



HAL
open science

Piezoelectric micromanipulator dataset for hysteresis identification

Helon Vicente Hultmann Ayala, Micky Rakotondrabe, Leandro dos Santos Coelho

► **To cite this version:**

Helon Vicente Hultmann Ayala, Micky Rakotondrabe, Leandro dos Santos Coelho. Piezoelectric micromanipulator dataset for hysteresis identification. *Data in Brief*, 2020, 29, pp.1-6. 10.1016/j.dib.2020.105175 . hal-03495841

HAL Id: hal-03495841

<https://hal.science/hal-03495841>

Submitted on 20 Dec 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License




OATAO is an open access repository that collects the work of Toulouse researchers and makes it freely available over the web where possible

This is an author's version published in: <http://oatao.univ-toulouse.fr/27129>

Official URL:

<https://doi.org/10.1016/j.dib.2020.105175>

To cite this version:

Hultmann Ayala, Helon Vicente and Rakotondrabe, Micky  and Dos Santos Coelho, Landro *Piezoelectric micromanipulator dataset for hysteresis identification*. (2020) *Data in Brief*, 29. 1-6. ISSN 2352-3409

Any correspondence concerning this service should be sent to the repository administrator: tech-oatao@listes-diff.inp-toulouse.fr



ELSEVIER

Contents lists available at ScienceDirect

Data in brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Piezoelectric micromanipulator dataset for hysteresis identification

Helon Vicente Hultmann Ayala ^{a, *}, Micky Rakotondrabe ^b,
Leandro dos Santos Coelho ^c^a Department of Mechanical Engineering, Pontifical Catholic University of Rio de Janeiro, Brazil^b Laboratoire Génie de Production, National School of Engineering in Tarbes / INPT, France^c Industrial and Systems Graduate Program, Pontifical Catholic University of Paraná, Brazil

ARTICLE INFO

Article history:

Received 10 December 2019

Received in revised form 15 January 2020

Accepted 16 January 2020

Available online 25 January 2020

Keywords:

Micromanipulators
System identification
Piezoelectric actuator
Mechatronics

ABSTRACT

This data in brief presents displacement measurements acquired from a piezoelectric cantilevered actuator when subjected to harmonic excitations. The micro displacements are measured with optical sensors. The dataset has been used recently for the purpose of nonlinear black-box modelling, where the hysteretic behaviour of such devices has been modelled [1,2]. We hope to enable reproducibility by sharing the data used in [1,2], which are previous works by the authors, allowing the comparison of new methods on a common basis. Additionally, researchers interested in piezoelectric actuators for high precision tasks may also benefit on working with the present dataset.

© 2020 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

1. Data description

The dataset is composed of two input/output data pairs. The system is excited with a sine voltage input of (a) 150 V and 1 Hz; and (b) 5 V and 300 Hz. The dataset (b) has been employed for identification in Refs. [1,2]. The goal of measuring both datasets is to evaluate the modelling activity when working

* Corresponding author.

E-mail address: helon@puc-rio.br (H.V. Hultmann Ayala).

<https://doi.org/10.1016/j.dib.2020.105175>

2352-3409/© 2020 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

Specifications Table

Subject	Control and Systems Engineering
Specific subject area	System identification and hysteresis modelling
Type of data	Deflection and displacement measurements
How data were acquired	Optical sensors
Data format	Raw
Parameters for data collection	The piezoelectric actuator was excited using a sine driving voltage. The amplitudes and frequencies tested were 5V and 150 V and 300Hz and 1 Hz, respectively.
Description of data collection	The entire test bench constructed to collect data is composed of (a) the piezoelectric actuator, (b) an optical sensor (LK2420 from Keyence company) which is employed to measure the deflection (displacement) of the above actuator and has been tuned to have 10nm resolution and in excess of 5kHz bandwidth, (c) a computer which is used to generate the sine driving voltage and to acquire the measurement from the optical sensor, (d) a dSPACE (type DS1104) acquisition board that serves as digital-to-analogic and as analogic-to-digital converters between the computer and the rest of the physical setup, with sampling period set as 50 μ s, and (e) a high voltage amplifier that multiplies by 20 the driving voltage from the computer before sending it to the actuator.
Data source location	Institution: ENIT/Toulouse University, University of Toulouse City/Town/Region: Tarbes Country: France
Data accessibility	With the article
Related research article	Helon Vicente Hultmann Ayala, Didace Habineza, Micky Rakotondrabe, Leandro dos Santos Coelho, Nonlinear Black-box System Identification through Coevolutionary Algorithms and Radial Basis Function Artificial Neural Networks, Applied Soft Computing, vol. 87, 105990, 2020.

