

IMageEXtractor Manual

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1 Introduction

IMageEXtractor (IMEX) is an App developed for extracting data from scatter plots, enabling automatic extraction, and manual extraction and correction. IMEX is written in MATLAB R2018b, with add-on ‘Computer Vision Toolbox v8.2’ installed.

2 Overview

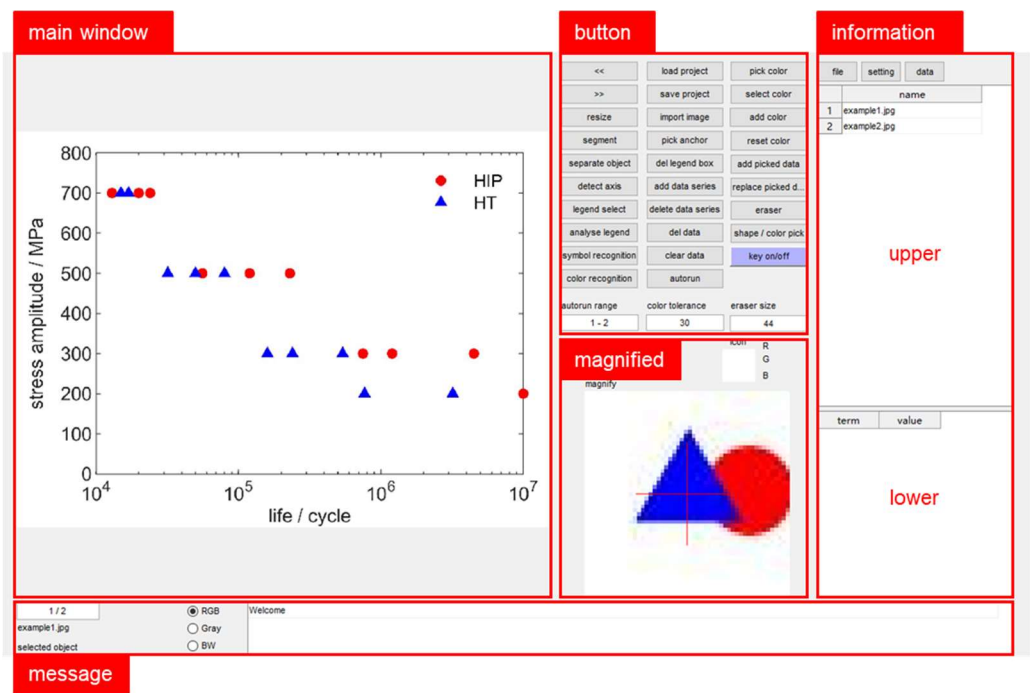


Figure 1. Major panels of IMEX.

The major panels of IMEX are shown in Figure 1. The **main window** shows the image to be processed. The **button panel** includes functional buttons and related input boxes.

The **information panel** displays the information on files, settings and data (Figure 2). Use the button at the top to switch between files, settings and, data information. Selecting an item in the **information upper panel** will trigger the **lower panel** to show

the corresponding detail data.

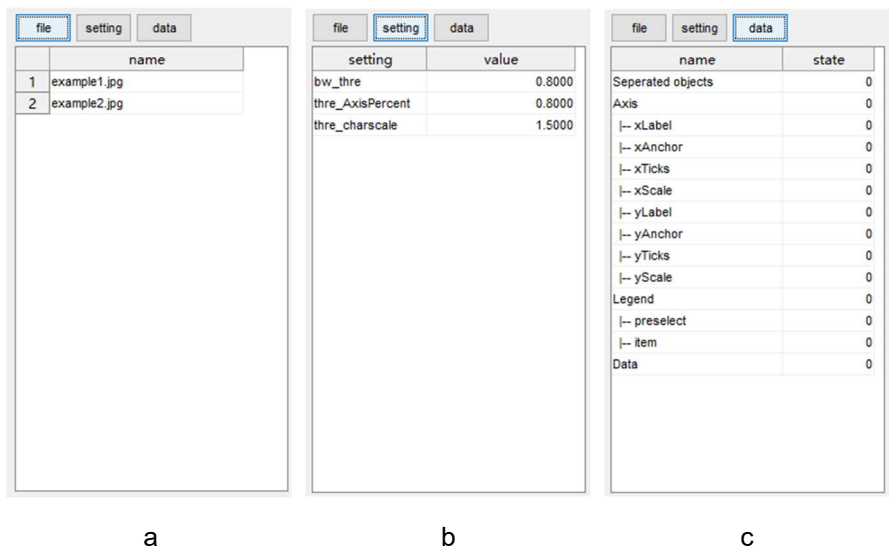


Figure 2. Information upper panel. (a) file, (b) setting and (c) data information.

The **magnified** panel displays the magnified view at the cursor position, marked by a red cross. In the upper left, there is also a small window to display the symbol of a data series and the RGB value of a pixel.

The **message** panel displays the message during app execution (Figure 3). In the first column, the first box shows the ID of the current image and the total number of images in the current project. It is an editable text box and entering a valid ID will trigger the main window to display the corresponding image. Below the text box, the image name and ID of selected object is shown. The second column includes 3 radio buttons to switch the color mode in the main window. The third column shows the real-time message during execution.



Figure 3. Message panel.

In the following, words in **red color** refer to panels of IMEX, and words in **purple color** refer to buttons.

3 Usage

3.1 Main window



The left button of the mouse can be used to add data points or select objects in the main window, such as data points, axis anchors, selected regions.

Holding the left button and moving the mouse will box select objects or regions.

