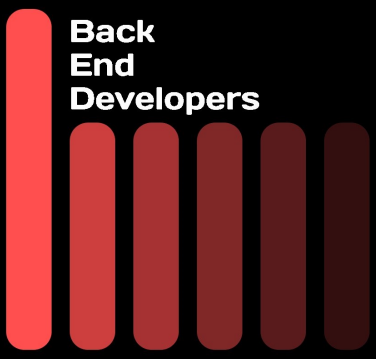
Module Interface Specification for Mechatronics Engineering



Team #1, Back End Developers
Jessica Bae
Oliver Foote
Jonathan Hai
Anish Rangarajan
Nish Shah
Labeeb Zaker

April 6, 2023

1 Revision History

Date	Version	Notes
2023-01-18	1.0	Initial documentation
2023-03-15	2.0	Minor improvements and proof reading for revision 1
2023-04-03	2.1	Incorporated TA feedback
2023-04-03	2.2	Included logo and added style to the document

2 Symbols, Abbreviations and Acronyms

Please refer to the System Requirements Specifications document at this link for relevant symbols, abbreviations.

Contents

1 Revision History i

2 Symbols, Abbreviations and Acronyms ii

3 Introduction 1

4 Notation 1

5 Module Decomposition 2

6 MIS of Battery Module 3
- 6.1 Module . . . 3
- 6.2 Uses . . . 3
- 6.3 Syntax . . . 3
  - 6.3.1 Exported Constants . . . 3
  - 6.3.2 Exported Access Programs . . . 3
- 6.4 Semantics . . . 3
  - 6.4.1 State Variables . . . 3
  - 6.4.2 Environment Variables . . . 3
  - 6.4.3 Assumptions . . . 3
  - 6.4.4 Access Routine Semantics . . . 4
  - 6.4.5 Local Functions . . . 4

7 MIS of microSD Module 5
- 7.1 Module . . . 5
- 7.2 Uses . . . 5
- 7.3 Syntax . . . 5
  - 7.3.1 Exported Constants . . . 5
  - 7.3.2 Exported Access Programs . . . 5
- 7.4 Semantics . . . 5
  - 7.4.1 State Variables . . . 5
  - 7.4.2 Environment Variables . . . 5
  - 7.4.3 Assumptions . . . 5
  - 7.4.4 Access Routine Semantics . . . 5
  - 7.4.5 Local Functions . . . 6

8 MIS of Local Database Module 7
- 8.1 Module . . . 7
- 8.2 Uses . . . 7
- 8.3 Syntax . . . 7
  - 8.3.1 Exported Constants . . . 7
  - 8.3.2 Exported Access Programs . . . 7
- 8.4 Semantics . . . 7

8.4.1 State Variables . . . 7
8.4.2 Environment Variables . . . 8
8.4.3 Assumptions . . . 8
8.4.4 Access Routine Semantics . . . 8
8.4.5 Local Functions . . . 8

9 MIS of Reading Sensor Module 9
9.1 Module . . . 9
9.2 Uses . . . 9
9.3 Syntax . . . 9
9.3.1 Exported Constants . . . 9
9.3.2 Exported Access Programs . . . 9
9.4 Semantics . . . 9
9.4.1 State Variables . . . 9
9.4.2 Environment Variables . . . 9
9.4.3 Assumptions . . . 10
9.4.4 Access Routine Semantics . . . 10
9.4.5 Local Functions . . . 10

10 MIS of Sensor Data Processing Module 11
10.1 Module . . . 11
10.2 Uses . . . 11
10.3 Syntax . . . 11
10.3.1 Exported Constants . . . 11
10.3.2 Exported Access Programs . . . 11
10.4 Semantics . . . 11
10.4.1 State Variables . . . 11
10.4.2 Environment Variables . . . 11
10.4.3 Assumptions . . . 11
10.4.4 Access Routine Semantics . . . 11
10.4.5 Local Functions . . . 12

11 MIS of Prompt Validity Module 13
11.1 Module . . . 13
11.2 Uses . . . 13
11.3 Syntax . . . 13
11.3.1 Exported Constants . . . 13
11.3.2 Exported Access Programs . . . 13
11.4 Semantics . . . 13
11.4.1 State Variables . . . 13
11.4.2 Environment Variables . . . 13
11.4.3 Assumptions . . . 13
11.4.4 Access Routine Semantics . . . 13
11.4.5 Local Functions . . . 13

