

## *Welcome to the imu2sto program!*

This program is designed to convert IMU data to quaternions and OpenSim .sto files.

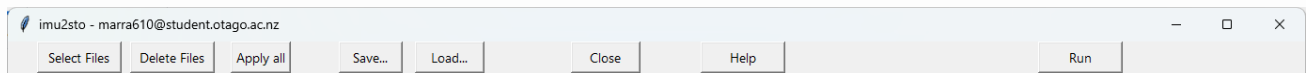
You can check a video demo of the program at the following link:

<https://www.youtube.com/watch?v=NBWucXQcozc>

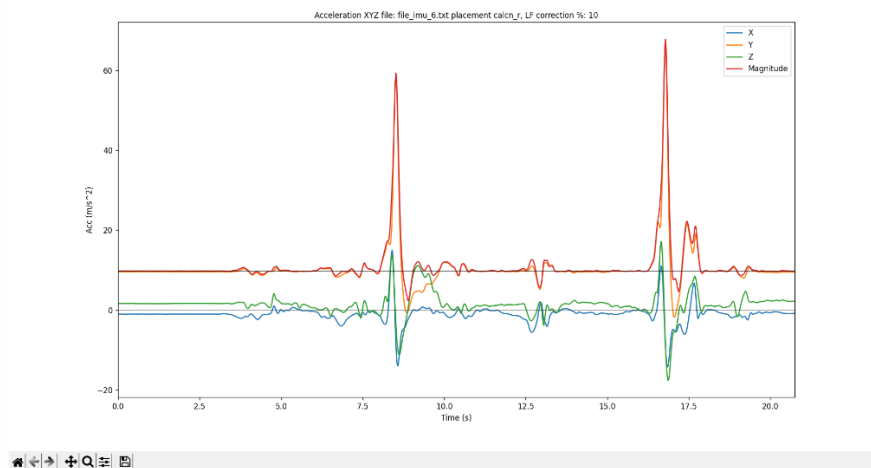
You can also find a folder with the IMU data and examples from the video, and a screenshot of the needed configuration, on the following link:

[Folder link](#)

To get started, use the following buttons and entry widgets:



- **<Select Files>** to add IMU data files. You can select multiple files at once or add more files to your selection.
- **<Apply all>** to copy the input data from the first file/row to the rest of the files/rows.
- **<Save...>** to create .xml files with the current configuration of files and inputs.
- **<Load...>** to open .xml files with a saved configuration of files and inputs.
- **<Help>** for more information on how to use the program.
- **<Run>** to create quaternions and .sto files for the selected files and inputs.
- **<Plot Acc>** **<Plot Gyr>** after creating the files, they can be used to plot different files on the same graph, this option is only available after running the program.



Example of acceleration plot. It is possible to plot more than one element on the same graph

In addition, the following entry widgets are available:

- **[Frequency]:** The frequency at which IMU data was collected.
- **[Output Folder]:** The folder where the resulting files will be saved.
- **[Elem./row]:** The number of IMU data for each row of the file, 1 IMU data for each acc+gyr+(mag) package.
- **[Placement]:** The OpenSim placement of the IMU sensor/file. Each file must have a different placement.
- **[Rotation XYZ°]:** To apply a rotation to the IMU data for global alignment before creating the quaternions and .sto files.
- **[Pos.]:** The position, starting at 1, of the first element of acceleration, gyroscope or magnetometer respectively.
- **[Pos.]:** If the IMU doesn't have magnetometer data, this value should be left blank in the Mag. Pos.
- **[Units]:** Units conversion from sensor units to Madgwick filter units (m/s^2, rad/s and mT).
- **[Filter LF]:** Leave blank for no filtering, or enter a value from the actual Frequency to 0 to apply an increasing level of, low pass, filtering to acc, gyr or mag.

