E-LEARNING SYSTEM FOR HEARING IMPAIRED STUDENTS

Project ID : Tmp_2021_176

Project Proposal Report

Niroshan Krishnamoorthy - IT18144772

B.Sc. (Hons) Degree in Information Technology

Department of Software Engineering

Sri Lanka Institute of Information Technology
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Supervised by – Miss. Janani Tharmaseelan

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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.

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Niroshan K.	IT18144772	

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

Name of supervisor: Ms. Janani Tharmaseelan

Name of co-supervisor: Ms. Samanthi Erang Siriwardene

…….. ……

Signature of the supervisor: Date

(Ms. Janani Tharmaseelan)

…….. ……

Signature of the co-supervisor: Date

(Ms. Samanthi Erang Siriwardene)

Abstract

With the Spread of Global Pandemic Covid-19 the Learning was transformed to Online learning from traditional learning. The use of eLearning platforms was increased. But this had issues with certain communities of people around the world. The hearing-impaired people had many issues with eLearning platforms because of their deficiency in hearing sound. Therefore, we are proposing a platform through which hearing impaired people effectively involve in learning. The proposing system will use sign language in addressing the students. We also introduce ways on which hearing impaired students can communicate with the tutors.

The proposing eLearning platform mainly uses recorded videos to be uploaded to the system by the tutor. The uploaded video will be enhanced using algorithms. The algorithms mainly use denoising techniques, low-light image enhancement and smoothing techniques. Then the Audio will be extracted from the uploaded video and use many robust speech detection techniques to convert the speech within the audio to text. The text output will be then used for real time captioning for the Video.

Keywords: *Video Processing, Image Processing, Speech Recognition, MIRnet, Tone Adjustment*

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LIST OF ABBREVIATIONS

Abbreviations	Description
ML	Machine Learning
CNN	Convolutional Neural Network
NLP	Natural Language Processing
WHO	World Health Organisation
PSNR	Peak Signal to Noise Ratio

1. INTRODUCTION

1.1 Background Study

In the year 2020 the World encountered a Global Pandemic Problem with the spread COVID-19 virus. This pandemic situation transformed many of the industries to Online basis with the use of Internet. This new transform of Industries to Online was quickly adapted by the people around the globe. One such sector of which transformed to Online was the education sector where students started learning through online platforms. Even though this transform was effective in continuing the learning some group of people encountered lots of difficulties compared to traditional learning. One such group of people is the Hearing-Impaired people. In [1] the author states that the study made by WHO had suggested that approximately 466 million of total population around the world has some sort of hearing deficiency in 2018. This is a total of 6.1% of the world's population. Out of this 432 million are adults and 34 million are children.

According to the statistics proposed by J.Elflein in [2] South Asian region had the maximum number of hearing impaired population in 2018 which is 131 million. It is expected to increase to 267 at the end of the year 2050. And also, the hearing-impaired population on different regions on the globe is statistically displayed in the Fig 1.1.1

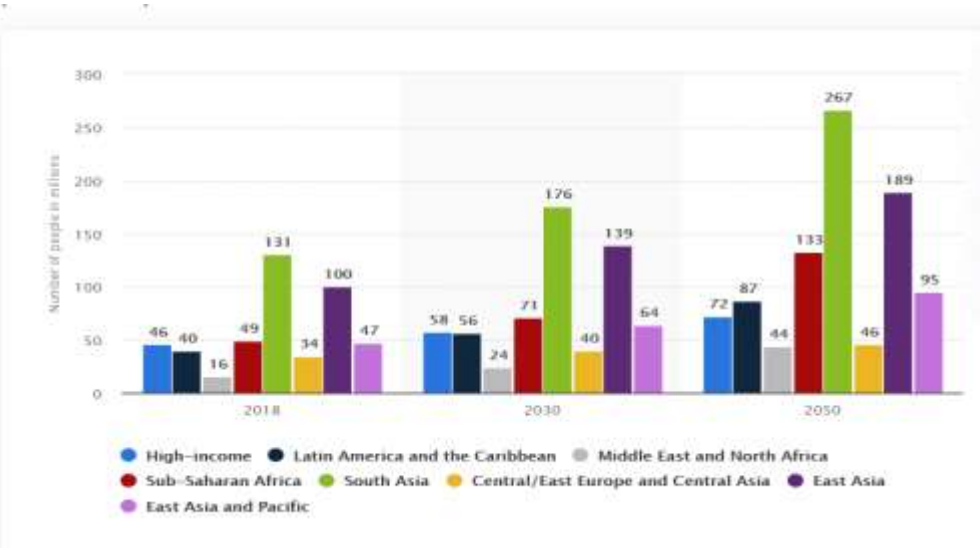

Figure 1.1.1 : Number of people with hearing loss worldwide

According to the above stats we can identify that the population of hearing-impaired people is significant amount. Hence it is very important to find the problems faced by this community and provide solutions.

Recently the shift towards eLearning has increased quite significantly that the traditional learning methods. According to I. Moriera in [3] he has showed that there is a general shift towards online learning among many students. The Fig 1.1.2 shows the reasons for shift in the learning style.

