System Design for Mechatronics Engineering

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1 Revision History

Date	Version	Notes
18 January 2023	1.0	Revision 0 for System Design

2 Reference Material

This section records information for easy reference.

2.1 Abbreviations and Acronyms

symbol	description
Mechatronics Engineering	Explanation of program name
[... —SS]	[... —SS]

Contents

List of Tables

List of Figures

3 Introduction

[Include references to your other documentation —SS]

4 Purpose

[Purpose of your design documentation —SS]
[Point to your other design documents —SS]

5 Scope

[Include a figure that show the System Context (showing the boundary between your system and the environment around it.) —SS]

6 Project Overview

6.1 Normal Behaviour

6.2 Undesired Event Handling

[How you will approach undesired events —SS]

6.3 Component Diagram

6.4 Connection Between Requirements and Design

[The intention of this section is to document decisions that are made "between" the requirements and the design. To satisfy some requirements, design decisions need to be made. Rather than make these decisions implicit, they are explicitly recorded here. For instance, if a program has security requirements, a specific design decision may be made to satisfy those requirements with a password. —SS]

7 System Variables

[Include this section for Mechatronics projects —SS]

7.1 Monitored Variables

7.2 Controlled Variables

7.3 Constants Variables

8 User Interfaces

8.1 Hardware User Interface

The device is worn by a participant on the wrist for measuring activity and generating prompts. The following items will be shown on the display of the activity tracker:

Description	**Behaviour of TFT Display**
Power up of activity tracker.	Displays Back End Developers on startup.
Default behaviour, no activity tracked.	Displays date and time.
Activity tracked.	Prompt generated on screen, for example: Are you in pain?
Answering prompts using touch sensor (bezel).	Toggle between different options on screen. For example: (Yes/No).