Frequency	52	Output Folder C:\mu2sto\9 devices\Penalty X2 Freq 52															Open Folder			
File name	Elem / row	Placement	Rotation XYZ°			Pos.	Units m/s²	Filter LF %		Pos.	Units rad/s	Filter LF %		Pos.	Units mT	Filter LF %				
file_imu_1.txt	8	<div>torso</div>	0	0	0	Acc.	4	0.01	10	Gyr.	7	0.00174	10	Mag.	10	0.001	0	Quaternion created, size: (1112, 4)	Plot Acc	Plot Gyr
file_imu_2.txt	8	<div>femur_r</div>	0	0	0	Acc.	4	0.01	10	Gyr.	7	0.00174	10	Mag.	10	0.001	0	Quaternion created, size: (1104, 4)	Plot Acc	Plot Gyr
file_imu_3.txt	8	<div>femur_l</div>	0	0	0	Acc.	4	0.01	10	Gyr.	7	0.00174	10	Mag.	10	0.001	0	Quaternion created, size: (1088, 4)	Plot Acc	Plot Gyr
file_imu_4.txt	8	<div>tibia_r</div>	0	0	0	Acc.	4	0.01	10	Gyr.	7	0.00174	10	Mag.	10	0.001	0	Quaternion created, size: (1096, 4)	Plot Acc	Plot Gyr
file_imu_5.txt	8	<div>tibia_l</div>	0	0	0	Acc.	4	0.01	10	Gyr.	7	0.00174	10	Mag.	10	0.001	0	Quaternion created, size: (1096, 4)	Plot Acc	Plot Gyr
file_imu_6.txt	8	<div>calcn_r</div>	0	0	0	Acc.	4	0.01	10	Gyr.	7	0.00174	10	Mag.	10	0.001	0	Quaternion created, size: (1080, 4)	Plot Acc	Plot Gyr
file_imu_7.txt	8	<div>calcn_l</div>	0	0	0	Acc.	4	0.01	10	Gyr.	7	0.00174	10	Mag.	10	0.001	0	Quaternion created, size: (1080, 4)	Plot Acc	Plot Gyr
file_imu_8.txt	8	<div>toes_r</div>	90	0	0	Acc.	4	0.01	10	Gyr.	7	0.00174	10	Mag.	10	0.001	0	Quaternion created, size: (1096, 4)	Plot Acc	Plot Gyr
file_imu_9.txt	8	<div>toes_l</div>	90	0	0	Acc.	4	0.01	10	Gyr.	7	0.00174	10	Mag.	10	0.001	0	Quaternion created, size: (1080, 4)	Plot Acc	Plot Gyr

Example of configuration for 9 Movesense devices with 8 IMU data collected for each row.

The first acceleration data (acc x) is in the 4<sup>th</sup> position (the first element on each row is considered to be in the 1<sup>st</sup> position), the IMU data from the sensor is in cm/s<sup>2</sup>, and the units conversion to m/s<sup>2</sup> is 0.01.

The first gyroscope data (gyr x) is in the 7<sup>th</sup> position the IMU data from the sensor is in d°/s, and the units conversion to rad/s is 0.00174.

The first magnetometer data (gyr x) is in the 10<sup>th</sup> the IMU data from the sensor is in cgauss, and the units conversion to mT is 0.001.

All the sensor, except for toes\_r and toes\_l, were placed with the Movesense Y-axis pointing up and Z axis pointing forward. The toes sensors are rotated around the X axis for global alignment.

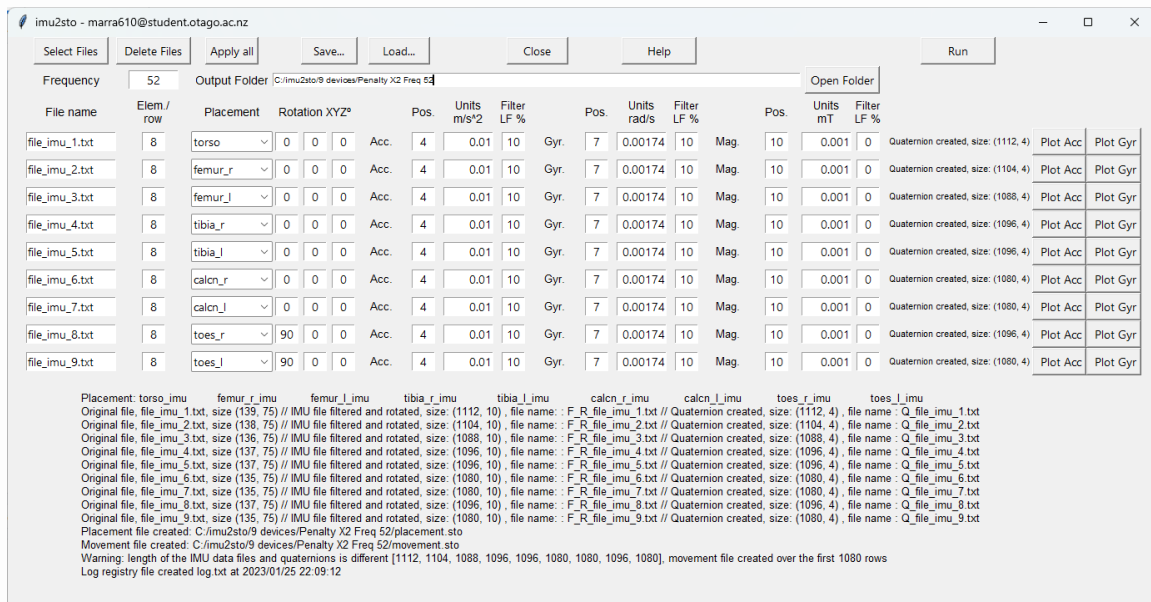
A 10% filtering is applied to the acceleration and gyroscope data.