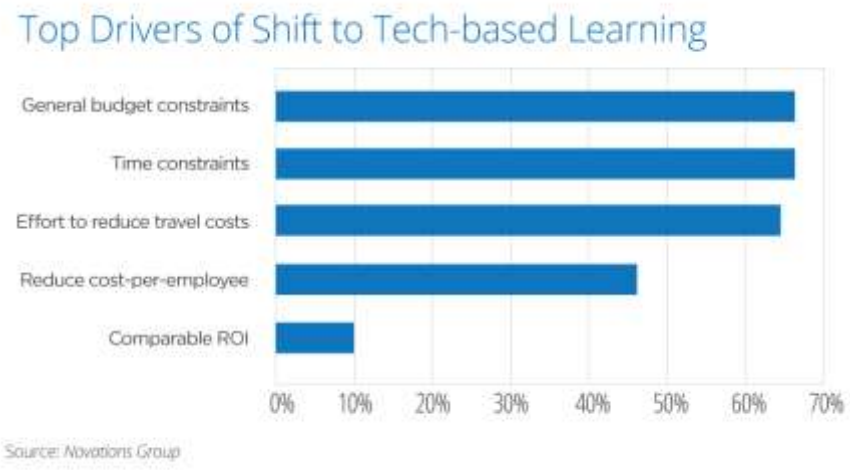

Figure 1.1.2 : Top Drivers of Shift to eLearning

Fig 1.1.2 shows us the main Drivers to shift to eLearning trend and the percentage rates for which students have chosen the eLearning. We can see that more than 60% of students have chosen the Drivers General Budget constraints, Time constraints and Effort to reduce travel cost as their key Drivers to shift towards eLearning. These outcomes show us that the eLearning system has solved many problems that was available in the traditional base learning. Along with these drivers the global pandemic of 2020 was also a major reason for the whole world to shift to online base learning.

According to [4], The Authors have conducted a study on the Impact of eLearning within the students of two universities in Saudi Arabia. The Authors have used Success/Impact measurement techniques for measuring the results from the study.
The analysis of the results shows eLearning systems has increased the ability to interpret information accurately. And also, eLearning systems has increased the students understanding of the area of study. Therefore, the overall study indicates that the use of eLearning has a positive impact on students.

With all these advantages eLearning systems also comes with some major drawbacks which have been addressed by the people around the world. According to the article [5] the study has found out many challenges related to eLearning system as show in Fig 1.1.3

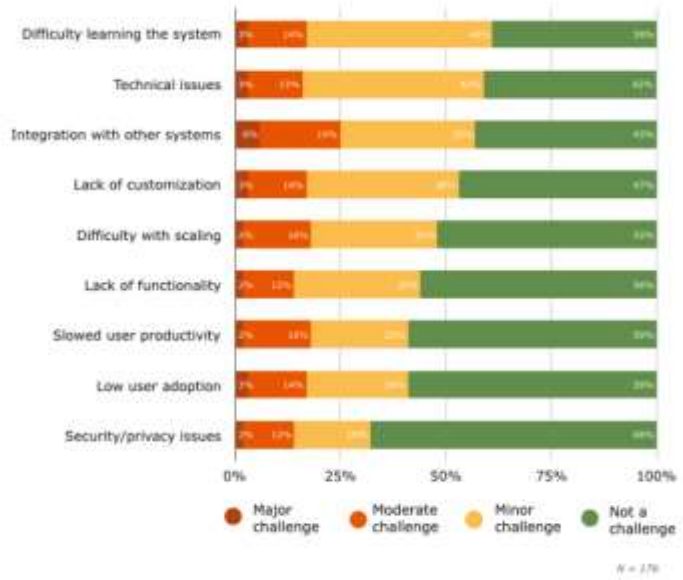

Figure 1.1.3: Biggest eLearning Challenges

According to the fig 1.1.3 the study shows us that slowed user productivity, Low user adoption and Difficult to learning the system are some common challenges faced by many groups of students around the world.

With all these disadvantages the hearing-impaired students face a major issue with accessibility of these type of eLearning systems [6]. Authors of also state that even

though MOOC platforms contain audio and visual content in the eLearning environment these platforms need additional features in terms of accessibility requirements for visual and hearing impairment students.

Many Scholars suggest that eLearning stakeholders should support efforts to develop interactive learning systems through instructional interfaces for users who experience the limitation of hearing that prevents them from “receiving sounds through the ear” [7].

With all these research that has been done in the past it is vital to understand that the use of a proper eLearning system that supports hearing-impaired students to continue and improve their learning skills. Hence eLearning is the most effective way of learning in the modern world [4].

Based on the above findings it is clear that there was a need for an eLearning system that can solve the problems faced by the hearing-impaired community. To Add on to this statement we conducted a survey which gathered some information on how a proper eLearning system can be helpful for the hearing-impaired community.

