Final Project Report

for

SIGN LANGUAGE RECOGNITION WITH MACHINE LEARNING (SLRWML)

Version 1.0

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Abstract

After the 2010s, technological developments focused on artificial intelligence and machine learning. Despite this, technologies that help people with disabilities have not improved as much as other technologies. They should have the same opportunity as other people. This project aims to bring deaf people closer to other people. Sign language is very important for communication. According to the project, Deaf people use that application to translate what they want to say to Turkish. In addition to that, people who need to communicate with deaf people also want that translation. The other usage of that technology is easy writing like what voice assistants do. Using sign language, users can easily send messages. In order to help programmers, videos explaining how the project works, open-source code, and libraries used are shared in the literature. This article aims to summarize the literature and research of previous projects that were the subject of this project. We also examine machine learning and artificial intelligence science literature to evaluate how to work in this field.

Keywords: Sign language, deaf people, machine learning, artificial intelligence

Öz

2010'lu yıllardan sonra teknolojik gelişmeler yapay zeka ve makina öğrenmesi alanlarında yoğunlaştı. Buna rağmen engelli insanlar için yapılan gelişmeler diğer gelişmelerin yanında eksik kaldı. Engelli insanlar da diğer insanlarla aynı fırsatlara eşit olmalıdır. Bu proje duyma engelli insanlarla diğer insanları daha çok yakınlaştırmayı amaçlar. Bu iletişim için de işaret dili büyük önem arz etmektedir. Bu projeye göre duyma engelli insanlar, uygulamayı kullanarak anlatmak istedikleri şeyleri işaret dilinden Türkçe'ye çevirebilirler. Buna ek olarak duyma engelli birisiyle iletişim kurmak istediğinde diğer insanlar da bu uygulamayı kullanarak onlara işaret dili tercümesini gösterebilirler. Bu uygulamanın diğer bir kullanım alanı da sesli asistanlar gibi çalışır. Nasıl sesli asistan kullanarak hızlı mesaj yazabiliyorsak, aynı şekilde işaret dili kullanarak da aynı işlemi

gerçekleştirebiliriz. Programcılara yardımcı olmak amacıyla literatür de projenin nasıl çalıştığını anlatan videolar, açık kaynak kodu ve kullanılan kütüphaneler paylaşılmıştır. Bu makale, bu projenin konusu olan önceki projelerin literatürünü ve araştırmalarını özetlemeyi amaçlamaktadır. Bu alanda nasıl çalışılacağını değerlendirmek için makine öğrenimi ve yapay zeka bilimi literatürünü de inceliyoruz.

Anahtar Kelimeler: İşaret dili, sağır insanlar, makine öğrenimi, yapay zeka

1. Introduction

According to the data of the World Health Organization (WHO), 466 million deaf people live worldwide and more than 3 million of them living in Turkey. Unfortunately, only 10 percent of people who are deaf today have hearing aids. Also, some of the people can not hear totally and hearing aids can not help them. Therefore, sign language is of great importance for deaf people. Using this language, they can communicate with the people they meet. We designed this project to make life easier for those with a high percentage (those without hearing aids).

We examined how existing projects work and what they benefit from. In addition, our literature research enabled us to identify gaps in the current literature. These shortcomings will contribute to the later stages of the project.

In the next section, the literature of previous projects is discussed. In the fourth section, we compare our project and previous projects. We mention the advantages of our project according to previous work. In the fifth part, we explain and conclude the contribution of the literature of the projects to us.

2.Related Work

The traditional way to prevent this issue is to use a mechanical tool for ears to improve the sound of the environment for deaf people. However, these devices only increase the sound, for totally deaf people this sort of device is not useful. There have been many studies on sign language in the past. We reviewed these studies, made improvements, and tried to fix the shortcomings we found in our project. We will examine a few examples made in the past below.

2.2.1 Real-Time Malaysian Sign Language Translation using Colour Segmentation and Neural Network[1]

Recommended automatic sign language translators provide a real-time English translation of Malaysian SL. A wearable glove is used in combination with colors to help identify fingertips in the color spectrum of the camera.

This project focuses solely on finger typing, which takes different approaches respectively. The working process takes place in 4 stages; First, read the frame, dissect the color, find the center of the image, and finally determine the result.

Finally, trained neural networks are used to describe signs to be translated into English.

2.2.2 A real-time continuous gesture recognition system for sign language[2]

First, a motion input is detected and analyzed, then motion is analyzed according to four parameters: stance, position, orientation, and motion.

The developers implemented a prototype system with a 250-word dictionary and collected 196 educational phrases in Taiwanese Sign Language (TWL). This system uses hidden Markov models (HMMs) for 51 basic postures, 6 orientations, and 8 motion principles.

The accuracy rate obtained in this study is approximately 80.4%.

2.2.3 A vision-based sign language recognition system using tied-mixture density HMM[3]

In this project, a vision-based vocabulary Chinese sign language recognition (SLR) system is presented.The system consists of two parts.
In the first part, hand sensing, background subtraction and pupil detection techniques are largely combined to show the movements in different environments with the help of appropriate colored gloves.Principal component analysis (PCA) is used to interpret finger features in more detail.
In the last section, the Bound Mix Density Hidden Markov Models (TMDHMM) framework for SLR is proposed.

The accuracy of this project reaches up to 92.5%.

2.2.4 A Video-Based Indian Sign Language Recognition System (INSLR) Using Wavelet Transform and Fuzzy Logic[4]

In this project, a simplified Video-Based Indian Sign Language Recognition System (INSLR) has been designed using a combination of various image processing techniques and computational intelligence techniques. At the same time, a wavelet-based video segmentation technique is used that detects many hand signals and head movements. The properties of hand gestures are understood using the feature vectors of the image using elliptical Fourier annotations.
Finally, the INSLR system uses a sound system to play recognized movements along with text output. The system was tested by 10 different programmers using a data set of 80 words and sentences.

It shows that it is 96% correct according to the results of the tests.

