Dataset supporting 'Fiber pumps for wearable fluidic systems'

Michael Smith, Vito Cacucciolo and Herbert Shea

Soft transducers laboratory (LMTS), EPFL, Switzerland

michael.smith@epfl.ch, herbert.shea@epfl.ch

This data set contains the data supporting the work: 'Fiber pumps for wearable fluidic systems'

The data set consists of the following folders:

- Pump characterisation data
- Demonstration characterisation data
- Design files

Below is a detailed description of the naming conventions, data types and the contents of each folder.

Naming conventions

Each pump has a unique name of the following form: ver[]-d[]-n[]-t[]-p[]-l[]-N[] where [] represents a value. The name of the pump describes its structure as follows:

- ver[]: the version of the pump. Used in this instance to distinguish between pumps made before (ver2) and pumps made after (ver3) the initial submission of the manuscript. Physically, there is no difference between ver2 and ver3 pumps.
- d[]: the inner diameter of the pump in micrometres (um)
- n[]: the number of TPU filaments used during manufacture
- t[]: the diameter of the TPU filaments in um
- p[]: the position of the copper wire electrodes, expressed as the number of TPU filaments between the copper wires
- l[]: the length of the pump in millimetres (mm)
- N[]: the pump repeat number

For example, the name ver2-d1200-n6-t400-p2-l100-N3 refers to a pump made prior to initial submission with a 1200 um inner diameter, 6 TPU filaments of 400 um diameter and 2 filaments between the electrode wire. The pump is 100 mm long and this is the third pump made with this particular design.

The pump name occurs in the filename of several of the characterisation data files.

Data types

There are 7 file types in this data set:

- .txt
- .res
- .csv
- .mp4
- .kva
- .seq
- .stl

.txt files

These files contain time series data from the pump characterisation set up. The data is comma delimited and the file can be opened with a text editor such as Notepad++. Each row corresponds to a point in time, each column gives the measured flowrate, pressure, current, voltage and associated errors. There is a header at the start of the file (marked with a # at the start of each line) which contains information regarding the pump under test and the measurement conditions. The column headers and units are also included in this file header.

.res files

Files with a *.res* extension (short for 'results') are data from a specific measurement of pump performance (such as a power density measurement, voltage ramp etc). They are comma delimited text files which can opened with a text editor such as Notepad++.

There are three types of *.res* file in this data set:

- *-MaxValues.res*
- *-RampAnalysis.res*
- *-ValveSweep.res*

MaxValues.res files are the results from a power density measurement at multiple voltage set points. Each row of data represents a different voltage set point and the columns display the maximum pressure, flowrate, current, voltage, electric power, hydraulic power, power density and efficiency measured at that voltage (with associated errors). Note that the power density shown here is volumetric. The mass power density is calculated from the hydraulic power and the pump mass. There is a header at the start of the file (marked with a # at the start of each line) which contains information regarding the pump under test and the measurement conditions. The column headers and units are also included in this file header.

RampAnalysis.res files are the result of a voltage ramp. In these experiments, the valve in the measurement circuit is either fully open or fully closed and the applied voltage is ramped. This gives a simple measurement of max pressure or max flowrate. Each row is a different voltage, each column gives the measured flowrate, pressure, current and associated errors. There is a header at the start of the file (marked with a # at the start of each line) which contains the column headers and units.

ValveSweep.res files are the results from sweeping the position of the valve in the measurement circuit from fully open (0 %) to fully closed (100 %). Each row is a different valve position and each column displays the maximum pressure, flowrate, current, voltage, electric power, hydraulic power, power density and efficiency measured at that valve position (with associated uncertainties). This can be repeated for several different voltages. Each file corresponds to one voltage set point, labelled as V[] in the filename (where [] is the applied voltage in volts).

.csv files

Files named *Specimen_RawData_X.csv* where X is an integer correspond to time series data from an Instron tensile

test machine. The data is semi-colon delimited and can be opened with a text editor such as Notepad++. Each row corresponds to a new point in time, each column gives the time, displacement (déplacement) and load (charge). The column headers and units are in the first two rows of the file.

Files named *YYYYMMDD - marker positions - testX.csv* where YYYYMMDD is a date and X is an integer correspond to the results of motion tracking using the software Kinovea (kinovea.org). Each row is a new point in time, and each column is the position of a marker at that time. The column headers and units are in the first row of the file.