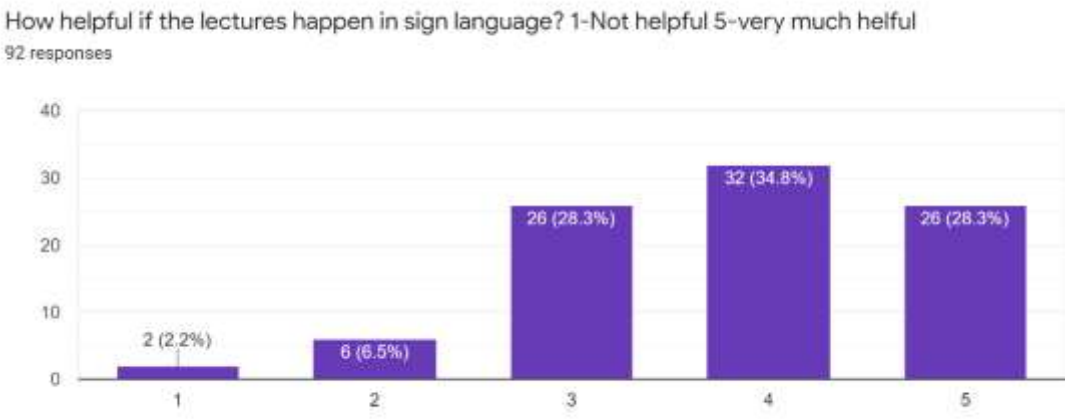

Figure 1.1.4: lecture in Sign language response

The fig 1.1.4 shows the results of how helpful it will be if the lectures happen in sign language. According to the results most of the responses depict that it's better when lectures happen in sign language. The reason for getting such a result is because many people or students had faced problems because they couldn't properly understand what is being taught or when tutors can't convey what they are trying to teach because of the conversational gap that is available between the hearing-impaired community. Therefore, it is clear that we need a proper eLearning system that can fill the gap between hearing-impaired community and others.

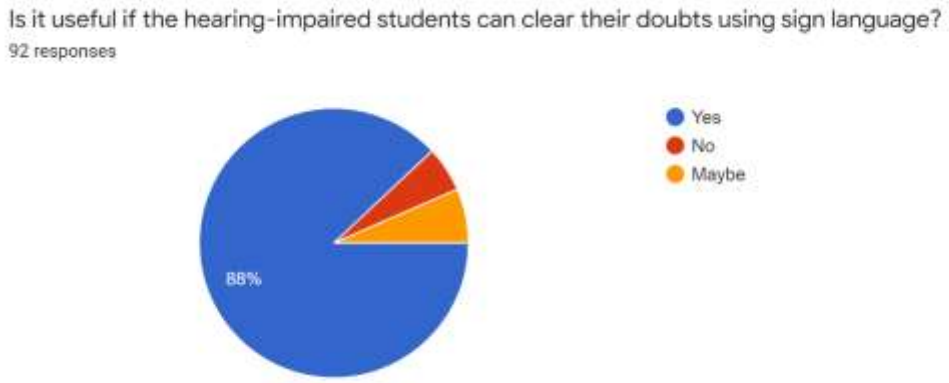

Figure 1.1.5: Clearing doubts through sign language

In our survey we also got the results on how hearing-impaired students can be affected when they are trying to clear their doubts. According to the fig 1.1.5, 85% of the responses state that it will be helpful if we can provide a way for hearing impaired students can clear their doubts using sign language. This is because the existing eLearning systems do not have a way for hearing-impaired students to communicate with the tutors.

Based on the survey that is conducted we have clearly identify where the hearing-impaired community faces their problems when it comes to learning and how we can utilize the technological advancements to provide a better solutions to the problems that are faced by the hearing-impaired students when learning.

1.2 Literature survey

For problems faced by hearing impaired people researches have proposed many solutions. But most of them are to reduce the communication gap between them. In [8] the authors have proposed an interpreter system to that can be used as an Android application. This application can convert the sign language into Normal speaking language. The proposed model was very successful for conveying messages from deaf people to others. The Authors have also stated that usage of these solution in various application where the hearing-impaired people can get maximum productivity throughout the day. According to the authors they are planning to use this solution in application like gesture-controlled robot, gesture-controlled doors and vehicles, gesture-controlled keyboard and mouse to interact with the computer and gesture-controlled appliances. Many solutions like this have been introduced to the hearing-impaired community but most of them are for to act as an interpreter of sign-language to speaking languages.

According to [9] the authors have discussed about using the human computer interaction approach to propose a new eLearning interface with interactional features for the use by students with varying visual and hearing needs. The proposed system is useful for visual/hearing impaired students as well as for the students without any defects. The assistive adaptive features used in this technology for hearing impaired students are Providing sign language when the user places the cursor over the text content in the page, Pre-recorded sign language videos, Sign language features to read command in toolbar, Explanation of graphs using sign language. Both students and teachers recognized that the proposed system interface had valuable features of interactional communication to support all students, regardless of visual or hearing ability. The authors also have suggested on making this system more robust in their future work.

Since having a good quality video in the eLearning system is important we need a function of enhancing the low-quality video which are uploaded to the system. Many

researches have been conducted in using different algorithms and improving existing algorithms in image enhancement and video enhancement.

According to [10] the Authors have proposed an algorithm for enhancement of low-light videos. The algorithm is first inverting an input low light video and then applying the optimized image de-haze algorithm on the inverted video. To increase the speed of the algorithm temporal correlations between the subsequent frames are utilized. Simulations results of this algorithm shows good enhancement results when compared to other frame wise enhancement algorithms. The Authors also stated that future improvements can be to improve better pre-processing of the filters.

In [11] the authors have proposed a video contrast adjusting using spatio-Temporal histogram specification method. This algorithm used depth guidance to identify the background and foreground of an image. The experimental results have showed that the algorithm has enhanced the salient foreground objects efficiently and preserving background details faithfully. The Authors state that the algorithms can efficiently enhance depth images of color images. Since there is a lack on depth data the authors have planned to conduct future research on adaptively enhance the contrast of visually important objects without requiring depth data.