Table 1: Components of Hardware User Interface

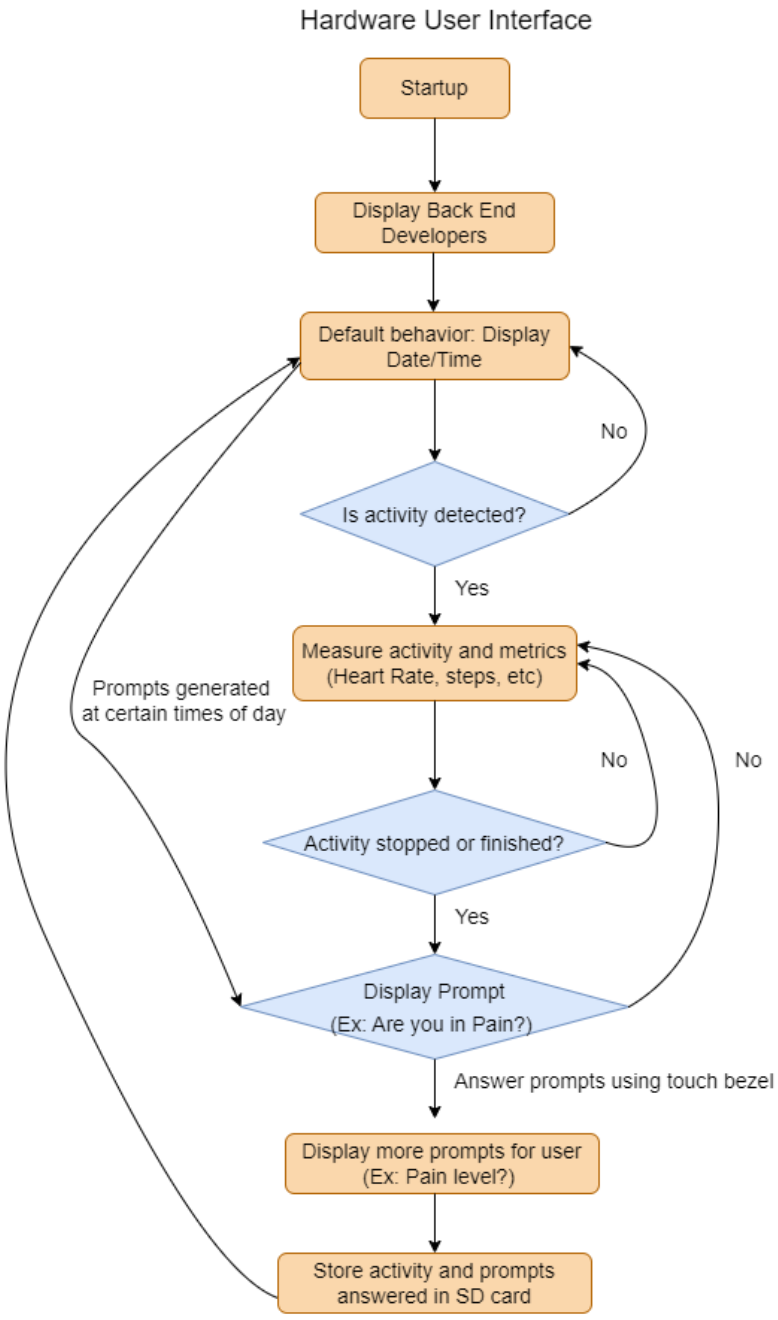

Figure 1: Finite State Machine for Hardware User Interface

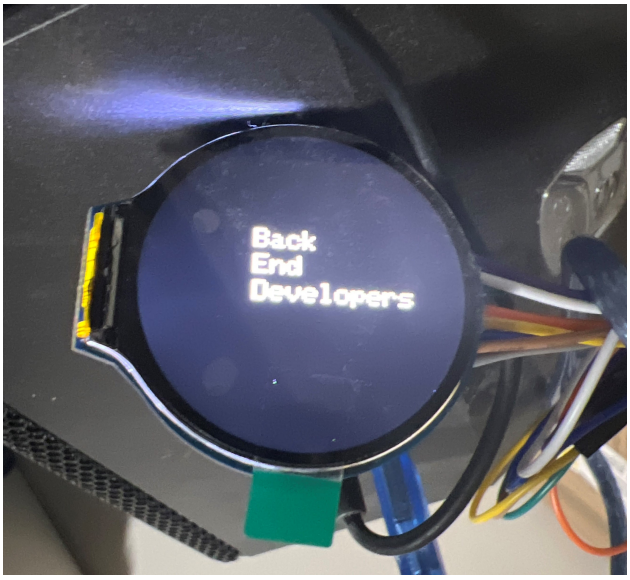

Figure 2: Display on activity tracker at startup

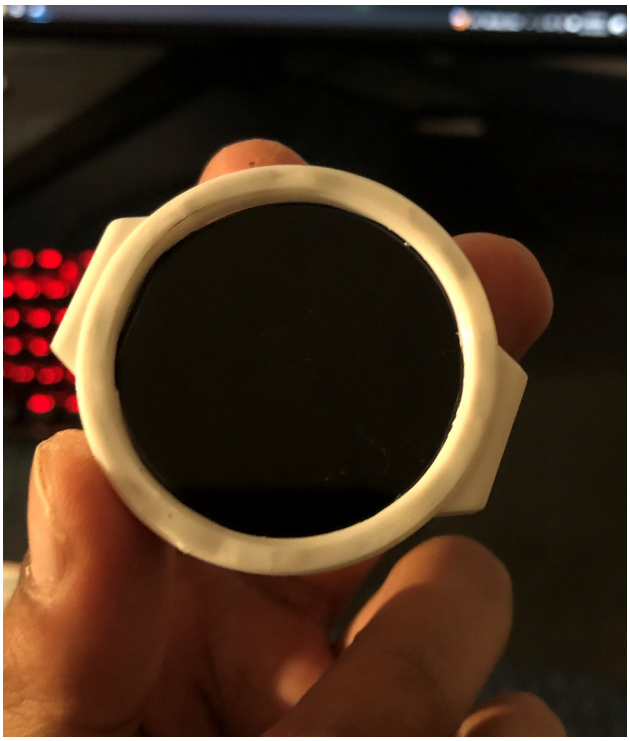

Figure 3: Display with custom 3D printed case

Figure 4: Display of Date/time on activity tracker.