Other functions of the left button will be activated for some buttons, which will be introduced in the following sections.



The middle scroll is used to zoom in or zoom out the image.



Holding the right button and moving the mouse will pan the image.

3.2 Quickstart

imex.m is the main file and **imex.fig** is used for the layout of the graphic user interface (GUI). Running the **imex.m** in MATLAB will launch a blank IMEX GUI. The quickstart involves steps shown in Figure 4.

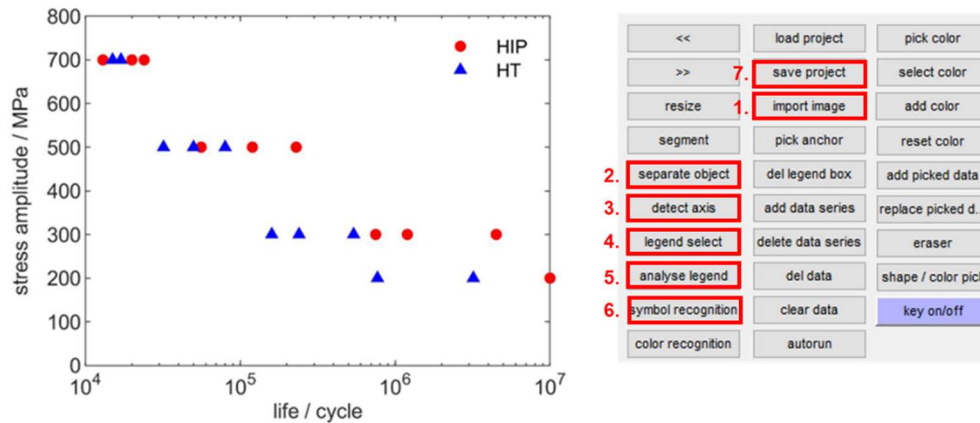


Figure 4. Steps of the quickstart.

1. Import image: click the **import image** button, a dialog box appears. Select the 'example' folder we provided, and IMEX will import all images under the folder.
2. Separate object: click the **separate object** button. A binary copy of the image is created. Connected black pixels in the binary image are identified as an object. Objects will be used for subsequent analysis.
3. Detect axis: click the **detect axis** button. The position of axis, axis ticks and axis labels are recognized automatically.
4. Legend selection: click the **legend select** button, the button is highlighted in blue. Use the left mouse button in the main window to box select the legend region (Figure 5). Click the **legend select** button again to finish the selection and the button will recover to gray. It is noted that color pixels irrelevant to the legend should not be included, which could influence the result of the analysis.
5. Analyse legend: click the **analyse legend** button, the symbols and corresponding annotations are analysed and stored as templates for the image. Click the 'item' in the **information upper panel**, the symbols and annotations will be wrapped by black boxes in the main window and the text of the annotation shown in the **information lower panel**.

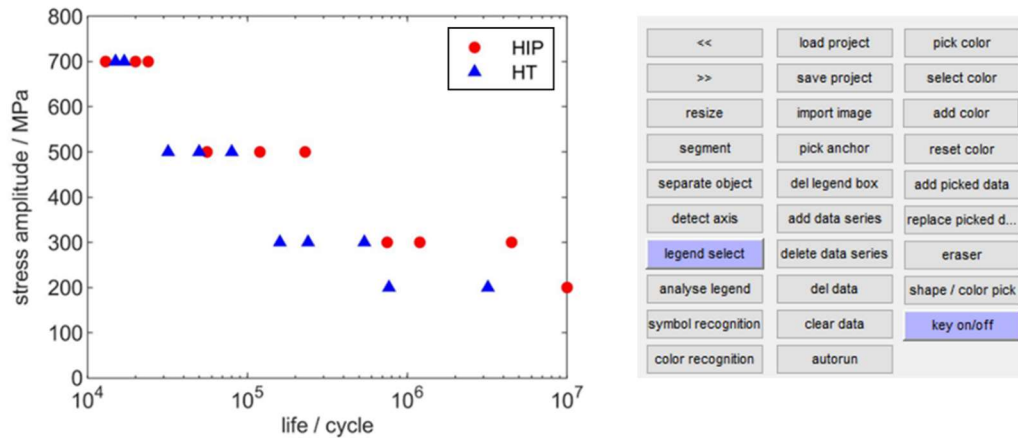


Figure 5. Box select the legend region.

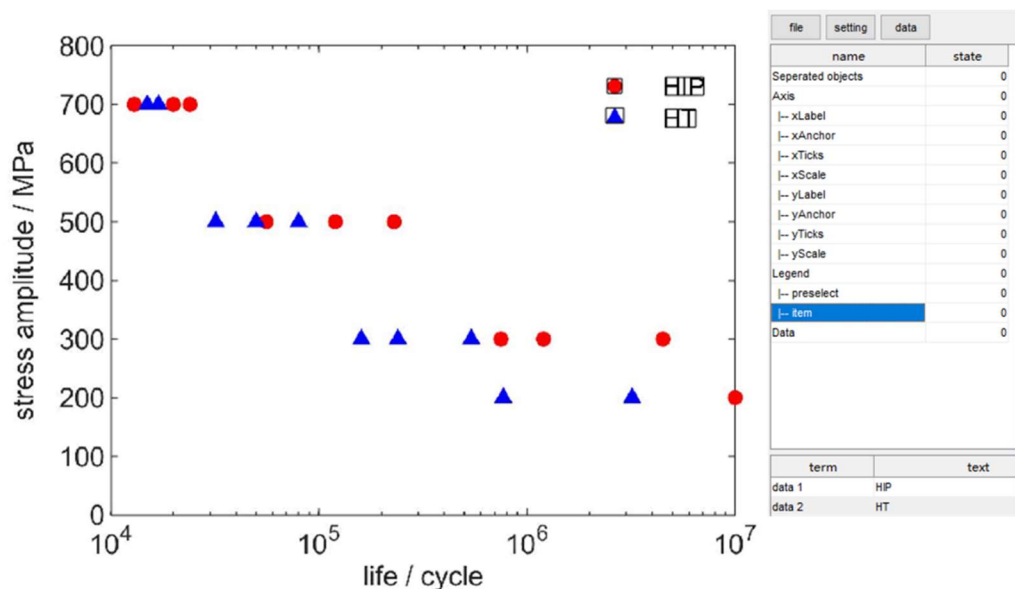


Figure 6. The result of legend analysis.