2.3 Sign Language Translator Using Machine Learning

According to research which was done in 2017, There is currently more than 3 million people have been suffering from deafness. Previous works work in English and translate word by word to text. Also, one of the project use gloves to recognize. These are not useful and efficient in real life. Translating word by word does not make sentences and it is hard to understand for people. Besides, people can not carry gloves all the time. People need a real-time translator to sign language to human languages. In addition to that, there is not any study in Turkey. In this project we want that solve this problem. Deaf people can use applications, which in their mobile phone, to communicate with other people. In addition to that, their relatives also want to translate human languages to sign language. To do this, people can use it with video or using the front camera of the mobile phone. Application translate it to writing and using voice assistants, other people can hear what deaf people sign. Another application area is similar to the voice assistant. While preparing some food or walking in the rain, writing text messages is very difficult. People use voice assistants at these times. Deaf people haven't that opportunity. To give them that chance, this application can be used as an assistant. Lastly, for online videos, movies, series, or tv shows, there exist subtitles but some people may want to sign language translation.

2.4 Conclusion

As a result, some projects have been carried out and designed to make life easy for 466 million deaf people around the world. There are not many applications for a sign language translator. The ones that exist could not use efficiently in real life. Based on these projects, we decided to identify the deficiencies and make an easier and more understandable project. Our project has been approaching issues

in a different way. In this way, it will be ensured that deaf people without hearing aids can easily communicate with anyone they want to use this project.

3. Software Requirements Specification

Change History

The first version of this document was prepared on 11 November 2020 in accordance with IEEE standards.

The second version was made on December 30, 2020. Changes made to 1000 datasets were updated to 100 datasets. It was decided as the speaker button instead of the microphone button.

The third version was made on March 28, 2021. Changes made to 100 datasets were updated to 50 datasets. It was decided as no button for voice assistant. Changes made mobile to a device that has an internet connection.

The last version was made on June 04, 2021. Changes made to 50 datasets were updated to 25 datasets. The limitations are added. Grammar and format errors are fixed.

Preface

This document contains the sign language recognition with machine learning (SLRWML) Software Requirements Specification (SRS), a project that aims to facilitate communication with deaf people in a web-based environment and enable us to understand them better.

SLRWML SRS has been prepared according to IEEE STD 830-1998, Recommended Practice for IEEE Software Requirements Specifications [1]. This document includes product perspective, functions, user features, requirements, system assumptions, and restrictions.

3.1 Introduction

The following subsections are an overview of the entire “Software Requirements Specification” (SRS) document.

3.1.1 Purpose

This document has been prepared to explain briefly what is the “Sign Language Recognition with Machine Learning” and why it will be implemented. The required information will be investigated in subsections.

3.1.2 Scope

Sign language has been being used by people who suffer from hearing loss. These people express themselves with a specific type of language which is called “Sign Language”.[1] Sign language is like the other languages, each region has its own specific sign language like normal language. The common thing in sign language is that; each expression is stated with fingers and some arm movement.

The interest to sign language has been increasing with growing media. Today each TV series, news, and movie have been using sign language to reach deaf people or people who communicate with sign language. Thus, sign language stuff and similar applications have been being used widely nowadays.

Sign Language Recognition has been providing to convert sign language to written language faster, safely and without human beings. Since it is not feasible technically to convert all media on the internet to written language from sign language, it will be useful to use an algorithm that does the same thing.

The software that will be prepared may use the dataset that is available on the internet but also it will be needed to generate some dataset. Sign language is used by many people, so it contains small differences for every person, the software

should understand the difference and ignore it by machine learning algorithms. The objectives of the project are:

• To convert the sign language that is perceived by the camera to written language.

• To do the conversion as much as faster.

• To do conversion truly, namely, it has to ignore expression not related to sign language gestures

• To store the user's type of speaking and understand words easily from the text.

3.1.3 Definitions, Abbreviations, Acronyms

AI	Artificial Intelligence
ML	Machine Learning
SLRWML	Sign Language Recognition with Machine Learning

3.1.4 References

[1] “https://tr.wikipedia.org/wiki/İşaret_dili (Last Access : 30 November 2020)”

3.1.5 Overview

This document had been prepared to give clear information about the software that converts sign language to written language. This document includes all technical detail and required specification for this purpose.

3.2 Overall Description

This section describes the requirements for SLRWML. To be easy to understand, this part of the SRS provides a basis for requirements. The detail definitions are mentioned in chapter 3.

3.2.1 Product Perspective

SLRWML is an application that has both a web interface and an app interface.

3.2.1.1 External System Interfaces

Since SLRWML is an independent system, there is no system interface with any other system.

3.2.1.2 User Interfaces

SLRWML has 1 user, but there are 2 different interfaces according to the users' request.

Translation From Image To Sound And Text Interface

The user interface is designed for everyone. Therefore, the interface should be simple and convenient. In this interface, there is a screen at the bottom of the screen that detects and shows the user's movements, and there is a text box that converts these movements into a written text.

Translation from Text to Image Interface

The user interface is designed for everyone. There is a text box in this interface where you can enter text. At the top is a screen that translates the entry in this text box into sign language.

3.2.1.3 Hardware Interfaces

Server Side

The PC will have a 64-bit architecture. The computer will have a hard disk large enough to hold close to 20 sign language data.

Client Side

Any personal computer that can support any Windows environment with mouse support or run on android devices is acceptable.

3.2.1.4 Software Interfaces

Server Side

The developed application will be accessed using a web browser. Approximately 20 sign language information will be uploaded to a database.

Client Side

The required software product on the client-side is an internet browser that supports at least HTML version 3.2, java enabled, camera-enabled, and any operating system that can run browsers.

3.2.1.5 Communication Interfaces

The default communication protocol for data transmission between server and the client is Transmission Control Protocol/ Internet Protocol (TCP/IP). At the upper level Hyper Text Transfer Protocol (HTTP, default port=80) will be used for communication between the web server and client.

3.2.1.6 Memory Constraints

SLWML will not use any additional resources. User's computer running the web browser or android phone must have enough physical memory to run this program.

