Module Interface Specification for Mechatronics

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January 19, 2023

1 Revision History

Date	Version	Notes
January 18, 2023	1.0	Everyone - Initial MIS Draft

2 Symbols, Abbreviations and Acronyms

See SRS Documentation at https://github.com/kelhuynh/OpenASL/blob/main/docs/SRS/SRS.pdf

Contents

3 Introduction

The following document details the Module Interface Specifications for OpenASL, a device developed with the aim of translating sign language into text-to-speech, with the purpose of helping members of the deaf and mute community communicate with those who do not know sign language.

Complementary documents include the System Requirement Specifications and Module Guide. The full documentation and implementation can be found at https://github.com/kelhuynh/OpenASL/.

4 Notation

N/A

5 Module Decomposition

The following table is taken directly from the Module Guide document for this project.

Level 1	**Level 2**
Hardware-Hiding Module	Video Capture Module
Behaviour-Hiding Module	Text-to-Speech Module Key Point Classification Module - Communicates with ML module with data from coordinate normalization module Training Module - Communicates with ML module to update dataset Coordinate Export Module - Read data from video capture and stores into file Motion Tracking Module - Controller (ties everything together)
Software Decision Module	Video Analysis Module - requires data to be used Machine Learning Module Coordinate Normalization Module

Table 1: Module Hierarchy

6 Connection Between Requirements and Design

The design of the system is intended to satisfy the requirements developed in the SRS. In this stage, the system is decomposed into modules. The connection between requirements and modules is listed in Table 2.

Req.	**Modules**
CFR1	M1, M4
CFR2	M5
MLFR1	M2
MLFR2	M3
MLFR3	M4
MLFR4	M6, M9, M10
MLFR5	M4
MLFR6	M4
MLFR7	M7, M8
NFR1	M5, M6, M7
NFR2	M1, M4
NFR3	M9
NFR4	M9
NFR5	M7
NFR6	M10
NFR7	M1, M4, M9

Table 2: Trace Between Requirements and Modules

7 MIS of Motion Tracking Module (M1)

7.1 Module

motionTrack

7.2 Uses

Video Capture, Coordinate Normalization, Coordinate Export, Video Analysis, Keypoint Classification, TTS

7.3 Syntax

7.3.1 Exported Constants

Name	In	Out	Exceptions
results	image	Object	-
hand_landmarks	-	Tuple of tuples	-
handedness	-	R	-

7.4 Semantics

7.4.1 State Variables

None

7.4.2 Environment Variables

f - file variable for coordinate export purposes

7.4.3 Assumptions

None

7.4.4 Access Routine Semantics

motionTrack():

- output: video consisting of overlay for hand gesture classification into ASL
- exception: exc := cv2.error

8 MIS of Coordinate Normalization Module (M2)

8.1 Module

Coordinate Normalization

8.2 Uses

Video Capture

8.3 Syntax

8.3.1 Exported Constants

Name	In	Out	Exceptions
pre_processed_landmark_list	landmark_list	Tuple of tuples	-

8.4 Semantics

8.4.1 State Variables

None

8.4.2 Environment Variables

None

8.4.3 Assumptions

None

8.4.4 Access Routine Semantics

pre_process_landmark(landmark_list):

- output: tuple of 20 tuples consisting of x and y coordinates for each hand joint
- exception: exc := ListIndexOutofBounds

8.4.5 Local Functions

- __calc_landmark_list

9 MIS of Coordinate Export Module (M3)

9.1 Module

Coordinate Export

9.2 Uses

Coordinate Normalization

9.3 Syntax

9.3.1 Exported Constants

Name	In	Out	Exceptions
keypoint.csv	-	File containing normalized coordinates	-

9.4 Semantics

9.4.1 State Variables

None

9.4.2 Environment Variables

None

9.4.3 Assumptions

None

9.4.4 Local Functions

- __make_csv

10 MIS of Video Capture Module (M4)

10.1 Module

Video Capture

10.2 Uses

None

10.3 Syntax

10.3.1 Exported Constants

Name	In	Out	Exceptions
success	-	R	-
image	-	Object	-

10.4 Semantics

10.4.1 State Variables

None

10.4.2 Environment Variables

success - indicates that the camera input is initialized for use

10.4.3 Assumptions

There is an available camera connected to the system

11 MIS of Video Analysis Module (M5)

11.1 Module

Video Analysis

11.2 Uses

Coordinate Normalization, Video Capture

11.3 Syntax

11.3.1 Exported Access Programs

Name	In	Out	Exceptions
draw_bounding_rect	-	image	-
draw_landmarks	-	image	-
draw_info_text	-	image	-

11.4 Semantics

11.4.1 State Variables

None

11.4.2 Environment Variables

None

11.4.3 Assumptions

None

11.4.4 Access Routine Semantics

draw_bounding_rect(self, use_brect, image, brect):

- output: image with overlaid bounding rectangle around hand
- exception: exc := None

draw_landmarks(self, image, landmark_point):

- output: image with overlaid hand joints and connections
- exception: exc := None

draw_info_text(self, image, brect, handedness, hand_sign_text):

- output: image with overlaid classifier label
- exception: exc := None

11.4.5 Local Functions

- __calc_bounding_rect

12 MIS of Keypoint Classification Module (M6)

12.1 Module

Keypoint Classification

12.2 Uses

Coordinate Export, Machine Learning

12.3 Syntax

12.3.1 Exported Constants

Name	In	Out	Exceptions
result$_index$	landmark$_list$	R	ListIndexOutofRange

12.4 Semantics

12.4.1 State Variables

None

12.4.2 Environment Variables

None

12.4.3 Assumptions

None

12.4.4 Local Functions

- __call__

13 MIS of Machine Learning Module (M7)

13.1 Module

Machine Learning

13.2 Uses

Keypoint Classification, Coordinate Export, Coordinate Normalization, Training

13.3 Syntax

13.3.1 Exported Constants

None

13.4 Semantics

13.4.1 State Variables

None

13.4.2 Environment Variables

None

13.4.3 Assumptions

None

14 MIS of Training Module (M8)

14.1 Module

ML Train

14.2 Uses

Coordinate Export

14.3 Syntax

14.3.1 Exported Constants

Name	In	Out	Exceptions
keypoint$_c lassifier.hdf5$	-	Hierarchical Data Format file	-
keypoint$_c lassifier.tflite$	-	ML model	-

14.4 Semantics

14.4.1 State Variables

None

14.4.2 Environment Variables

None

14.4.3 Assumptions

None

15 MIS of Text to Speech Module (M9)

15.1 Module

TTS

15.2 Uses

Video Analysis, Keypoint Classification, Coordinate Normalization

15.3 Notes

To be implemented

16 MIS of Hardware Hiding Module (M10)

16.1 Module

Hardware hiding

16.2 Notes

To be implemented