- Symbol recognition: click the **symbol recognition** button and the data points will be recognized according to the shape and color of the templates. Select a data 'series' in the **information upper panel**, recognized data points will be marked by yellow circles in the **main window** and corresponding numeric data shown in the **information lower panel**. If no 'series-*n*' appear in the **information upper panel**, click the 'data' button at the top to refresh the page.

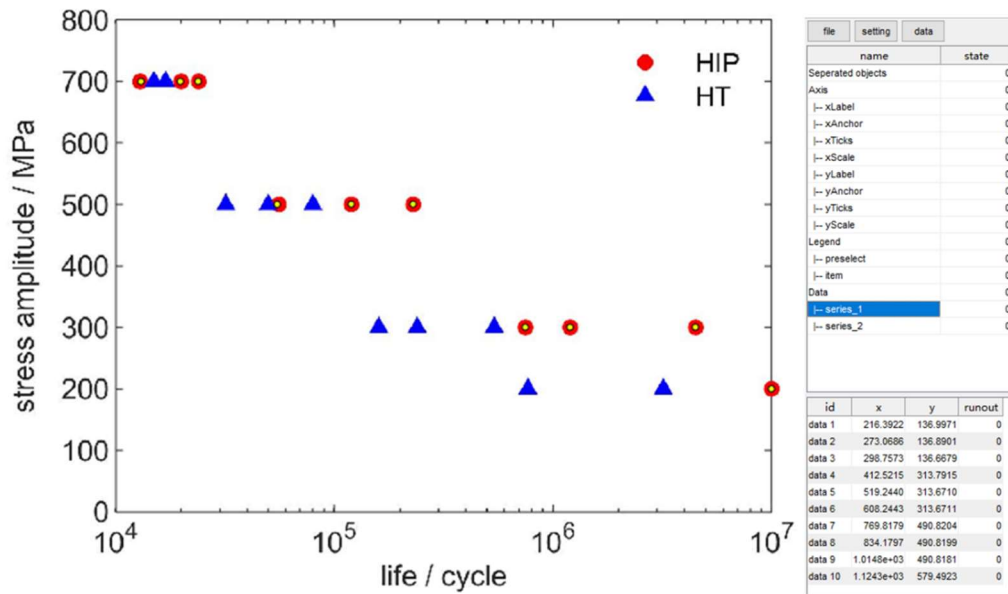


Figure 7. The result of symbol recognition.

When a data series is selected, the left mouse button is activated to select or add data points in the **main window** (Figure 8). When the mouse hovers over a data point, the cursor appears as a hand. Click the left mouse button at the time will select the data point and the marker of the data point will turn to a yellow cross. Once selected, the position of the data point can be adjusted by 'w', 's', 'a' and 'd' keys and deleted by the 'delete' key on the keyboard if the button **key on/off** is activated in blue. When the cursor appears as an arrow, clicking the left mouse button will add a data point to the data series.

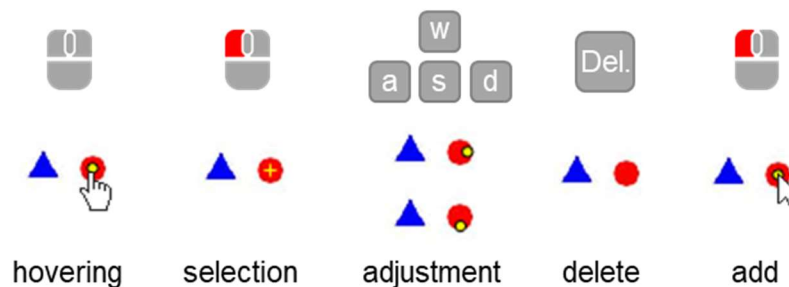


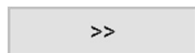
Figure 8. Interactions with the data points.

7. Save project: click the **save project** button and a dialog box will appear. Choose

the path and enter the filename for the project file, and save it as a MAT file (.mat). The project file records the information of axis and data in pixel coordinates for all images and can be transformed into data in physical units by post-processing. The project file can be loaded for subsequent analysis by using the **load project** button.

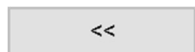
Tips: After importing images, legends can be selected at first. And then specify the autorun range and click the **autorun** button. The function of **separate object**, **detect axis**, **analyse legend** and **symbol recognition** will be executed sequentially for images in the autorun range.

3.3 Functions of buttons



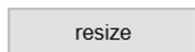
next image

Switch to the next image.



