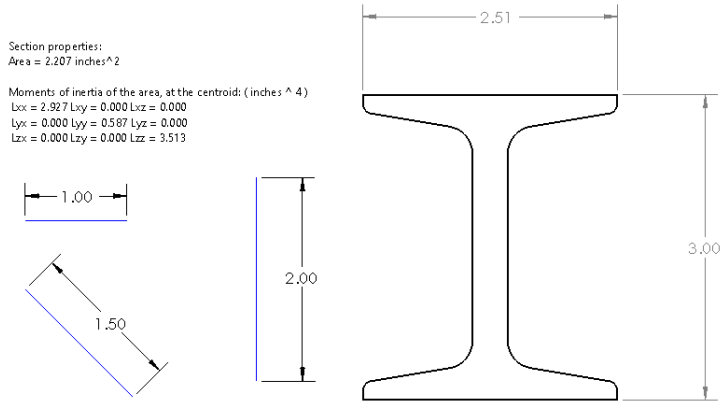
Area Moment of Inertia Calculator

To begin a structural analysis project, you must figure out the stiffnesses of some legacy beams. You have images of beam cross sections with scale bars saved in common formats (.jpg, .bmp, .png) and need to efficiently calculate area moments of inertia and other section properties.



1 WORKFLOW

- Import the image file into the MATLAB workspace
- Select a region of the image that contains your cross-section shape
  - Crop the image so that only the Region of Interest (ROI) containing the shape is shown
- Use mouse input to define the perimeter of the beam shape
- Use mouse input to select a scale bar length
- Input the length of the scale bar (**we will use inches, inches^2, and inches^4 for units**)
- Output is a *structure array* containing section data

1.1 INPUT

The file takes an optional input which is the name of an image file (a string). If no input is given, a graphical user interface input box asks the user to select a file.

1.2 OUTPUT

The program should display an image of the shape defined by the perimeter tracing step, and should display the centroid on the image for visual confirmation.

The output variable is a MATLAB struct with the following information:

- area - area of traced region (in^2)
- width - width of traced region (in)
- height - height of traced region (in)

- Ixx - Area MOI about x-centroidal axis (in^4)
- Iyy - Area MOI about y-centroidal axis (in^4)
- Ixy - XY product of intertia (in^4)
- I1 - 1st Principal Moment (in^4)
- I2 - 2nd Principal Moment (in^4)
- angle - angle between 1st principal axis and y-axis (degrees)
- mask – a binary file with ones showing the solid cross-section and zeros in empty space

2 HINTS

Use the MATLAB documentation to find information and examples. There is also excellent information and examples in online forums – use google!

A few things to get you started:

Search Matlab documentation for the following:

- structure array
- nargin – this is a way to have optional inputs

Note: the following functions require the image processing toolbox. It should be available in MATLAB online, or you can install it for free to your student installation.

- imrect – draw a rectangle on an image
  - use getPosition to get rectangle coordinates
- impoly
  - createMask
- imread, imshow
- ginput

At some point you will need to convert coordinates from pixels to inches. It is up to you when you want to convert, but you may find it easiest to work with pixel values for most calculations and then convert to units of length, area, and area MOI toward the end.

Compare your results to the values given in the test images. These were calculated using the SOLIDWORKS *Section Properties* tool.

2.1 TEAMWORK

There are several different sections to this small project: file input, mouse input, calculations. You could break this up into several functions (in separate files) each assigned to a team member. All team members are expected to participate. If a team member is not communicating and not contributing, I want to hear about it early so that I can give that team member an individual assignment rather than a zero for not participating.

Every team should work independently of each other – no sharing code.

3 STARTER CODE

```
function [SectionData] = tracePic(fName)
%TRACEPIC - traces image to get section properties
% SectionData = tracePic (fName)
%
% INPUT
%   fName - the name of an image file (should be a string)
%           if empty, file is selected using graphic user interface
%
% OUTPUT is a struct with the following section Data
%   area - area of traced region
%   width - width of traced region
%   height - height of traced region
%   Ixx - Area MOI about x-centroidal axis
%   Iyy - Area MOI about y-centroidal axis
%   Ixy - XY product of intertia
%   I1 - 1st Principal Moment
%   I2 - 2nd Principal Moment
%   angle - angle between 1st principal axis and y-axis
%   mask - a binary file with ones showing the solid cross-section
%          and zeros in empty space

% 2020 MEMS 201 final project.
% Team members:
% member1, member2, member3, ...

if nargin == 0
      % get an image file using uigetfile
end


% CROP IMAGE USING RECTANGLE

% TRACE PERIMITER USING POLYGON

% GET LENGTH SCALE FROM SCALEBAR OR DIMENSION

% CALCULATE SECTION PROPERTIES

% SHOW RESULTS

% OUTPUT TO STRUCTURE ARRAY
SectionData.mask = ;
SectionData.height = ;
SectionData.width = ;
SectionData.area = ;
SectionData.Ixx = ;
SectionData.Iyy = ;
SectionData.Ixy = ;
SectionData.I1 = ;
SectionData.I2 = ;
SectionData.angle = ;

end
```