8.2 Software User Interface

The Software User Interface will be used by the Researcher for configuring the activity tracker according to the participant. The interface will be on the Host Computer and will be able to store participant data, create new data and view records using encryption. The interface will also have authentication, and only the Researcher will be able to log in. The following features are available on the Software User Interface:

Options on UI	Description
Main window	Main menu that leads to different windows when clicked.
Connect to tracker	Connects to SD card for device and shows status of connection.
Create Records Window	Creates new record for particpant and stores it in a database. A record can only be created if the correct username and password is provided.
Records Window	Participant records can be viewed in a tabular format and can be searched/filtered.
Data View Window	Data stored on SD card can be viewed and filtered. Data can also be plotted using Graph button. For example: Heart Rate vs Time.

Table 2: Components of Software User Interface

Below is an example of the Software User Interface for the Main window.

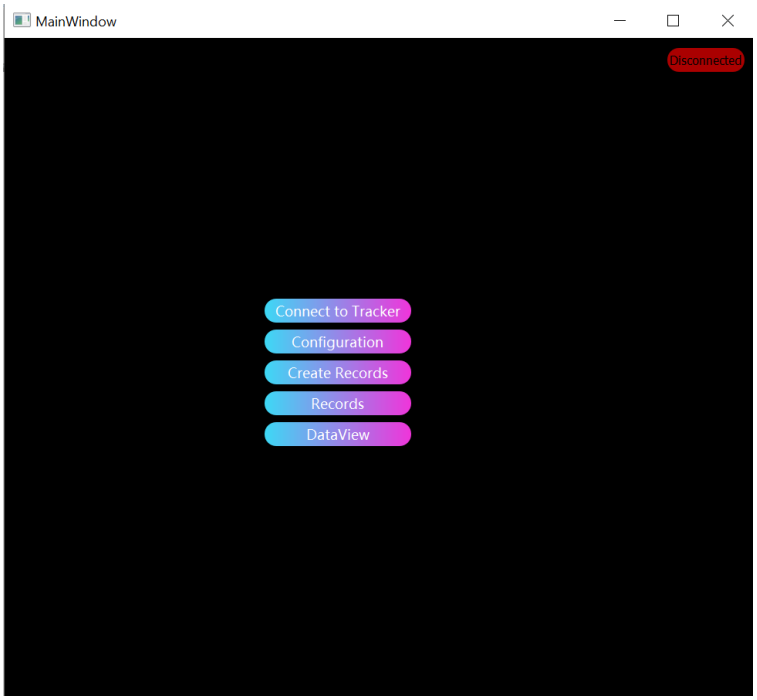

Figure 5: Main Window for Software User Interface

For more examples of Software User Unterface, refer to Appendix.

