1. What does SVD do, and how about PCA, also Fourier transforms?

Answer:

*For SVD, it can decompose a matrix into two orthogonal matrices and one diagonal matrix. SVD is very useful when doing dimension compressing since we can drop up some small eigenvalues in the diagonal matrix without losing too much information. And this is what PCA are doing, which applies SVD on the data covariance matrix. For Fourier transform, it transforms the time-domain signal to the frequency-domain signal by considering the signal as the summation of sinusoidal functions. In this case, we can do meaningful things like filtering signal with low-pass filter or high-pass filter to process like images.*

1. What is quaternion, and its advantage and disadvantage compared to rotation matrix and euler angle. What is rigid transforms, and what is affine transform?

Answer:

*Quaternion is composed of two part, one is the scalar w, and another is the vector v. For v, it is represented by three imagine number. For advantage, quaternion can prevent Gimbal lock since 4-dimension parameter can ensure that each rotation is shown uniquely, while the euler angle might leads to same result for different angles. The disadvantage is that the computation is relatively complexed like multiplication and exponential. Rigid transform is the normal projection by homogeneous vector. Affine transform did not preserve the relative distance and angle between points. But will confirm that parallel lines are still parallel after transformation.*