DigitSeis v1.5 QuickStart Guide

0 Downloading DigitSeis and Other Resources

DigitSeis is available at http://www.seismology.harvard.edu/research/DigitSeis_test.html. It is provided as a `.zip` file containing a standalone package for either Mac OS X or Windows, and so does not require installation of MATLAB[1]. In the package, `README.txt` contains information for installing and uninstalling DigitSeis[2].

A sample image of an analog seismogram is available for download; it was used to produce the step-by-step examples found in this guide. A comprehensive guide is also available both within the bundles and as an individual download. Videos demonstrating usage of DigitSeis step-by-step and answers to frequently asked questions are available as online resources.

1 Loading and Preparing Images

Upon opening DigitSeis, the following window (Figure 1) appears.

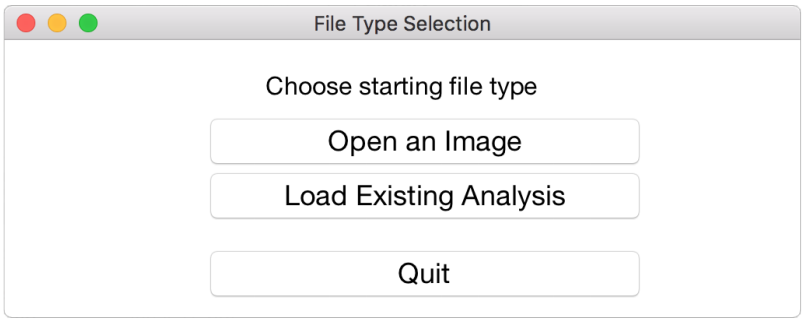

Figure 1: File loading options presented upon opening DigitSeis.

To continue work on an existing analysis, load a `.mat` file by selecting **Load Existing Analysis**. The user can then pick up from where the loaded analysis was saved.

[1] For MATLAB source codes, please contact the Harvard Seismology Group.
[2] Step-by-step instructions for installation can also be found in the comprehensive DigitSeis manual.

To upload a new image[3], select **Open an Image**. The image may take some time to load. Once it has been loaded, an image with light-coloured traces over a dark background should be visible as in Figure 2.