12 MIS of Display System Module **14**
12.1 Module . . . 14
12.2 Uses . . . 14
12.3 Syntax . . . 14
12.3.1 Exported Constants . . . 14
12.3.2 Exported Access Programs . . . 14
12.4 Semantics . . . 14
12.4.1 State Variables . . . 14
12.4.2 Environment Variables . . . 14
12.4.3 Assumptions . . . 14
12.4.4 Access Routine Semantics . . . 14
12.4.5 Local Functions . . . 14

13 MIS of Prompt Generation Module **15**
13.1 Module . . . 15
13.2 Uses . . . 15
13.3 Syntax . . . 15
13.3.1 Exported Constants . . . 15
13.3.2 Exported Access Programs . . . 15
13.4 Semantics . . . 15
13.4.1 State Variables . . . 15
13.4.2 Environment Variables . . . 15
13.4.3 Assumptions . . . 15
13.4.4 Access Routine Semantics . . . 15
13.4.5 Local Functions . . . 15

14 MIS of Real Time Clock Module **16**
14.1 Module . . . 16
14.2 Uses . . . 16
14.3 Syntax . . . 16
14.3.1 Exported Constants . . . 16
14.3.2 Exported Access Programs . . . 16
14.4 Semantics . . . 16
14.4.1 State Variables . . . 16
14.4.2 Environment Variables . . . 16
14.4.3 Assumptions . . . 16
14.4.4 Access Routine Semantics . . . 16
14.4.5 Local Functions . . . 16

15 MIS of Create New User Module **17**
15.1 Module . . . 17
15.2 Uses . . . 17
15.3 Syntax . . . 17
15.3.1 Exported Constants . . . 17
15.3.2 Exported Access Programs . . . 17

15.4 Semantics . . . 17
15.4.1 State Variables . . . 17
15.4.2 Environment Variables . . . 17
15.4.3 Assumptions . . . 17
15.4.4 Access Routine Semantics . . . 17
15.4.5 Local Functions . . . 17

16 MIS of Configuration Module **18**
16.1 Module . . . 18
16.2 Uses . . . 18
16.3 Syntax . . . 18
16.3.1 Exported Constants . . . 18
16.3.2 Exported Access Programs . . . 18
16.4 Semantics . . . 18
16.4.1 State Variables . . . 18
16.4.2 Environment Variables . . . 18
16.4.3 Assumptions . . . 18
16.4.4 Access Routine Semantics . . . 18
16.4.5 Local Functions . . . 18

17 MIS of Graph Plotter **19**
17.1 Module . . . 19
17.2 Uses . . . 19
17.3 Syntax . . . 19
17.3.1 Exported Constants . . . 19
17.3.2 Exported Access Programs . . . 19
17.4 Semantics . . . 19
17.4.1 State Variables . . . 19
17.4.2 Environment Variables . . . 19
17.4.3 Assumptions . . . 19
17.4.4 Access Routine Semantics . . . 19
17.4.5 Local Functions . . . 19

18 MIS of Watch Strap Module **20**
18.1 Module . . . 20
18.2 Uses . . . 20
18.3 Syntax . . . 20
18.3.1 Exported Constants . . . 20
18.3.2 Exported Access Programs . . . 20
18.4 Semantics . . . 20
18.4.1 State Variables . . . 20
18.4.2 Environment Variables . . . 20
18.4.3 Assumptions . . . 20
18.4.4 Access Routine Semantics . . . 20
18.4.5 Local Functions . . . 20

19 MIS of Watch Case Module **21**
19.1 Module . . . 21
19.2 Uses . . . 21
19.3 Syntax . . . 21
19.3.1 Exported Constants . . . 21
19.3.2 Exported Access Programs . . . 21
19.4 Semantics . . . 21
19.4.1 State Variables . . . 21
19.4.2 Environment Variables . . . 21
19.4.3 Assumptions . . . 21
19.4.4 Access Routine Semantics . . . 21
19.4.5 Local Functions . . . 21

3 Introduction

The following document details the Module Interface Specifications for the EMAnator; the system currently being developed by the Back End Developers designed to aid in Ecological Momentary Assessment research. This document describes the various relevant details of interfacing with each module. These details include module descriptions, the uses of each module, the syntax of each module, and the semantics associated with each module.

