E-LEARNING SYSTEM FOR HEARING IMPAIRED STUDENTS

Project ID : 2021-176

Project Proposal Report

Sangeeth Raj Arulraj - IT18152074

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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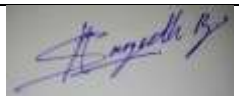
Declaration

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.

Name	Student ID	Signature
Sangeeth Raj A	IT18152074	

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

Due to the pandemic situation everything is digitalized especially education is transferred to an online. But the certain community of people faces lots of difficulties to transferring to the online education, one of them is the hearing impaired students. We are exploring to provide a solution to them by providing Learning Management System (LMS) which enable the hearing impaired students to learn from the lectures who don't have knowledge or experience in sign language. This will increase the educational quest of the hearing impaired community and help them to get an education through the best educators in their field. The proposed system will generate sign-language for the videos uploaded by the lecturers using Machine Learning, Natural Language Processing and Video Processing techniques. The students will be able to upload a video in case of having doubts, and the exact process will happen in reverse. Further, all the web content in the LMS including notices and other details, will also be converted into sign language and be made available to the hearing impaired users. In addition, there will be a tutorial segment where student learn sign language and they will be tested using quizzes by using motion detection technique we can analyzing their learning.

As mentioned above the tutorial segment for the user gives a chance to learn to sign language and check the knowledge whether they are following the instruction correctly using python OpenPose and Convolutional Neural Network we can detect the motion of the user using webcam. If the user followed the instruction and do as the system request he/she can learn sign language easily but in order to reach next level, he/she should pass by following correct instruction. Last but not least after complete completing all the tasks user required to attempt a quiz, which analyses his/her knowledge in studies using algorithms.

Keywords: *Machine Learning, Video Processing, Natural Language Processing, Convolutional Neural Network, OpenPose*

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LIST OF ABBREVIATIONS

Abbreviations	Description
LMS	Learning Management System
ML	Machine Learning
CNN	Convolutional Neural Network
NLP	Natural Language Process
WHO	World Health Organization
HCI	Human Computer Interaction
FEMD	Finger Earth Mover Distance
SP-EMD	Super - pixel Earth Mover Distance
CSL	Chinese Sign Language
CSV	Comma Separated Value
XML	Extensible Markup Language
RCNN	RegionBased Convolutional Neural Networks

1. INTRODUCTION

1.1 Background Study

Nowadays, e-learning has become an essential component of higher education for both teachers and students. According to a study on the effectiveness of e-learning on education, it was found that students nowadays are more satisfied with web enhanced learning when compared to a traditional classroom environment[1]. But there many people who are unable to accept the change of education into online e-learning, one such group of is the hearing-impaired community. We are aware that universities and higher education institutes adopting some form of e-learning to assist their students. Many institutes use their own customized version of a Learning Management System (LMS) to provide online course material. But there is not good source or proper guidance to the hearing-impaired community, even thought people are willing to help but lack of proper knowledge in sign language they are unable to communicate and guide the student, this brings a huge gap being the two communities[17]. According the WHO estimated that approximately 466 million people around the world has disable hearing loss which is a total sum of 6.1% of the world's population. Where 34 million are children and projections of WHO show that the number could rise to 630 million by 2030[20]. There is no 100 percent cure for hearing disability but we can help the community but providing products and service specially designed for them so that we can reduce the gap between them and us. The motivation, goal of the research proposal is to reduce the gap between the hearing impaired community and us by breaking the barriers.

Our suggestion for a hearing-impaired LMS would make a difference and will benefit both students and teachers in a variety of ways. For example, nowadays lecture video are available online so that students are less likely to miss a lecture, and professors can ensure that regardless of location and time all student have accessibility to lecture