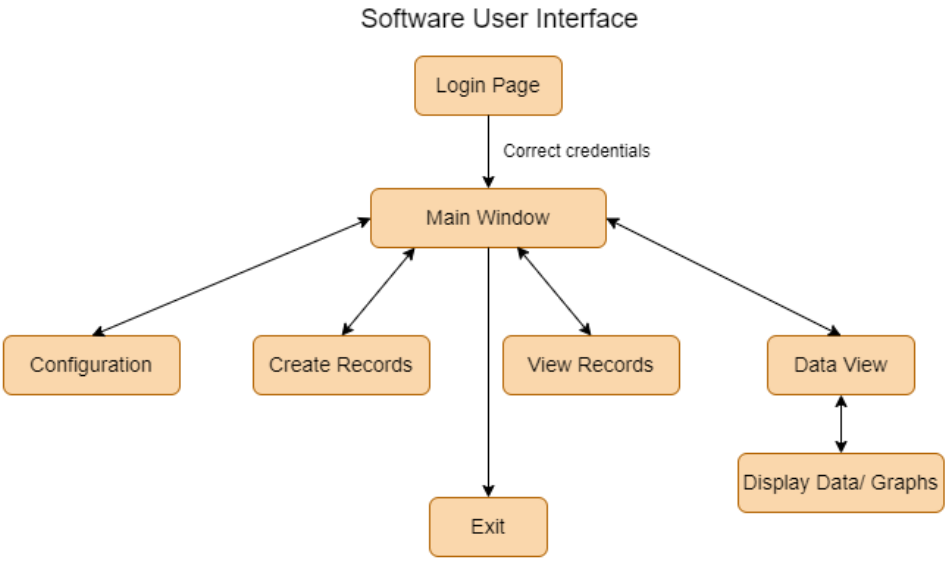

Figure 6: Finite State Machine for Software User Interface

[Design of user interface for software and hardware. Attach an appendix if needed. Drawings, Sketches, Figma —SS]

9 Design of Hardware

The table below shows hardware components that will be used in the activity tracker.

Hardware Component	Description
Custom PCB	Custom PCB designed to fit in activity tracker.
MPU 6050	Accelrometer/Gyroscope, off-shelf component.
seeeduino xiao samd21	off-shelf microcontroller for activity tracker.
DS1307 RTC	Real time clock, off-shelf component.
TFT Display	Off-shelf display used in activity tracker.
Outer casing for TFT Display	Designed using Autodesk Inventor and 3D printed
Pulse sensor	Plug and play Heart Rate sensor for Arduino (off-shelf component)
Li-Po Battery	Generic off-shelf lipo battery used for smart watches.
USB Type-B charger	Generic off-shelf usb to Type-B charger to charge device.
MicroSD card	Standard off-shelf SD card.
SDCARD connector 473521001	MicroSD connector (off-shelf component)
Watch straps	Generic watch-straps for strapping device onto the wrist.

Table 3: Components of Hardware Design

[Most relevant for mechatronics projects —SS] [Show what will be acquired —SS] [Show what will be built, with detail on fabrication and materials —SS] [Include appendices as appropriate, possibly with sketches, drawings, CAD, etc —SS]

10 Design of Electrical Components

The schematic/circuit diagrams shown below are used to generate the PCB layout.