Value of the Data

- The dataset provided is important for nonlinear modelling of hysteretic systems
- Researchers in the system identification community at large may benefit for testing nonlinear modelling techniques. Researchers and engineers working with piezoelectric actuators for high precision positioning applications may also be interested with and benefit from the data.
- The present dataset enable comparison among methods for modelling a phenomenon that is frequently found in positioning applications, but not only.

under different frequencies and amplitudes. Dataset (a) has not been explored thus far in any publications.

The datasets (a) and (b) are provided in two comma separated values (CSV) files. In these files, which can be visualized in any text editor, each line refers to a sampling time instant. Both CSV files are zipped in a single file, which is provided as a supplement to this article. In this zip file, there is also a MATLAB code to plot the data. It is possible to find below a detailed description of both datasets, according to their filename:

- h50us.csv**: this dataset contains 200,001 measurements sampled in time every 50 microseconds. The second, third, and fourth columns are respectively the vector with time, output displacement, and input voltage. The measurements are drifted, so a pre-processing is needed (in the code provided this is already arranged).
- hysteresis_v_150_1hz.csv**: the second dataset has the same file structure with respect to the columns as (a) but measured every 20 milliseconds with 50,001 samples. The sinusoidal signal starts at approximately 3.25 seconds, so the first samples of the dataset should be discarded (in the code provided this is already arranged).

Table 1

Dataset characteristics for each file provided.

Dataset	Input Amplitude [V]	Input Frequency [Hz]	Sampling Frequency [kHz]	Time [s]
(a)	5	300	20	10
(b)	150	1	5	10