Complementary documents include the System Requirement Specifications and the Module Guide. The Back End Developers highly recommend a thorough read-through of each document prior to a reading of this document to attain the prerequisite knowledge necessary to fully understand this MIS. The System Requirements Specifications can be found at this link, and the Module Guide can be found at this link.

4 Notation

The structure of the MIS for modules comes from Hoffman and Strooper (1995), with the addition that template modules have been adapted from Ghezzi et al. (2003). The mathematical notation comes from Chapter 3 of Hoffman and Strooper (1995). For instance, the symbol := is used for a multiple assignment statement and conditional rules follow the form $(c_1 \Rightarrow r_1|c_2 \Rightarrow r_2|...|c_n \Rightarrow r_n)$.

The following table summarizes the primitive data types used by Mechatronics Engineering.

Data Type	Notation	Description
Character	char	A single symbol or digit
Integer	$\mathbb{Z}$	A number without a fractional component in (-∞, ∞)
Natural number	$\mathbb{N}$	A number without a fractional component in [1, ∞)
Real	$\mathbb{R}$	Any number in (-∞, ∞)

The specification of Mechatronics Engineering uses some derived data types: sequences, strings, and tuples. Sequences are lists filled with elements of the same data type. Strings are sequences of characters. Tuples contain a list of values, potentially of different types. In addition, Mechatronics Engineering uses functions, which are defined by the data types of their inputs and outputs. Local functions are described by giving their type signature followed by their specification.

5 Module Decomposition

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

Level 1	Level 2	Level 3
Hardware-Hiding Module	Battery Management	Battery
	Data Storage	microSD Database
	Sensor Array	Sensor Reading Sensor Data Processing Sensor Prompt Validity
	Physical Design	Watch Straps Watch Case
Behaviour-Hiding Module	Display System	Display Screen
	Prompt Generation	Prompt Generation
	Real Time Clock	RTC
Software Decision Module	Parameter Selection	Create New User Configuration
	Data Processing	Graph Data Display

Table 1: Module Hierarchy

6 MIS of Battery Module

6.1 Module

Bat_Man

6.2 Uses

None.

6.3 Syntax

6.3.1 Exported Constants

- Minimum battery threshold for voltage
- Maximum battery limit for voltage
- Low charge indicator for 10% limit

6.3.2 Exported Access Programs

Name	In	Out	Exceptions
bed_getBatteryLev	Bat_Raw	$\mathbb{Z}$	BED_ERR_BAT

6.4 Semantics

6.4.1 State Variables

None.

6.4.2 Environment Variables

- battery level
- low_Flag

6.4.3 Assumptions

System responds instantaneously to changes in flags (exported constants).

6.4.4 Access Routine Semantics

bed_getBatteryLev:

- Transition: Extracts the current battery level
- Output: Integer percentage value of the battery level.
- Exception: BED_ERR_BAT = Z

6.4.5 Local Functions

- bed_lowIndicator: boolean

7 MIS of microSD Module

7.1 Module

microSD_Stor

7.2 Uses

Sensor Prompt Validity Module (Section 11), Real Time Clock Module (Section 14)

7.3 Syntax

7.3.1 Exported Constants

None.

7.3.2 Exported Access Programs

Name	In	Out	Exceptions
listDir	FS, const char*, uint8_t	dirname: string	BED_ERR_SD: $\mathbb{Z}$
createDir	FS, const char *	-	BED_ERR_SD: $\mathbb{Z}$
removeDir	FS, const char *	-	BED_ERR_SD: $\mathbb{Z}$

7.4 Semantics

7.4.1 State Variables

None.

7.4.2 Environment Variables

- fs: A text file.

7.4.3 Assumptions

- MicroSD card is formatted correctly.
- MicroSD card is inserted correctly.

7.4.4 Access Routine Semantics

None.

7.4.5 Local Functions

- readFile
- writeFile
- appendFile
- renameFile
- deleteFile

8 MIS of Local Database Module

8.1 Module

Database_Stor

8.2 Uses

microSD Module (Section 7)

8.3 Syntax

8.3.1 Exported Constants

- Size of the field: First Name = 25
- Size of the field: Last Name = 25
- Size of the field: Gender = 25
- Size of the field: Phone Number = 20
- Size of the field: Email = 25
- Size of the field: Address = 255
- Size of the field: Device model number = 50

8.3.2 Exported Access Programs

Name	In	Out	Exceptions
object.connect	-	Read_Data: string, integer	BED_ERR_DB: $\mathbb{Z}$
object.cursor	Write_Data: string, integer	BED_ERR_DB: $\mathbb{Z}$	
object.execute	Write_Data: string, integer	BED_ERR_DB: $\mathbb{Z}$	
object.commit	Write_Data: string, integer	BED_ERR_DB: $\mathbb{Z}$	
object.close	Write_Data: string, integer	BED_ERR_DB: $\mathbb{Z}$	

8.4 Semantics

8.4.1 State Variables

None.