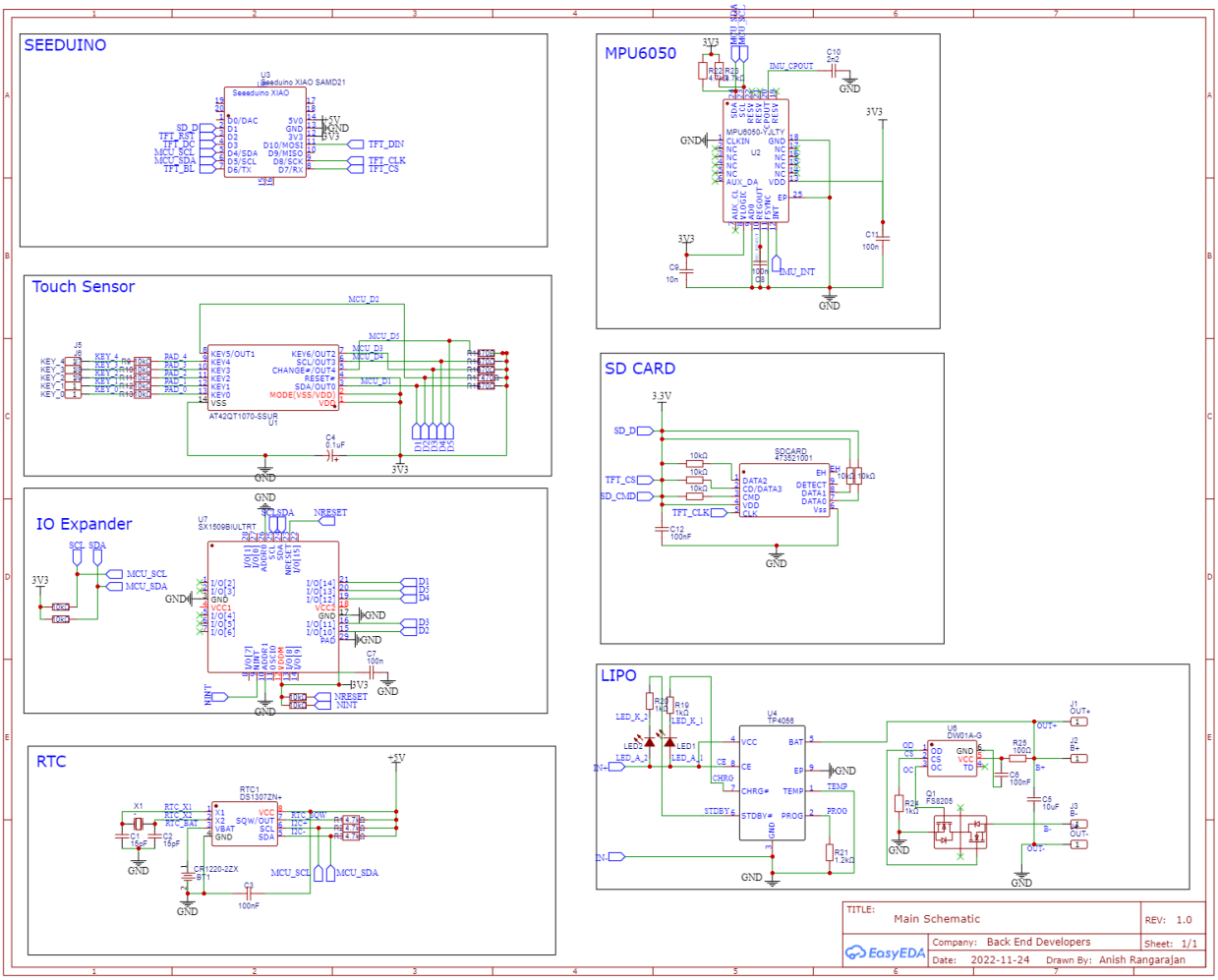

Figure 7: Schematic for PCB

The custom PCB designed is shown below.