video and other study material[1]. When lecture videos is recorded and published it helps student with different level of learning and this result in gain a better understanding of the module of the subject. For example, those who are familiar with the work can skip ahead to a section of interest while those that need more time to understand the concepts can pause and rewind to digest the lecture at their own pace [2,3]. Usually, many LMSs enable lecturers to upload course material such as tutorials, lab sheets, lecture slides, and lecturer's video. Lecture videos are always benefit student with auditory and visual effect so that is more effective and they are not without any drawbacks[4] but in our LMS student can watch the video which are translated to sign language and many students find watching recorded lecture videos tedious due to their length, which typically ranges from 1 to 2 hours long, and student losses interconnection and refer to other or related course content[5] so we will have a time restriction to be effective in the limited time period to avoid conflicts. Although many video-creation and editing platforms exist that enable users to create interactive course materials, these technique is more time consuming user as significant amount of time spent on making the lecture video more interactive so that we are presenting in a simpler way in which the regular lecture video will be uploaded and user will get the translated sign language video and if the student got any doubts on the subject he/she can upload the video of his/her doubt in forum where the lecturer will receive it in a meaningful text format as they only communication using sign language[15,18], once the lecturer answered the question the student will be able to see the answer in a sign language content. All the user may get benefit form the module forum by this functionality.

At the time of writing this proposal, to the best of our understanding, there isn't a system which automatically identifies detection of user's motion and analyse for quiz, in the aim of teaching sign language in a few steps[6]. As a result, the primary emphasis will be on two facets of course content: accessibility and interactivity. Our goal is to develop an intelligent system capable of teaching students and improving the interactivity and learner engagement of tutorial material in just a few clicks.

1.2 Literature Survey

For the past two decade there are number of researches have been conducted under motion detection of sign language but all of them do not related one another because the main conflict is existence of different sign languages all over the world[7]. Therefore I have collected and review some of the research papers related to American Sign Language (ASL) which in the motion detection of hand gesture in sign language for e-learning and algorithm to identify motion of the user.

In the year 2000 Zhao , Karin & Schuler, Liwei , Kipper , William , Christian , Vogler , Norman , Palmer , Badler and Martha in their paper "*Machine Translation System from English to American Sign Language*" [15] has proposed Language-based engineering system with high cost and user friendly natural looking human hand gesture which provide insight for the design principles that has changed over time period in the natural human interaction or communication. Researcher have suggest a machine translator system to convert English to ASL that considers both linguistic and visual and spatial content related with ASL. As a conclusion we can see that research are proposed system to translate English to ASL, this was proposed in earlier 2000 which means it was not possible back then but it is not with significant dataset we can make it possible.

In 2010, Mona M. Nasr, in their paper "Enhanced e-Learning Environment for Deaf/HOH Pupils " [10] has proposed an e-Learning system to the hard of hearing community, based on the Chinese Sign Language. It includes a variety of learning activities that can assist deaf students in performing on equal level with their fellow students. Students can learn and communicate with others in virtual classrooms using chat rooms and discussion forums provided by the system. There is also a translation feature that allows course materials to be translated into Chinese Sign Language and re-uploaded for use by others. They can be converted into animations or videos. It also has many user positions for system maintenance, including administrator, teacher, and

student. As a conclusion the e-Learning system has proven to be useful in locating other LMS components that need to be converted to sign language, such as discussion forms to make communication more effective.

In the year 2013 V. Adithya, U. Gopalakrishnan and P. R. Vinod in their paper "Artificial neural network based method for Indian sign language recognition "[13] proposed an approach for deaf people are unable to communicate with the general public without a sign language interpreter, deaf people are unable to communicate with the general public. Deaf people become isolated in society as a result of this conflict so that we need sign language recognizing system. By introduction SL recognizing system it will bring a change for the hearing-impaired individuals to communicate with general people with any conflicts or interpreter. The researcher have proposed a SL fingerspelling recognizing in Indian SL in their paper. The dataset collected from hand gesture are used to figure the signs, for extracting the hand area from the photograph, we used skin color based segmentation. Using image distance transform researcher proposed a shape feature technique. The dataset collection of sign image are used to ML model training by forward CNN. Using digital image processing method the proposed component it developed. So that we don't use any external hardware device to get hand gesture or features. As a conclusion using low computational complexity we can gave high accuracy with only software to implement a system.

