Readme: zloss.m

Introduction

Using information contained in a PiCUS® sonic tomogram (Argus Electronic GmBH, Rostock, Germany), the MATLAB function *zloss* computes the percent decrease to the section modulus, Z_{LOSS} (%), for estimating the load-bearing capacity of standing trees with internal damage (Burcham et al. 2019). The function uses image segmentation and numerical integration to compute estimates, and the code is commented extensively to explain the steps involved in the analysis. To execute, the program requires two image files and accepts several optional inputs (the MATLAB image processing and mapping toolboxes are required to execute the function). The function uses a tomogram showing the visualized decay pattern (Figure *1*A) and a geometry image showing the corresponding blue trunk boundary line (Figure *1*B). The images should be oriented identically and exported without annotation from the PiCUS software. For optimal results, the images should be the same size and sufficiently large. In the PiCUS Q74 software, the size of exported images can be adjusted by changing the size of the window in which the tomogram is displayed.

The optional inputs for *zloss* indicate the colors used in the analysis and physical extent of pixels in the images. First, the user may specify whether to compute a conservative or liberal Z_{LOSS} estimate by including (Figure 2A) or excluding (Figure 2B) green, respectively, when determining the extent of hollow parts. The 'colors' option can be specified as a name-value pair with either 'GVB' or 'VB' indicating a conservative or liberal Z_{LOSS} estimate, respectively. The default color setting, 'GVB,' will be used if the user does not provide a color input. Second, the user may specify the physical extent of pixels in the horizontal and vertical directions for both the tomogram and geometry image. Using the pixel indices of various tick marks on the x- and y-axis, this can be computed for each image as the actual length (any units) divided by the number of pixels (*n*) spanning the length in the image, and the corresponding number represents the physical extent of each pixel (e.g., meters per pixel). The default setting (1) will be used if the user does not provide the corresponding inputs.

The results will be displayed using a color map projected onto a circular annulus. The Z_{LOSS} values corresponding to various directions of loading can be referenced using the color bar.

Interpretation

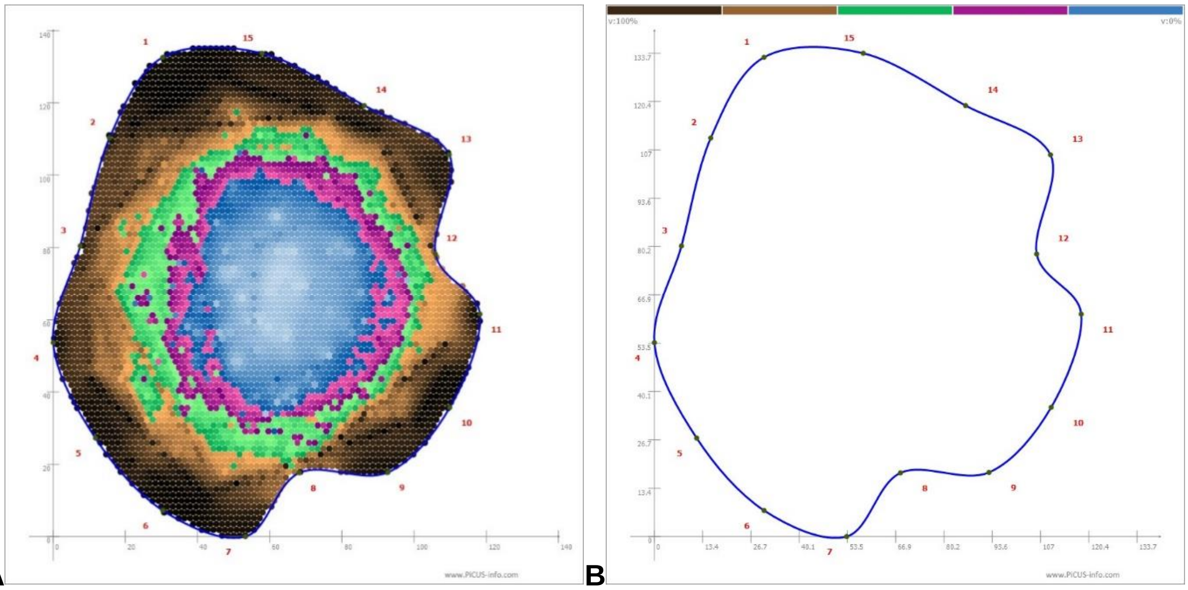
The estimates can be used to inform the likelihood of failure by material fracture for a tree part in bending (*not* buckling). The percent decrease in the section modulus is determined with respect to a solid tree with the same shape, and the values correspond to the percent increase in local stress, for a given bending moment, caused by the defect.

Limitations

The function will not execute if any of the red number labels associated with measuring points overlay the blue trunk geometry line. If these are present in a tomogram, they should be removed with an image editing software before analysis.

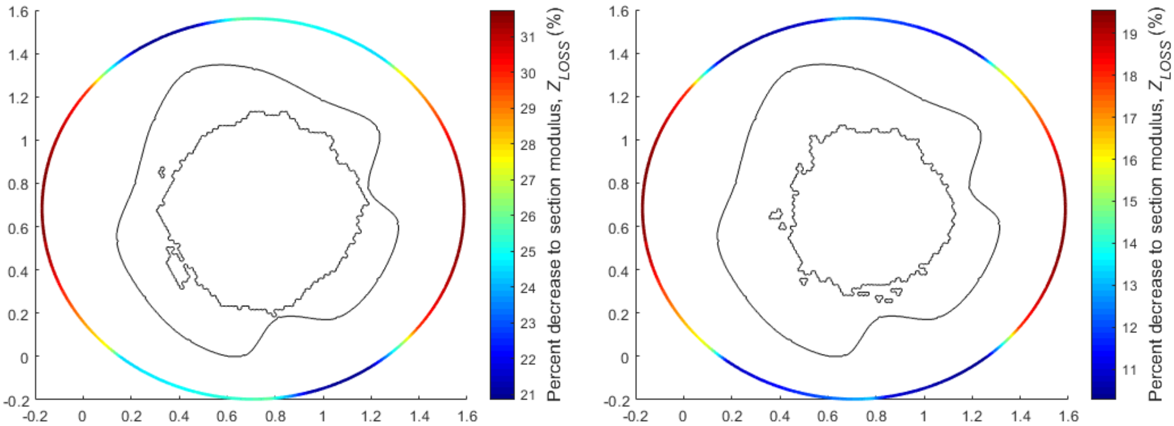
Literature cited

Burcham DC, Brazee NJ, Marra RE, Kane B (2019) Can sonic tomography predict loss in load-bearing capacity for trees with internal defects? A comparison of sonic tomograms with destructive measurements. Trees 33:681–695. https://doi.org/10.1007/s00468-018-01808-z



A B

Figure 1: Two images are used for analysis, including a sonic tomogram showing the visualized decay pattern (A) and a geometry file showing the blue trunk boundary line (B).



A B

Figure 2: The estimates are displayed using a red, green, and blue color scale showing directional Z_{LOSS} between the minimum and maximum values for a cross section. For this case, the measurements were computed by including (A) and excluding (B) green when determining the extent of hollow parts.