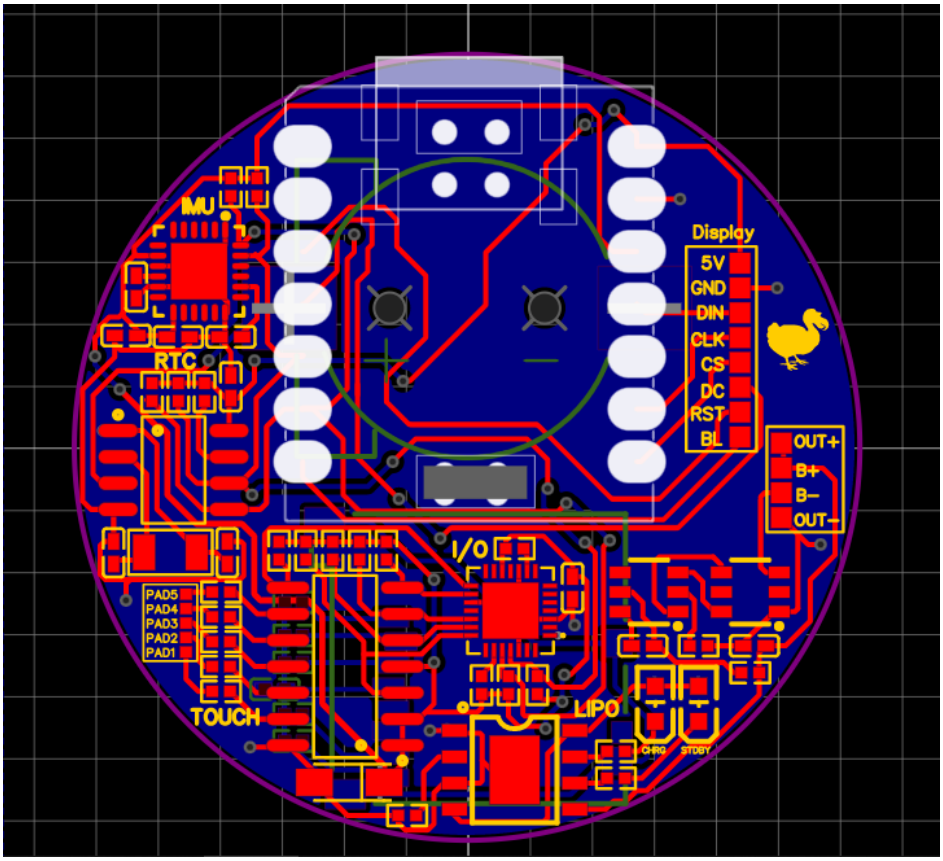

Figure 8: Layout of PCB design

The table below shows Electrical components built into the activity tracker.

Electrical Component	Description
IO Expander SX1509BIULTRT	off-shelf IO Expander used in PCB.
Resistors	Resistors built into hardware components (1k ohms, 10k ohms).
Capacitors	Capacitors built into hardware components (15pF, 100nF).
LEDs	Various LEDs in device used to identify status of operation.

Table 4: Electrical Components

[Most relevant for mechatronics projects —SS] [Show what will be acquired —SS] [Show what will be built, with detail on fabrication and materials —SS] [Include appendices as appropriate, possibly with sketches, drawings, circuit diagrams, etc —SS]

11 Design of Communication Protocols

[If appropriate —SS]

12 Timeline

[Schedule of tasks and who is responsible —SS]