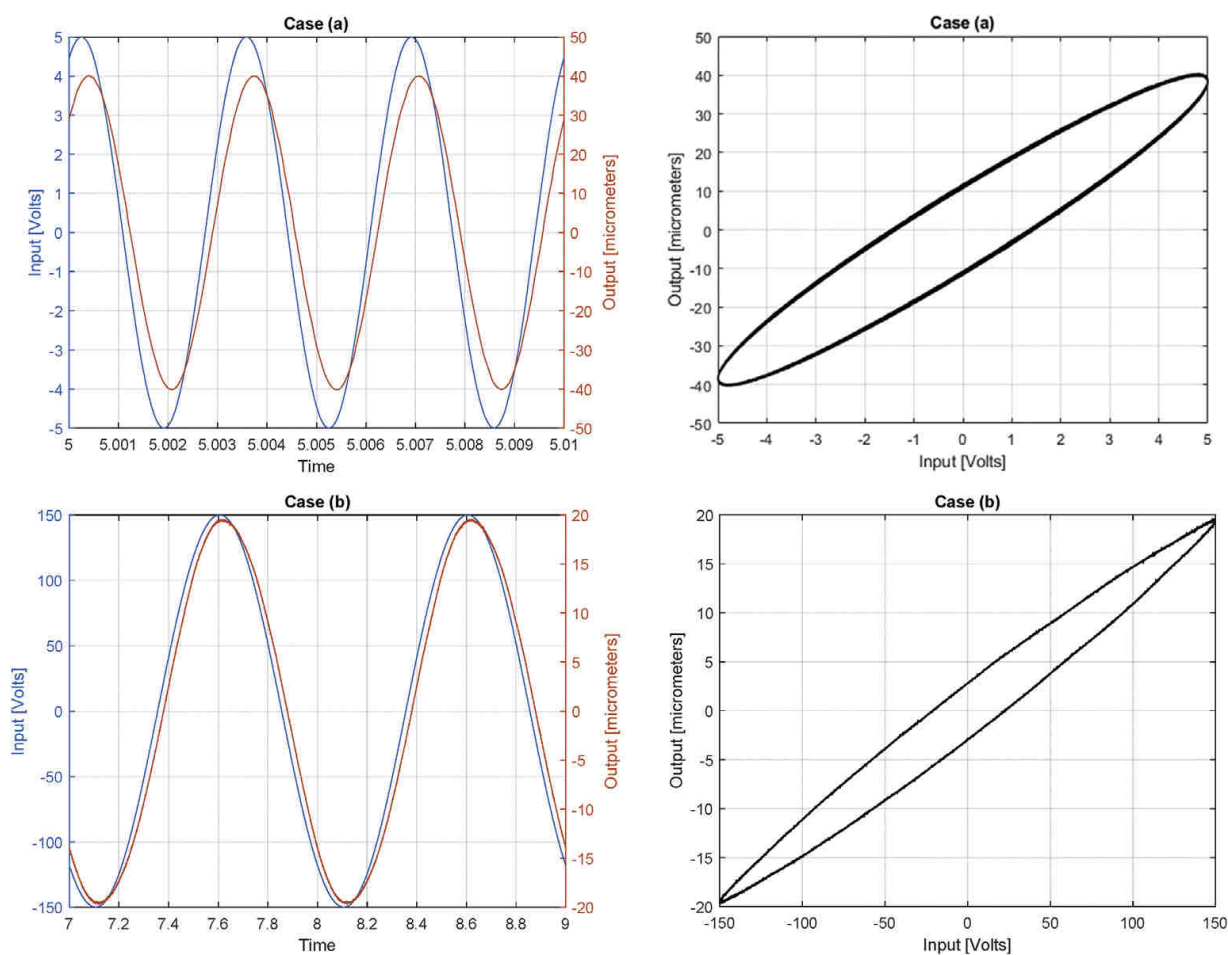


Fig. 1. Input and output data for case (a) – top - and (b) - bottom. On the left we see the time histories for both input and output and on the right the semi-static curves (input vs. output) are given.

Datasets (a) and (b) characteristics are summarized in Table 1 and depicted graphically in Fig. 1. They are sampled at different rates as the dynamics due to the excitation is faster in case (a). It is possible to see that the voltage amplitudes and frequencies are different for each file, as Table 1 shows. Nonetheless, the amplitudes for the deflections are in the same order of magnitude, as the input/output gain for each frequency is different for the system. For the sinusoidal-like type of input, it is possible to plot the graph with input versus output through time, where the hysteric behaviour can be clearly observed.

2. Experimental design, materials, and methods

A schematic of the experimental benchmark setup is described in Fig. 2. The components used in this setup are described in detail in Table 2. The piezoelectric micromanipulator is manufactured with

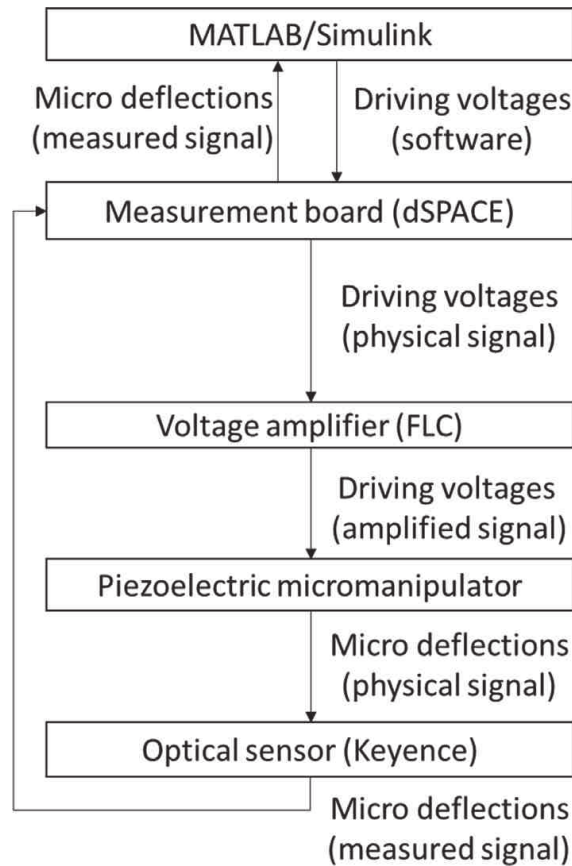


Fig. 2. Schematic of the measurement setup and the data flow among its components.

Table 2

Hardware used for instrumentation of the test bench and respective purpose description.