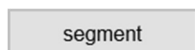
previous image

Switch to the previous image.



resize

Resize the image to fit the **main window**.



segment

The button is used to segment images with multiple panels. First clicking the button will trigger the **main window** to enter the mode of box selection and the button turn

blue **segment**. In the **main window**, box select the target regions using the left mouse button. Selecting multiple regions is allowed. Clicking the **segment** button again completes the procedure and those regions will be saved as images to a 'segmentation' folder created in the current path.

separate object

separate object

A copy of a binary image is created and those connected black pixels are detected as objects. As shown in Figure 9, detected objects are wrapped in boxes. The object data will be passed to the subsequent **detect axis**, **analyse legend**, and **symbol recognition** functions.

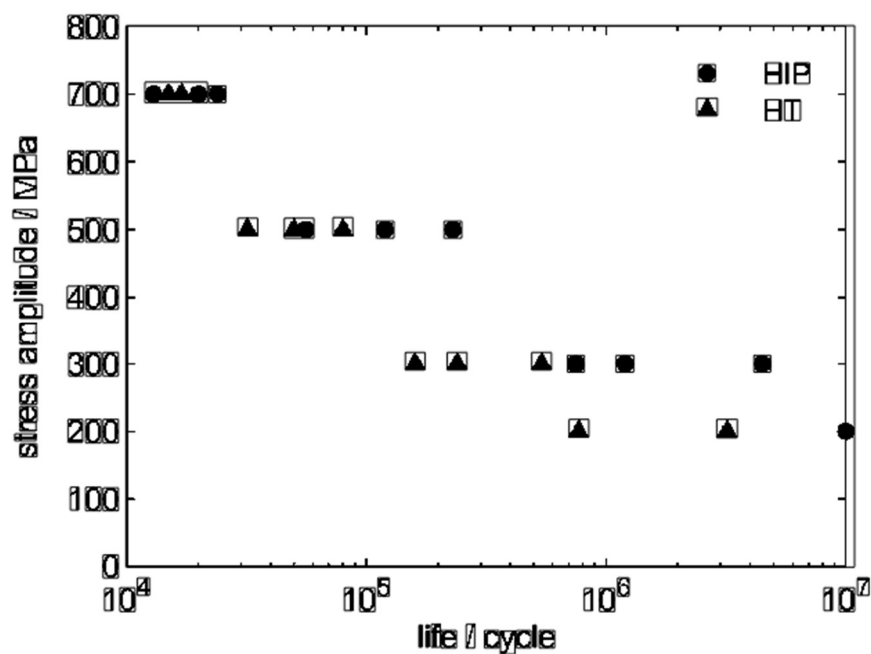


Figure 9. Result of 'separate object'. Each object is wrapped by a box.

detect axis

detect axis

The x and y-axis are detected. According to the position of objects passed from previous **separate object**, objects were grouped for ticks' labels and axis labels, and then

parsed by optical character recognition (OCR). Selecting the ‘xLabel’, ‘xTicks’, ‘yLabel’ and ‘yTicks’ in the **information upper panel**, the corresponding object will be highlighted by a box in the **main window** and data shown in the **information lower panel**, as shown in Figure 10 and Figure 11. The scale of axis (linear/log) is determined according to the position and value of ticks.

Axis anchors are selected as the ticks at the two ends of the axes. They stand for the position and the range of axes. Selecting the ‘xAnchor’ and ‘yAnchor’ in the **information upper panel**, the xAnchor and yAnchor will be denoted by circle and triangle markers in the **main window** respectively (Figure 12). The anchors corresponding to the small and large tick value are in blue and red color, respectively. Only the x position of xAnchor and the y position of yAnchor matter.

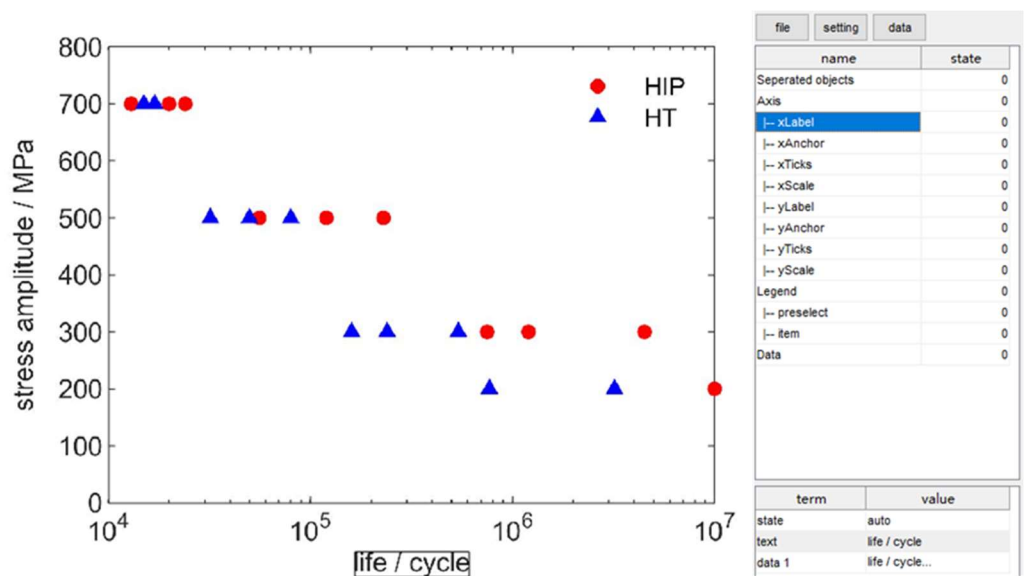


Figure 10. The result of parsing the label of x-axis.

