**Parametric Affine Transformation**

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We present a 2D affine transformation, which is composed of transformations of scaling, shear, rotation, and translation. The affine transformation consists of the following four elementary transformations.

**□ Elementary transformation** , , ,

|  |  |  |
| --- | --- | --- |
| Transformation | Parameter | Matrix |
| Scaling | , |  |
| Shear | , |  |
| Rotation |  |  |
| Translation | , |  |

**□ Composite transformation**

Based on the above elementary transformations, we build a transformation :

If a point exists, we can get a transformed point .

Because we hope the rotation, shear and scaling can be done at an arbitrary point (e.g. the center point of given points), we use the following *translation-offset* applied elementary transformation:

where is an elementary transformation, and is a matrix representing the translation-offset.

If we want to use the center point of all the given points, then is given as

where , , and , are x, y value of th point, respectively.

**□ Reference**

http://www.cs.brandeis.edu/~cs155/Lecture\_06.pdf

https://people.cs.clemson.edu/~dhouse/courses/401/notes/affines-matrices.pdf