



THE LCIMU SYSTEM USER MANUAL

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1.0 General Information

This section explains in general the LCIMU system and its purpose.

1.1 LCIMU System Overview

The LCIMU system aids in the capture of inertial motion data from three segments of a human anatomy. The data captured is saved on a base station (laptop/PC). The LCIMU will function on a base station with the appropriate java IDE (preferably IntelliJ).

1.2 Organization of the User Manual

The LCIMU user manual consists of several sections amongst which are: General Information, LCIMU System Summary, Getting Started, Utilizing the LCIMU system and Correspondence.

The General Information section elucidates in general terms the LCIMU system and its purpose.

The LCIMU System Summary section provides a general overview of the system. It outlines the basic uses of the system's hardware and software requirements, it's configuration and behaviour.

The Getting Started section explains how to get the LCIMU system up and running and installed on a device of choice.

The Utilizing the System section provides a detailed description of system functions and how the hardware component is worn.

The Correspondence section describes the ways the data captured by the system is processed and analysed.

2.0 System Summary

This section gives an overview of the LCIMU system application, its configuration, user profiles and contingencies.

2.1 The Configuration of the LCIMU application.

The LCIMU application is compatible with any laptop that has any suitable java IDE installed (Eclipse, NetBeans, IntelliJ etc.). It is important that the most recent Java compiler version (JDK 8) is installed on the IDE. The base station (laptop/pc) should have a relatively high processing speed, preferably those with Intel processor series of Core I5 and above, as this would increase the functionality of the system. The data is captured offline and saved on the base station so there is no need for continued access to the internet after installing the application as described in section 3. After importing the LCIMU project there is need for further configuration to ensure that the application functions properly, this would be further addressed in section 3.

2.2 User Profile

The LCIMU system application can be assessed by everyone that has downloaded and successfully registered a profile. Although, the data can only be accessed by registered users who have access to the LCIMU system or have been successful in developing the system from scratch as described in the design documentation.

2.3 Contingencies

In case there is an interruption in the transmission of data from the LCIMU system for any given period, unplugging and plugging back the system will eventually fix this. The LCIMU system is powered from the base station with a USB cable so there is no need for a power surge protector. A hard reset on any of the IMU slave sensors that fails to display data will correct any break in the interruption of data transmission.

3.0 GETTING STARTED

This section details how the LCIMU application is downloaded and installed on a device.

3.1 Installation

The current version of the LCIMU application is available for download from its Git hub repository, <https://github.com/DrewOma/dragonada>. This repository can also be cloned directly into a working directory of choice on a local system. In this section, the steps taken to install the application will be highlighted. It is important to note here that it is assumed that the latest Java JDK would already have been installed on the local system for the installation and all file paths predefined.

Step 1

On a web browser.

- Go to <https://github.com/DrewOma/dragonada>

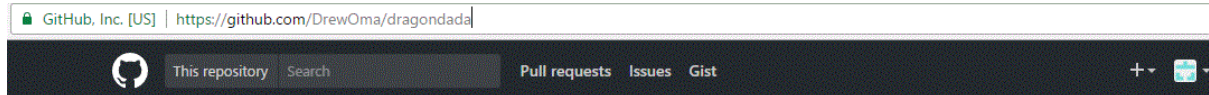


Figure 3.1. Web Browser Navigation

- On the repository, Click **Clone or Download**, and download the zip file unto a working directory on your local system.

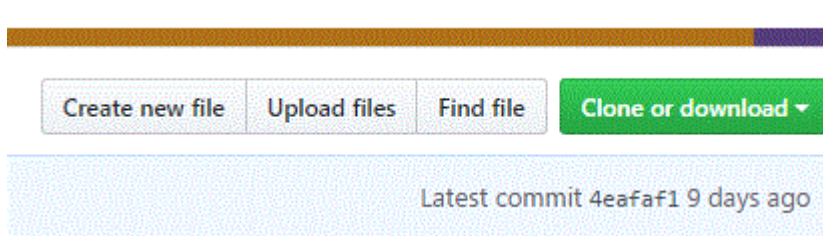
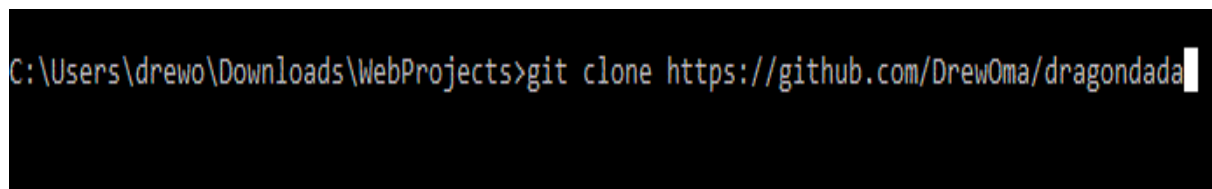