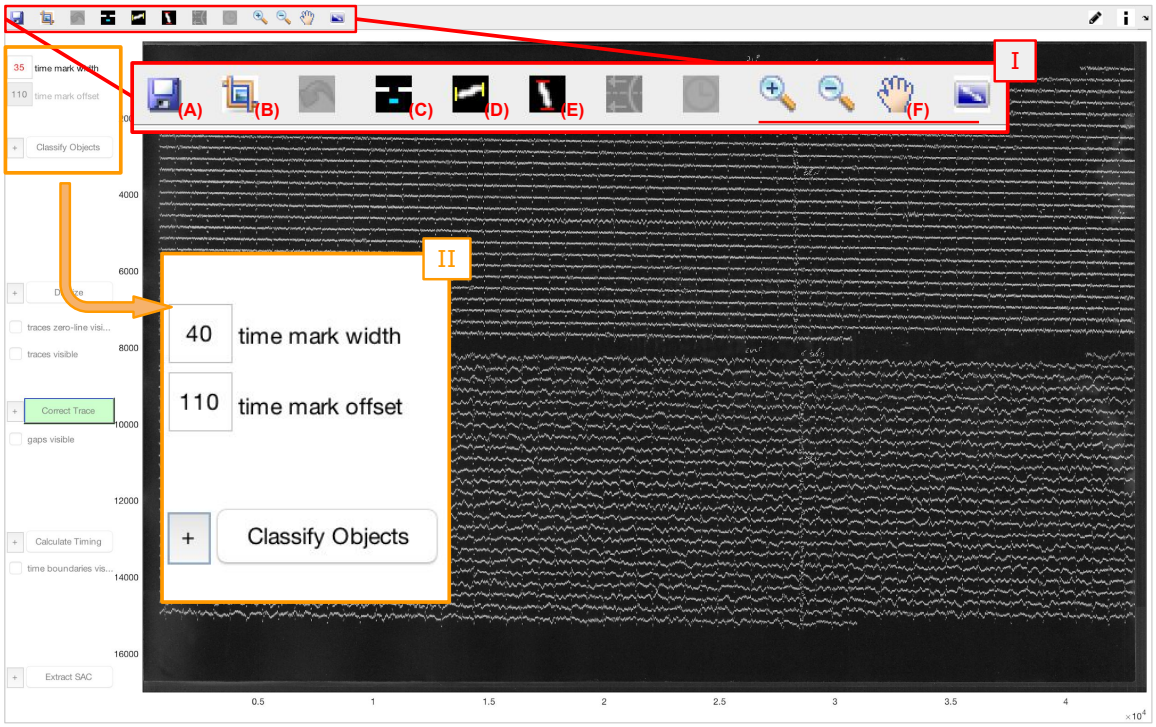

Figure 2: Main DigitSeis window after loading a new image. At top (I), Save (A), Crop (B), Time Mark Direction (C), Measure Width (D), Measure Offset (E), and navigation (F) tools. At left (II), fields to input time mark dimensions and begin classification.

New images must be cropped to eliminate space without data. Select the Crop tool (Figure 2, A), then click and drag to create a box encompassing the desired area. Finish cropping the image by double clicking anywhere within the box.

Before classifying, time mark properties must be defined. Using tools D and E in Figure 2, measure the approximate offset and width of a time mark[4] (as shown in Figure 3) and input the results in the corresponding fields in the left sidebar (Figure 2, II). Ensure that the Time Mark Direction icon (Figure 2, C) displays a time mark in the correct orientation; click the icon to toggle between positions[5].

[3] DigitSeis works with all image formats supported by the MATLAB function `imread`, detailed at https://www.mathworks.com/help/matlab/import_export/supported-file-formats.html.

[4] To make this process as easy as possible, zoom in on a single time mark to measure it. See the comprehensive DigitSeis manual for tips on using navigation tools.

[5] For images without time marks, see the comprehensive DigitSeis manual.

