

Geometric Operations

This exercise is intended to expose you to some basic geometric operations.

Exercises

1. Write a **function** that will implement an affine transform with the following specifications:
 - The input arguments should be a 2x2 matrix, a 2x1 vector, and the input image. The matrix and vector should describe a mapping from the input image to the output. You will need to figure out how to invert the mapping within the function so that it uses backward mapping.
 - The function should do nearest-neighbor interpolation.
 - The center of both the input and output images should be treated as the origin.
 - **The first coordinate should be the row coordinate and the second the column coordinate.**
 - The output image should be sized relative to the input image size to accommodate the entire input image without cutting anything off but should not be any larger than necessary. Explain how you handle the situation in which the output image value is defined by a value outside of the input image.
 - **Do not use built-in MATLAB geometric transformation or interpolation functions.**

(Although you are not required to implement it this way, you should know that this function can be implemented entirely without loops.)
2. Read in the images `books1.jpg` and `books2.jpg`. Note that these images are full color and are represented as 3D arrays. What happens when the input matrix is $\begin{bmatrix} 0.5 & 0.5 \\ 0.5 & -1.5 \end{bmatrix}$ and the input vector is $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$ and `books1` is transformed? Explain.
3. Using the function `ginput`, collect 10 matching coordinate pairs from each image. Using the method described in class, calculate the least-squares solution for the affine parameters to determine the best mapping from `book1` to `book2`. (Note that you will need to adjust the coordinates from `ginput`, since it returns ordinary array coordinates and not the coordinates assumed by your affine transform above.)
4. Apply the affine transform you derived to `book1`, and compare the result to `book2`.

Write a report that summarizes your findings. (You may use two pages if absolutely necessary, but one page is best. Images can be small.) Include at least one image or image comparison and one code snippet. If the project specifically asks that an image or code snippet be created, then you must include that. The memo should be written so that it makes sense without reference to the project instructions. Please number/letter your paragraphs corresponding to the project instructions.

Submit a PDF of your project memo on Canvas by class time on the due date.

NOTE: All out-of-class work is to be done **independently** and should represent your work alone. Sharing of programming tips and discussing general concepts is ok. Collaborating on experiments or code-writing is not. **Any** such collaboration on these assignments will be considered an act of dishonesty and will be treated accordingly. Memos may be checked using Turnitin (TM) for excessive similarity to one another and to documents available online.

For further help:

- Matlab Primer
- Matlab Documentation