Figure 3.2. Cloning the LCIMU Project Repository

OR

If Git is installed on the local system

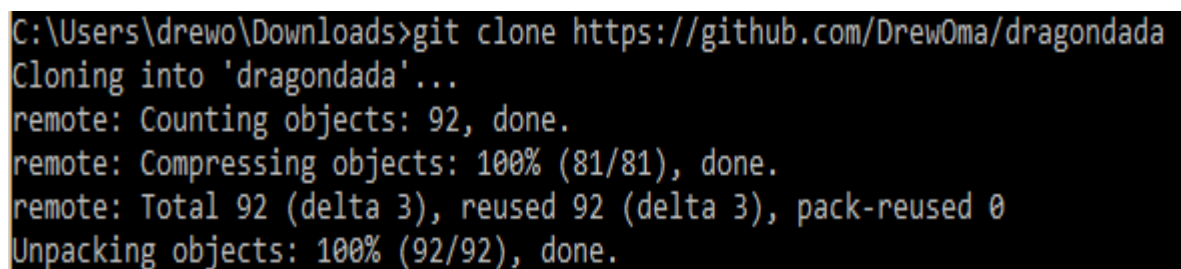
- Open Git Bash
- Change the current working directory to a directory of choice for the cloned repository and ensure that the directory is where Git is installed.
- Type in ...git clone <https://github.com/DrewOma/dragondada>



```
C:\Users\drewo\Downloads\WebProjects>git clone https://github.com/DrewOma/dragondada
```

Figure 3.3. Cloning from Command Prompt

- Press Enter and the cloned repository will be downloaded into the system's directory.



```
C:\Users\drewo\Downloads>git clone https://github.com/DrewOma/dragondada
Cloning into 'dragondada'...
remote: Counting objects: 92, done.
remote: Compressing objects: 100% (81/81), done.
remote: Total 92 (delta 3), reused 92 (delta 3), pack-reused 0
Unpacking objects: 100% (92/92), done.
```

Figure 3.4. Successful Project Cloning from Command Prompt

Step 2

- Download the RXTXComm library from the web.
- There are many websites available to get this library from, one of which is

<https://blog.henrypoon.com/blog/2010/12/25/installing-rxtx-for-serial-communication-with-java/> . It has instructions on how to set up the library on the local system as shown below.

32-bit version: <http://rxtx.qbang.org/wiki/index.php/Download>

64-bit version: <http://fizzed.com/oss/rxtx-for-java>

To install the libraries (instructions from **JControl**):

1. a. Copy rxtxSerial.dll to %JAVA_HOME%bin, (%JAVA_HOME% is the folder where JRE is installed on your system; e.g. c:\Program Files\Java\j2re1.4.1_01)
- b. Copy RXTXcomm.jar to %JAVA_HOME%\libext

Figure 3.5. Installing the RXTX Library

Step 3

- Download the latest free version (Community) of the IntelliJ IDE from <https://www.jetbrains.com/idea/download/index.html#section=windows>
- Run the .exe file and complete the installation as prompted.
- On the main IDE, navigate to the Options menu at the top of the IDE and click on *File* -> *Open* and navigate to the folder that contains the cloned repository and click on the folder to load the project unto IntelliJ.



Figure 3.6. Setting Up the Project on IntelliJ

- After the project has been loaded navigate to the options menu again and click on *File -> Project Structure* and ensure the Project settings is configured as shown below.