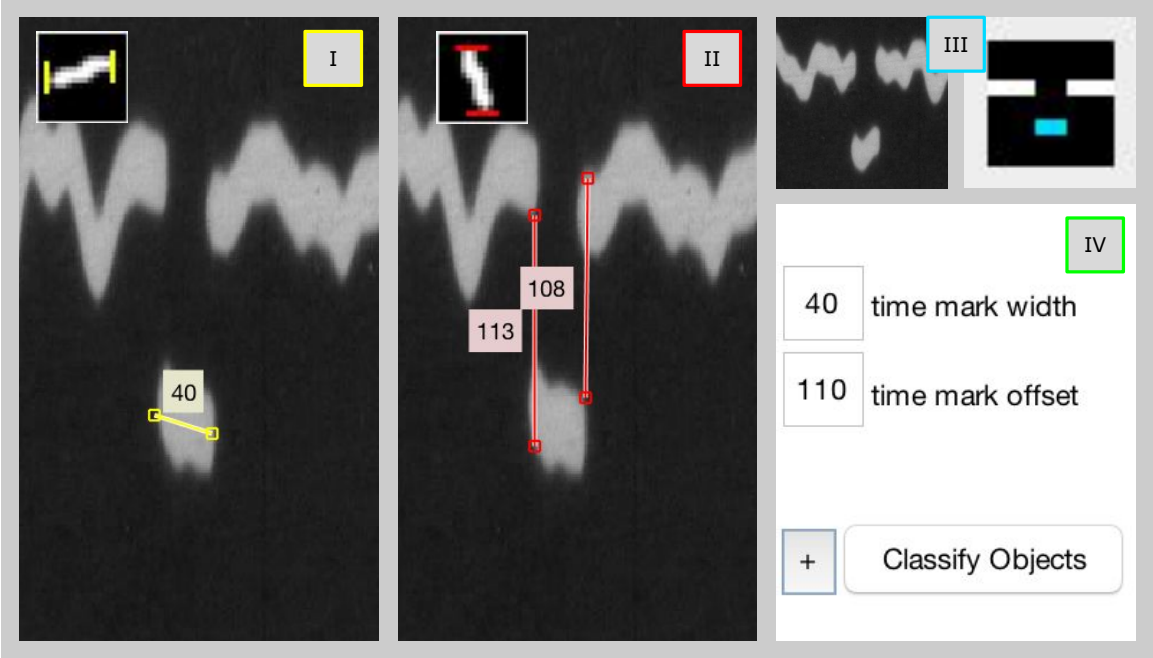

Figure 3: Measuring time mark width and offset. (I) Tool measuring only horizontal distance for width, (II) tool measuring only vertical distance for offset, (III) toggle indicating time marks are below traces for the image, and (IV) fields in left sidebar for inputting time mark dimensions.

2 Classifying Objects

Once the image has been cropped and time mark dimensions have been input, pressing **Classify Objects** in the left sidebar (Figure 2, II) opens a window where objects detected by DigitSeis can be classified, as below (Figure 4). It takes some time to open.

For the image to be digitized, the objects within it must be properly labeled. Though a majority of objects should already be correctly classified, the tools[6] displayed in Figure 4 can be used to ensure proper classification of all objects:

(A) Small Region Analysis. Creates a box which can be double-clicked to open a new window to more closely examine a region of the image[7].

(B) Remove Pixels. The first of these two tools masks individual pixels in a line drawn by the user; the second masks an area indicated by a shape drawn by the user.

[6] For in-depth information about these and other tools, see the comprehensive DigitSeis manual.
[7] More information regarding options in the Small Region Analysis window can be found in the comprehensive DigitSeis manual.

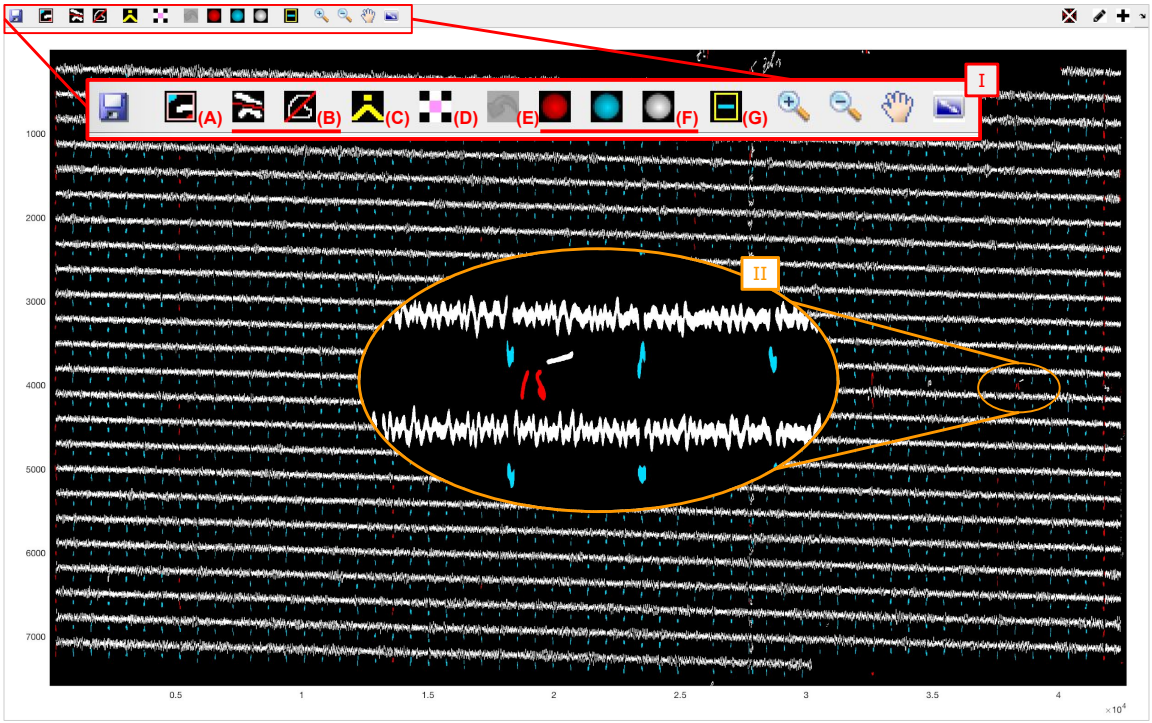

Figure 4: DigitSeis classification window. At top, icons for Small Region Analysis (A), Remove Pixels (B), Combine Objects (C), Overlap Analysis (D), Undo (E), Classify Objects (F), and Show Time Marks (G).