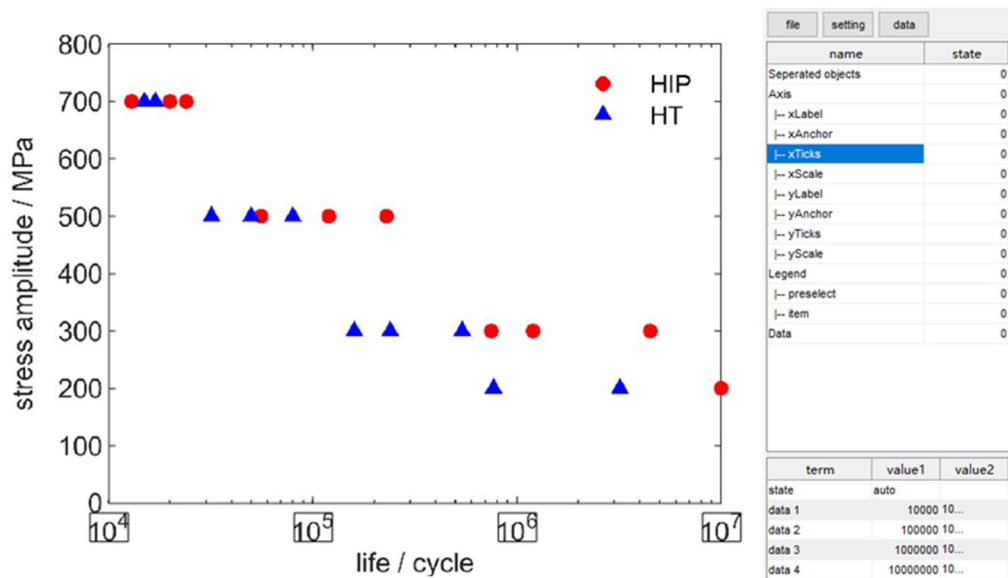


Figure 11. The result of parsing the tick labels of x-axis.

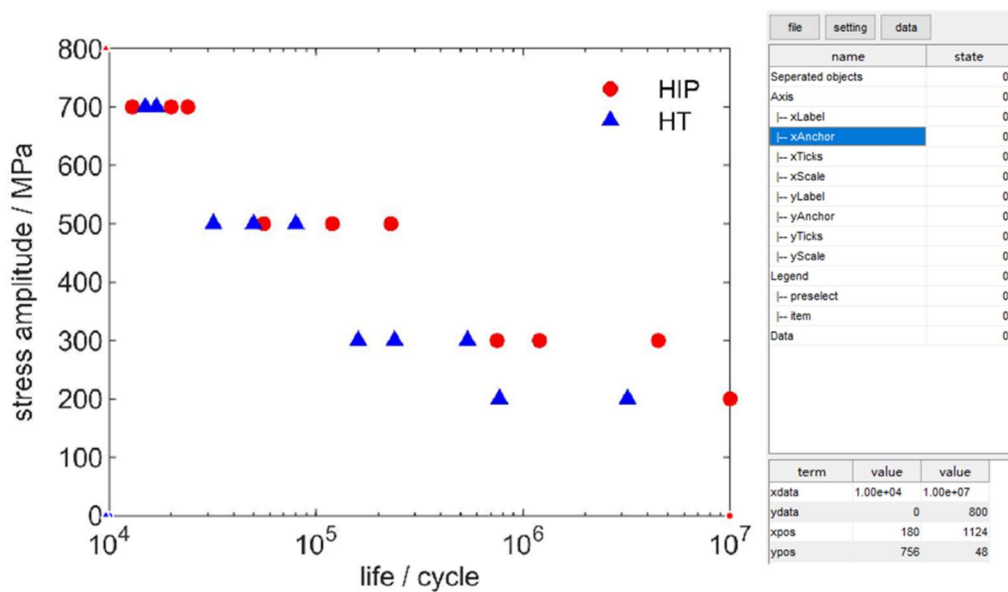


Figure 12. The result of anchors of x and y-axis.

legend select

legend select

First clicking the button will trigger the **main window** to enter the mode of box selection and the button turn blue **legend select**. In the **main window**, box select the target regions using the left mouse button. Selecting multiple regions is allowed. Clicking the **legend select** button again completes the procedure and the button turns

back to gray.

analyse legend

analyse legend

Before using the analyse legend button, legend select should be conducted in advance. Symbols and corresponding annotations are extracted in the selected legend region. It is assumed that symbols are placed in front of annotations and each line contains only one record of symbol and annotation. Therefore, for those legend with multiple columns, each column can be selected as a single legend region. After completing the analysis of legend, clicking ‘item’ in the information upper panel, the symbols and annotations will be highlighted by a box in the main window and annotation shown in the information lower panel (Figure 13). The symbols are stored as templates and passed to symbol recognition or color recognition function.

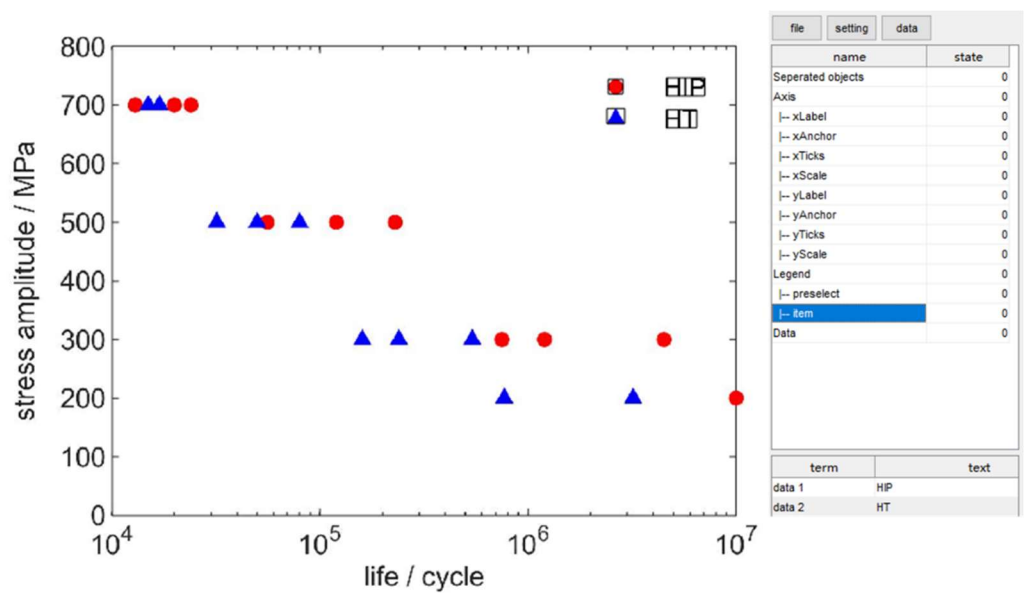


Figure 13. The result of analyse legend.

symbol recognition

symbol recognition

Using the templates of symbols from the analyse legend function, data points are extracted from the image using both shape and color. Click the data button at the top of

the **information panel** to refresh the page, and then click ‘series-*n*’ in the **information upper panel**. Data points will be highlighted by yellow circles in the **main window** (Figure 14). See **3.2 Quickstart** for the interaction with data points.

color recognition

color recognition

Using the templates of symbols from **analyse legend**, pixels are extracted from the image using color. The function is used where symbols are heavily overlapped and locating the symbol position is difficult, such as the fatigue crack growth rate (FCGR) figures. Clicking ‘series-*n*’ in the **information upper panel**, pixels will be highlighted by yellow in the **main window** (Figure 15).

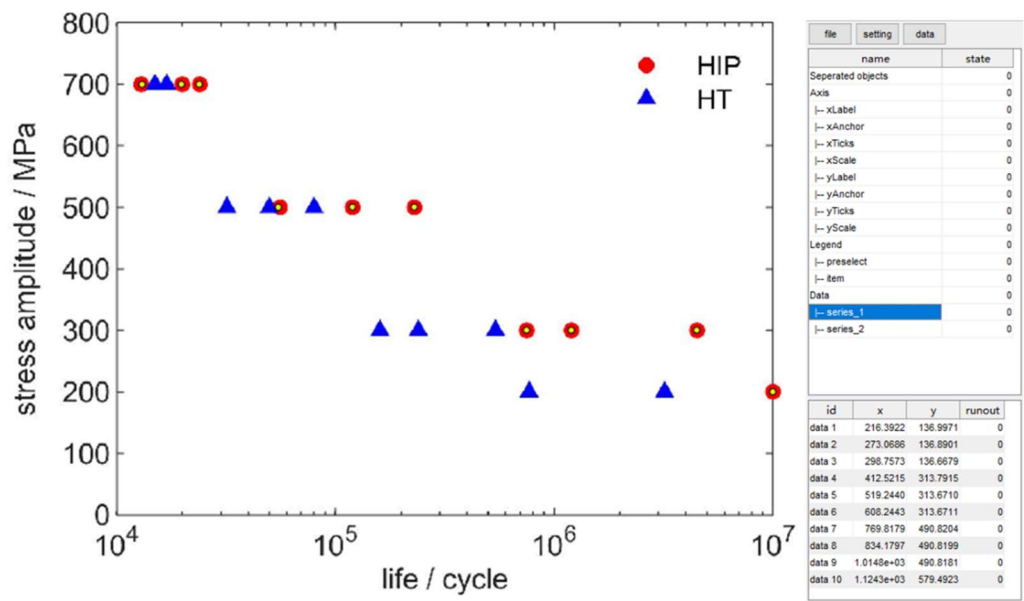


Figure 14. The result of **symbol recognition**.

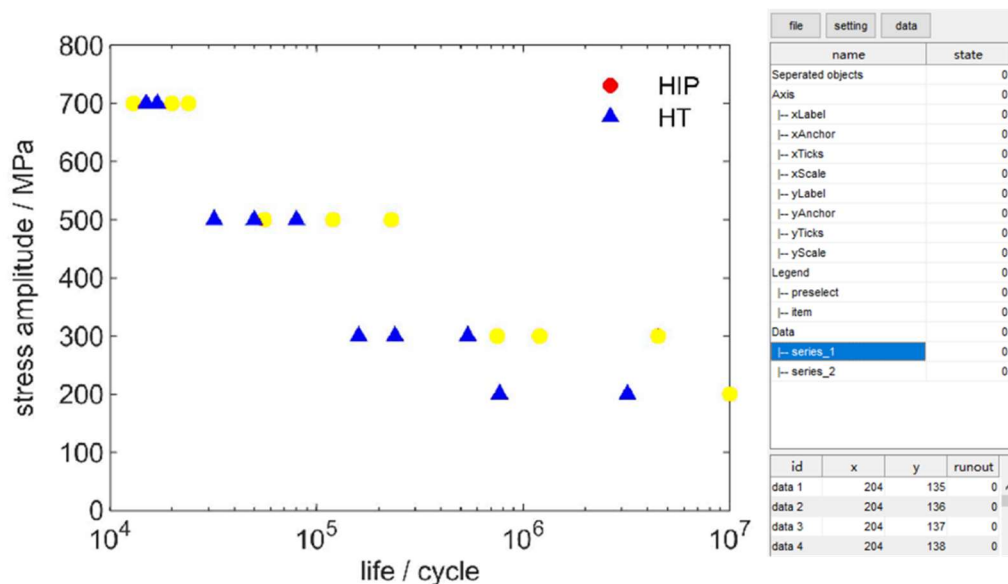


Figure 15. The result of color recognition.

load project

load project

Load a project file (MAT file) whose format is consistent to IMEX.

save project

save project

Save the data of current project to a MAT file.

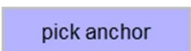
import image

import image

Import images under a folder.

pick anchor

pick anchor

Use to correct the position of axis anchor or place axis anchor manually. After clicking, the pick anchor button turns blue , and the main window enter the mode of anchor selection. Select 'xAnchor' or 'yAnchor' in the information upper

panel to display axis anchors. A specific anchor can be selected directly from the **main window** or clicking the corresponding table cells that displaying the value of ‘xpos’ and ‘ypos’ in the **information lower panel**. When an anchor is selected, clicking the left button in the **main window** will move the anchor to the position of the cursor. ‘w’, ‘s’, ‘a’ and ‘d’ keys can be used to adjust the position of anchors when the **key on/off** button is activated. The axis tick value of the anchor can be modified in the table cells of ‘xdata’ and ‘ydata’ in the **information lower panel**.

del legend box

delete legend box

After legend selection, clicking the ‘preselect’ in the **information upper panel** will display all the selected regions by boxes. Select a region by left clicking it and delete the region by **del legend box** button.

add data series

add data series

After clicking the **add data series** button, it will turn blue **add data series** and the **main window** enters the mode of symbol selection. Box select a symbol for the data series in the **main window** and click the **add data series** button again to complete the procedure. A new data series will display in the **information upper panel** and selecting it triggers the mode of manual data points addition or correction, whose operation is the same as **3.2 Quickstart**.

delete data series

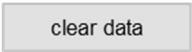
delete data series

Select a data series in the **information upper panel** and use the **delete data series** button to delete it.

A rectangular button with a gray background and the text "del data" in black.

delete data

Select a data point or box select a group of data points and use the [del data](#) button to delete them. When the [key on/off](#) button is activated, the 'Delete' or 'Del.' keys have the same function.

A rectangular button with a gray background and the text "clear data" in black.

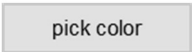
clear data

Data for all data series are deleted.


A rectangular button with a gray background and the text "autorun" in black.

autorun

After selecting the legend region for images and specifying the range of autorun in the [autorun](#) text box (format: ' $n - m$ '), the [autorun](#) button executes the functions of [separate object](#), [detect axis](#), [analyse legend](#) and [symbol recognition](#) sequentially for images in the range.

A rectangular button with a gray background and the text "pick color" in black.

pick color

Clicking the [pick color](#) button will turn it to blue  and trigger the mode of picking a color in the [main window](#). Clicking the left mouse button in the [main window](#) and the color of the pixel under the cursor is displayed in the [magnified panel](#). Clicking the [pick color](#) button again will turn off the color picking mode and the button turn back to gray.

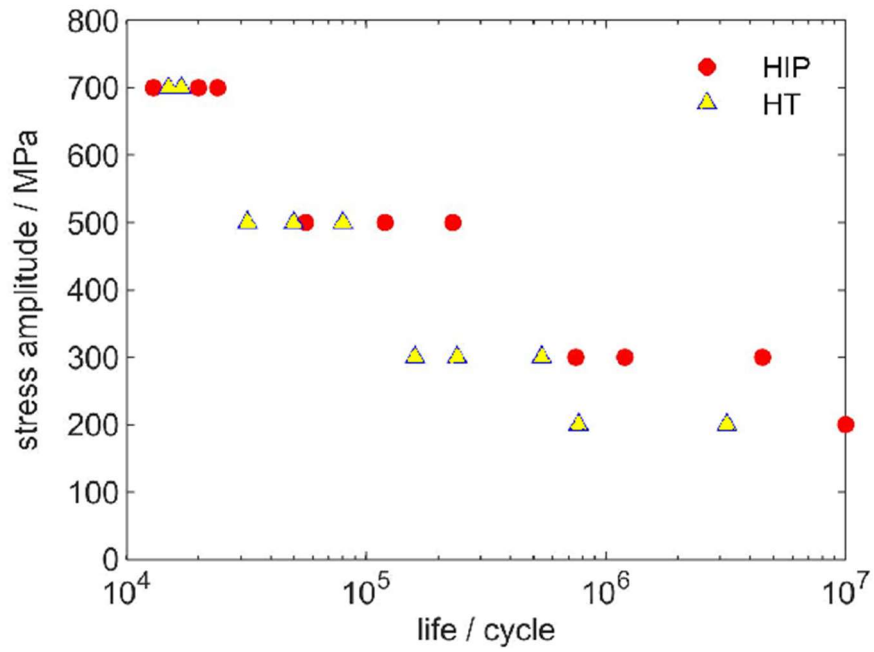


Figure 17. The result of **select color**. Blue pixels are selected.

