Module Interface Specification for 4TB6 - Mechatronics Capstone

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1 Revision History

Date	Version	Notes
16/01/23	1.0	Abi started M4, M5, M7
17/01/23	1.1	Abi finished M4, M5, M7, Intro
18/01/23	1.2	Anthony finished M2,3,6,8

2 Symbols, Abbreviations and Acronyms

See SRS Documentation here.

Contents

3 Introduction

The following document details the Module Interface Specifications for SmartLock, a bluetooth-driven bike lock brough to you by the Locked & Loaded team. The SmartLock allows users to unlock their bike remotely using Bluetooth.

Complementary documents include the System Requirement Specifications and Module Guide. The full documentation and implementation can be found in the GitHub repo.

Note that not every module documented in the Module Guide has a corresponding section in this document, as an MIS was only completed for every software module, and not those modules with a hardware implementation.

4 Notation

[You should describe your notation. You can use what is below as a starting point. —SS]

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 4TB6 - Mechatronics Capstone.

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 4TB6 - Mechatronics Capstone 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, 4TB6 - Mechatronics Capstone 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**
Hardware-Hiding Module	
Behaviour-Hiding Module	Input Parameters Module Output Parameters Module Engage Status Signal Module Wireless Signal Connection Module Battery Status Module Location Module Lock Frame Module
Software Decision Module	Load Power Signal Module Battery Module Electromagnet Module Locking Mechanism Module

Table 1: Module Hierarchy

6 MIS of M2

6.1 Input Parameter Module

As described in the MG document, the Input Parameter Module (M2) is responsible for receiving input from the user. Parameters include input to unlock the bike as well as request the current geo location of the user.

6.2 Uses

6.3 Syntax

6.3.1 Exported Constants

N/A

6.3.2 Exported Access Programs

N/A

6.4 Semantics

6.4.1 State Variables

- storedLocation, type: Location object, package: location

6.4.2 Environment Variables

- engageButton, type: Floating Action Button, Screen Interface
- locationButton, type: Floating Action Button, Screen Interface

6.4.3 Assumptions

None.

6.4.4 Access Routine Semantics

None.

6.4.5 Local Functions

None.

7 MIS of M3

7.1 Output Parameter Module

As described in the MG document, the Output Parameter Module (M3) is responsible for displaying the battery status, location, and the engaged status signal. In this module, there are submodules to store the current location requested by the user.

7.2 Uses

7.3 Syntax

7.3.1 Exported Constants

N/A

7.3.2 Exported Access Programs

N/A

7.4 Semantics

7.4.1 State Variables

- storedLocation, type: Location object, package: location

7.4.2 Environment Variables

None.

7.4.3 Assumptions

None.

7.4.4 Access Routine Semantics

loadScreen(): This routine oversees the layout and UserInterface architecture. It ensures all buttons, labels, and images fall within the constraints of any mobile device.

- inputs: engageButton, locationButton
- transition: none
- output: none
- exception: none

7.4.5 Local Functions

None.

8 MIS of M4

8.1 Engage Status Signal Module

As described in the MG document, the Engage Status Signal Module (M4) is responsible for trasmitting the engagement status of the lock from the Arduino to the mobile app. If the status reads "engaged", then the Arduino is not currently sending a high signal to the transistor, and the electromagnet remains off, meaning the latch in the locking mechanism is shut. Therefore, if the pin is in the lock, it will not be able to move. If the status reads "disengaged", then the Arduino is currently writing a high signal to the transistor, and the electromagnet is on, opening the latch in the locking mechanism, and allowing the pin to move freely (in or out of the lock).

8.2 Uses

8.3 Syntax

8.3.1 Exported Constants

N/A

8.3.2 Exported Access Programs

N/A

8.4 Semantics

8.4.1 State Variables

None.

8.4.2 Environment Variables

- e_BTService, type: BLEService
- e_DisengageCharacteristic; type: BLEByteCharacteristic

Note that the environment variables are the same as that of M5, as an established Bluetooth connection is a prerequisite of M4, and these variables must still be used to keep the BlueTooth connection active.

8.4.3 Assumptions

This module assumes there is a successful BlueTooth connection established between the Arduino and the mobile app.

8.4.4 Access Routine Semantics

readEngagementStatus():

This access routine will be implemented on the mobile app, and will read the current value of e_DisengageCharacteristic.

