PROCESSING OF ARDUINO-CONTROLLED VALVOMETRY DATA FOR MUSSEL RAFT AND LABORATORY MONITORING

Martínez-Fernández, A.*1; Silva, E.1; Velo, A.1; Carrouée, M.1; García-Sanmartín, I.1; Santos-Domínguez, D.2; Mateu, C.3; Babarro, J.M.F.1; Galimany, E.3; Peteiro, L. 1& Gilcoto, M.*

Instituto de Investigaciones Marinas, Consejo Superior de Investigaciones Científicas (IIM-CSIC), Vigo, SPAIN 2 Instituto de Ciencias del Mar (ICM-CSIC), Barcelona, SPAIN atlanTTic Research Center, Universidad de Vigo (Uvigo), Vigo, SPAIN

*amartinez@iim.csic.es / mgilcoto@iim.csic.es





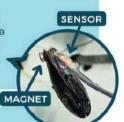


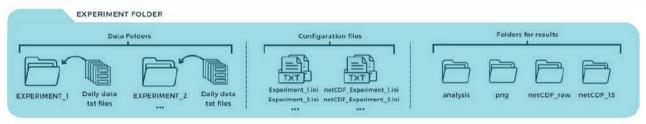


Valvometry equipment is a High-Frequency (10 Hertz), Non-Invasive (HFNI) instrument used as a biosensor to assess the gaping behavior (valve opening and closure) of bivalve molluscs [1].

Gaping activity of many bivalve species is closely related to physiological processes such as nutrition, respiration, and waste elimination, which respond to environmental conditions following rhythmic cycles. Bivalves alter their normal gaping behavior in the presence of stressors, indicating environmental perturbations, allowing us to use this response and this technology for marine monitoring and assessment [1].

The principle behind the use of these (bio)sensors involves gluing a Hall-effect sensor to one valve and a magnet to the other. The intensity of the magnetic field detected by the sensor changes according to the distance between the two valves.





PYTHON SCRIPTS FOR VALVOMETRY DATA PROCESSING



Lab valvo / Raft valvo

Python module for implementing a class and its methods for the import, curation, processing and plotting of valvometry data

LabValvoFile / RaftValvoFile

netCDF_Experiment_1.ini

Experiment channels

Set the name of the experiment and the path where data is storage.
 Change the active/inactive channels swiching between 0 and 1.



Import Experiments all

Python script for importing, preprocessing and

Python script for curating and plotting of preprocessed valvometry data



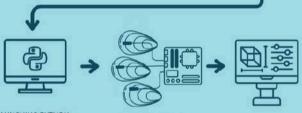
Process Experiments all Python script for processing and plotting of





Python script for defining parameters as start and end dates for data selection, channels to





SCRIPT FOR DATA

EQUIPMENT

EXPERIMENT / DATA

DATA PROCESSING

CONFIGURATION

For more details about the process of getting Valvometry data and technical details about the lab/raft equipments see Gilcoto etal. (2021) [2] and Gilcoto et al. (2023) [3]

Data acquisition and processing were developed with open hardware, opensource software and userfriendly code, with shareable results in NetCDF format in accordance with FAIR principles. The code will soon be publicly

available in DIGITAL.CSIC and other public repositories. This technology

contributes to early warning systems and to less invasive animal monitoring.

[1] Andrade, H., Massabuau, J.C., Codhrane, S., Ciret, P., 627 Tran, D., Sow, S., and Camus, L., "High Frequency Non-invasive (HFN) Bio-Sensors As a Potential Tool for Marine Monitoring and Assessments", Front. Mer. Sci. vol. 8, pp. 137, 2016, doi: 10.3389/fmars.2016.00187
[2] Glooto, M., W. Redondo-Caride, E. Silva, A. Velo, L. A. Comeau, R. Filgueira, and J. M. F. Babarro (2021), Anduino controlled velvomenty equipment for laboratory monitoring, Instrumentation Viepoint. 21.9th Marine International Workshop on Marine Technology (MARTECH/21), 60-61.
[3] Glooto, M., W. Redondo Caride, A. L. Velo, L. A. Comeau, R. Figueira, and J. M. F. Babarro (2023), Arduino controlled valvometry equipment for mussel raft monitoring, Instrumentation Viewpoint, 22(10th International Workshop on Marine Technology (MARTECH/2023)), 43-44.







RAFT VALVOMETRY EQUIPMENT

Python module for defining functions intended for use as methods in Lab valve / Raft valve class. Contains default values for variables.



· Set the start and end dates of your experiment with the indicated data format and end dates of your experiment with the indicated data format. Set the name of the experiment on indicated lines. Set the channels to remove from the importing process (Channels that were active during the experiment but aren't going to be imported due to problems, removed channel during the experiment...). Set the reference values for each channel registrated during the gluing process.



OUTPUTS



netCDF_1S



Curate_Experiments_all

TXT)

Set the general path/directory for valvometry.
 Set the name of the experiment on indicated lines.
 Hun the code

This script executes the following steps:

Import raw data from doily .txt files.

Save all raw data in NetCDF format, organized by channels.

Select the channels to be removed.

Filter outlier values exceeding 5 times the standard deviation (STD).

Save the "clean" raw data. Save the "clean" raw data in NetCDF format, organized by channels.

Detect gaps longer than 1 second and summarize them in a .csv file.

csv file.

Resample data to 1 Hz and save the resampled series in NetCDF and txt formats, organized by channels.

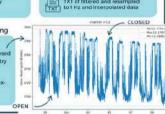
Applie a rolling window filter (4 hours) to remove values exceeding 5 times the STD within the window.

Convert voltage levels to millivolts and plot valvometry data per channels.

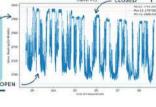
per channel.

Calculate daily maximum and minimum values, summarize them in a .csv file, plot and save the results per channel.





NetCDF of valid channels flaw Data



netCDF_1S

NetCDF of filtered and resampled to 1 Hz data



Curate_Experiments_all

Set the general path/directory for valvometry.
 Set the name of the experiment on indicated lines.
 Set the periods to fill with NaNs or add an offset.
 Run the code.

Script recommended for removing or correcting time periods affected by activities such as mussel feeding or tenk maintenance, as well as for eliminating any values or time intervals suspected to be incorrect







Experiment channels

Set the minimum and maximum values of the plots from curating process.

Process_Experiments_all



Set the general path/directory for valvometry Momento.
 Set the period to analize
 Set the name of the experiment on indicated lines.
 Runthe code

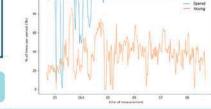
This script executes the following steps:

Import the preprocesed data from the netCDF files
 Convert voltage levels to millivolts, normalize it linearly.
 Detect opening and closing movements and save its results in netCDF format organized by channels.
 Analyse activity per predefined period of time, summarized it in .csv file and save results in netCDF format organized by channels.

channels.Plot and save figure of activity results.



NetCDF of Movement Data RetCDF of activity Data



analysis

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