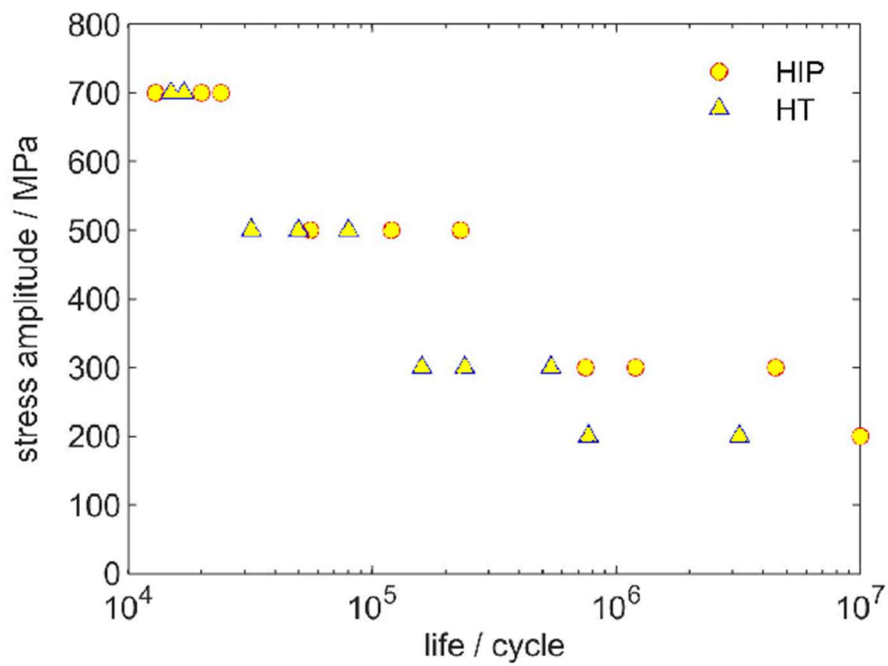


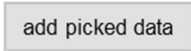
Figure 18. The result of **add color**. Red pixels are added to the selection in addition to blue pixels.

reset color

reset color


The pixels highlighted in yellow are restored to their original color by the **reset**

color button.

A rectangular button with a light gray background and a thin black border. The text "add picked data" is centered in a small, black, sans-serif font.

add picked data

When pixels are selected by [pick color](#), [select color](#) and [add color](#), choosing a data series in the [information upper panel](#) and using the [add picked data](#) button can add pixels data to the data series.

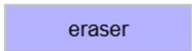
A rectangular button with a light gray background and a thin black border. The text "replace picked data" is centered in a small, black, sans-serif font.

replace picked data

When pixels are selected by [pick color](#), [select color](#) and [add color](#), choosing a data series in the [information upper panel](#) and using the [replace picked data](#) button can replace the original data by the newly picked pixel data.

A rectangular button with a light gray background and a thin black border. The text "eraser" is centered in a small, black, sans-serif font.

eraser

Clicking the [eraser](#) button turns it blue  and triggers the eraser mode in the [main window](#). The eraser is in the shape of a rhombus and clicking the left mouse button erases the data within the rhombus. The size of eraser can be specified in the [eraser size](#) text box, in the unit of pixel. Clicking the [eraser](#) button again turns off the eraser mode and the button turns gray.

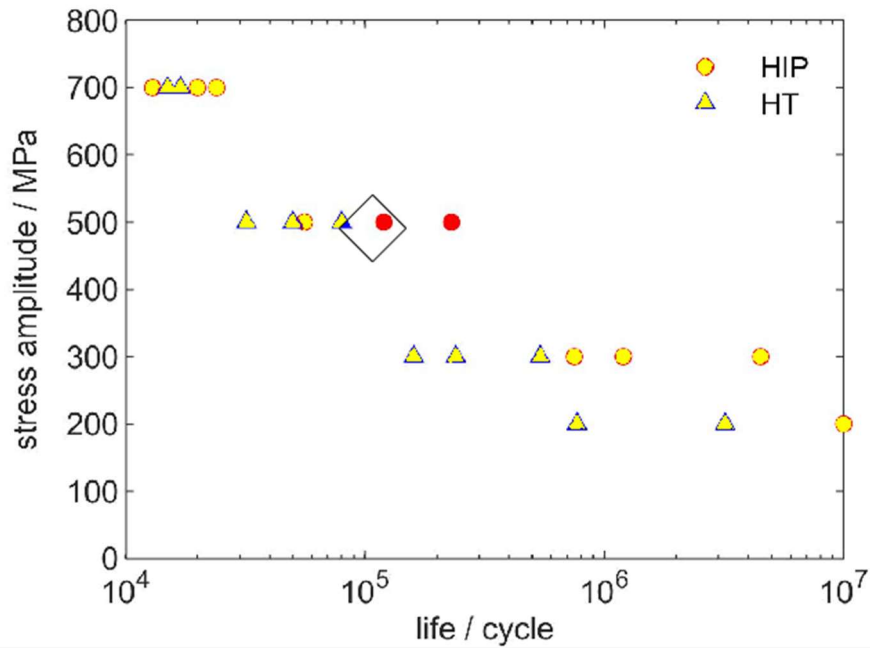


Figure 19. The result of **eraser**.

shape / color pick

shape / color pick

The button is used to switch the type of data extraction, using shape information and locating the position of symbols, or simply extracting pixels by color. It affects the how the data is displayed when selecting data series in the **information upper panel**. For those data recognized with shape information, each data point is represented by a yellow circle marker. For those pixels recognized only by color, the color of the pixels is directly turned yellow in the **main window**.

key on/off

key on / off

When the **key on / off** button is activated **key on/off**, the keyboard takes effect in interacting with the **main window**. Clicking the button again will turn off the interaction function of the keyboard, and only the input function is preserved.

4 Tips and plans:

The IMEX is under development and ERROR could occur in use. It could be better to save the data first by the [save project](#) button. And then close the IMEX and relaunch it. The saved data can be loaded by the [load project](#) button.

We will continue to improve the code and provide better user experience. A python version could be better since MATLAB is a charging software, limiting the usage.