(C) Combinine 0bjects. Allows for selection of multiple objects to be defined as a single object. Once all desired objects have been selected (temporarily highlighted in yellow), right-click to complete.

(D) Overlap Analysis. Opens a new window displaying only a single selected object. Allows for closer examination and masking, or designation of overlapping regions[8].

(E) Undo. Undoes only one, most recent, past action. Appears as a green arrow when an action can be undone. Cannot be redone.

(F) Classify Objects. Introduces crosshairs to define objects as noise (red), time marks (blue), or traces (white). Once objects have been defined, right click to end selection.

(G) Show Time Marks. Boxes all defined time marks with yellow for ease of error detection.

[8] More information regarding options in the Overlap Analysis window can be found in the comprehensive DigitSeis manual.

3 Digitizing and Correcting Traces

Once all objects in the image have been correctly classified, the classification window can be closed. This automatically reopens the main DigitSeis window.

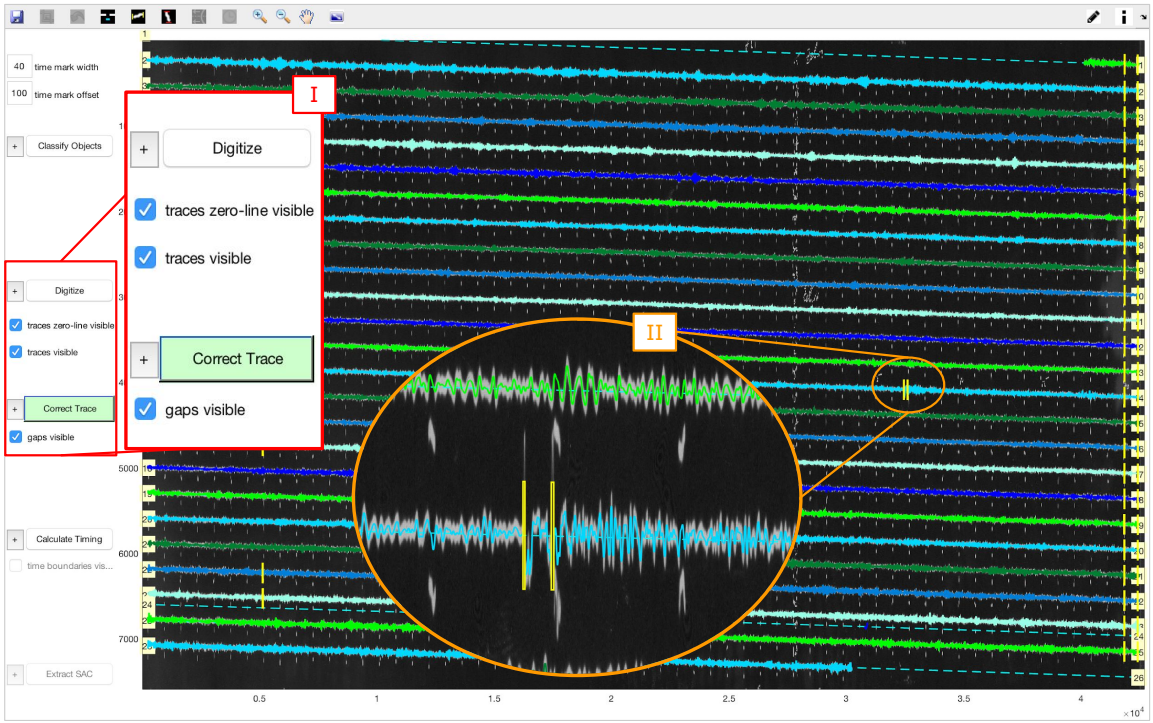

Figure 5: Main DigitSeis window after creation of digitized traces. Traces, zero lines, and gaps are visible. At left (I), the sidebar contains options for displaying zero lines, traces, and gaps, and for correcting traces. A zoomed in view of the digitized traces (II) displays correctable gaps, indicated in yellow.