In the year 2015 C. Wang, S. Chan and Z. Liu in their paper "Super pixel Based Hand Gesture Recognition with Kinect Depth Camera"[12] proposed an approach for new SL recognition system with the novelty of SP-EMD including `Kinect` depth technology camera which identifies the color of skin and shape of the hand gestures, depths and corresponding textures are representing Super pixel form. The proposed system illustrated by extensive experiment with two third part dataset and with the own research team dataset to experiment whether there was effectiveness in proposed hand recognition algorithm and distance metric. As a the final outcome the system was able to reach higher mean accuracy above 75% also faster hand gesture recogniting

speed of average 0.067 second per gesture. As a conclusion this proposed system is very efficient and best fit for HCI application when compared to other SP-EMD and FEMD metric the proposal hand gesture recognition system achieved best performance.

In the year 2016, Goyal, Lalit & Goyal, Vishal, in their paper Text to Sign Language Translation System [14] has proposed that SL user uses facial expression, head notation, body posture, hands and arms to communicate for three dimensions translation of text to SL and translation of spoken or verbal language is totally different as the grammatical order of sentence is not standard in SL, direct translation of SL is complicated. Still, a variety of methods for converting Text to Sign Language have been used, with the input being text and the output being pre-recorded videos or computer-generated animated characters (Avatar). As mention earlier three dimensions translation takes lots of work, to characterize an event, the SL user must takes the 3D space around his user's body which include manual signs, non manual, and also combination of both(2003 Zeshan signs category). Where shapes, location, and movement of hand are known as manual signs and non manual signs considered of head notation, facial expressions, and the user's body postures. A sign have either a manual component or a non-manual component, or both combination so that we must consider all the above when has dataset input to train the ML model and to get accurate result from model.

In the year 2016, D . Kelly , C . Markham , and J . Mc Donald in their paper Weakly Supervised Training of a Sign Language Recognition System Using Multiple Instance Learning Density Metrices[17] has proposed an approach using a metric mentioning that not a strong supervised training is need for SL hand gesture recognition system with the help of novel multiple instance learning density technique. Using the metric we can identify isolated SL from a sentence. Our spatiotemporal gesture and hand posture classifiers are then trained using the automatically extracted

isolated samples. The research is to evaluate sign language extraction, identify hand gesture and posture classification and spatiotemporal spotting system. This was experimented on a pre-trained model of 48 different vocabulary sign in SL to evaluate overall sign spotting system of 30 sign which resulted in 87% success rate. They suggested a hand posture classification model that can reliably identify hand postures regardless of who is performing the gesture, and a spatiotemporal spotting ML model that can classify gestures on spatiotemporal and detect movement without being specifically trained on a sign. Spatiotemporal ML model and detect posture have be integrated into the framework, using the proposed MIL density algorithm they were able to learn sign language of hand gestures from noisy and weak oversight of translation automatically. The researcher have extending the vocabulary of our automatic training system based on 30 different sign takes only automatic processing of a wider video dataset including accompanying text translations. As a conclusion Proposed system was able to learn using unsupervised training and dataset were from different source and still was able to identify the object, using this method we can conclude efficiency of the unsupervised model.

In the year 2018 M. G. Grif with his colleague A. L. Prikhodko, in their paper "Approach to the Sign Language Gesture Recognition Framework Based on HamNoSys Analysis"[20] BamNoSys analysis and data from the OpenPose program library are used to develop the proposed SL gesture recognition framework. BamNoSys is a transcription system for both manual and non-manual gestures that makes for accurate linguistic transcription. With SL gesture classification based the on BamNoSys linguistic examine a single sign whether it is characterized as a combination of other SL components in the framework which are Trajectory component, Axis component, Hand Shape component, Rotation component, and Orientation component. The findings of this study will be useful and the development of improved methods and techniques for applied linguistic research, as well as in carrying out educational or research activities related to the Sign Language. As a

conclusion we say that the ML can identify both manual and non-manual gestures using BamNoSys transcription system and OpenPose.