3.2.1.7 Operations

The SLRWML operations that users need are explained below.

• Users will first see 2 different translation options. These are image-to-text translation and image-to-text translation. By choosing one of these options, they will be directed to the relevant page.

• On the image-to-text translation page, the user shows the words they want to tell in sign language and the computer detects it, then translates the detected word into text and displays it in the text box.
• On the text-to-image translation page, users type the word they want to tell in the text box. Then, the sign language equivalent of this word is projected as an animation on the display screen.

3.2.2 Product Functions

The system has 1 different function for 1 different user group:
User: Chooses what kind of translate he wants to do, then writes or displays the inputs requested by the system.

3.2.3 User Characteristics

There will be 1 types of users: User: The user must have a web browser with an internet connection in order to use the SLRWML website.

3.2.4 Constraints

- The size of the hard disk should be close to 25 data that the system wants to keep in memory. For image to text translation, there is 6 words which are "güzel", "evet", "sıkılmak", "cevap", "seni seviyorum", "beş". For text to image translation, there is 18 words which are "ben", "sen", "bugün", "cevap", "çengel", "deli", "demokrasi", "gerekli", "güney", "hoşçakal", "iki", "kirli", "işaret dili öğreniyorum", "merhaba", "rapor", "seni seviyorum", "üç", "yumruk".
- For the image to text translation, there is a delay nearly 15 seconds after camera opening because of the system delay.
- To obtain a good result, the background should be white and the user should wear long sleeve black clothes.

3.2.5 Assumptions and Dependencies

Each user will have the appropriate hardware and software configuration specified in sections 2.1.3, 2.1.4, 2.1.5.

3.2.6 Apportioning of Requirements

Language usage requirements such as server type, communication type and secure connection should be determined. The problems that the user will experience in the application should be determined and appropriate solutions should be produced for them.

3.3 Specific Requirements

3.3.1 External Interface Requirements

There are no external interfaces for this system.

3.3.2 Functional Requirements

Assuming there is a pre-existing database of Turkish word and sign language gestures as animation. Users don’t have to sign up or sign in. Applications will be available for everyone.

3.3.2.1 Image-to-Text Conversion Functions

Devices must have a camera for detection. The gestures which are detected via camera will translate to text messages.

3.3.2.2 Text to Image Conversion Functions

Users can write it down as text for input. After translation, the output will be shown as animation on the screen.

3.3.2.3 Common Functions

There is just one type of user. So, all functions are common

3.3.3 Performance Requirements

We aim that people can use it in daily life. Because of that, translation should take less than 5 second.

3.3.4 Security Requirements

The security is provided using HTTPS over SSL protocol for secure communication between the client and the server. Also, secure network protocol TCP/IP protocol in SQL Server will be used.

3.3.5 Design Constraints

No planning was made about that section.

3.3.6 Software System Attributes

Functionality: Application is designed to translate sign language to human language and human language to sign language.

Reliability: Application will work properly on computers.

Security: Users are not allowed to reach the database directly, so data will be saved in this way. User information will not share with 3th party applications.

Safety: Safety will be covered by using TCP/IP on the network side.

Performance: Translation should take less than 5 seconds.

Flexibility: Responsive web design (RWD) will be used in GUI design. RWD is an approach that makes web pages render well on a variety of devices and window or screen sizes.

Scalability: Application is designed to cover the needs of all users.

Portability: The system works on all operating systems.

Availability: As long as there is access to the internet, there will be access to the application without any interrupts.

Usability: GUI will be designed to make users comfortable and familiar with the application. Every type of human can easily use applications. GUI will be mapped according to that.

Maintainability: Application will be updated according to coming feedback from users and improving the word database of application. The database will be backed up monthly in case of data loss.

3.3.7 Other Requirements

Users must have a device that has an internet connection for using the application. For database connection, Devices have to have an internet connection. Users should know basic computer usage.

4. Software Design Description

4.1 Introduction

Sign Language has been used to express feelings, thoughts without speaking because of some diseases related to the speaking ability or lack of hearing ability which is called deafness. The Sign Language Recognition with Machine Learning provides a translation between sign language and normal language. The translated sign language can be easily converted to other languages or vice versa.

4.1.1 Purpose

This project has been aiming to generate a useful, fast translation between sign language and normal language. The program will use machine learning to improve the correctness of the translation.

4.1.2 Scope

The Software Design Description has been explaining what will be used in the project, what the system will look like. The required functions, definitions, basics of the project are explained in the report. The main structure of this project will be explained briefly in the following sections.

4.1.3 Definitions, Abbreviations, Acronyms

● GIF- This means Graphics Interchange Format. It is a bitmap image format.

● Machine Learning - A branch of science that deals with perception of computers, datasets or data types to design algorithms that allow learning based on data types.

● Python- Python is a programming language that allows users to build programs, it is preferred by data scientists, AI programmers or similar people because of its usability.

4.1.4 References

There are no references that were used for section 1.

4.1.5 Overview

The following sections will be investigated through this report.

● In section 2, used tools in the design of the system and the purpose of usage will be investigated.

● In section 3, the architecture of the system, system existence, and physical location will be mentioned.

● In section 4, the system interface will be explained.

● In section 5, the user interface of the system will be mentioned for design.

● In section 6, the process design will be mentioned as sketches.

● In section 7, the dataset design and relations of data will be mentioned.

4.2 Design Considerations

4.2.1 Approach

Software architecture diagram-It was used to show how users of a typical software system can interact with external systems, data sources, and services.

● Hardware architecture diagram-This diagram presents the hardware (servers, workstations) that are interconnected by a network, as well as the technical and application components that are deployed on this hardware.

● We made the dataset to keep the information of the users who reported the error with the dataset.

4.2.2 Tools Used

- For ER diagrams no specific software will be used, instead of software, “draw.io” will be used.
- The Phyton will be used as a programming language on the “Anaconda”.
- For analyzing the pictures, a sort of webcam will be used.
- “OpenCV” library, “PyTorch” and “onnx” will be used also.
- Keras
- Tensorflow
- React
- For the documentation, MS office documentation will be used.

