

Appendix A

SMPtoolkit User Manual

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A.1 Preface

SMPtoolkit is a MATLAB based Graphical User Interface (GUI) for use with the Snow MicroPen [1]. The software was developed to make collecting and viewing the data simple and accessible from a single program. The following document is a basic user manual for the software operation. The current version of SMPtoolkit requires MATLAB to execute, but future versions will be available to any Microsoft Windows based computer.

A.1.1 License

SMPtoolkit was developed by Andrew E. Slaughter, with the exception of the m-file readSMP.m (see Section A.8), which was developed by Hans-Peter Marshall. SMPtoolkit is intended for research purposes only, any commercial use is prohibited. Copyright Andrew E. Slaughter, 2008.

A.2 Installation

To install , simply unzip the contents of the provided SMPtoolkit.zip ¹ file into the desired location. Then from within MATLAB, change the working directory to the directory you created and type `SMPtoolkit` in the command-line. This will open the window shown in Figure A.1, which is the main controls for SMPtoolkit.

A.3 Opening/Saving Files

The SMPtoolkit software is capable of opening Snow MicroPen raw data files (*.pnt extension) as well as simple text files with the *.smp extension. The *.smp files are files that are saved via the SMPtoolkit, the details of this file format are contained in Section A.8.6. The *.pnt files are binary format, the details of the standard format are contained in Section A.8.5.

When the **Save** option is selected SMPtoolkit will create a *.smp file for the currently opened SMP profile. There is no method for altering the raw *.pnt files.

¹http://www.coe.montana.edu/wti/snow_ice/Slaughter/YCtoolkit.zip

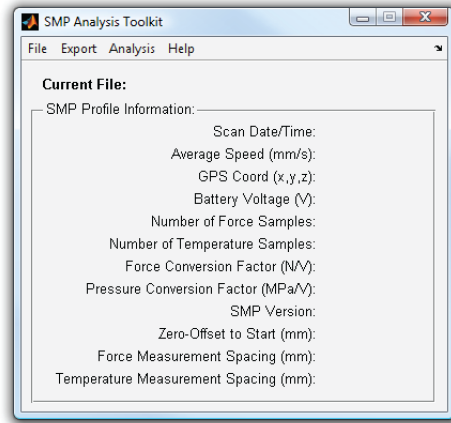


Figure A.1: The main window for SMPtoolkit graphical user interface.

A.4 Plotting

After opening a profile, plotting this profile is accomplished by choosing **Plot** from the **Analysis** menu. Selecting this option will open a plot with depth (mm) on the y-axis and either Force (N), Pressure (MPa), or Temperature (C) on the x-axis. The type of plot that is produced is controlled by the settings in **Preferences** menu, see Section A.5. An example, Depth–Force plot is shown in Figure A.2.

There are two features that distinguish the a figure produced with SMPtoolkit versus a standard MATLAB figure: zooming and scrolling.

A.4.1 Zooming

An SMPtoolkit graph has a zooming feature that allows the user to focus in on small depth ranges without seperating the data and opening numerous plots. Zooming is accomplished in two ways:

1. The slider bar on the top of the plot axes. The leftmost position is zoomed out to the complete extent and the rightmost setting zooms to 0.5 mm on the y-axis.
2. A single left-click of the mouse will zoom in and a single right-click will zoom out.

The zooming location of the plot is dictated by the last position you clicked the mouse. For example, if you left-click the mouse around the 100 mm point in Figure A.2 and then slide the slider to about 75% zoomed the y-axis will zoom keeping the 100 mm point in the center, as shown in Figure A.3.

The zooming increments are based on the total depth of the SMP profile. A click of the mouse will zoom in 5% and the click of the arrows on the slider will zoom 1%. For example, if the total depth is 200 mm and the left mouse button is pressed the y-axis will reduce its range to 190 mm.

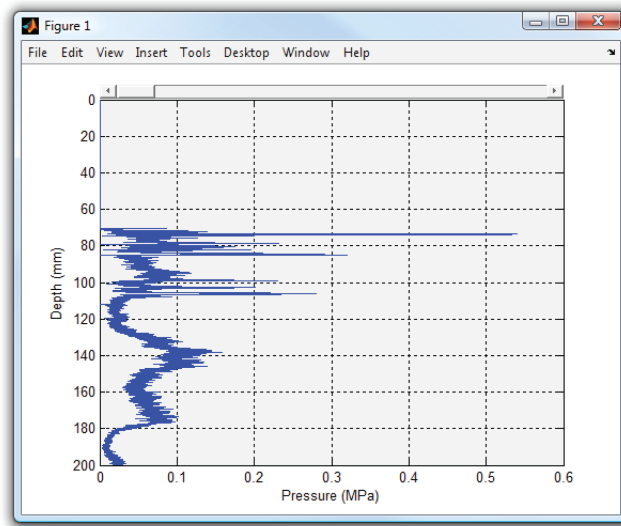


Figure A.2: An example Snow MicroPen force profile produced by SMPtoolkit.