In 2020, Tariq Jamil, in his paper “Design and Implementation of an Intelligent System to translate Arabic Text into Arabic Sign Language” [8] has suggested the development of an intelligent system to transform Arabic text to Arabic Sign Language(ArSL). It was created to address the need for the Arabic deaf community to be integrated into society and to be able to communicate with them without difficulty. Text input, parsing, word processing, and ArSL output are the four key steps in the system's implementation. Basically, the sentence that needs to be translated will be passed to the translator user interface and the system will identify each part such as, noun, verb, adjective, and consequently eliminate the words that are meaningless. Then the other meaningful words will be checked with the already updated system’s database full of signs, and hence display the correct output in GIF format. The user interfaces for the translator were created using the ScreenBuilder application and the Java programming language. For quick and accurate text processing, the ‘Farasa' toolkit was used, which also helps to identify the parts of a sentence. Finally, the ArSL signs output was displayed using an animated character supplied by MindRockets, Inc. As a conclusion this research work clearly outlines the implementation process, where the tools and software used for development will be efficient to build an eLearning system and output dataset can be GIF format which mean the GIF can be used as input dataset.

In the year 2020 Xi Hu, Jiayi Zhou, Liming Tan, Shahid Ali, Jun Liao, Zirui Yong, and Li Liu in their paper ″Recognizing Chinese Sign Language Based on Deep Neural Network ″ [9] proposed an approach for hand gesture recognition to identify complex and complicated sign languages in the HCI with the help of DNN technology algorithm, but the research on CSL recognition remains debate. Researcher gathered dataset and proposed recognition solution to CSL using 2D image. They used a self-

created dataset to train the model with excellent classification precision, and they were able to reach a complete sign language recognition with an accuracy rate of 0.9324. As a conclusion this proposed system is very efficient and accurate in analyzing 2D image of sign language of CSL which are really difficult in identify in real, we can use the idea to apply deep neural network in identifying image and analyze motion.

In the year 2020 D. Manoj Kumar, K. Bavanraj, S. Thavananthan, G. M. A. S. Bastiansz, S. M. B. Harshanath and J. Alosious in their paper "EasyTalk, A Translator for Sri-Lankan Sign Language using Machine Learning and Artificial Intelligence"[22] proposed an approach to convert SL text to auditory format, enabling people to communicate more efficiently. This is divided into four sub parts, Hand Gesture Detector, the first component, uses pre-trained models to capture hand gestures. The Image classification component translates hand gesture signs that have been found. The Voice generator component produces a text output or auditory format for the hand gesture signs that have been recognized. Finally, the Text to Sign Converter turns entered English text into animated images based on sign language. Using these tools, EasyTalk can more accurately identify, translate, and produce relevant outputs. As a conclusion The application translated all NLP connected language and SL using an NLP-based API. Ordinary citizens should use the application's reverse engine to translate verbal languages into Sri Lankan sign language. They only need a valid dataset to use this API. The Text and Voice Generator aids in the recognition of word segments from alphabet collections, the correction of spelling, and the conversion of word segments to speech. This reverse translator use Semantic Analysis to get GIF images of relevant SL using text input from the user so that it will be an efficient way to use sign language video or gif as a data using RCNN base ML model.

1.3 Research Gap

Even though there are several technologies is already available with similar objectives of motion detection of hand gesture, most of them are not succeed or given efficient and accuracy in the past proposed system. The major goal is involving human intervention to make the content more interactive and increase the user experience with user friendly technology. Our proposed solution aims to increase the amount of human interaction needed for this process by introducing very computationally efficient and best fit for real-world HCI application which will analyze their motion in real-time and LMS gives the content automatically if the user's motion is similar to dataset. Table 1.3.1 comparison of the existing proposed system in the market to detect hand gesture.

Features	FEMD	SP-EMD	Super-pixel Based Hand Gesture Recognition	Recognizing CSL Based on DNN	Our Solution
Achieve accuracy in detection	✔	✔	✔	✔	✔
Fast recognition speed in analyzing	✗	✔	✗	✗	✔
Achieve high mean accuracy in detection	✗	✗	✔	✔	✔

TABLE 1.3.1: TABLE COMPARISON OF PROPOSED SYSTEM WITH EXISTING SYSTEM

1.4 Research Problem

There are number of researches have been conducted under motion detection of sign language but all of them do not related one another because the main conflict is existence of different sign languages all over the world [7] but when it comes to big picture there only one major issue which the presence of two hand gesture and one hand gesture. The they have used image as the dataset to find the accuracy of the hand gesture and have succeed in their research but previous researches have not achieved the best accuracy level of prediction when the dataset in video format and for a certain point we can get a good accuracy level of prediction[22].