4.2.3 Constraints

The perceiver of the computer will perceive the movement of the hand instead of perceiving face expression.

4.2.4 Assumptions and Dependencies

The Sign Language will be expected as in American. Thus, other languages will not be expected from the user.

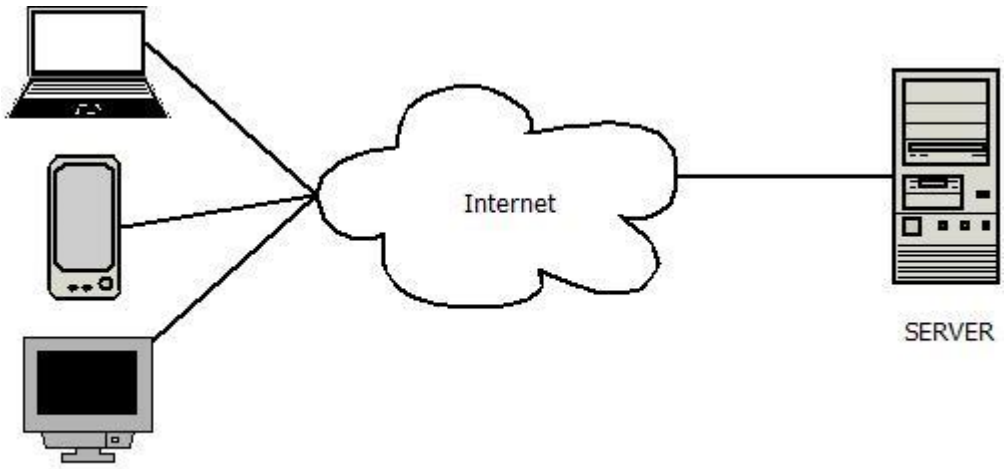
4.3 Architecture

4.3.1 Software Architecture

We do not use database design in this project.The format of the pictures will be GIF.

4.3.2 Hardware Architecture

The hardware architecture to be used in this project is client-server architecture. The client-server model describes how a server provides resources and services to one or more clients. When a client requests a connection to a server, the server can accept or deny the connection. If the connection is accepted, the server establishes and maintains a connection with the client over a specific protocol.



In this project, the client will make a request to the SLRWML application server and the connection will be made using the TCP / IP protocol.

4.4 System Interfaces

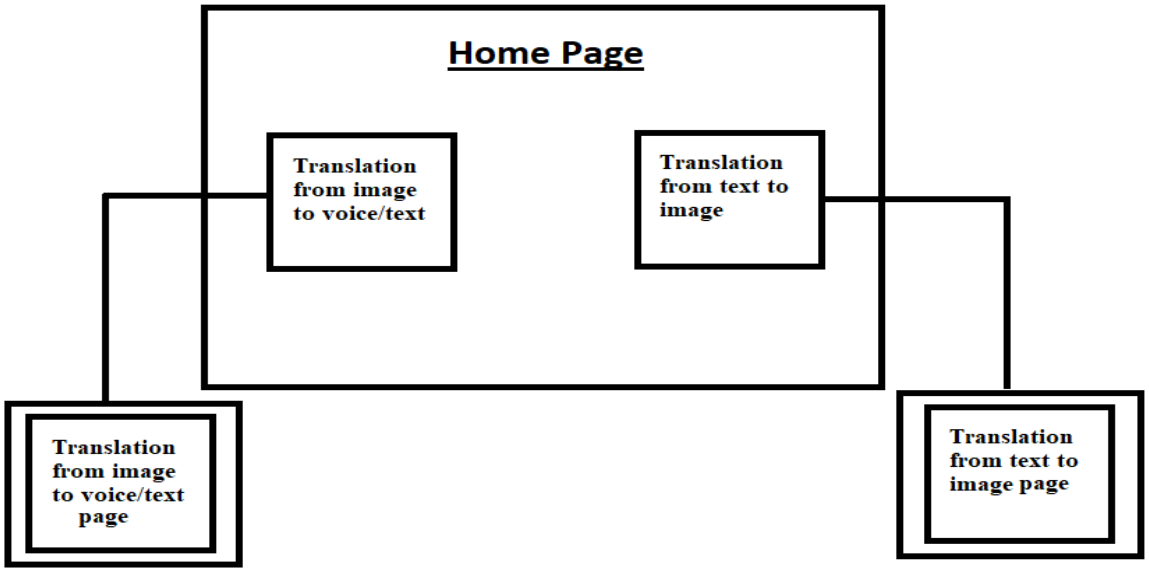
4.4.1 External System Interfaces

There is no external interface in this system.

4.5 User Interface Design

The general view of the site is shown in this section.

4.5.1 Navigation



● Users will be directed to "Home Page" by opening the application they downloaded on their android phone or by using the URL link.

● There are 2 different buttons on the homepage. The first is the "Translation from image to text" and the other is the "Translation from text to image" button.

● When the "Translation from image to text" button is pressed, it is directed to the desired page. This page asks for camera permission when first opened. After this permission is given, words are explained using sign language through the camera, and then the words corresponding to this sign language appear in the text box below.

● When the "Translate from text to image" button is clicked, it is directed to the desired page. The text is written in the text box. Then, when the 'translate' button is pressed, an animation appears at the top, this animation shows the equivalence of those words in sign language.