According to [12] the authors have proposed a real time video enhancement technique for videos with complex conditions like insufficient lighting. This method provided a better approach to enhance the video in low-lighting conditions without any loss of color. The approach was based on histogram manipulation La*b* color model of video frame. The algorithm is providing effective enhancement using simple computational procedures. The results were analyzed on the videos that were taken on the bad light conditions. The Author has not mentioned anything about the effectiveness of the algorithm in the normal light.

The Authors of [13] have found a new approach for noise reduction and enhancement of extremely low-light video. They have used motion adaptive temporal filtering based Kalman structure updating is presented. They use spatio-temporal filtering for the

noise reduction of extremely low light videos. After filtering out some noise will be remaining those noise level will be raised by tone mapping and at final stage Spatial Noise reduction will be used to remove uplifted noise leaving us with a quality image. This algorithm was very effective in moving parts of the image under low light. The Authors have expecting to use this algorithm in various software systems in the future. The Systems that planning to use this system in the future are consume CCTV cameras, black box camera for vehicles and video signal-based surveillance systems. The proposed system is said to be highly promising in the low light conditions.

In [14] the authors have proposed a video enhancement framework consisting of bilateral tone adjustment and Saliency-Weighted Contrast enhancement. This algorithm will enhance the parts of an image were human give more attention. This algorithm has given efficient results in removing noise from an image. This algorithm performs efficiently in regions where humans give more attention. As a future work this algorithm can be used in enhancing the quality of the low-grade video surveillance cameras. The author is expecting to use this algorithm for license plate detection and surveillance cameras.

According to [15] Authors discuss about two scientific experiments speech recognition techniques. They are using real time captioning using IBM ViaScribe and Post lecture transcription using IBM hosted transcription service. The main processes of these to techniques are Process of recording instructor's speech, Captioning the methods using a human captioner or providing transcript using the human transcript services and finding errors of the transcripts or captions. The study tells us that the Real-time captioning and Post lecture transcriptions has improved the students note taking ability. The future improvements of this study is to check how students with disabilities utilize these technologies.

1.3 Research Gap

According to the literature review above, the following research gaps have been identified.

- No eLearning System has automated video enhancement ability in them. All the available systems need a human effort to edit and enhance the video using a 3rd party video editing software.
- When low-light enhancement algorithms are used in brighter images the contrast of the image increases and provides a very bright image which disturbs the eye. Therefore, we need to identify at which part of the video we need to use low-light enhancement techniques.
- All the available systems are producing captions or transcriptions that is written by a human and that has to be separately updated to the eLearning system for a lecture video.

So, we are introducing a system using special algorithms to enhance the video quality of the uploaded lecture videos and providing system generated captions for the uploaded videos.

Table 1.3.1: Functionality Comparison with available systems

System	Automated enhancement of the video quality for the uploaded lecture	System Generated Captions for the lecture videos
System proposed by W. Farhan and J.Razmak **[9]**	X	X
System proposed by R.Ranchel, Teresa, Y. Guo and K. Bain **[6]**	X	X
Our System	✓	✓

1.4 Research Problem

Based on the survey that is conducted by our team I identified two important features that is missing and not addressed in the existing eLearning systems.

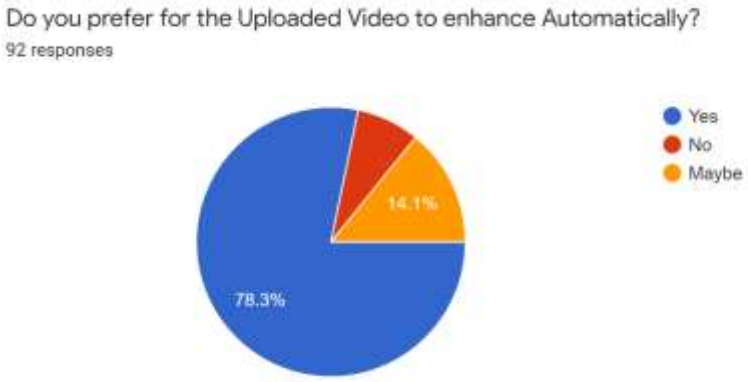

Figure 1.4.1: Video Enhancement response

According to the fig 1.4.1 we can see 78% of the responses prefer to have automated video enhancement feature in a system. This is mainly because they have faced a problem of low-quality video in eLearning systems or rather, they need to use additional tools to enhance the video if they are uploading a video to the online learning system. Therefore, this survey result suggests that video enhancement feature will be helpful for students when watching the lectures or it will be helpful for the tutors when uploading the video to the system since it is being enhanced automatically.

Most of the lectures record their videos using their laptop web cameras, these cameras don't have good quality compared to professional video recording gear. Hence these recordings have noisy outputs when shot in low lighting. Therefore, it is important to reduce the noise in these videos and enhance the quality of those videos. But many tutors who use these systems doesn't have the required skills to edit the videos, they will always acquire assistance to edit these videos in another 3rd party video editing software. Therefore, we are introducing a system that can automate the process of enhancing the quality of the video if it has noise or if the video is recorded in low light conditions.