The resulting IMU files after applying the rotation and filtering are named as F\_R\_<name of the file>, with 1 IMU data for each row.

This program is developed as a part of my PhD research to facilitate the data processing.

If you have any questions or feedback, please contact me at [marra610@student.otago.ac.nz](mailto:marra610@student.otago.ac.nz) / [raulmartinphd@gmail.com](mailto:raulmartinphd@gmail.com)

Examples of screenshots:



Full screen with the result of the example of configuration for 9 a Movesense device with 8 IMU data collected for each row.

**Resulting files:**

F\_R\_files, one for each input file, with 1 IMU element for each row, rotated and filtered.

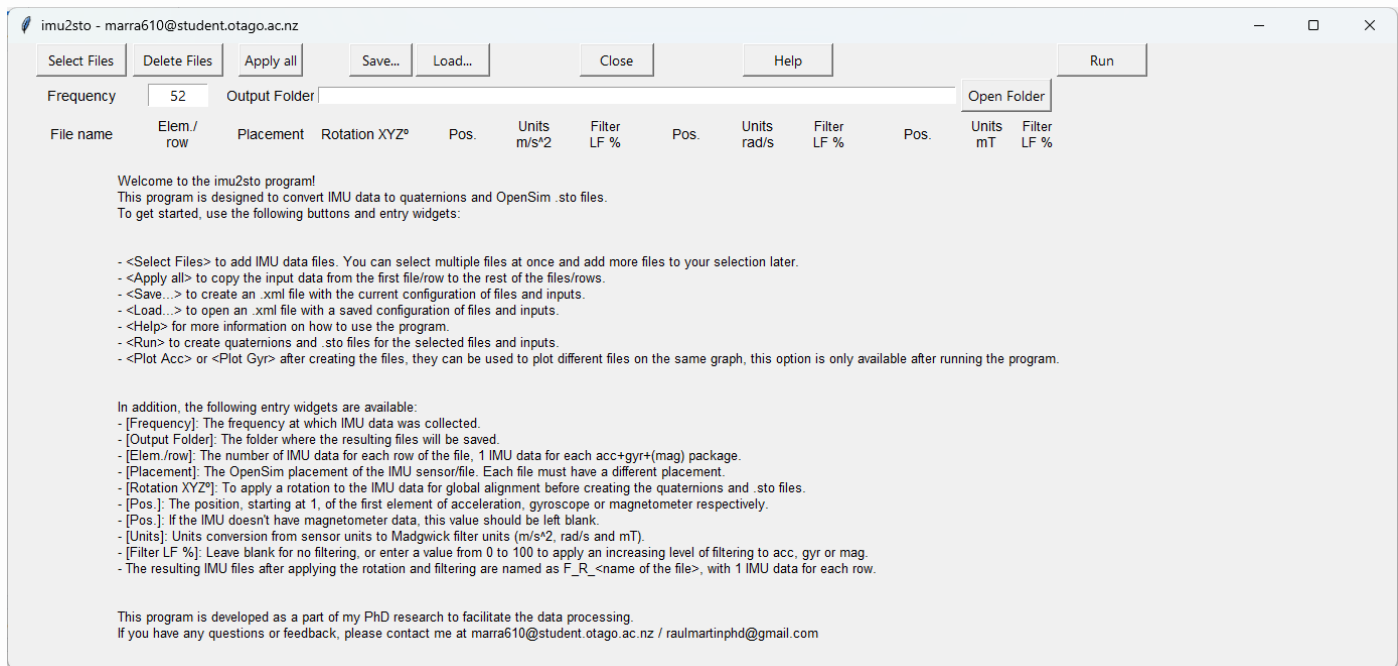
Q\_files, one for each input file, with the correspondent quaternion

placement.sto file for IMU Place... in Opensim

movement.sto file for IMU Inverse Kinematics... in Opensim

log.txt with the information of the files created

Warning and error messages are also displayed for input errors (duplicated placements, numbers with errors...)



imu2sto program initial screen