Therefore, the main idea behind this particular component is to implement a best accuracy level of prediction using video dataset and combine different ML algorithms for classification to improve the accuracy of user motion and prediction good result for user end and evaluate the accuracy of prediction by applying advanced techniques.

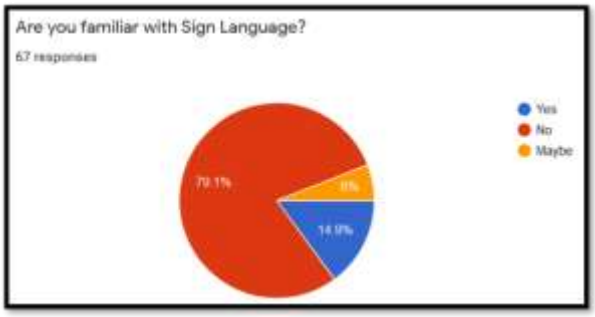

Figure 1.4.1 – Illustration of people who are familiar with sign language

Figure 1.4.2 – Illustration of people will to learn sign language

2. OBJECTIVE

The proposed LMS is a research study to improve the e-learning method to hearing-impaired students by delivering convert sign language content form lectures video and to increase the level of participation of the hearing-impaired students. The main and sub objectives of the research are as follows.

2.1 Main Objective

The motive of this component is detecting the user's motion and analyses motion is similar with the system. This is done while the users are learning the sign language and repeating after the system and analyze whether he/she is following the instructions and repeat exactly as the system request them. If he/she successfully completed learning then user is asked to attempt quiz in order to check there knowledge and progress. These are done by implementing an efficient algorithm.

2.2 Specific Objective

- Feeding the system with tutorial of the module. *ex: Learn alphabet – feeding database with sign used for alphabet.*
- Providing correct instruction to user and to follow
- Getting optimized/enhanced video from the user.
- Detect the user's motion using TensorFlow and fast RCNN.
- Analyze the video whether the user's motion detected and the motion in ML model is accurate by CNN.
- Using algorithm to initialize next stage in module.
- Testing user with random sign language object to check there knowledge.

3. METHODOLOGY

This component of the system has of three sub parts;

1. Hand Gesture Detector
2. Image Classifier
3. Analyze Motion

with the intension of implementing this functionality is to teach user sign language with accuracy.

3.1 System Overview Diagram

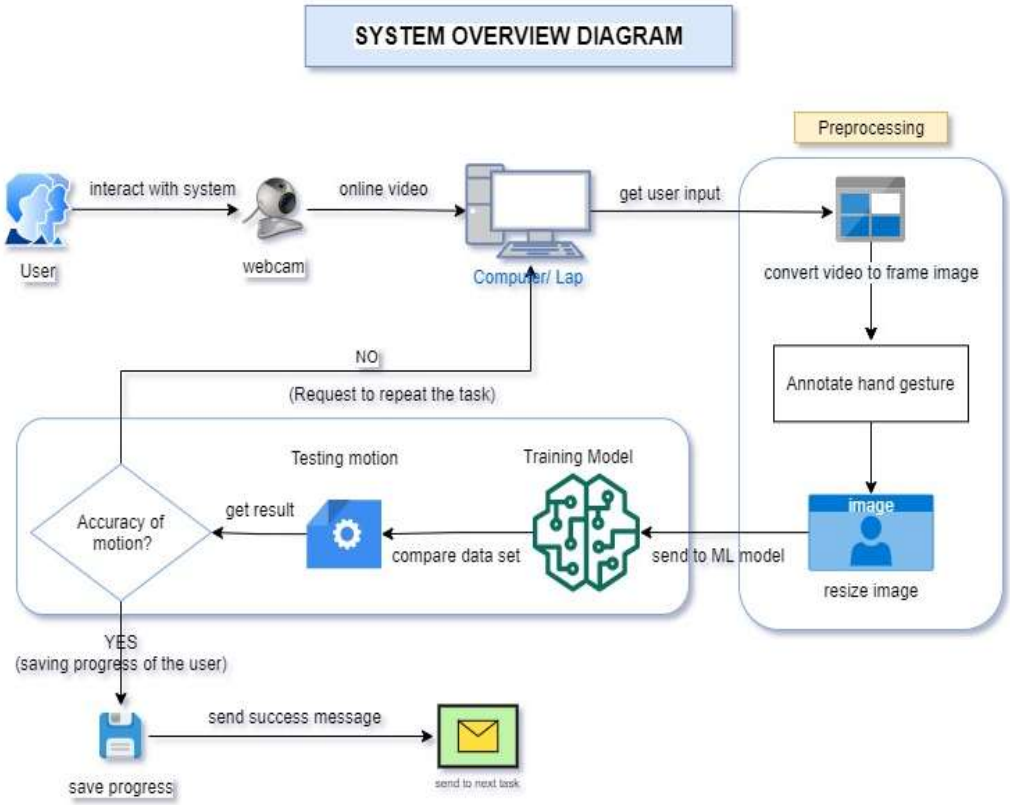

Figure 3.1.1 – Illustration of the system overview

3.3 System Description

To basic functionality of this component is to teach sign language to hearing-impaired students and also this can be a great opportunity for the general user to learn and improve their knowledge in sign language, this will be an easy mode of learning sign language remotely for their premises. The LMS will help the learning from basic and test their knowledge in what they have studied so far in the module, for the user will need a personal computer, webcam, and internet connection. The user will be given basic lesson such as alphabet words, number in sign language, and once the task begins he/she is asked to repeat as per the tutorial in example system displays video show sign language of LETTER (***Figure 3.1.1***) and the user will have to do it in front of the webcam (***Figure 3.2.2***). In the preprocessing segment using OpenPose user's motion is detected and send to the ML model, then it is analyzed[9]. If the motion of the user is correct then it will save and the user will be taken to the next task else if he/she is performing incorrectly then the student is asked to repeat the task once more. Finally, the student is asked to attempt a quiz in order to check their knowledge in the current module using implementing an efficient algorithm his/her score will be given.

Figure 3.2.1 – The system requesting sign language

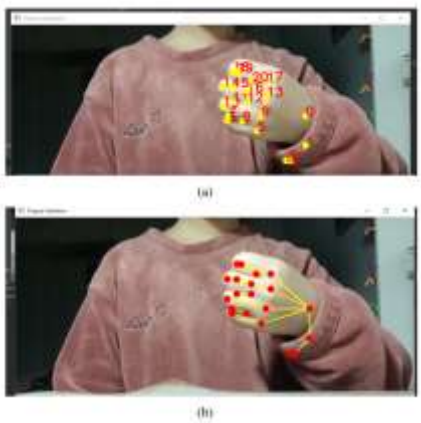

Figure 3.2.2 – User's motion detection

3.4 Development Process

3.4.1 Annotate Hand Gesture

The Faster RCNN (RegionBased Convolutional Neural Networks) configuration will be used to implement this feature on TensorFlow ML model trainer.
The teaching process is based on low-resolution imagery.

- Faster training
- Storage efficiency
- Low latency network connections (low internet speed)

Once the images are detected they are separated has training dataset segment and testing dataset segment, using PASCAL VOC labeling tool XML (extensible markup language) record is obtained each image.

For the train and test image datasets, images are manipulated into CSV (Comma Separated Value) files. Finally using Faster RCNN and TensorFlow ML model to start train with the dataset. After successfully training the ML model, we will be using webcam to test whether the model is working, using pre trained ML model we can detect images [20].

3.4.2 Image Classifier

ML model implemented using Convolutional Neural Networks. Using CNN classifier we can process different image then we can categorize them accordingly[22]. Using ‘keras’ library going to be used to implement CNN ML model. Dataset American sign language alphabet is used, each letter will be class. There will be 26 classes and each with minimum 100-150 images per class to train.