4.5.2 Screen Definitions

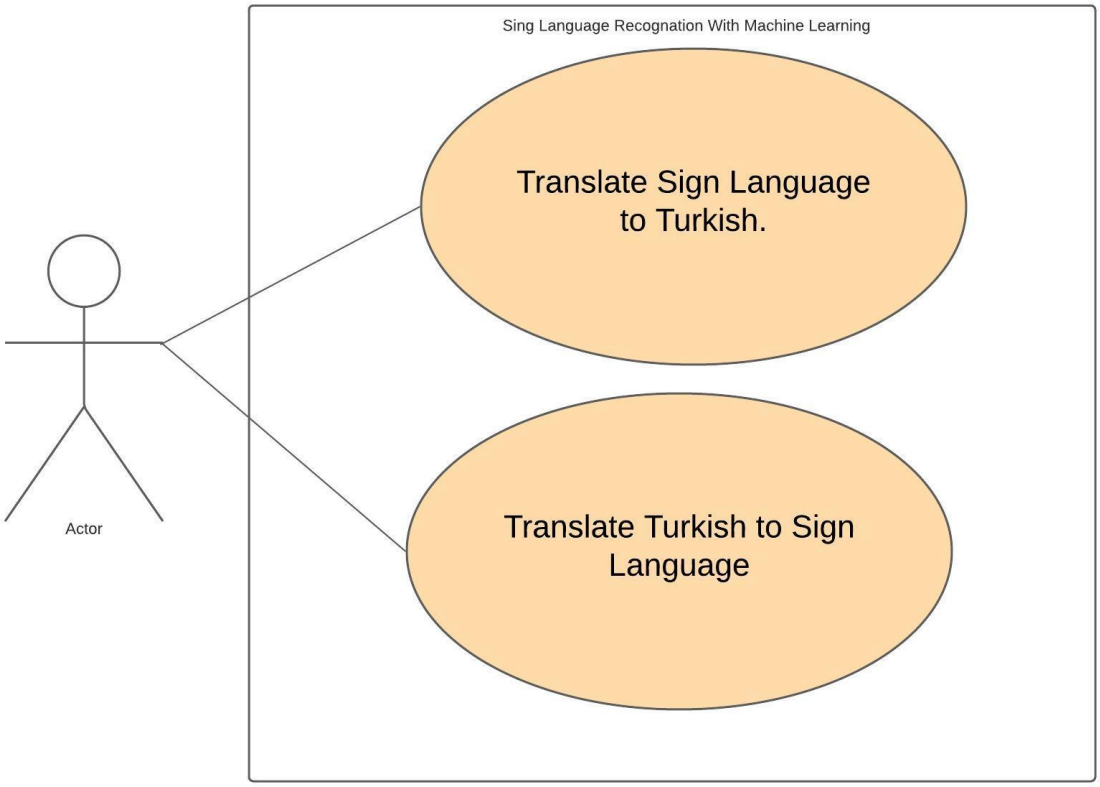
4.5.2.1 Home Page

4.5.2.2 Translation from text to image page

4.5.2.3 Translation from image to text

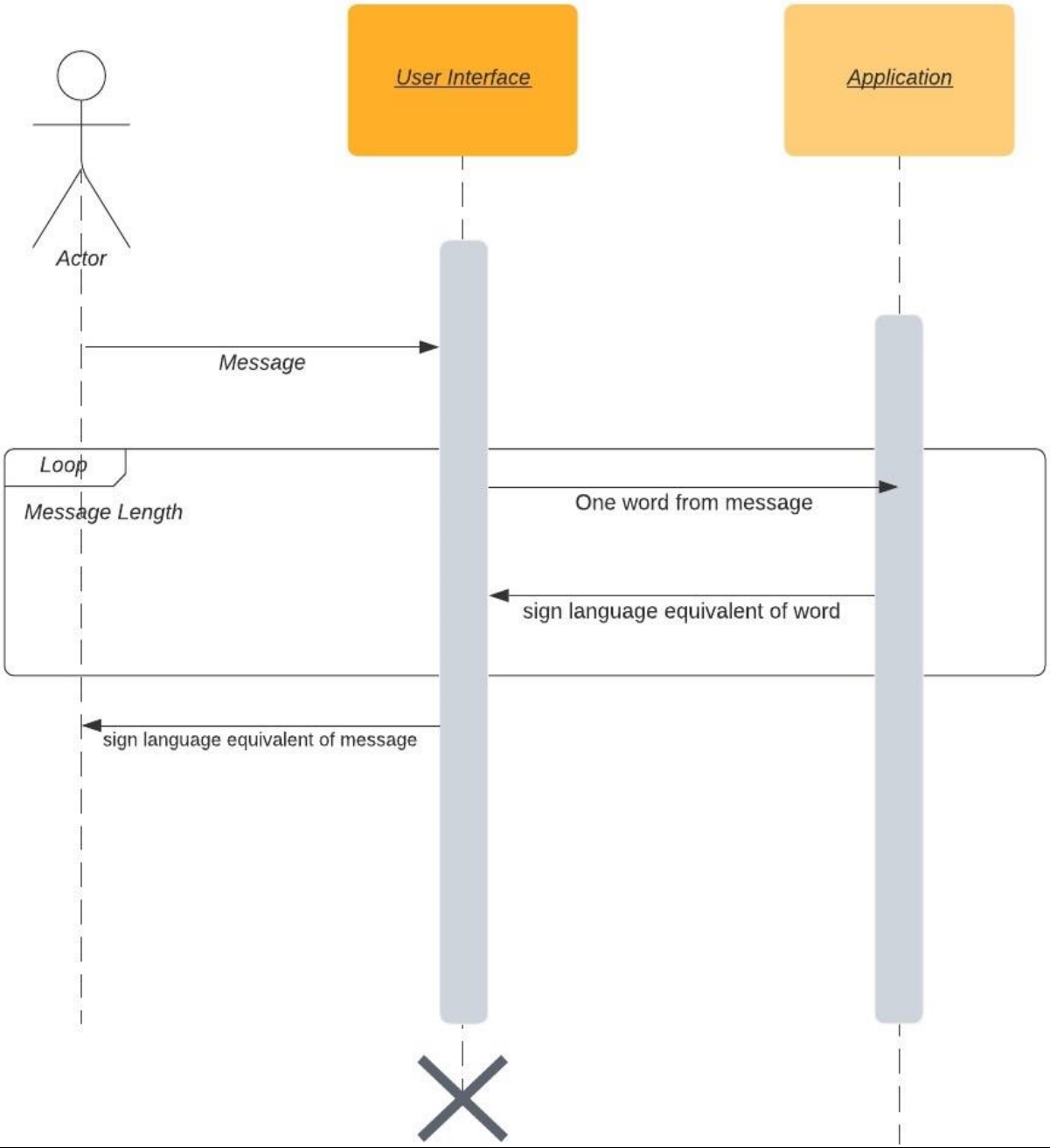
4.6 Process Design

4.6.1 Use Case

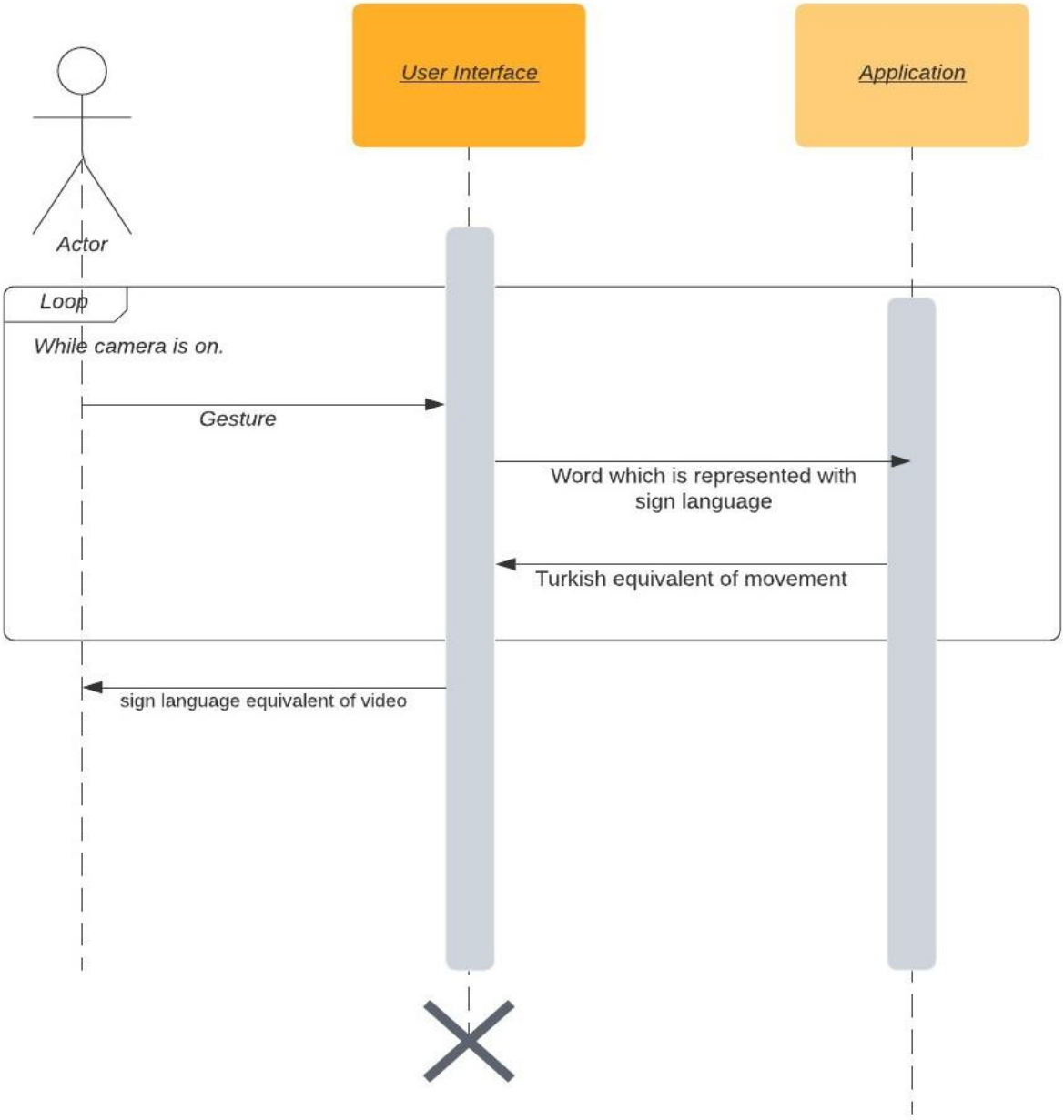


4.6.2 Sequence Diagrams

4.6.2.1 Text to Sign Language:



4.6.2.2 Sign Language to text:



4.7 Dataset Design

This section describes how SLRWML handles data. In this project, we hold data in file architecture. For an image to text translation, we hold pictures on a folder and train TensorFlow from that folder. On the other hand, for text to image translation, there is a folder which contains gif files, according to input, gif file is shown on the screen.

5. Test Plan and Results

5.1 Introduction

5.1.1 Version Control

Version No	Description of Changes	Date
1.0	First Version	28.03.2021

5.1.2 Overview

The application of the Sign Language Recognition with Machine Learning Project will be tested in different ways in this document.The main tests are related with the translating sign language to Turkish and also Turkish to sign language. Application interface's main features also will be tested like whether buttons work or not properly.

5.1.3 Scope

This document will include some features that will be tested to check whether the software works like desired.The features of the software will be tested like explained in the following sections.

5.1.4 Terminology

Acronym	Definition
AI	Artificial Intelligence
ML	Machine Learning
SLRWML	Sign Language Recognition with Machine Learning

5.2 Features To Be Tested

All main functions that are mentioned at SRS and SDD documents of our project will be tested.

5.2.1 Translate Sign Language to Turkish(SLT)

This function is in charge of translating sign language to Turkish. We basically aim to translate gestures to Turkish words correctly.

5.2.2 Translate Turkish to Sign Language(TSL)

This function is opposite of the first function. The purpose of that function is translating Turkish words to sign language graphically.

5.3 Features Not To Be Tested

The technical thing related to the computer's hardware will not be tested. The hardware features like whether the camera works or not, the computer works or not, the internet connection works properly or not and similar things will not be tested during the test case because it is out of the scope of the project.