8.4.2 Environment Variables

- First Name
- Last Name
- Gender
- Phone Number
- Email
- Address
- Device Model Number

8.4.3 Assumptions

None.

8.4.4 Access Routine Semantics

- object.connect(): Connects to the database.
- object.cursor(): Establishes connection between the database and the query.
- object.execute():
- object.commit():
- object.close(): Disconnects from the database.

8.4.5 Local Functions

None.

9 MIS of Reading Sensor Module

9.1 Module

Sensor_Reding

9.2 Uses

Battery Management (Section 6)

9.3 Syntax

9.3.1 Exported Constants

- ACCEL_SENSITIVITY: Z
- GYRO_SENSITIVITY: Z
- Threshold: Z
- MPU_CALIBRATION: Z

9.3.2 Exported Access Programs

- bed_mpu_detect
- bed_hr_detect

9.4 Semantics

9.4.1 State Variables

$currTime : \mathbb{R}$

9.4.2 Environment Variables

- curr_ax
- curr_ay
- curr_az
- curr_gx
- curr_gy
- curr_gz

9.4.3 Assumptions

- All activity thresholds are provided from the configuration file.

9.4.4 Access Routine Semantics

- bed_mpu_detect: Returns the current values of the accelerometer and gyroscope.
- bed_hr_detect: Returns the current values of heartrate sensor.

9.4.5 Local Functions

- bed_mpu_setup
- bed_hr_setup

10 MIS of Sensor Data Processing Module

10.1 Module

Sensor_Data

10.2 Uses

Sensor Reading (Section 9)

10.3 Syntax

10.3.1 Exported Constants

- ACTIVITY_STEPS
- ACTIVITY_IDLE_RESET
- ACTIVITY_IDLE_WAIT

10.3.2 Exported Access Programs

Name	In	Out	Exceptions
HeartRate_Read	-	Read_Data: integer	BED_ERR_SE: $\mathbb{Z}$
MPU_Read	-	Read_Data: integer	BED_ERR_SE: $\mathbb{Z}$
Touch_Read	-	Read_Data: bool	BED_ERR_SE: $\mathbb{Z}$

10.4 Semantics

10.4.1 State Variables

None.

10.4.2 Environment Variables

None.

10.4.3 Assumptions

- There is space available in microSD card.

10.4.4 Access Routine Semantics

None.

10.4.5 Local Functions

data_smoothing_filter(): The purpose of this function is to make sure that the data coming from all the sensors is smoothed, in order to prevent a prompt from being generated erroneously and disturbing the user.

11 MIS of Prompt Validity Module

11.1 Module

Sensor_Prompt

11.2 Uses

Sensor Data Processing (Section 10)

11.3 Syntax

11.3.1 Exported Constants

11.3.2 Exported Access Programs

Name	In	Out	Exceptions
Check_Validity	Read_Data	Prompt_Valid: bool	BED_ERR_SE: $\mathbb{Z}$

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

None.

11.4.5 Local Functions

12 MIS of Display System Module

12.1 Module

Disp_Sys

12.2 Uses

Prompt Generation Module (Section 13), Real Time Clock Module (Section 14), Battery Management (Section 6)

12.3 Syntax

12.3.1 Exported Constants

None.

12.3.2 Exported Access Programs

Name	In	Out	Exceptions
Disp_Time	-	-	BED_ERR_DISP: $\mathbb{Z}$
Disp_Prompt	Prompt: string	Response: string	BED_ERR_DISP: $\mathbb{Z}$
Switch_Window	Window: $\mathbb{Z}$	-	BED_ERR_DISP: $\mathbb{Z}$

12.4 Semantics

12.4.1 State Variables

None.

12.4.2 Environment Variables

None.

12.4.3 Assumptions

None.

12.4.4 Access Routine Semantics

None.

12.4.5 Local Functions

None.