A Software Interface

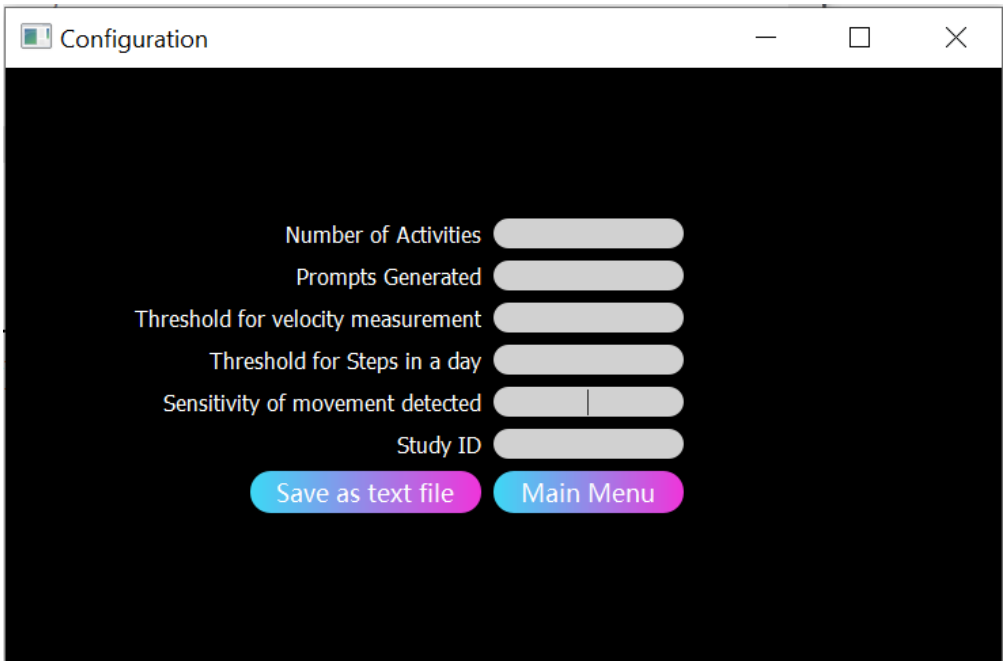

Figure 9: Configuration Window

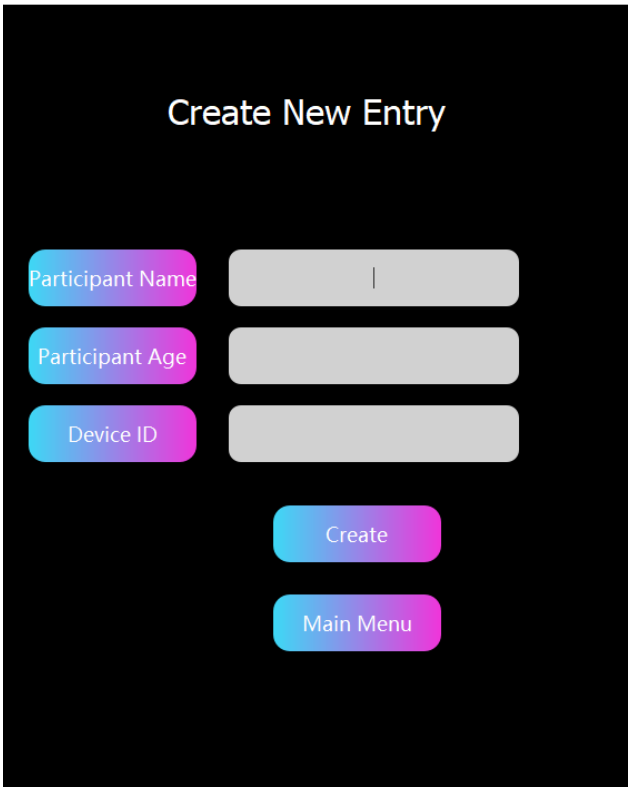

Figure 10: Create Record Window

	First Name	Last Name	Age	Participant ID	StudyID	Gender	Weight (kgs)	Height (cm)	Phone number	Email ID	Address	Monitoring Period	Tracker model
1	Jack	Jones	60	1	32	Male	75	180	(338) 437-5840	jack@gmail.com	8710 Hilltop St.	13	1
2	Rose	Lindt	65	2	32	Female	63	150	(864) 315-3964	rose@gmail.com	Mundelein, IL 60060	12	2
3	Ashley	Dunder	63	3	32	Female	57	160	(238) 233-4530	ashley@gmail.com	9022 Jennings Drive	15	1
4	May	Potter	75	4	32	Prefer Not t...	80	172	(990) 200-7813	may@gmail.com	North Miami Beach, FL 33160	15	1