Image going through different stage in CNN classifier

1. Convolutional Layer
2. Nonlinearity
3. Pooling Layer

Nonlinearity is a term used in statistics to describe a situation in which an independent variable and a dependent variable do not have a straight-line or direct relationship. Changes in the output are not proportional to changes in any of the inputs in a nonlinear relationship[22].

Using pooling layers, the feature maps' dimension are reduced. The number of time parameters used to learn and the amount of computation in the network are both reduced as a result. The pooling layer sums up the features present in an area of the feature map formed by a convolution layer[22].

Once the filtration is satisfied the system notifies user passed the task.

3.5 Software Development Life Cycle

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 3.5.1 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 3.5.1 – Agile Scrum Process

3.6 Gantt Chart

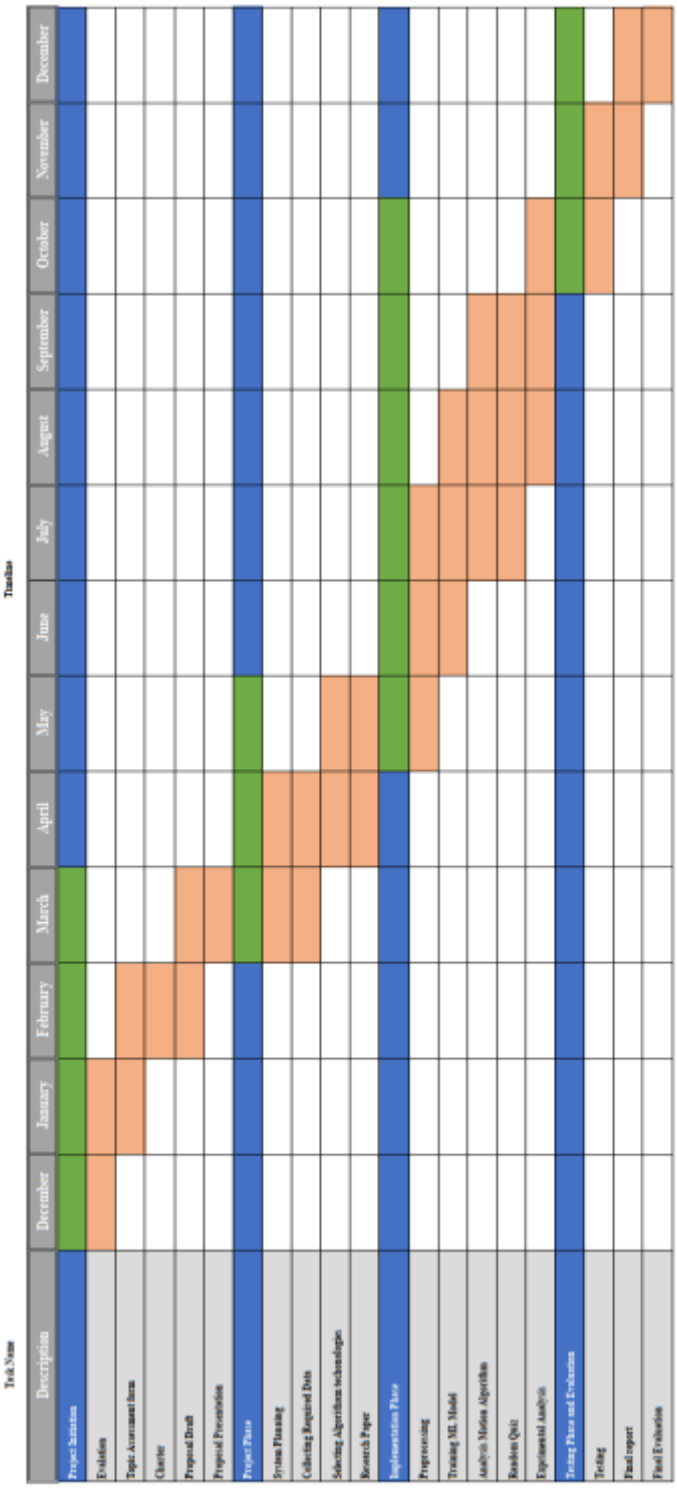

Figure 3.6.1 – Gantt Chart

3.7 Work Breakdown Structure