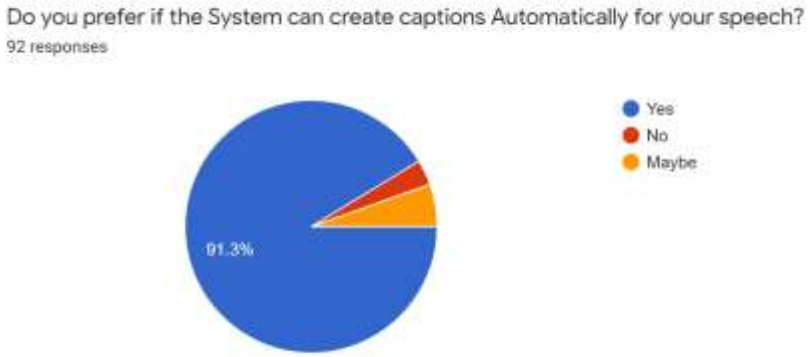

Figure 1.4.2: caption generation response

Based on the results on fig 1.4.2, 91% of the responses are preferring to have an automated captioning feature this shows that most of the people involved in the survey have faced some difficulty when captioning videos. Writing captions for video needs additional human effort or need support from a 3rd party software tool. Hence it is identified that it is important to implement a feature where the system can automatically generate captions to videos that is uploaded to the eLearning system.

Once the videos are recorded to the systems the tutors need to write captions or transcripts for the system by their own or use another human to do the job. Therefore, we introduce an algorithm that can achieve this process without any human efforts and provide captions in real time.

2. OBJECTIVE

The LMS systems we are proposing is trying to reduce the communication gap between hearing-impaired students and tutors in eLearning system. We are proposing a solution in which the uploaded lecture videos can be converted to sign language. Web contents and Notices can also be converted to sign language in our LMS system. We are also implementing a feature on the system so that the hearing-impaired students can clear their doubts through sign language this increases the engagement of the hearing-impaired students in learning through online.

2.1 Main Objective

The main objective of this component is to enhance the uploaded video quality(low-light) using an effective algorithms and various other noise reduction and contrast enhancement techniques. Once the video is uploaded the system Autogenerate captions for the uploaded video.

2.2 Specific Objective

Video Enhancement

- Use an algorithm to identify low light videos.
- Enhance the low light videos and reduce the noise in them.

Automated Captioning

- Extracting Audio from the video content.
- Identify the voice in the audio content.
- Convert the Speech to Text using Speech-to-Text Model.
- Add the Captions generated to the Video.

3. METHODOLOGY

The main functionality of this component is to Enhance the video that is being uploaded by the lecture using various enhancing techniques so that the final video is denoised and gives a quality output if the video is recorded in the low light environment. Then the audio is extracted from the video and we use Google Speech to text API to generate text for the audio content. Finally, the subtitles generated will be attached to the final out put video.

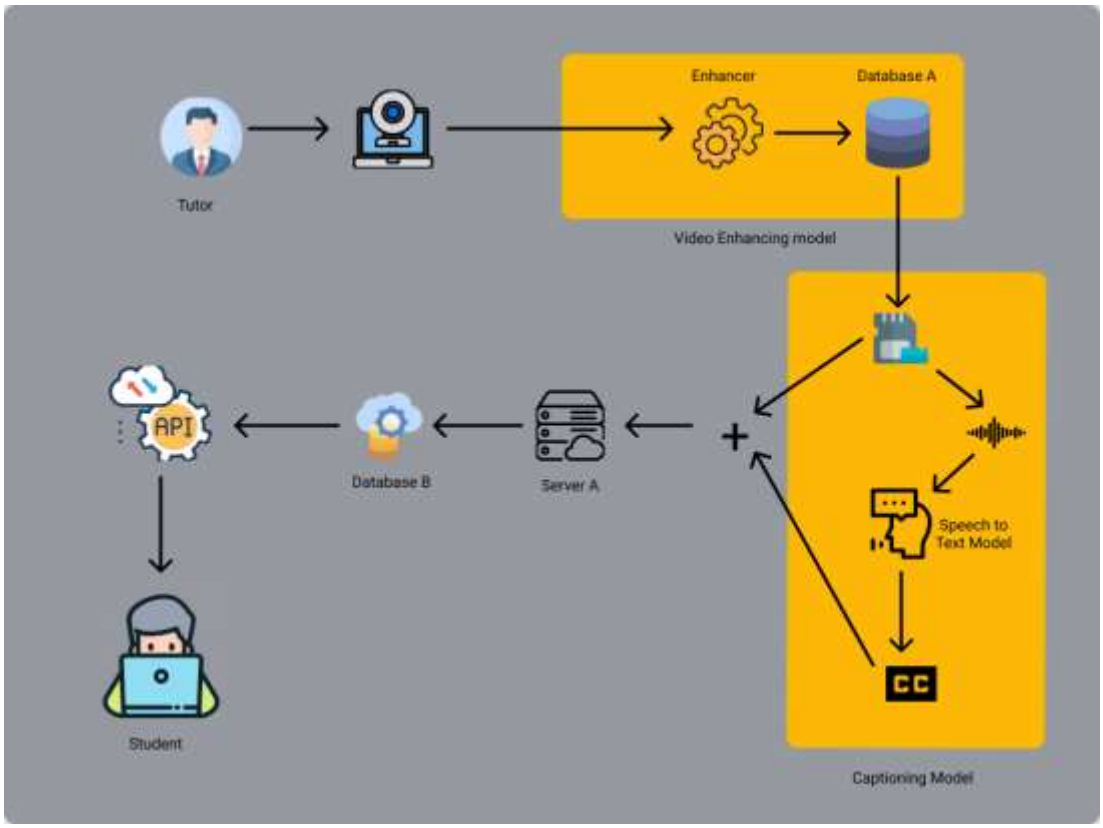

Figure 3.0.1: System Overview Diagram

3.1 Video Enhancing

Once the tutor uploads the video to the system the Video Enhancing model do the preprocessing of the overall function. This unit is in charge of enhancing the uploaded video into a quality video.