5.4 ITEM PASS/FAIL CRITERIA

The working condition of the buttons will be tested without any error. The buttons must work properly, if any of the buttons will not work the test will be considered as failed criteria. The images which were taken by camera will be investigated also properly. The images must be read correctly by the software also.

5.4.1 Exit Criteria

If the following conditions are satisfied, the exit criteria will be achieved.

- All test cases are executed
- All buttons work properly
- 90% of images are read properly.

5.5 Test Design Specifications

5.5.1 Graphical User Interface (GUI)

5.5.1.1 Subfeatures to be Tested for Home Page

5.5.1.1.1 'Metinden Görüntüye Çeviri' Button (GUI.MGC_BTN)

The user should press the 'Metinden Görüntüye Çeviri' button to translate from written language to sign language. Thus, it is directed to the page where the translation will be made.

5.5.1.1.2 'Görüntüden Metne Çeviri' Button (GUI.GMC_BTN)

The user must press the 'Görüntüden Metne Çeviri' button to translate from sign language to text. Thus, it is directed to the page where the translation will be made.

5.5.1.2 Subfeatures to be Tested for Translation From Text-to-Image Page

5.5.1.2.1 'İşaret Dili Çevirisi' Button (GUI.IDC_BTN)

When the user presses the 'İşaret Dili Çevirisi' text at the top of the page, it returns to the home page.

5.5.1.2.2 Data Screen Showing Sign Language (GUI.DS)

The screen here is the one where the sign language corresponding to the text entered by the user is displayed.

5.5.1.2.3 Text Box to Enter Text (GUI.TBE_BTN)

The user should type the text that wants to translate into sign language in this box.

5.5.1.2.4 'Çevir' Button (GUI.CB_BTN)

It is the button that gives the order to translate the text entered in the text box into sign language.

5.5.1.3 Subfeatures to be Tested for Translation From Image to Text Page

5.5.1.3.1 'İşaret Dili Çevirisi' Button (GUI.IDC_BTN)

When the user presses the 'İşaret Dili Çevirisi' text at the top of the page, it returns to the home page.

5.5.1.3.2 The Screen That Takes the Webcam View (GUI.SWV)

It is the screen where hand movements corresponding to the sign language are detected by the camera.

5.5.1.3.3 Text Box to Showing Text (GUI.TBS_BTN)

It is the box where the text equivalent of the text corresponding to the sign language is displayed

5.6 Test Cases

Here list all the related test cases for this feature

TC ID	Requirements	Priority	Scenario Description
GUI.MGC_BTN	6.1.1.1	H	Select 'Metinden Görüntüye Çeviri' Button. After selecting, it is directed to the page to be translated from text to image.
GUI.GMC_BTN	6.1.1.2	H	Select 'Görüntüden Metne Çeviri' Button. After selecting, it is directed to the page to be translate from sign language to text.

TC ID	Requirements	Priority	Scenario Description
GUI.IDC_BTN	6.1.2.1	M	Select 'İşaret Dili Çevirisi' Button. After selecting, back to the homepage.
GUI.DS	6.1.2.2	H	On the display screen we see the sign language corresponding to the entered text.
GUI.TBE_BTN	6.1.2.3	H	The text to be translated into sign language is written in this box.
GUI.CB_BTN	6.1.2.4	H	Select 'Çevir' Button. After selecting, It allows the text entered in the text box to be translated into sign language.

TC ID	Requirements	Priority	Scenario Description
GUI.IDC_BTN	6.1.3.1	M	Select 'İşaret Dili Çevirisi' Button. After selecting, back to the homepage.
GUI.SWV	6.1.3.2	H	On the screen, the screen where hand movements corresponding to the sign language will be detected by the camera will appear.
GUI.TBS_BTN	6.1.3.3	H	The text equivalent of the text corresponding to the sign language is displayed.

5.7 Detailed Test Cases

5.7.1 GUI.MGC_BTN

TC_ID	GUI.MGC_BTN
Purpose	Redirects to the page where the Text-to-image translation is made
Requirements	6.1.1.1
Priority	High
Estimated Time Needed	5 sec
Dependency	Main Page should open
Setup	-
Procedure	[A01] Go to the home page.
	[A02] Click on the 'Metinden Görüntüye Çeviri' button.
Cleanup	Exit

5.7.2 GUI.GMC_BTN

TC_ID	GUI.GMC_BTN
Purpose	Redirects to the page where the Sign Language to Text translation is made
Requirements	6.1.1.2
Priority	High.
Estimated Time Needed	5 sec
Dependency	Main Page should open
Setup	-
Procedure	[A01] Go to the home page.
	[A02] Click on the 'Görüntüden Metne Çeviri' button.
Cleanup	Exit

5.7.3 GUI.IDC_BTN

TC_ID	GUI.IDC_BTN
Purpose	Back to the homepage.
Requirements	6.1.2.1
Priority	Medium
Estimated Time Needed	5 sec
Dependency	Main Page should open
Setup	Text-to-image translation page is open
Procedure	[A01] Go to the Text-to-image translation page.
	[A02] Click on the "İşaret Dili Çevirisi" button.
Cleanup	Go back to the Main Page

5.7.4 GUI.DS

TC_ID	GUI.DS
Purpose	See visually the sign language corresponding to the entered text.
Requirements	6.1.2.2
Priority	High.
Estimated Time Needed	<1 Minute
Dependency	Main Page should open
Setup	Text-to-image translation page is open
Procedure	[A01] Go to the Text-to-image translation page.
	[A02] Enter text in the text box.
	[A03] Click on the "Çevir" button.
	[A04] The display screen appears
Cleanup	Go back to the Main Page

5.7.5 GUI.TBE_BTN

TC_ID	GUI.TBE_BTN
Purpose	Enter the desired text to be translated into sign language.
Requirements	6.1.2.3
Priority	High.
Estimated Time Needed	<1 Minute
Dependency	Main Page should open
Setup	Text-to-image translation page is open
Procedure	[A01] Go to the Text-to-image translation page.
	[A02] Enter text in the text box.
Cleanup	Go back to the Main Page