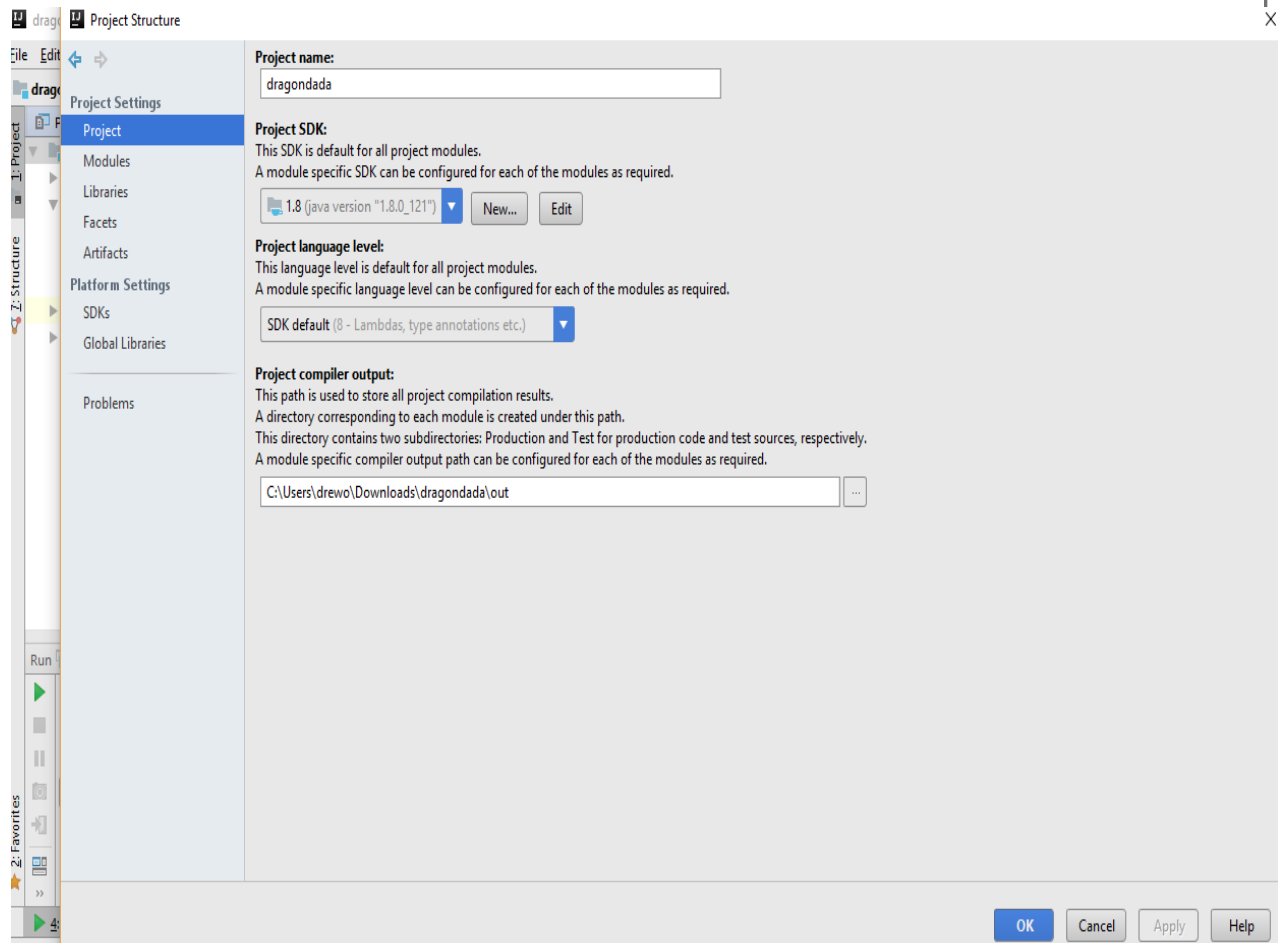


Figure 3.7a. Configuring the Project Structure

- Next Navigate to the Modules settings and ensure that the settings for the Sources, Paths and Dependencies options are as shown in the diagrams below.