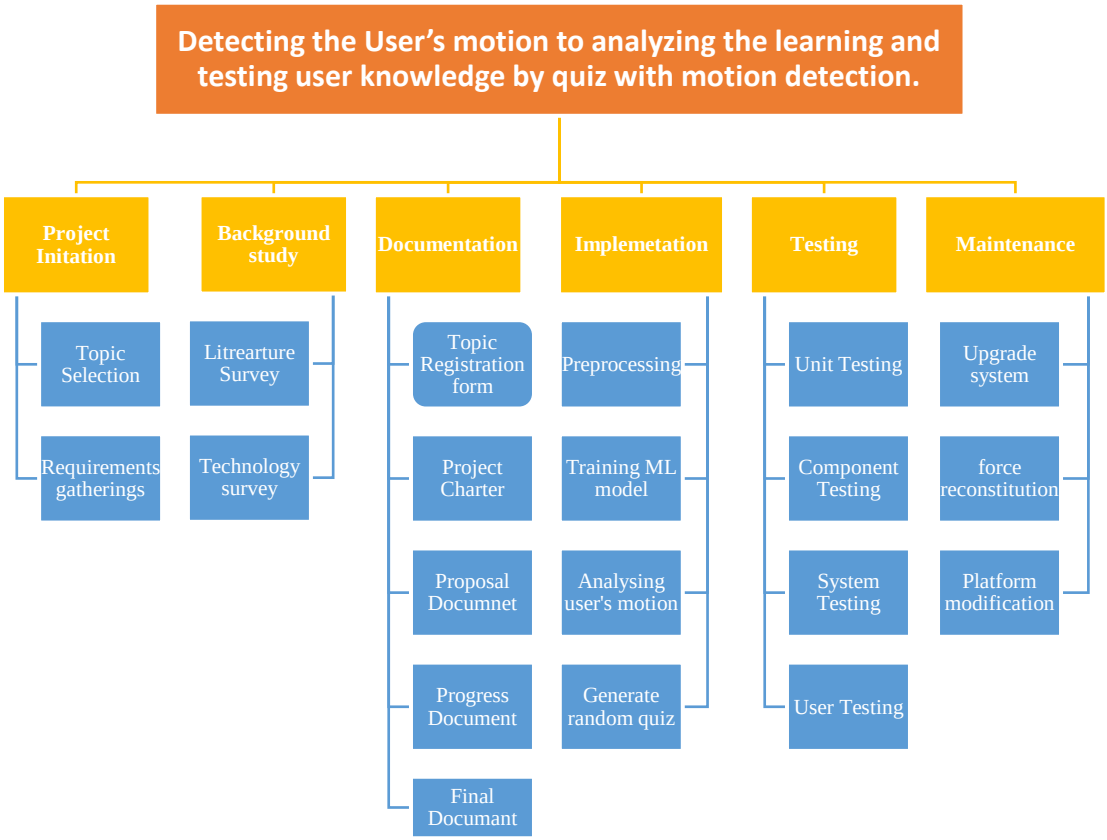

Figure 3.7.1 – Work Breakdown Structure

4. PROJECT REQUIREMENTS

4.1 Functional Requirements

1. Analyse user hand gestures effectively and correctly.

2. Analyse user knowledge on learning.

4.2 Non-Functional Requirements

1. Giving accurate result of user’s hand gestures without further ado.

2. Accuracy of analysis.

4.3 User Requirements

1. PC or Laptop

2. Webcam

3. Internet connection

4. 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 analyse 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 4.1: DESCRIPTION OF PERSONAL AND FACILITIES

5. 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.

6. BUDGET AND BUDGET JUSTIFICATION

The research involves the requirement of various resource types and the budget allocation is given below.

Resource type	**Amount (LKR)**
Preparation of reports and printing	Rs. 400
Internet usage for researching	Rs. 2000
Cloud charges	Rs. 2000
AWS Cost	Rs. 3000
Total	**Rs. 7400**

TABLE 6.1: PROPOSED SYSTEM BUDGET

REFERENCES

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