Figure 11: Record Window

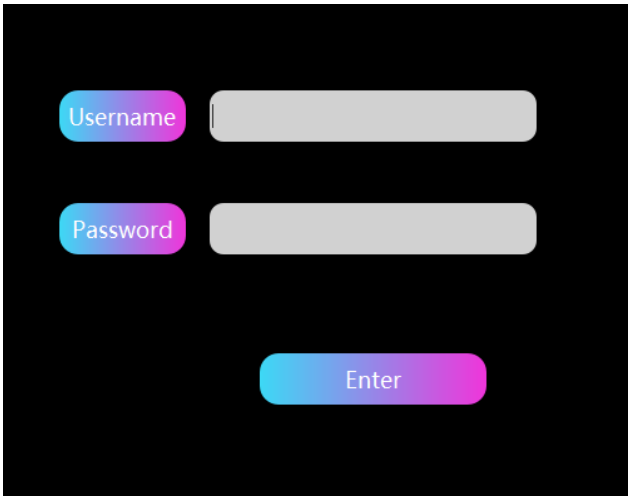

Figure 12: Login Dialogue box

	Participant ID	Time	StudyID	Steps	Heart rate	Active time (mins	Type of Activity	rompt generate	Are you in pain?	Pain level (1-10)
1	1	7:22	3	20	69	1	walking	No	nan	nan
2	1	9:20	3	50	100	6	walking	Yes	Yes	2.0
3	1	11:18	3	30	85	5	Movement ...	Yes	Yes	4.0
4	1	13:12	3	10	70	1	walking	No	nan	nan
5	1	16:29	3	0	67	1	Movement ...	Yes	No	nan
6	1	17:46	3	10	70	1	walking	No	nan	nan
7	1	19:05	3	200	110	10	walking	Yes	Yes	6.0
8	1	21:53	3	0	80	0	Idle	No	nan	nan
9	1	22:00	3	0	65	0	Idle	No	nan	nan
10	1	22:38	3	20	70	2	walking	Yes	No	nan

Figure 13: Data View Window

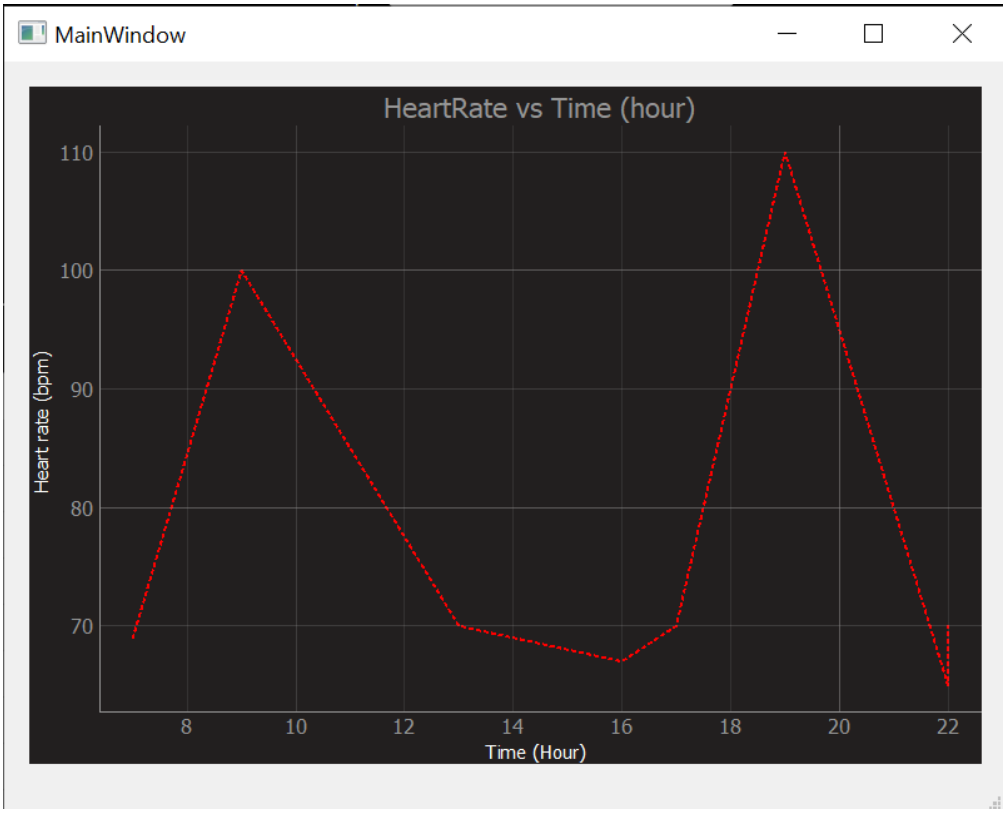

Figure 14: Generated Graph for Heart Rate vs Time

B Mechanical Hardware

C Electrical Components

D Communication Protocols

E Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Problem Analysis and Design. Please answer the following questions:

1. What are the limitations of your solution? Put another way, given unlimited resources, what could you do to make the project better? (LO_ProbSolutions)

2. Give a brief overview of other design solutions you considered. What are the benefits and tradeoffs of those other designs compared with the chosen design? From all the potential options, why did you select documented design? (LO_Explores)