Once the tutor uploads the video the video will broke down into frames, then it will be converted into gray channel, we are converting it into gray channel because it is easy to process frames under gray channel rather than using the RGB channel.

According to [16] in this work Authors have identified that intensity distribution of images captured under low light conditions show more than 50% of total number of pixels fall under low intensity values and for day light condition more than 50% of total number pixels fall under high intensity values. According to this we can develop the Algorithm to identify low light frames separately from normal light frames on the same video. As an initiative to this process we construct the histogram for each frame of the video so that we can identify its intensity values.

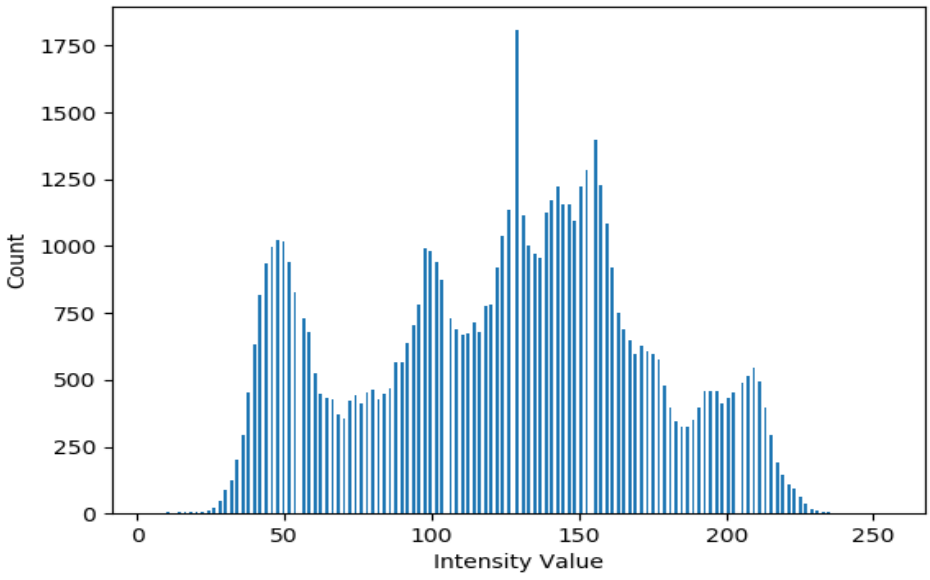

Figure 3.1.1: Intensity values vs number of pixels.

Fig 3.1.1 shows an intensity histogram. This histogram shows us the total number of pixel count of each intensity level. Using the help of an intensity histogram we can find the at which intensity the highest number of pixels fall for each frame. Based on this I next develop the Cumulative Intensity Histogram.

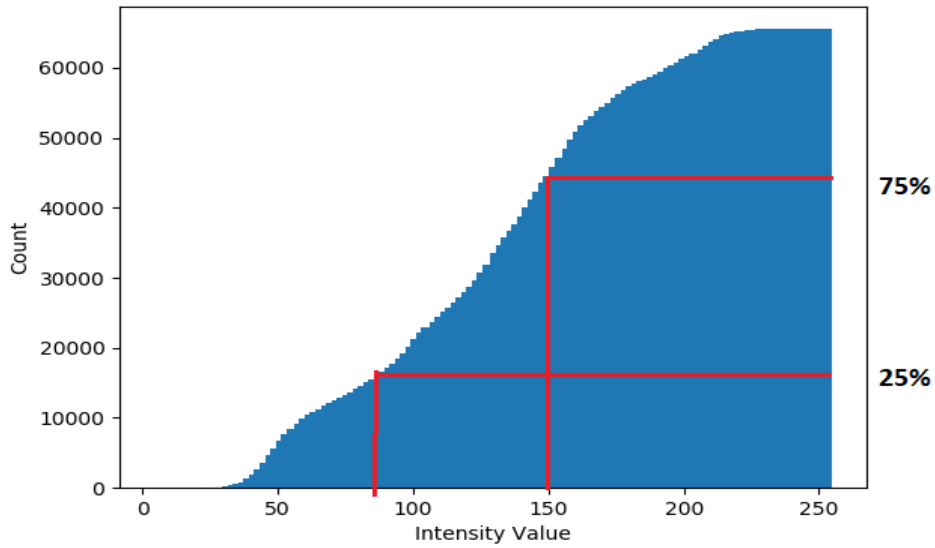

Figure 3.1.2: Cumulative Intensity Histogram

Fig 3.1.2 shows a Cumulative Histogram, this will show the cumulative number of pixels at each intensity level. Which means at the 1st Intensity level it will show the number of pixels related to the 1st intensity and in the 2nd intensity level it will show the sum of the number of pixels at both 1st and 2nd intensities similarly at the final intensity level which is 255 it will show all the total number of pixels in the image/ frame. Therefore, using this Cumulative Histogram, we can find a threshold value for which the majority of the pixels fall. Based on the cumulative histogram we can find a threshold value for which corresponding intensity falls. When comparing Fig 3.1.2 we can state that 25% of the total number of pixels corresponds to an intensity value less than 100 and 75% of the total number of the pixel corresponds to an intensity of 150. Therefore, using a cumulative graph we can identify to which intensity value the majority of the pixel value will corresponds to. This will be the threshold value which decides whether the frame shifts to a low light frame or day light frame.