A.4.2 Scrolling

The SMPtoolkit plots also have scrolling capabilities that are particularly useful when the y-axis is zoomed in. Scrolling your mouse wheel up will shift the y-axis closer to the surface (0 mm) and moving the wheel down will shift the y-axis close to the maximum depth. This allows the user to move through the entire profile without zooming in and out.

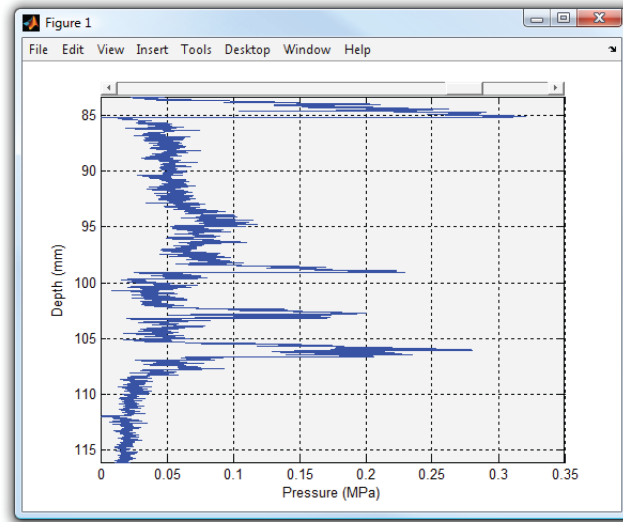


Figure A.3: An example of the zooming capabilities of the SMPtoolkit plotting function. This plot is identical to Figure A.2 but is zoomed in to show detail of the profile between 80 mm and 120 mm depths.

A.5 Preferences

The preferences may be accessed via the File menu. There are two options available: Clear open figures and Type of Plot. Setting the clear open to “yes” will close all open figures when a new profile plot is opened. Alternatively, selecting “no” will open a new figure. The “Type of plot” option controls the data that is plotted: Force, Pressure, or Temperature. If prompt is selected the user will be asked before the plot is generated what type to display.

Selecting the Open Temperature Calibrations button opens the `tempconstants.txt` file that contains the temperature calibration values used to calculate the temperature from the raw SMP data. These values should correspond to your specific SMP, see Section A.8.4.

A.6 Import Menu

The import menu allows the user to download and save *.pnt from the Snow MicroPen multi-media card as well as check the status of the card.

This option requires that your computer has the appropriate card reader, such as the OmniDrive Professional.²

The importing of *.pnt data utilizes the program `mmcread.exe` that was supplied with the SMP, which has two options. The `mmcread -a` option will display the status of the multi-media card and the `mmcread -r` will read the card. The read option prompts the user to select a save location as well as allow the user to change the filenames. The default filename is “FILE”; the files are numbered sequentially but will all include the name entered in the dialog box.

A.7 Future Developments

The following is a list of additions that are planned for the SMPtoolkit software package.

1. Ability to read and save *.tab files as created by PeneWin.
2. Capability of exporting force, pressure, and temperature data with depth to Excel or text files.
3. Ability to plot multiple plots on in a single figure for direct comparison.
4. Option for manually entering the x- and y-axis limit in the figure window.
5. Capability of finding and setting the snow surface.
6. Option for turning of the plotting controls (e.g. slider) for exporting plots.
7. The ability to save the settings of SMPtoolkit for recalling.

A.8 Software Details

This section provides details regarding the MATLAB code with the purpose as a reference for future and further development by other authors who want to add additional functionality to the SMPtoolkit. The SMPtoolkit GUI was constructed using MATLAB's Guide program, which can be accessed via

²Information on the OmniDrive Professional, including the latest drivers may be found at <http://www.csm.de/>.

the command window by typing `guide`. The files created by Guide include `SMPgui.m`, `SMPgui.fig`, `callback_pref.m`, and `callback_pref.fig`. The controlling function of the entire program is the m-file, `SMPtoolkit.m`. Within `SMPtoolkit.m` the GUI is opened, the callbacks for all the GUI operations are set, and the data structure that is based between these functions is created.