Back in the main DigitSeis window, pressing **Digitize** in the left sidebar produces digitized traces and zero lines[9] along the traces in the image, as in Figure 5. Any gaps in the digitized traces are boxed in yellow if the **gaps visible** box, below **Correct Trace** in the left sidebar, is checked.

To correct a gap in a digitized trace, first select **Correct Trace**, which introduces crosshairs that can be used to select the trace to be corrected. A box, outlined in red, subsequently appears; this box can be adjusted to encompass the area to be corrected. Double clicking anywhere inside the red-outlined box opens a window to correct the trace, as in Figure 6.

[9] To troubleshoot extra zero lines or misplaced traces, see the comprehensive DigitSeis manual.

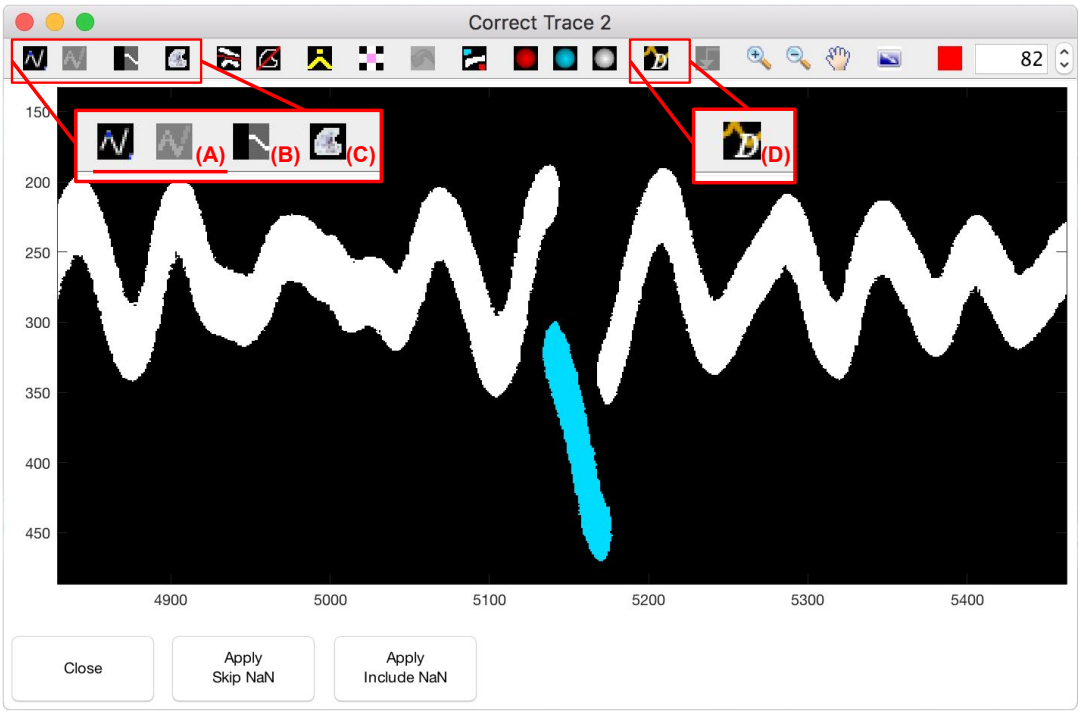

Figure 6: Correct trace window. At top, icons for pinpointing tools (A), Show Original Image (B), Unmask (C), and Digitize Trace (D).

The **Correct Trace** window allows for masking, unmasking, and reclassification of objects in the selected area of the trace. Gaps in data existing in the original media should remain, but any gaps created by errors in classification or digitization can be corrected in the **Correct Trace** window.

Once all objects are properly masked and classified, or a point-traced curve has been created and classified[10], the Digitize Trace tool (Figure 6, D) can be used to create a digitized trace. That digitized trace is then applied to the final trace either with or without NaN values[11], after which the window can be closed.