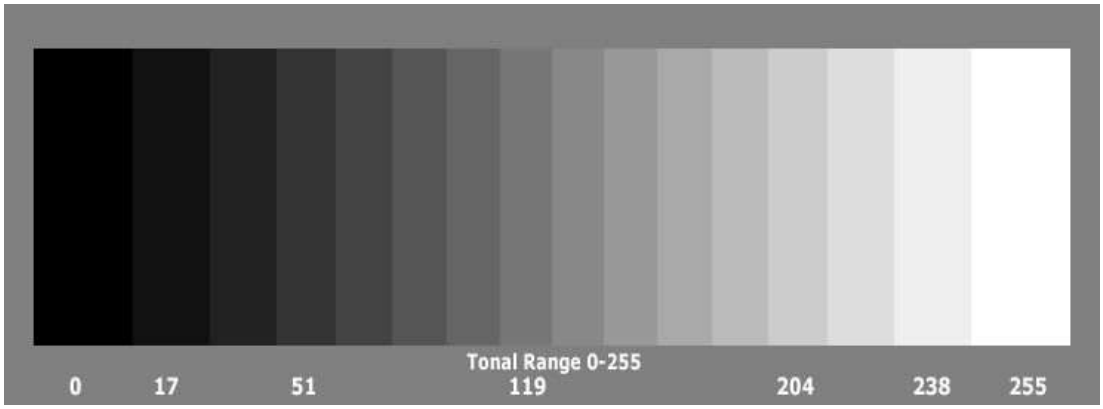

Figure 3.1.3: Intensity Distribution

The Fig 3.1.3 shows the intensity distribution of an image or frame in grey scale. We can state that intensity values less than 119 are shifting to a darker region. As a result of this we can select an intensity value which is >100 and <120 as our threshold value which detect the low light frames. Therefore, when comparing both fig 3.1.2 and .3.1.3 we can say that histogram constructed above shows an image which is taken in day light since 75% of the total number of pixels falls under a bright light region.

Once low-light frames are identified using this method denoising algorithms and contrast enhancement algorithms will be used for this frame to increase the quality of video and improve the visual details of the video. The Enhanced Video will be stored in the database A.

3.2 Captioning Model

Captioning Unit will get the video from database A and extract the audio format from it. The extracted Audio will be sent into the Google Speech to Text Model and the Text File will be generated. Using the time stamps of the video the text will be categorized in an algorithm. This algorithm will output a text for each 10 seconds time stamp. Then the generated text will be attached to the video. For attaching the text with the video, a subtitle attachment technique will be used. After processing the video completely, it will be sent into the Database B. Using web API, the client can show the processed output as captions along with the video. The Final Output of this function will be a Visually enhanced Video with captions for each 5 seconds.

3.3 Testing

For Testing this function, I am planning to use my own videos which are recorded using web cams and my colleague's videos. I am also planning to use the videos that are collected manually from YouTube

3.4 Software Development Life Cycle

The Overall project Uses Agile SDLC for the development of the project. Since at the beginning Requirements are unclear it is better to use a Agile Scrum model as the software development life cycle. The Agile Scrum model Figure 3.4.1 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. As our team consists of four members, having daily scrum meetings will allow each member to have a general understanding of the whole project and be aware of problems faced by other members as all the functionalities depend on one another. Also, this will improve the collaboration between team members encouraging better team work.