5.7.6 GUI.CB_BTN

TC_ID	GUI.CB_BTN
Purpose	Allowing the text entered in the text box to be translated into sign language.
Requirements	6.1.2.4
Priority	High.
Estimated Time Needed	<1 Minute
Dependency	Main Page should open
Setup	Text-to-image translation page is open
Procedure	[A01] Go to the Text-to-image translation page.
	[A02] Enter text in the text box.
	[A03] Click on the "Çevir" button.
Cleanup	Go back to the Main Page

5.7.7 GUI.IDC_BTN

TC_ID	GUI.IDC_BTN
Purpose	Back to the homepage.
Requirements	6.1.3.1
Priority	Medium
Estimated Time Needed	5 sec
Dependency	Main Page should open
Setup	Sign Language to Text translation page is open
Procedure	[A01] Go to Sign Language to Text translation page.
	[A02] Click on the "İşaret Dili Çevirisi" button.
Cleanup	Go back to the Main Page

5.7.8 GUI.SWV

TC_ID	GUI.SWV
Purpose	Perception of hand movements corresponding to sign language by the camera.
Requirements	6.1.3.2
Priority	High.
Estimated Time Needed	< 4 Minutes
Dependency	Main Page should open
Setup	Sign Language to Text translation page is open
Procedure	[A01] Go to Sign Language to Text translation page.
	[A02] Opening the camera
Cleanup	Go back to the Main Page

5.7.9 GUI.TBS_BTN

TC_ID	GUI.TBS_BTN
Purpose	Display the text equivalent of the text corresponding to the sign language.
Requirements	6.1.3.3
Priority	High.
Estimated Time Needed	<4 Minutes
Dependency	Main Page should open
Setup	Sign Language to Text translation page is open
Procedure	[A01] Go to Sign Language to Text translation page.
	[A02] Opening the camera
	[A03] Make the actions that apply in sign language
	[A04] Writing the text corresponding to the sign language by the computer into the text box.
Cleanup	Go back to the Main Page

5.8 Test Results

TC ID	Requirements	Priority	Scenario Description	Date Run	Result	Explanation
GUI.MGC_BTN	6.1.1.1	H	Select 'Metinden Görüntüye Çeviri' Button. After selecting, it is directed to the page to be translated from text to image.	27.05.2021	Pass	'Metinden Görüntüye Çeviri' button selected. After clicking button, Directing to the 'Metinden Görüntüye Çeviri' page is successful.
GUI.GMC_BTN	6.1.1.2	H	Select 'Görüntüden Metne Çeviri' Button. After selecting, it is directed to the page to be translate from sign language to text.	27.05.2021	Pass	'Görüntüden Metne Çeviri' button selected. After clicking the button, Directing to the 'Görüntüden Metne Çeviri' page is successful.

TC ID	Requirements	Priority	Scenario Description	Date Run	Result	Explanation
GUI.IDC_ BTN	6.1.2.1	M	Select Logo Button. After selecting, go back to the homepage.	27.05.2021	Pass	Logo button selected. After clicking the button, Directing to the homepage is successful.
GUI.DS	6.1.2.2	H	On the display screen we see the sign language corresponding to the entered text.	27.05.2021	Pass	Several words are written to the text box separately. The sign language equivalents of the words are displayed.
GUI.DS	6.1.2.2	H	On the display screen we see the sign language corresponding to the entered text.	27.05.2021	Pass	Several words are written to the text box separately. The sign language equivalents of the words are displayed.
GUI.TBE _BTN	6.1.2.3	H	The text to be translated into sign language is written in this box.	27.05.2021	Pass	Writing to textbox is successful.
GUI.CB_ BTN	6.1.2.4	H	Select 'Çevir' Button. After selecting, It allows the text entered in the text box to be translated into sign language.	27.05.2021	Pass	'Çevir' button worked properly. After clicking that button. Gif image appeared.

TC ID	Requirements	Priority	Scenario Description	Date Run	Result	Explanation
GUI.IDC_ BTN	6.1.3.1	M	Select Logo Button. After selecting, back to the homepage..	27.05.2021	Pass	Logo button selected. After clicking the button, Directing to the homepage is successful.
GUI.SWV	6.1.3.2	H	On the screen, the screen where hand movements corresponding to the sign language will be detected by the camera will appear.	27.05.2021	Pass	Camera is opened without any problem.
GUI.TBS_ BTN	6.1.3.3	H	The text equivalent of the gestures corresponding to the sign language is displayed.	27.05.2021	Pass	Several gestures are shown to the camera. The Turksih equivalent of gestures are displayed.

5.10 Summary of Test Results

Priority	Number of TC's	Executed	Passed
H	8	8	8
M	2	2	2
Total	10	2	2

We tested 10 cases and all of them executed successfully.

5.11 Exit Criteria

We tested 10 cases and all of them executed successfully.

Criteria	Met or Not
100% of test cases are executed	Met
%80 of text cases passed	Met
All High Priority test cases are passed.	Met

6 Conclusion

This document is a full review of the sign language with machine learning project. We started our project by examining similar examples made in the past. With all these researches, we found the shortcomings of the projects and tried to complete them in our own project. First of all, we decided on the platform of our project. This project is a web-based project. We explored methods for image processing and deep learning. The requirements we set beforehand during the construction of the project have changed. We took the sign language pictures that we will use in the deep learning side of our project. We researched sign language animations for text-to-image translation. Since the number of data we set before exceeds the power of our computer, we reduced the number of data. Thus, we obtained more accurate results. While we were going to use Django web framework for web design, we used React web framework, which is more suitable for our project and because Tensorflow connection is easier. We have kept our interfaces simple to offer a more understandable interface to the users, but the background structures of this project are quite complex. We distributed the React application made after the development of the project to GitHub pages. The

construction of our project took 4 months. We found the errors we detected in the first version and edited and shared them in the final version.

All in all, this project has been a useful project for deaf people and those trying to communicate with them. We had to keep our dataset limited due to the resources we have, but we can expand our dataset in the future after we improve the conditions we have. Thus, deaf people have access to more words.

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