4 Timing

Once the digitized traces are correct, press **Calculate Timing** to initiate calculation of the timing anchors. The time marks are indicated by yellow marks (timebars) within traces, and as red timebars at the ends of traces, as in Figure 7.

[10] DigitSeis's pinpointing feature is frequently used for thin, high-amplitude traces that overlap others. For more information about using this tool, see the comprehensive DigitSeis manual.

[11] If NaNs are included, all NaN values for the segment of the trace in the **Correct Trace** window are applied to the trace.

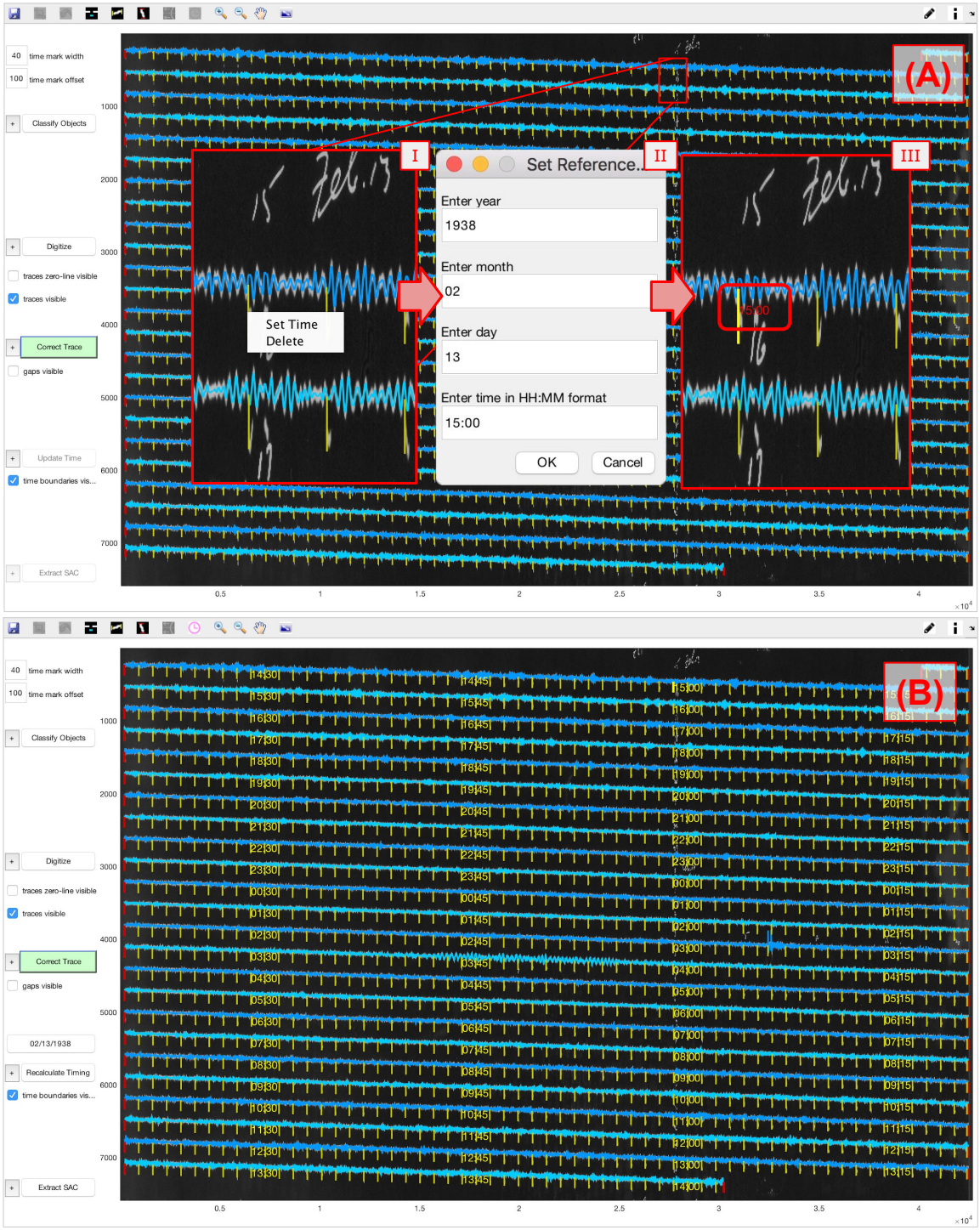

Figure 7: At top (A), main DigitSeis window after calculating timing. Zoomed views shown in center are (I) the right-click options for a timebar, (II) the window for setting absolute time of selected time bar, and (III) absolute time appearing in red once set. At bottom (B), after time has been updated, times at 15-minute intervals line up vertically.