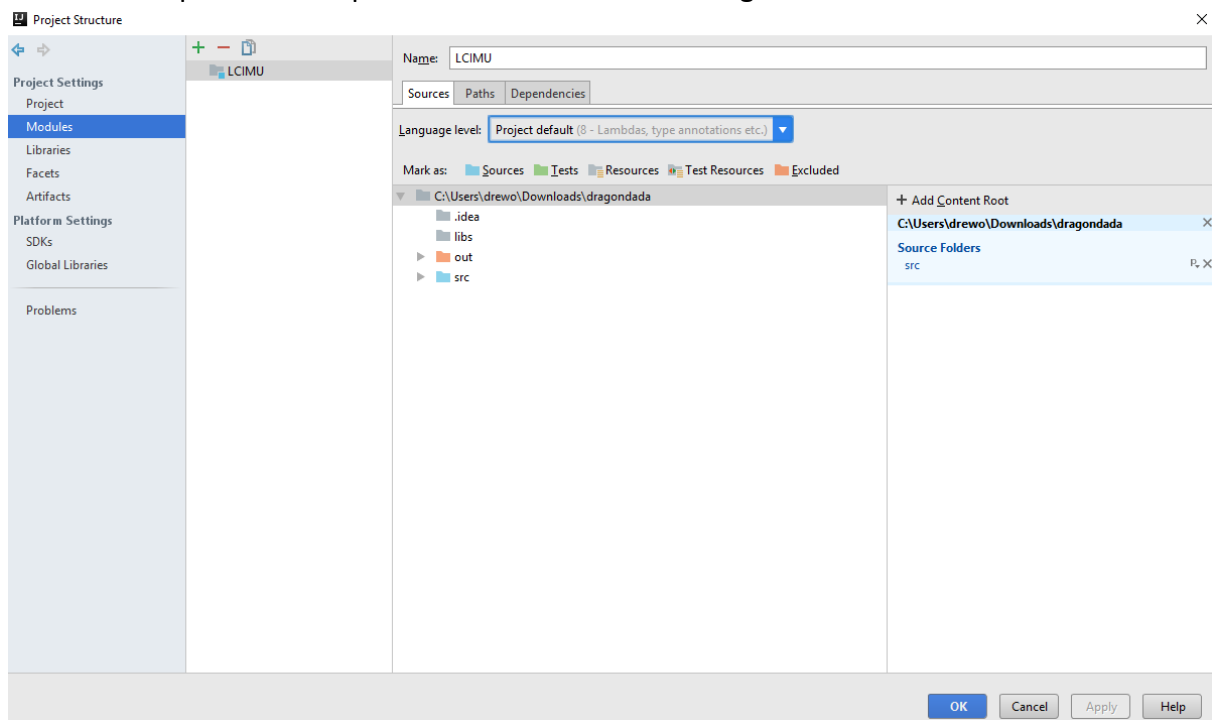


Figure 3.7b. Configuring the Project Structure

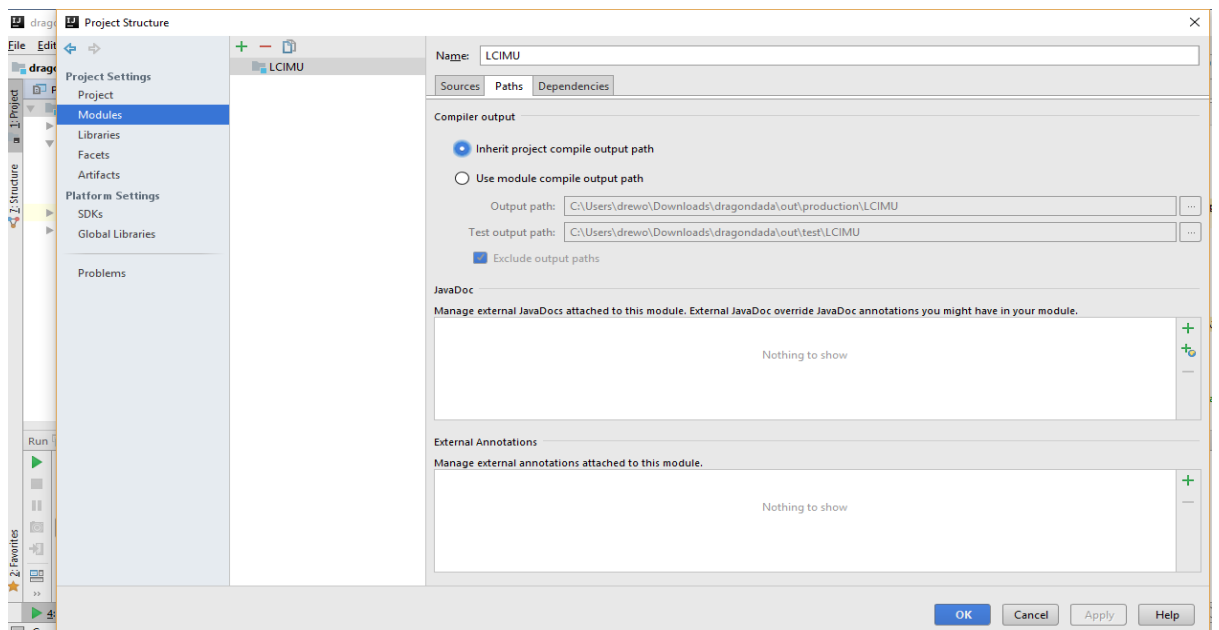


Figure 3.7a. Configuring the Project Structure

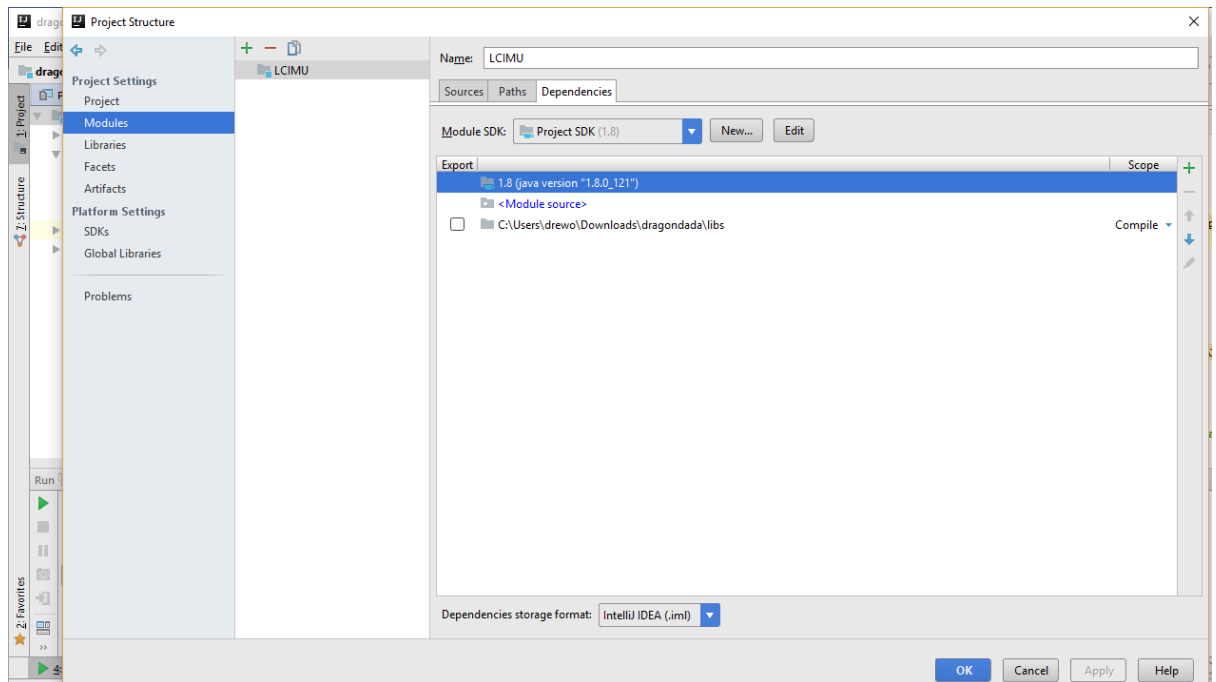


Figure 3.7c. Configuring the Project Structure

- If the project is structured correctly, click ok and return to the project main page.
- Navigate to the top right hand corner of the main page and click on the Edit Configuration menu.
- Set up the Configuration pane as shown below and press ok when done.

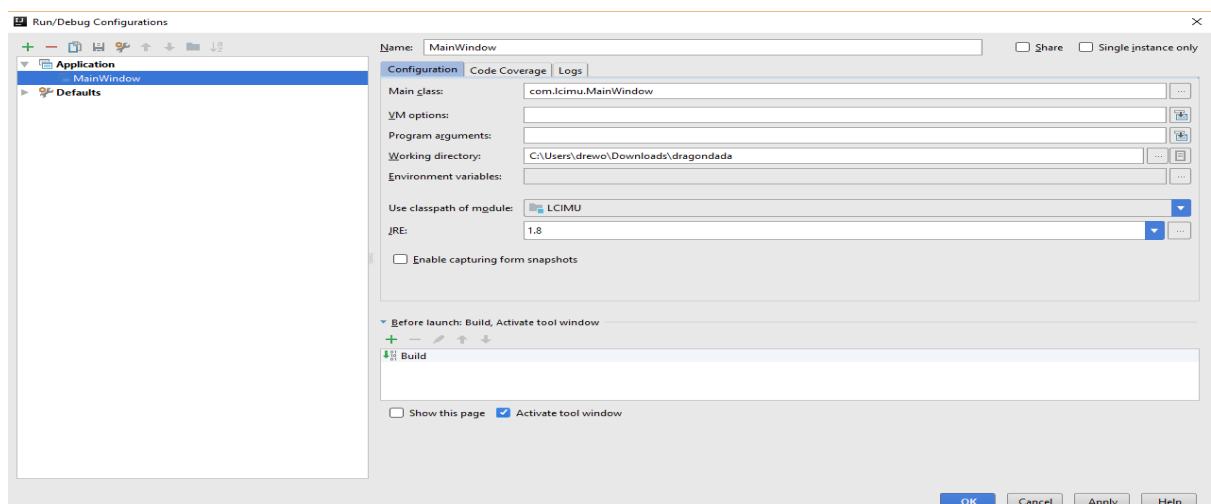


Figure 3.7d. Configuring the Project Structure

4.0 Utilizing the System

This section would highlight how the LCIMU system is worn and how to use the application connected to the system.

4.1 Wearing the LCIMU Hardware system

The LCIMU system comes outfitted with a strap that allows the user to wear the system on the upper part of the body. Figure 4.1 a, b, c, d shows the different profile views of the system being worn.



Figure 4.1a. The Front Profile view of the LCIMU system worn



4.1b. The Peripheral View of the LCIMU system worn



Figure 4.1c. The Side Profile View of the LCIMU System being worn

These different views show how a user can wear the LCIMU system before beginning the data capture process. The system is strapped using a make shift Go-Pro strap to the upper body section of the human anatomy.

4.2 Powering the LCIMU Hardware system

The LCIMU hardware system is powered by connecting the USB cable from the device to a local system or computer.

4.3 Utilizing the Application

The LCIMU application requires registration to access the main functions. After launching the application, the main window page will be displayed as shown below.

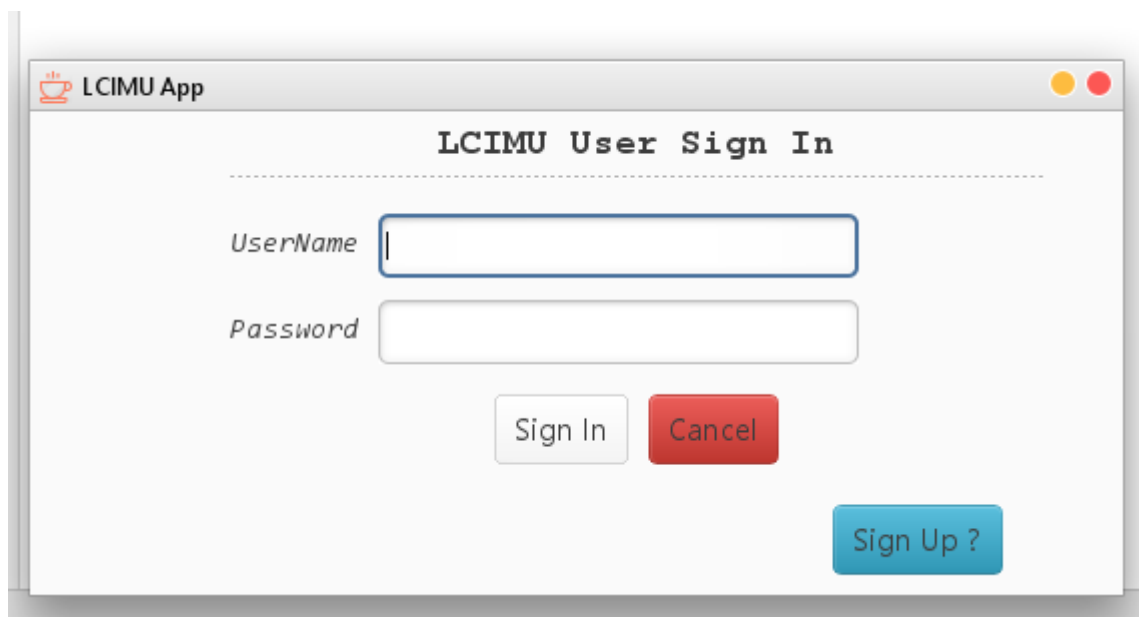


Figure 4.2. User Logging In

Click the *Sign Up* button to input a Username and Password of choice and click the *Sign Up* button again to complete the registration process as shown below.



Figure 4.3. User Registration

On completion of the *Sign Up* process, a redirection to the Sign in Page will then allow logging on to the application.

4.3.1 LCIMU Application Menu

This application consists of three main button controls. A Start button, A Stop Button and a Log Out Button.



Figure 4.4. Application Control Panel

The Start Tab initiates the data capture process, the Stop button terminates the process and the Log Out button logs out the current user from the application.

The Start Button

- On Clicking the Start Button a pop up page appears with a prompt to selecting the serial port where the USB cable from the LCIMU is plugged in as shown below.

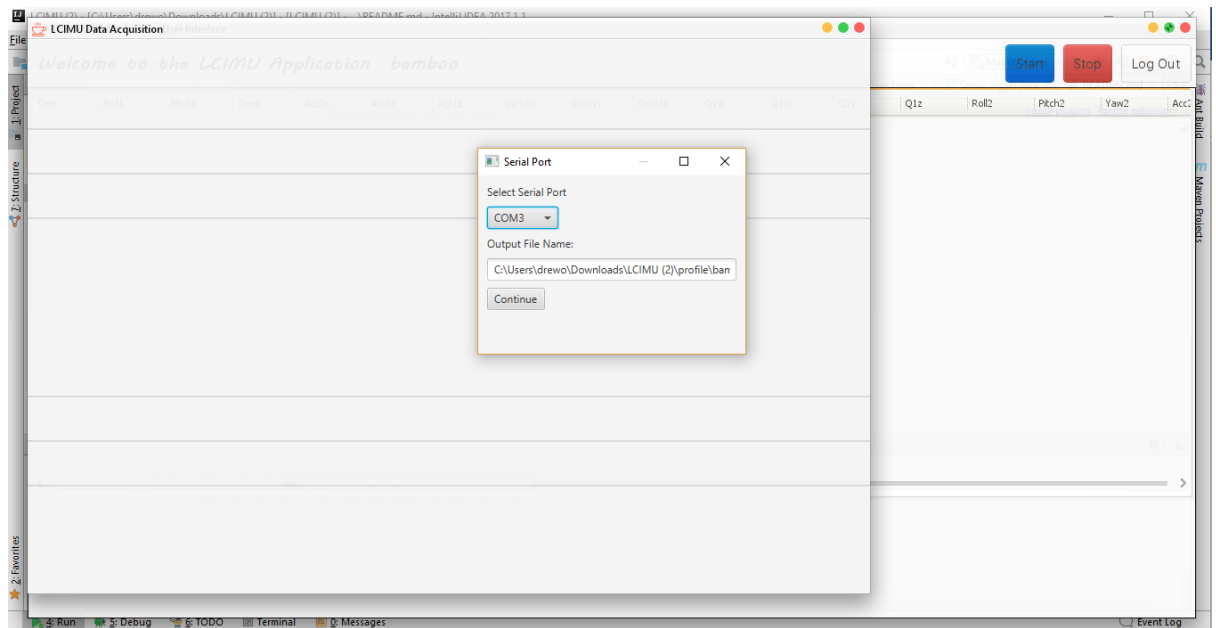


Figure 4.5. Starting the Application

- After selecting the appropriate port, click continue to capture the data. A real-time graph plot will be displayed as shown below.

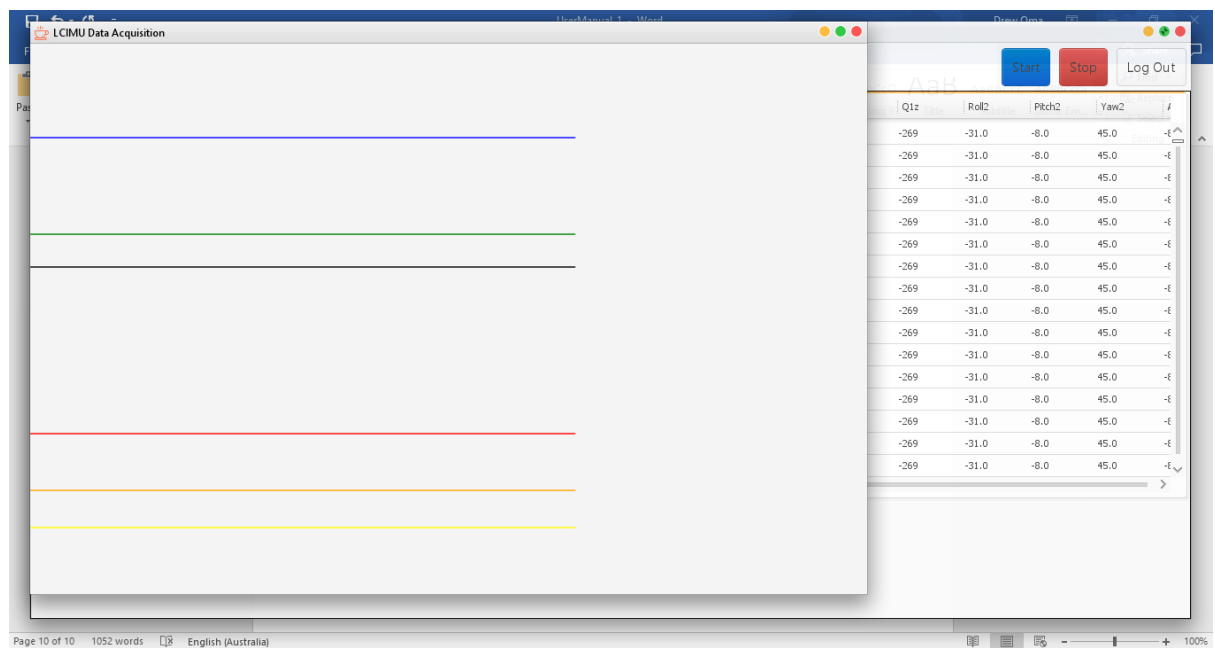
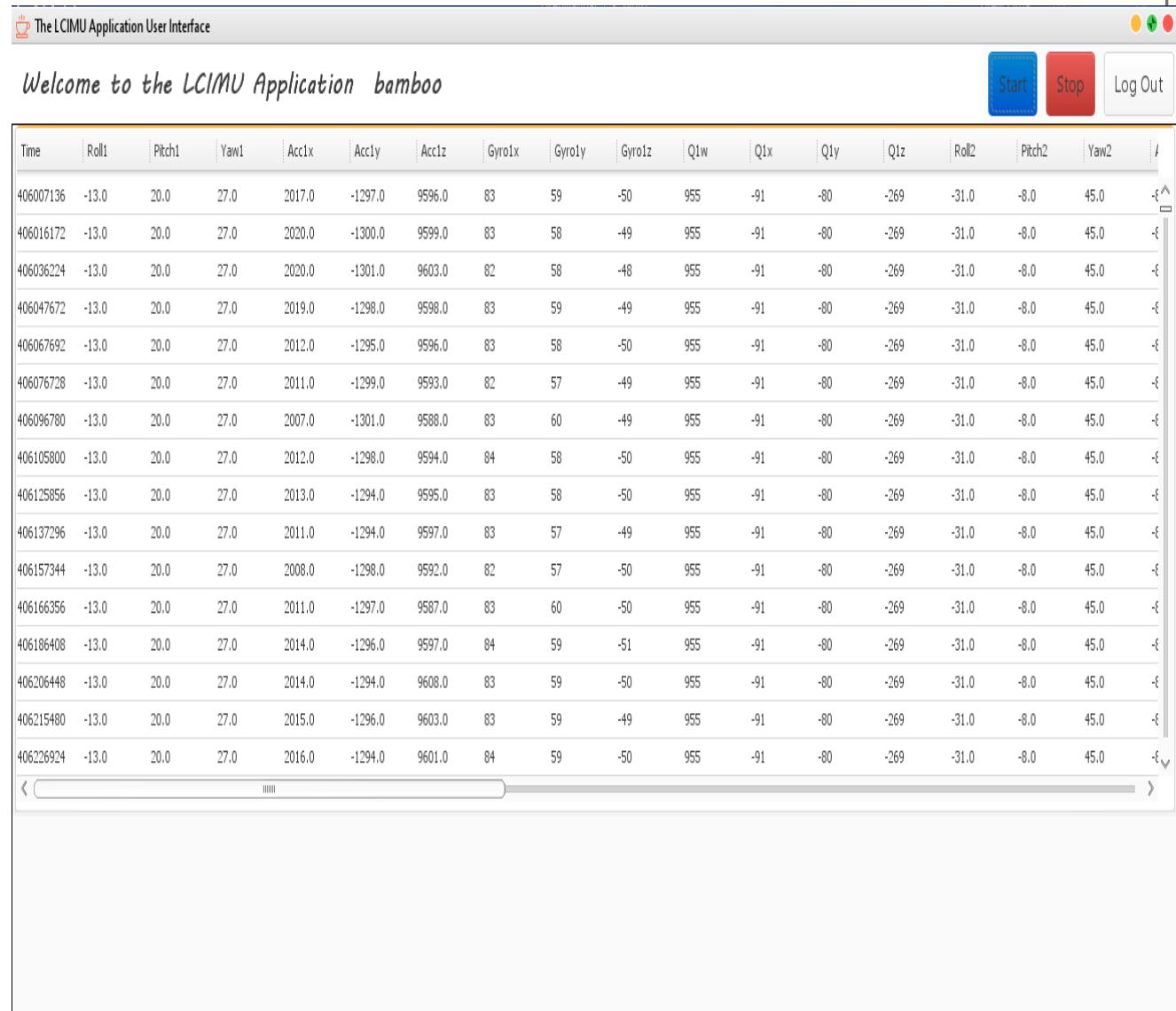


Figure 4.6. Data Display in Real time

As can be seen from the Figure 4.6, the data will be displayed on the graph pane on the left and the raw data will be displayed on a table as shown on the right. Figure 3.10 is an image of the data as displayed on the table.



The screenshot shows the 'The LCIMU Application User Interface' window. It has a title bar with standard OS window controls. Below the title bar, there's a welcome message 'Welcome to the LCIMU Application bamboo' and three buttons: 'Start' (blue), 'Stop' (red), and 'Log Out' (grey). The main area contains a table with 18 columns: Time, Roll1, Pitch1, Yaw1, Acc1x, Acc1y, Acc1z, Gyro1x, Gyro1y, Gyro1z, Q1w, Q1x, Q1y, Q1z, Roll2, Pitch2, Yaw2, and a final column with a scroll handle icon. The table displays 20 rows of data. A scrollbar is visible on the right side of the table, and a horizontal scrollbar is at the bottom of the table area.

Time	Roll1	Pitch1	Yaw1	Acc1x	Acc1y	Acc1z	Gyro1x	Gyro1y	Gyro1z	Q1w	Q1x	Q1y	Q1z	Roll2	Pitch2	Yaw2	
406007136	-13.0	20.0	27.0	2017.0	-1297.0	9596.0	83	59	-50	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406016172	-13.0	20.0	27.0	2020.0	-1300.0	9599.0	83	58	-49	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406036224	-13.0	20.0	27.0	2020.0	-1301.0	9603.0	82	58	-48	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406047672	-13.0	20.0	27.0	2019.0	-1298.0	9598.0	83	59	-49	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406067692	-13.0	20.0	27.0	2012.0	-1295.0	9596.0	83	58	-50	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406076728	-13.0	20.0	27.0	2011.0	-1299.0	9593.0	82	57	-49	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406096780	-13.0	20.0	27.0	2007.0	-1301.0	9588.0	83	60	-49	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406105800	-13.0	20.0	27.0	2012.0	-1298.0	9594.0	84	58	-50	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406125856	-13.0	20.0	27.0	2013.0	-1294.0	9595.0	83	58	-50	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406137296	-13.0	20.0	27.0	2011.0	-1294.0	9597.0	83	57	-49	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406157344	-13.0	20.0	27.0	2008.0	-1298.0	9592.0	82	57	-50	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406166356	-13.0	20.0	27.0	2011.0	-1297.0	9587.0	83	60	-50	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406186408	-13.0	20.0	27.0	2014.0	-1296.0	9597.0	84	59	-51	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406206448	-13.0	20.0	27.0	2014.0	-1294.0	9608.0	83	59	-50	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406215480	-13.0	20.0	27.0	2015.0	-1296.0	9603.0	83	59	-49	955	-91	-80	-269	-31.0	-8.0	45.0	⬅
406226924	-13.0	20.0	27.0	2016.0	-1294.0	9601.0	84	59	-50	955	-91	-80	-269	-31.0	-8.0	45.0	⬅

Figure 4.7. Data Display on a Table

The Stop Button

When the Stop Button is clicked, the data capture process terminates and the User can then view the data by scrolling up and down the table shown on Figure 3.14. The User has the option of accessing the data captured in a stored file on the folder *Profile* on the Main IDE has shown below. The data is stored on a csv file and it can be retrieved offline to be used for analysis.

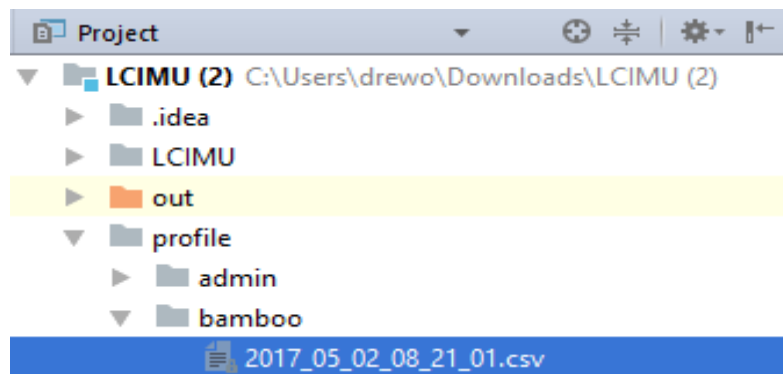


Figure 4.8. Accessing the stored data on the User's profile.

The Log Out Button

The Log Out Button exits the application and returns the user to the Sign-In/Sign-On page.

5.0 Correspondence

This section describes how the data captured can be applied.

5.1 MATLAB Application

The data captured as described in the design documentation can be retrieved from csv files on the profile folder of the project as shown in Figure 4.6. This data can then be uploaded unto MATLAB and used in analysis. Figure 4.8 is an image of the power spectral density of an individual cycling on a mounted bicycle with the sensors strapped to the biceps and mounted on the chest.

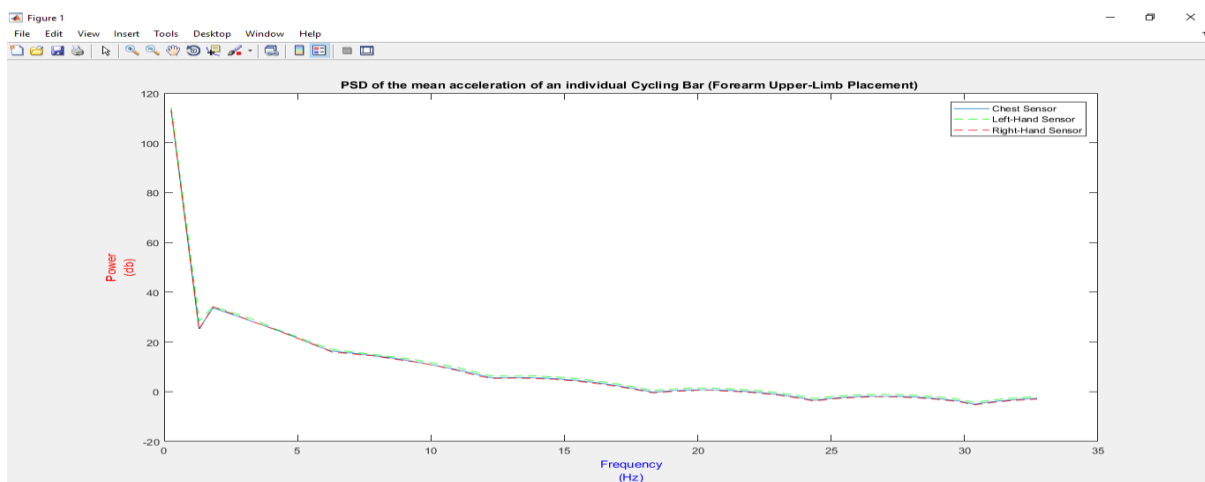


Figure 5.1 Application of the Captured Motion Data

This figure points out that a significant amount of energy is expended in lower frequency cycles of this activity than it does in higher frequencies, also there are no significant changes or variation in the data captured from all three sensors during this activity.

Conclusively, there are other ways and methods the data captured from this system can be applied and the LCIMU system should be robust enough as per its requirements to be utilized as required.

Appendix A: Specifications

LCIMU Hardware

Operating Voltage	<p>When powered via USB:</p> <p>3.3V on the Master Device and 5V on all three IMU slave devices.</p> <p>When powered via a battery:</p> <p>3.7V lithium-ion battery for the Master Device and two 3.7V lithium-ion batteries (connected in parallel) each for the IMU slave devices.</p>
Dimensions (Width x Height x Depth)	<p>Master device: 15cm x 5 cm x 10cm</p> <p>IMU slave devices: 10cm x 3.3cm x 7cm</p>
Weight	The entire system weighs 4.4kg
Environment Conditions	<p>Operating temperature for the whole hardware system: -40 to 85° C</p> <p>Storage temperature for the whole hardware system: -10 to 35° C</p>
Sampling frequency	63 Hz (± 1).