

# Module Interface Specification for Mechatronics

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# 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>

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### 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
$result_i$ <i>index</i>	$landmark_l$ <i>ist</i>	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 <sub>classifier</sub> .hdf5	-	Hierarchical Data For- mat file	-
keypoint <sub>classifier</sub> .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