An absolute time can then be assigned to one or more timebars. This is done by right-clicking a timebar and choosing **Set Time**, which opens a window where the absolute time corresponding to the timebar can be set (Figure 7, A, II). Once enough[12] timebars have been set, **Update Time** in the left sidebar becomes clickable. When clicked, it assigns absolute time to each timebar that is displayed for every 15 minutes (Figure 7, B).

5 Saving Results

Data can be saved from DigitSeis in two ways – as a `.mat` file and as a `.SAC` file. An analysis can be saved as a `.mat` file at any time by clicking the save icon at top (Figure 2, A). When the analysis is first saved, a window opens where information about the analysis[13] can be input. Once that window is closed, and for all subsequent saves, the standard save window for the user's operating system opens to allow for file naming and choice of save location.

To extract the data as a `.SAC` file, all steps for digitization must first be complete. Then, **Extract SAC** in the left sidebar can be clicked, which opens a window (Figure 8) where station information can be input. Once **Generate SAC Files** is clicked, the user can choose where to store the `.SAC` files through the operating system's save window.

Throughout the process of digitizing a record, frequent saves to new `.mat` files are recommended, to make backtracking easy in case of an error.

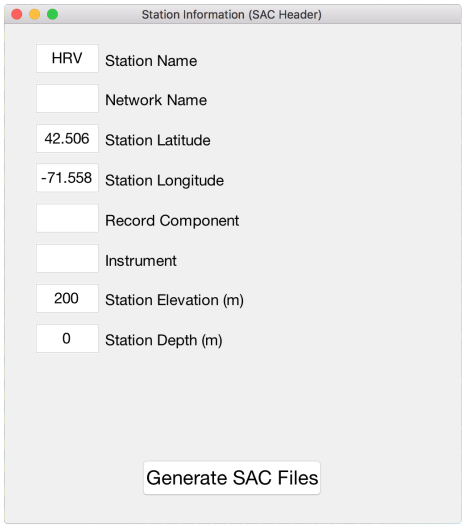

Figure 8: Window for inputting station information before saving `.SAC` files.

[12] As long as no timebars are missing, only one timebar should need to be set; for more information on other situations, see the comprehensive DigitSeis manual.

[13] The window collects information for the user signature. Other information about the analysis can be accessed through the Show Information icon in the top left corner of the main DigitSeis window.

This manual is provided to complement the DigitSeis v1.5 package for digitization of analog seismograms available on the http://www.seismology.harvard.edu/research/DigitSeis.html

DigitSeis manuals and supplementary materials prepared by Katelyn Lee for the Harvard Seismology Group.

For more information on the Harvard Seismology Group, please visit: http://www.seismology.harvard.edu/index.html.

For any questions, comments, or bug reports, please contact Thomas Lee, graduate student in the Harvard Seismology Group at thomasandrewlee@g.harvard.edu.

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DigitSeis uses two functions that were not written by the authors nor are built-in functions that come with MATLAB. Permissions from the functions' authors to include them in the DigitSeis package were obtained prior to inclusion. The individual functions can be obtained from sources below.

`rgb2hsv_fast.m`

This function was written by Dr. Alexander Ihlow (Technische Universitat Ilmenau), and is available at http://www.mathworks.com/matlabcentral/fileexchange/15985-fast-rgb2hsv/content/rgb2hsv_fast.m.

`writesac.m`

This function was written by Dr. David Yang (Los Alamos National Laboratory). The latest version of this function was obtained from the author, but it can also be found included in the Seismic Analysis Code (SAC) distribution, at http://ds.iris.edu/ds/nodes/dmc/forms/sac/.

Copyright statement for this function: