NTNU Structural Dynamics Group

Tutorial of a Vision-Based Line-Tracking Technique

Tengjiao Jiang
NTNU, Trondheim, Norway

1. Introduction

Line-tracking technique is an image-processing technique and is designed for detecting and tracking a linear object, e.g., a railway catenary wire, from noisy backgrounds. The technique is based on a coarse subset and line search and a subpixel centerline detection. The principles are described in detail in the following article [1]. Displacement response of the linear object can be obtained.

Citation

Please cite the following article and code if used in research.

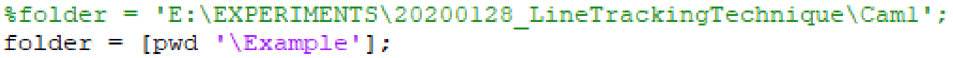
[1] Tengjiao Jiang, Gunnstein Thomas Frøseth, Anders Rønnquist, Egil Fagerholt. A Robust Line-Tracking Photogrammetry Method for Uplift Measurements of Railway Catenary Systems in Noisy Backgrounds, Mechanical Systems and Signal Processing. 144 (2020) 106888. https://doi.org/10.1016/j.ymssp.2020.106888.

[2] Tengjiao Jiang, Gunnstein Thomas Frøseth, Anders Rønnquist, Egil Fagerholt. A vision-based line-tracking technique, Zenodo, 2020, version 1.1. http://doi.org/10.5281/zenodo.3685219.

2. Instructions for use

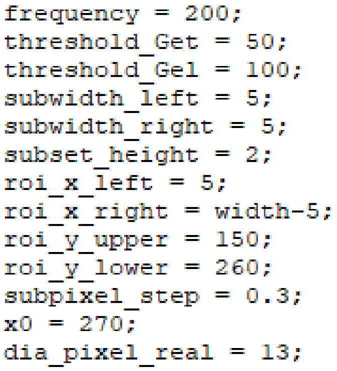
There are three steps for using the MATLAB code "Line_Tracking_Technique_1_1.m":

a) Input the folder location of images.



```
%folder = 'E:\EXPERIMENTS\20200128_LineTrackingTechnique\Cam1';
folder = [pwd '\Example'];
```

b) Input parameters for line tracking, and variable descriptions show in Table 1.



```
frequency = 200;
threshold_Get = 50;
threshold_Gel = 100;
subwidth_left = 5;
subwidth_right = 5;
subset_height = 2;
roi_x_left = 5;
roi_x_right = width-5;
roi_y_upper = 150;
roi_y_lower = 260;
subpixel_step = 0.3;
x0 = 270;
dia_pixel_real = 13;
```

c) Run MATLAB code.

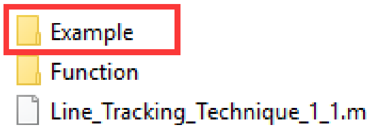
Note that the format of image filenames must be uniform and in numerical order and placed in a separate folder, and the filename length must be the same, as shown in the “Example” folder.

Table 1. Input parameters

Variables	Description
frequency	Camera sampling frequency (Hz)
threshold_Get	The grayscale intensity threshold for the coarse subset search Get. For 8-bit gray image, intensity is [0,255].
threshold_Gel	The grayscale intensity threshold for the coarse line search Gel. Usually, Gel >= Get
subwidth_left	The left subset width in the coarse search
subwidth_right	The left subset width in the coarse search
subset_height	The height of the subset for both coarse search and subpixel centreline detection
ROI	Region of interest, user-defined search rectangle area in the image.
roi_x_left	roi_x_left is the minimum x of the rectangle area, such as roi_x_left = 1.
roi_x_right	roi_x_right is the maximum x of the rectangle area, such as roi_x_right = width.
roi_y_upper	roi_y_upper is the minimum y of the rectangle area, such as roi_y_upper = 1.
roi_y_lower	roi_y_lower is the maximum y of the rectangle area, such as roi_y_lower = height.
subpixel_step	Vertical step of the subpixel interpolation in the subpixel centerline detection.
x0	User-defined x coordinate of the tracking point in pixels.
dia_pixel_real	The real diameter of the wire in pixels.

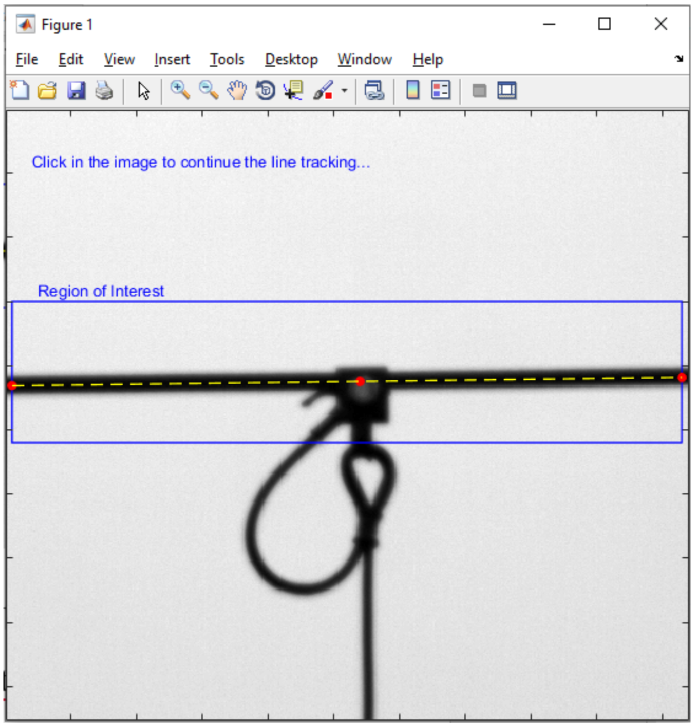
3. Example

There is an example that the user can try, and all variables in the code "Line_Tracking_Technique_1_1.m" have been set well.



Example
Function
Line_Tracking_Technique_1_1.m

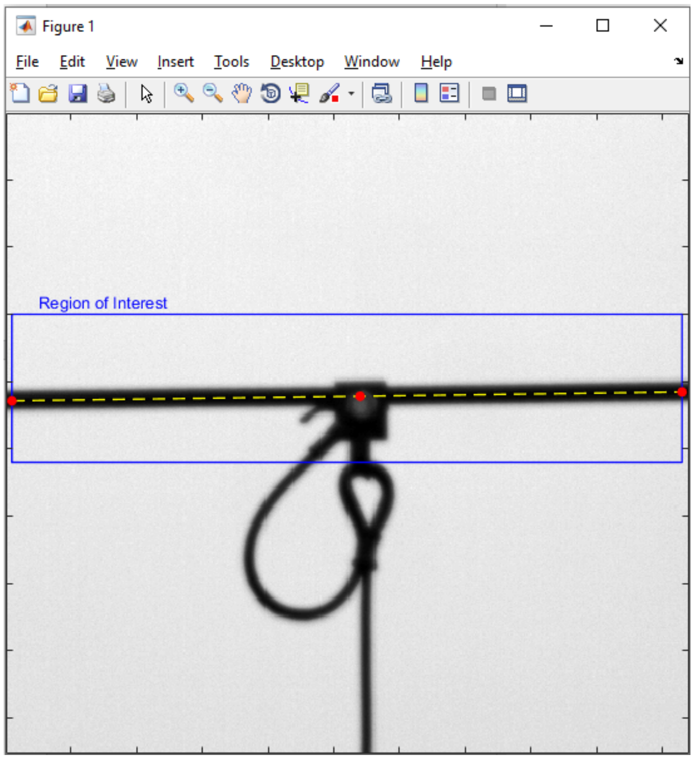
First, run the MATLAB code "Line_Tracking_Technique_1_1.m". Then, there will be a window to confirm if the region of interest and detected linear object is correct, as shown below:



Click in the image to continue the line tracking...

The blue rectangle is a searching region (region of interest), and both left and right sides are search columns for the coarse subset search and subpixel centerline detection. The yellow dash line is the detected centerline of the linear object. The red points on both sides are candidate endpoints, and the red center point is the user-defined tracking point.

Next, click in the image to continue the line tracking, as shown below:



After processing all images in the "Example" folder, the vertical displacement data can be obtained and plotted.

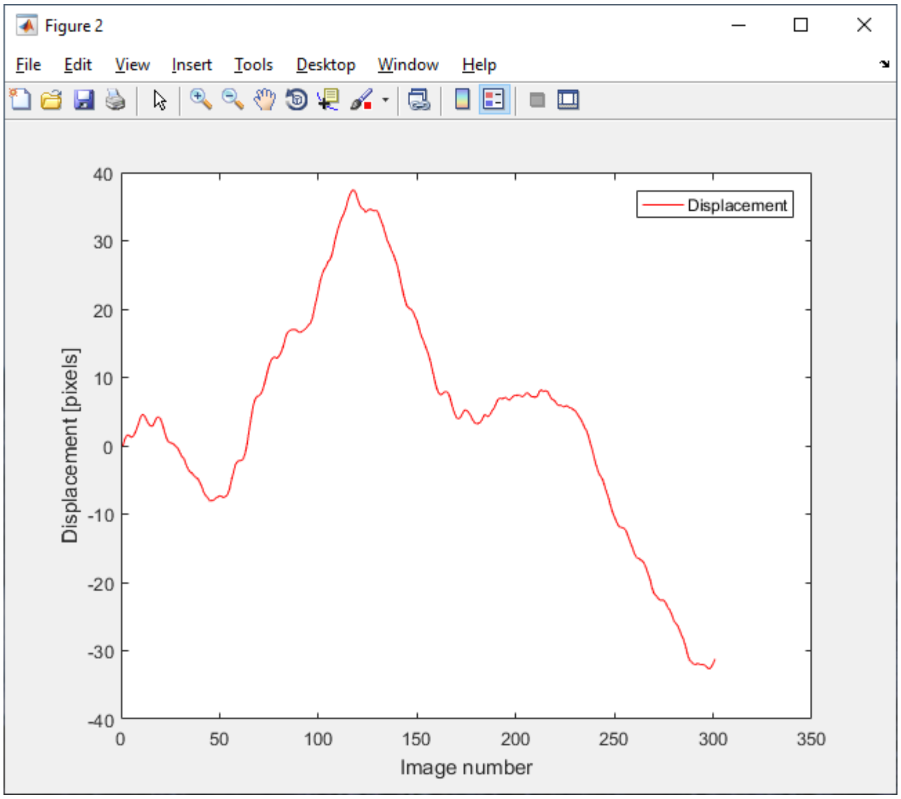


Figure 2
File Edit View Insert Tools Desktop Window Help
Displacement
Displacement [pixels]
Image number