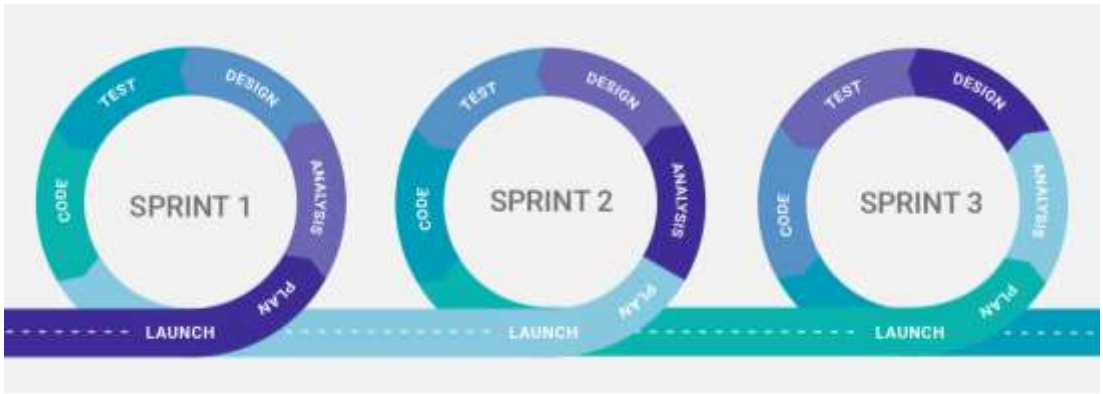

Figure 3.4.1: Agile Scrum Model

3.5 Gantt Chart

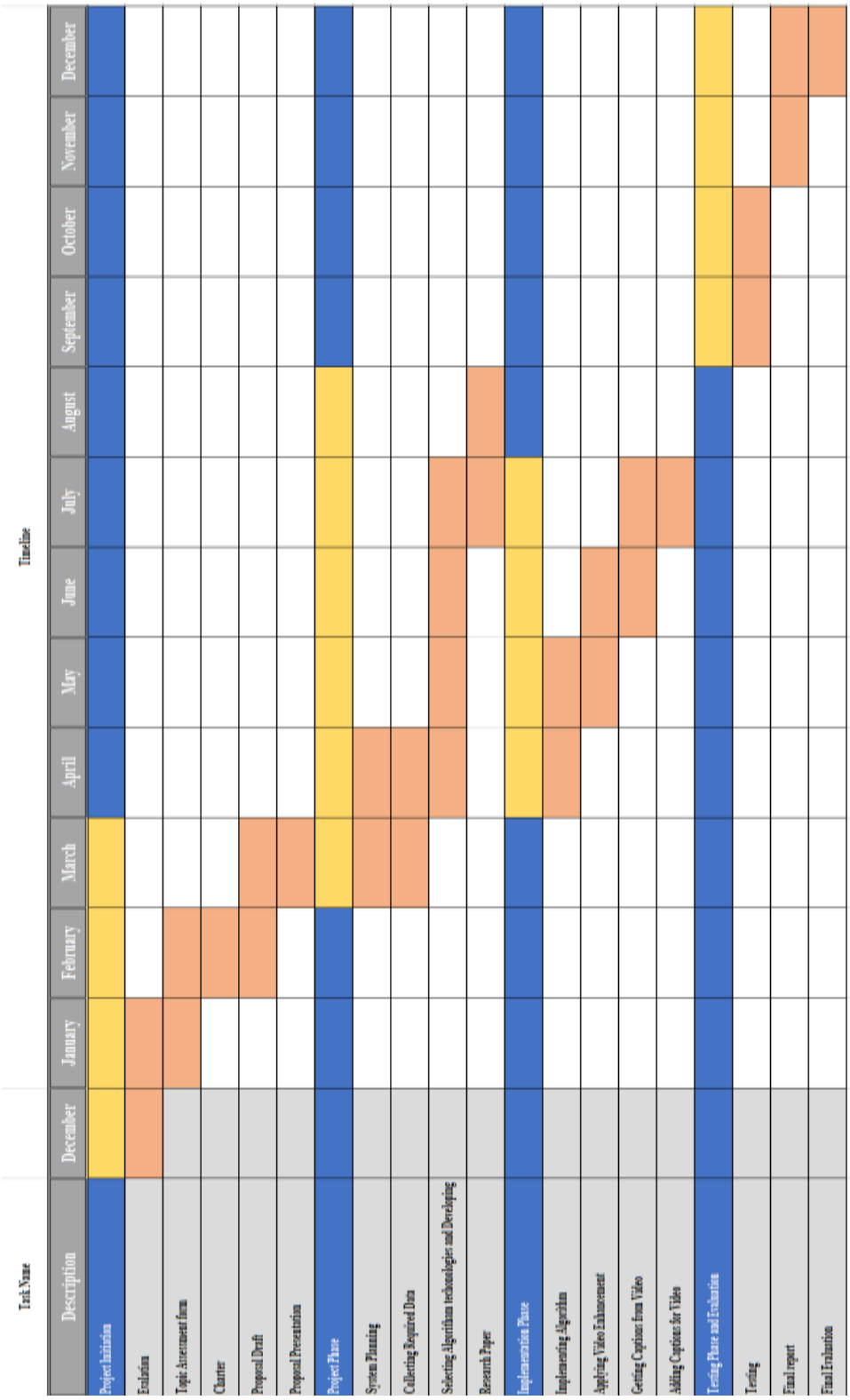

Figure 3.5.1 :Gantt Chart

3.6 Work Breakdown Structure

Figure 3.6.1: Work Break down Structure

3.7 Technology Selection

- Software component:-

Version controlling:	Git
Language:	Python
API:	REST
Voice Recognition:	Google API

- Project Management:- Azure Boards , JIRA

4. PROJECT REQUIREMENTS

4.1 Functional and non-functional requirements

- Functional Requirements

    1. Enhancing the video quality of the uploaded video
    2. Providing machine generated subtitle for the video

- Non-Functional Requirements

    1. Less manual work to Enhance the video
    2. Less manual work to Provide Captions
    3. Performance

4.2 User requirements

1. Webcam at tutor end.

5. DESCRIPTION OF PERSONAL AND FACILITIES

Registration No	Name	Task Description
IT 18152074	Sangeeth Raj A	• Develop algorithm for identify and extract user's motion and analyze from sign language video transcript. • Develop algorithm for generate quiz and distractors using extracted ML model. • Documentation • Testing
IT18068610	Pirathikaran V	• Develop algorithm for identify the user's hand gestures and convert into text using ML model. • Develop algorithm for fine-tune the text into meaning full sentence according native language using NLP technique. • Documentation • Testing
IT18144772	Niroshan K	• Using Video processing techniques to enhance video quality • Creating an Algorithm to produce real time caption

		for speech recognized from Audio • Documentation • Testing
IT18069600	Accash R	• Using NLP techniques preprocessing the extracted data • Develop algorithm for converting the text / captions to the sign language using ML technique • Documentation • Testing

Table 5.1.1: Description of Personal

6. BUSINESS POTENTIAL

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.

7. PROJECT BUDGET

Phase	Description	Amount
Development	Setting Up AWS Cloud	12 * 5 = 60 USD

Table 7.0.1: Budget Table

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