A.8.1 SMPtoolkit Data Structure

`SMPtoolkit` functions around a single data structure that is passed between the various m-files and subfunctions. This data structure may be accessed via the command window after initial execution of the `SMPtoolkit`, as follows. The structure in `settings` contains the settings used by `SMPplotter.m` and determines if new figures are removed and what type of plot to create. The `HPM` field contains the data structure developed by Hans-Peter Marshall.

```
>> gui = SMPtoolkit;
>> GUI = guidata(gui);
>> GUI

GUI =

    HPM: [1x1 struct]
    temp: [-0.0182 0.0079 -9.8276e-004 4.2608e-005]
    figures: [ ]
    settings: [1x1 struct]

>> GUI.settings
ans =

    clearfig: 1
    type: 'Pressure'

>> GUI.HPM
ans =

    force: [48800x1 double]
    dzF: 0.0041
    temp: [381x1 double]
    dzT: 0.5246
    vers: 400
    cF: 0.0013
    cP: 6.4227e-005
    zero_off: 0
    year: 2008
    month: 4
    day: 23
    hr: 9
    min: 40
    sec: 26
```

```
xcoor: 0
ycoor: 0
zcoor: 0
batt_V: 12.7256
vel: 20
fsamp: 48800
tsamp: 381
```

A.8.2 Program Flow

SMPtoolkit is a contains multiple files and many subfunctions, Figure [A.4](#) is flow chart that describes the relationship of each of the m-files, subfunctions, callbacks, and external files and programs.

A.8.3 Program Descriptions

This sections contains brief descriptions of the m-files that comprise the SMPtoolkit software. The primary bullets indicate actual m-files and the sub-items are internal functions associated with the m-file.

- **SMPtoolkit.m**

The main program for operating the SMPtoolkit that builds the GUI and sets the GUI functionality. This m-file contains the callbacks or callback reference for every option on the SMPtoolkit GUI.

- *gettempconstants* – Sets the main data structure entry containing the temperature calibration values using the file “tempconstants.txt” or the default values provided by Hans-Peter Marshall.
- *callback_plotter* – Operates when the plot option is selected and calls the m-file SMPplotter.
- *callback_exit* – Closes all open MATLAB windows.
- *callback_about* – Opens a dialog provided SMPtoolkit information to the user.
- *callback_help* – Opens this document via the web.

- **callback_export.m**

Exports the current open profile to a text file with extension of *.smp.

- **callback_read.m**

Reads the data from either the raw binary files (*.pnt) of the text files (*.smp) and inserts the profile data into the GUI and the GUI’s data structure.

- **callback_pref.m**

The m-file associated with `callback_pref.fig` that opens the preferences window and allows the user to change the plot settings as well as examine the temperature calibrations file. These functions were build using MATLAB's Guide program. The m-file was edited slightly outside of Guide, see the program code for details.

- *callback_apply* – This executes when the “Apply” button is pressed and changes the data structure to reflect the changes made by the user.

- **callback_mmcread.m**

Utilizes the supplied program `mmcread.exe` to gather binary data directly from the SMP data card. This also requires the file `CsmDll.dll`.

- **callback_openrecent.m**

This function executes when the File menu is selected to build a list of recently open files from the file `recent.txt`. This list is also updated using this function each time a new file is open.

- **SMPplotter.m**

This function builds the SMP profile with custom operations. This program can easily be used without the SMPtoolkit GUI and it will prompt the user to specify a file to open if no inputs are provided to the program.

- *buildslider* – This subfunction creates the slider bar on the top of the graph.
- *scroll* – This subfunction executes each time the mouse scroll wheel is moved and adjusts the y-axis accordingly.
- *press* – Press executes each time a mouse button is selected on the plot and zooms in and out as well as moves the slider bar.
- *sliderfcn* – This executes each time the sliderbar is moved and is also executed when the mouse buttons are clicked.

- **readTXT.m**

This file executes when a *.smp file is selected from the Open menu options.

- **readSMP.m**

The m-file `readSMP.m` was modified from code provided by Hans-Peter

Marshall and reads the binary *.pnt files that are obtained from the SMP multi-media card.

A.8.4 Temperature Calibrations (tempconstants.txt)

The temperature calibrations for converting the voltage reading to temperature data are stored in a text file names: tempconstants.txt, as shown below. This file must contain four numbers organized vertically. If this file is not present, the values listed below are used by default.

```
-0.018205007
0.0078710989
-0.00098275584
4.2608056e-5
```

A.8.5 SMP *.pnt File Format

Information regarding the format of the raw data file will be viable in future versions of this file.