Hardware	Manufacturer	Purpose
DS1104	dSPACE	- converts the sine driving voltage generated from MATLAB-Simulink in the computer into analogic voltage outside the computer, - converts the measured displacement from the sensor into numeric measurement inside MATLAB-Simulink.
LK2420	Keyence	Optical sensor that measures the deflection (displacement) of the piezoelectric actuator.
A400DI	FLC	Amplifies the voltage from the acquisition board and computer before driving the piezoelectric actuator.
Computer (with MATLAB-Simulink)	Any	MATLAB-Simulink has been used to program the voltage to be amplified and sent to the actuator and used to save or display the measurement from the sensor.

15 × 2 × 0.3 (length, width, and thickness, in millimetres), where the piezoelectric and passive layers have, respectively, 0.2 and 0.1 mm. For a real picture of the setup with the measurement device, please refer to [Fig. 3](#).

The dataset is provided with a MATLAB code (`read_plot_data.m`) that reads the data into memory and plots the graphs given in [Fig. 1](#).

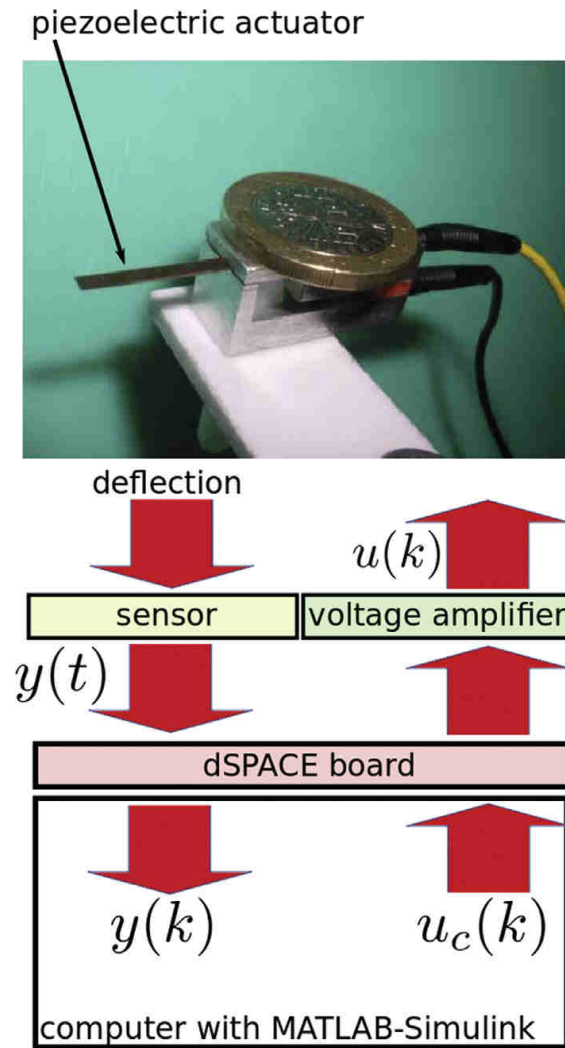


Fig. 3. Description of the piezoelectric micromanipulator and its measurement interfaces.

Acknowledgments

The authors would like to thank the financial support from CAPES (Coordination for the Improvement of Higher Education Personnel - Brazilian Government) grant no. 88887.163347/2018-00, the National Council of Scientific and Technologic Development of Brazil - CNPq (Grants number: 303906/2015-4-PQ, 404659/2016-0-Univ, 430395/2018-3-Univ, and 400119/2019-6-ERC) and FA (Fundação Araucária) PRONEX:042/2018 for their financial support.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.dib.2020.105175>.

References

- [1] Helon Vicente Hultmann Ayala, Didace Habineza, Micky Rakotondrabe, Leandro dos Santos Coelho, Nonlinear Black-Box System Identification through Coevolutionary Algorithms and Radial Basis Function Artificial Neural Networks, *Appl Soft Computing* (2020). <https://www.sciencedirect.com/science/article/abs/pii/S1568494619307719>.
- [2] Helon Vicente Hultmann Ayala, Didace Habineza, Micky Rakotondrabe, Carlos Klein, Leandro S. Coelho, Nonlinear black-box system identification through neural networks of a hysteretic piezoelectric robotic micromanipulator, *IFAC-PapersOnLine* 48 (28) (2015) 409–414.