13 MIS of Prompt Generation Module

13.1 Module

Prompt_Gen

13.2 Uses

Sensor Array Module (Section **??**)

13.3 Syntax

13.3.1 Exported Constants

$max\_prompts : \mathbb{Z}$

13.3.2 Exported Access Programs

Name	In	Out	Exceptions
Access_Prompt	Prompt_: $\mathbb{Z}$	Prompt: Struct	BED_ERR_PG: $\mathbb{Z}$

13.4 Semantics

13.4.1 State Variables

None.

13.4.2 Environment Variables

None.

13.4.3 Assumptions

None.

13.4.4 Access Routine Semantics

None.

13.4.5 Local Functions

None.

14 MIS of Real Time Clock Module

14.1 Module

RTC

14.2 Uses

None.

14.3 Syntax

14.3.1 Exported Constants

None.

14.3.2 Exported Access Programs

Name	In	Out	Exceptions
Get_DateTime	-	$\mathbb{R}$	BED_ERR_RTC: $\mathbb{Z}$

14.4 Semantics

14.4.1 State Variables

Date: string
Time: string

14.4.2 Environment Variables

None.

14.4.3 Assumptions

- Initial date and time is correctly set.

14.4.4 Access Routine Semantics

None.

14.4.5 Local Functions

None.

15 MIS of Create New User Module

15.1 Module

NewUser_Enter

15.2 Uses

Local Database Module (Section 12)

15.3 Syntax

15.3.1 Exported Constants

None.

15.3.2 Exported Access Programs

None.

15.4 Semantics

15.4.1 State Variables

$param\_input$: string, integer

15.4.2 Environment Variables

File: A new information line in database.

15.4.3 Assumptions

- All configuration parameters within acceptable limits.

15.4.4 Access Routine Semantics

None.

15.4.5 Local Functions

None.

16 MIS of Configuration Module

16.1 Module

Config_Param

16.2 Uses

MicroSD Module (Section 7)

16.3 Syntax

16.3.1 Exported Constants

None.

16.3.2 Exported Access Programs

None.

16.4 Semantics

16.4.1 State Variables

$param\_input$: string

16.4.2 Environment Variables

None.

16.4.3 Assumptions

- All configuration parameters within acceptable limits.

16.4.4 Access Routine Semantics

None.

16.4.5 Local Functions

None.

17 MIS of Graph Plotter

17.1 Module

Graph_Plot

17.2 Uses

Device Manager Module (Section **??**)

17.3 Syntax

17.3.1 Exported Constants

None.

17.3.2 Exported Access Programs

None.

17.4 Semantics

17.4.1 State Variables

$graph\_select$: bool

17.4.2 Environment Variables

File: A database on the host computer.

17.4.3 Assumptions

- Data is in proper format and not corrupted.

17.4.4 Access Routine Semantics

None.

17.4.5 Local Functions

$graph\_stat$: Statistical analysis function.

18 MIS of Watch Strap Module

18.1 Module

Watch_Strap

18.2 Uses

Watch Case Module (Section 19)

18.3 Syntax

Velcro straps going tied to the watch case.

18.3.1 Exported Constants

None.

18.3.2 Exported Access Programs

None.

18.4 Semantics

Allow the device to be strapped onto the user.

18.4.1 State Variables

None.

18.4.2 Environment Variables

None.

18.4.3 Assumptions

Will not impact the functionality of any other components.

18.4.4 Access Routine Semantics

None.

18.4.5 Local Functions

None.

19 MIS of Watch Case Module

19.1 Module

Watch_Case

19.2 Uses

None.

19.3 Syntax

CAD model and 3D printed.

19.3.1 Exported Constants

None.

19.3.2 Exported Access Programs

None.

19.4 Semantics

Holds the display screen, touch bezels, and display screen together into 1 single device.

19.4.1 State Variables

None.

19.4.2 Environment Variables

None.

19.4.3 Assumptions

Will not impact the functionality of any other components.

19.4.4 Access Routine Semantics

None.

19.4.5 Local Functions

None.

References

Carlo Ghezzi, Mehdi Jazayeri, and Dino Mandrioli. *Fundamentals of Software Engineering*. Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 2003.

Daniel M. Hoffman and Paul A. Strooper. *Software Design, Automated Testing, and Maintenance: A Practical Approach*. International Thomson Computer Press, New York, NY, USA, 1995. URL http://citeseer.ist.psu.edu/428727.html.