.mp4 files

These are video files that can be played using any video player.

.kva files

These are annotation files from the motion tracking software Kinovea (kinovea.org). They are loaded automatically when the corresponding video file is opened in Kinovea. This will load the calibrated co-ordinate system used for motion tracking as well as the positions of the markers. Motion tracking data is available via the menu Tools -> Linear kinematics.

.seq files

These are the raw infra-red video files captured from the thermal camera. They can only be opened using the ResearchIR software from FLIR.

.stl files

These are 3D design files of various components used throughout this work. The files can be opened with any 3D model viewer and sliced for 3D printing using any slicing software (PrusaSlicer, for example).

Pump characterisation data

This folder contains all the data associated with characterising the performance of individual fiber pumps (that is, pumps not integrated or combined with another device).

01 Changing pump length

Pressure ramps, flowrate ramps and power densty measurements for three pumps of each length [100, 200, 400, 800] mm

02 Changing pump diameter

Power density measurements for three pumps of each inner diameter [800,1200,1500,1800] um

03 Pump curve family 800 mm pump

A family of pump curves for a single pump of length 800 mm. The pump curves are measured at [800, 1600, 2400, 3200, 4000, 4800, 5600, 6400] V

04 Pump curve family each length

The pump curve measured at 6400 V for one pump of each length [100, 200, 400, 800] mm

05 Pump curves under strain

The pump curves of one 200 mm long pump measured at 6400 V as this pump is subjected to different levels of strain: [0, 2.5, 5, 7.5, 10, 12.5, 15] %

06 Pump curves under flexion

The pump curves of one 400 mm long pump measured at 6400 V as this pump is deformed to different bend diameters: [Undeformed, 64, 32, 16, 8] mm

07 Transient response

The short-time pressure and flowrate response of the pump to a voltage square wave

08 Repeated strain

The time series flowrate data of 200 mm long pumps as they are repeatedly strained to 10 % and 20 % strain

09 Repeated flexion

The time series flowrate data of a single 200 mm long pump as it is repeatedly flexed to high and low bend radii

10 Pump lifetime test

The time series flowrate data of a single pump operating continuously until failure

11 Reversibility of flowrate

Flowrate ramps of a single pump operating in positive and negative polarity

12 Kinking pump

The time series flowrate data while a pump is subjected to kinking. The power supply detects breakdowns and marks the position with a negative number in time column corresponding to the number of breakdown events (i.e. the first breakdown is marked -1, the second -2 etc). The voltage is reset automatically after the breakdown.

Demonstration characterisation data

This folder contains all the data associated with characterising the fiber pump demonstrations presented in this paper

01 Fabric actuator

01 Isostatic force measurements: force measurements of the fabric actuator at different applied voltages [4000, 4800, 5600, 6400] V
02 Free displacement measurements: motion tracking at different applied voltages [4000, 4800, 5600, 6400] V
03 Actuator work cycle: An example work cycle of the fabric actuator with data from the pull tester (force and displacement) and the pump characterisation set up (pressure, flowrate, current)

02 Fiber IHAM actuator

01 Voltage response: motion tracking data of the fiber actuator driven by a 6400 V triangle wave
02 Frequency response: motion tracking data of the fiber actuator driven by a 6400 V square wave signal at different frequencies
03 Repeated cycles: motion tracking data of a fiber actuator driven by a 6400 V square wave for 5000 cycles

03 Thermal haptic glove

Rec-glove demo-00042-049_15_39_06_805.seq: Raw IR video of the thermal haptic glove, activating each pump separately.
Rec-glove demo-00059-049_17_42_32_357.seq : Raw IR video of the thermal haptic glove interacting with an object

04 Thermal t-shirt

Rec-tshirt-000005-084_11_24_40_554.seq: Raw IR video of untethered thermoregulatory t-shirt

05 Woven pumps

Rec-woven-000002-082_16_42_50_613.seq: Raw IR video from the demonstration of woven pumps

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Design files

This folder contains 3D design files of various components used throughout this work

01 Pump fabrication design files

The upper and lower guides used in the filament winding process

02 Pump characterisation design files

The components used to create the scissor mechanism for repeated flexion of the fiber pumps

03 Demonstration design files

01 IHAM actuator demo: The moulds used to create the IHAM actuators and the clamp used in the 3 fiber actuator
02 Woven pumps demo: The frame used in the demonstration of two pumps woven together.
