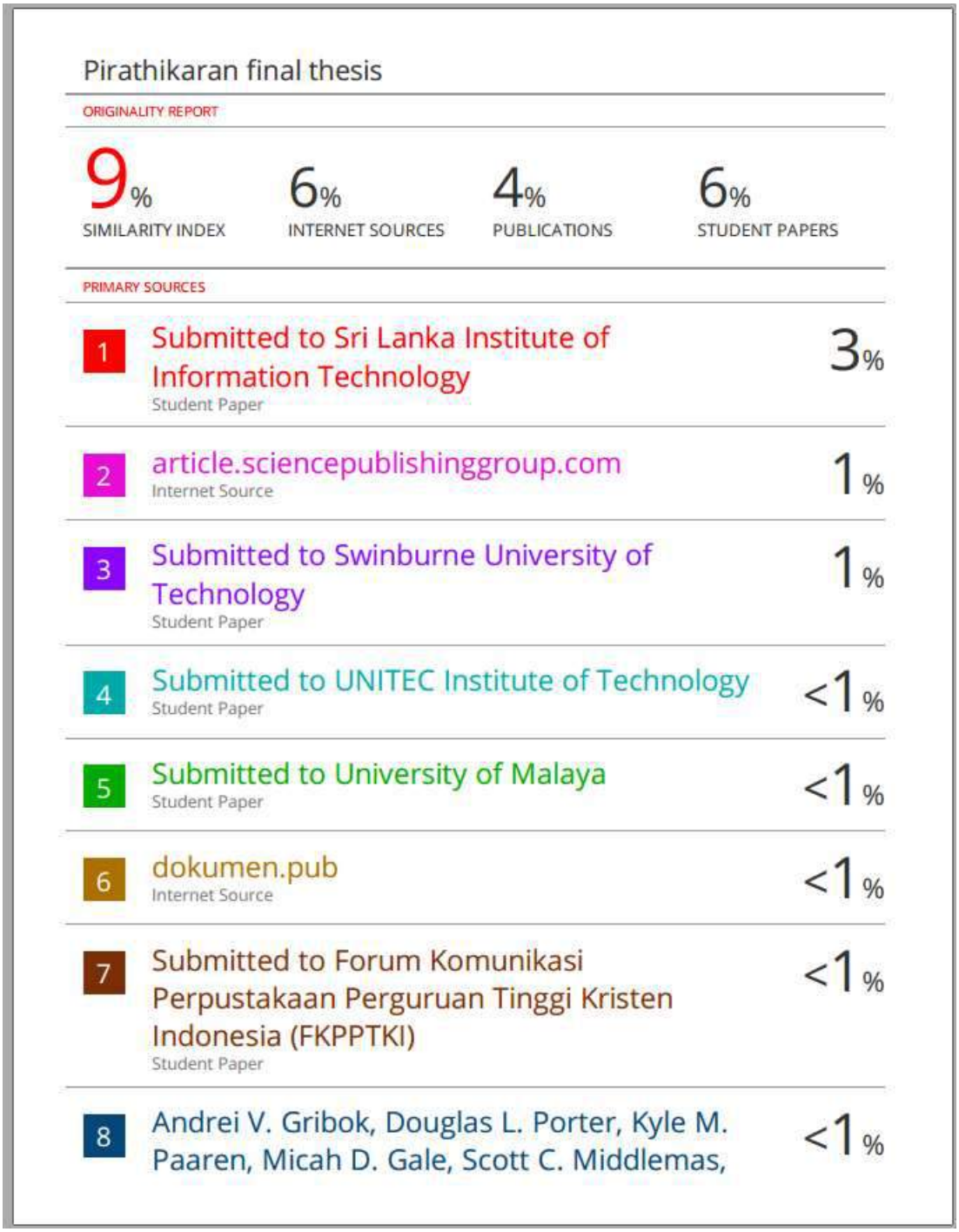

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