- inputs
- transition:
- output: e_DisengageCharacteristic
- exception:

8.4.5 Local Functions

None.

9 MIS of M5

9.1 Wireless Signal Connection Module

As described in the MG document, the Wireless Signal Connection Module (M5) is responsible for establishing a BlueTooth connection between the Arduino and the mobile app.

9.2 Uses

9.3 Syntax

9.3.1 Exported Constants

N/A

9.3.2 Exported Access Programs

N/A

9.4 Semantics

9.4.1 State Variables

None.

9.4.2 Environment Variables

- e_BTService, type: BLEService
- e_DisengageCharacteristic; type: BLEByteCharacteristic

9.4.3 Assumptions

- Arduino is powered on.

9.4.4 Access Routine Semantics

BTconnect():

This routine creates a BlueTooth connection between the mobile app and the Arduino so that they can send and receive signals from each other. This routine will need an implementation both for the Arduino, and for the mobile app, where the Arduino will act as the peripheral device, and the mobile app will act as the central device.

- inputs: none
- transition: loadPower(), the access routine of M7, upon successful connection
- output: none
- exception: connection status will appear on the mobile app. Therefore, the user will be aware of the connection status, whether that be successful or unsuccessful.

9.4.5 Local Functions

None.

10 MIS of M6

10.1 Battery Status Module

As described in the MG document, the Battery Status Module (M6) is responsible for calculating the battery status. In this module, there are submodules to calculate the amount of battery left.

10.2 Uses

10.3 Syntax

10.3.1 Exported Constants

N/A

10.3.2 Exported Access Programs

N/A

10.4 Semantics

10.4.1 State Variables

None.

10.4.2 Environment Variables

None.

10.4.3 Assumptions

None.

10.4.4 Access Routine Semantics

getBatteryStatus(): This routine gets the battery amount remaining.

- inputs: batteryCalculator()
- transition: none
- output: none
- exception: none

10.4.5 Local Functions

batteryCalculator(): This function is used to calculate the amount of battery remaining. The output is used in the getBatteryStatus function.

11 MIS of M7

11.1 Load Power Signal Module

As described in the MG document, the Load Power Signal Module (M7) is responsible for sending a high power/ON signal to the transistor once a disengage signal is written to the Arduino. An ON signal to the transistor acts as a switch ON, and will power the electromagnet to disengage the lock.

11.2 Uses

11.3 Syntax

11.3.1 Exported Constants

N/A

11.3.2 Exported Access Programs

N/A

11.4 Semantics

11.4.1 State Variables

None.

11.4.2 Environment Variables

- e_BTService, type: BLEService
- e_DisengageCharacteristic; type: BLEByteCharacteristic

Note that the environment variables are the same as that of M5, as an established Bluetooth connection is a prerequisite of M7, and these variables must still be used to keep the BlueTooth connection active.

11.4.3 Assumptions

Assumes M5 has been successfully completed; there is an established BlueTooth connection between the Arduino and the mobile app.

11.4.4 Access Routine Semantics

loadPower():

This access routine is responsible for recieving the signal to disengage the lock, and then, should this signal be received, sending a HIGH signal to the transistor. This will be implemented on the Arduino.

- inputs: e_DisengageCharacteristic
- transition: none
- output: if e_DisengageCharacteristic has a nonzero value (i.e., the disengage button on the app GUI is pressed), write a HIGH signal to the Arduino pin wired to the corresponding transistor terminal for five seconds (enough time to pull the pin out of the lock, or in other words, unlock your bike).

- exception: none

11.4.5 Local Functions

None.

12 MIS of M8

12.1 Location Module

As described in the MG document, the Location Module (M8) is responsible for gathering the location data requested by the user. In this module, there are submodules to store the current location requested by the user.

12.2 Uses

12.3 Syntax

12.3.1 Exported Constants

N/A

12.3.2 Exported Access Programs

N/A

12.4 Semantics

12.4.1 State Variables

- storedLocation, type: Location object, package: location

12.4.2 Environment Variables

None.

12.4.3 Assumptions

None.

12.4.4 Access Routine Semantics

updateLocation(): This routine writes to the local json file to store the last location requested by the user.

- inputs: locationButton()
- transition: none
- output: none
- exception: none

getLocation(): This routine reads from the local json file to get the last location requested by the user

- inputs: none
- transition: none
- output: storedLocation
- exception: none

12.4.5 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.

13 Appendix

[Extra information if required —SS]