A.8.6 SMP *.smp File Format

The text files created by SMPtoolkit have the following format.

```
FILE0065.pnt
#####
    Force Step size (mm): 0.004098
    Temperature Step Size (mm): 0.524590
        Version: 400
    Force Conversion (N/V): 0.001261
    Pressure Conversion (MPa/V): 0.000064
        Zero Offset: 0.000000
        Year: 2008
        Month: 4
        Day: 23
        Hour: 9
        Minute: 40
        Second: 26
        x-coordinate: 0.000000
        y-coordinate: 0.000000
        z-coordinate: 0.000000
    Battery Voltage: 12.725600
    Average Speed (mm/s): 20
    Force Sample Size: 48800
    Temp. Sample Size: 381
#####
#Force Data
1.203085
```

```
1.181646
1.233351
1.277490
1.282534
1.319106
1.223263
1.161469
##Temperature Data
0.830682
0.833917
0.830682
0.829610
```

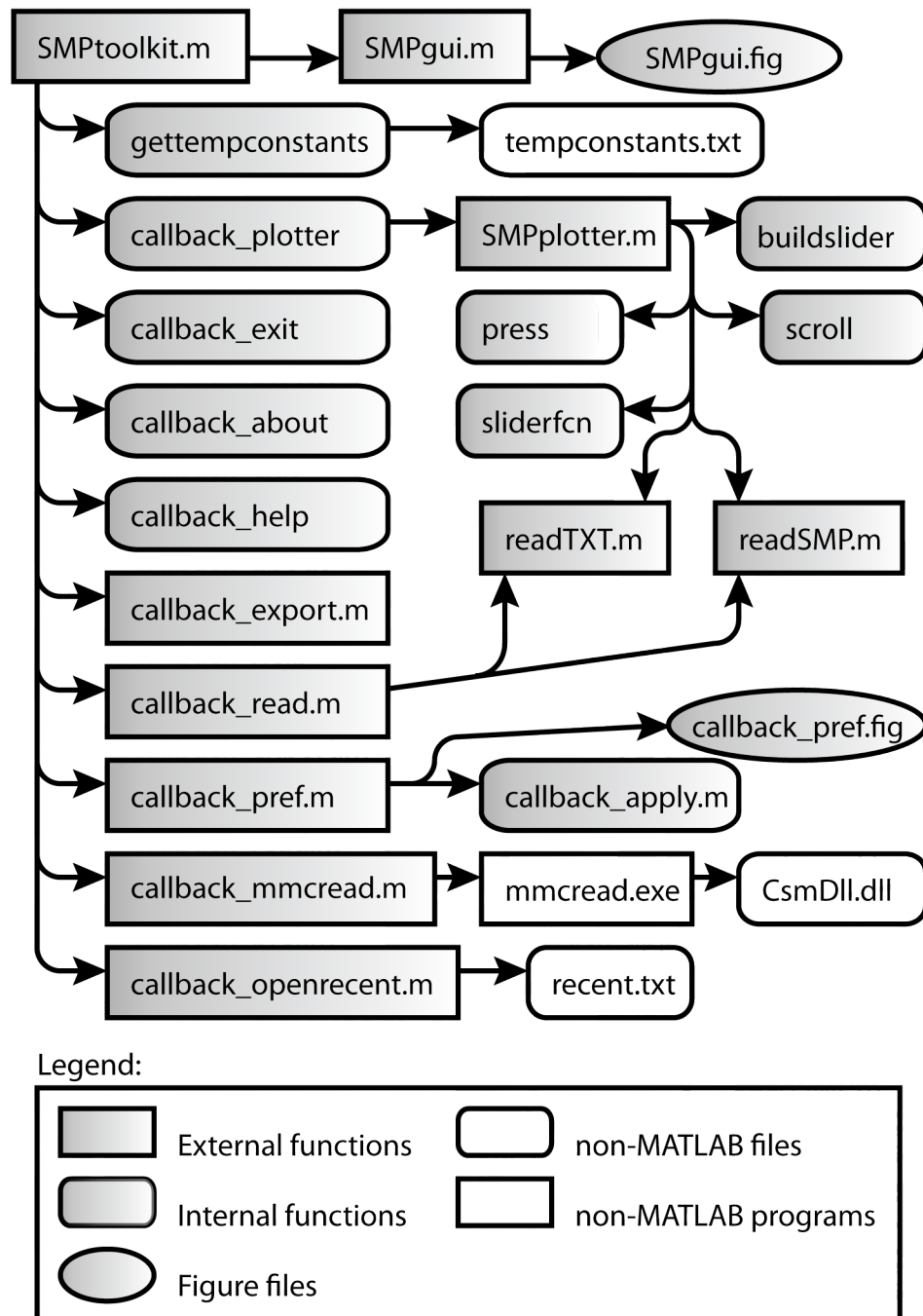


Figure A.4: Flow chart showing the relationship of the m-files, subfunctions, and external functions associated with the SMPtoolkit software.

A.9 Bibliography

- [1] Martin Schneebelli, Christine Pielmeier, and Jerome B Johnson. Measuring snow microstructure and hardness using a high resolution penetrometer. *Cold Regions Science and Technology*, 30:101–114, 1999.