

In Ghost Imaging (GI) we illuminate the object with many non-uniform light patterns, which we call references (each light pattern is different from the others). By correlating the references, and the total intensities detected after the object, which are called tests, we can reconstruct the object's image.

A simple simulation of this process is as following:

1. Create a 2D matrix that represents the object. Let's say that the dimensions of the object are (100X200) pixels. We will note this as 'obj'.
2. Create a 3D matrix that represent the different light patterns. For example, a set of 2D random matrices. The dimensions are (100X200XN where N is the number of realizations i.e. light patterns). This will be noted as 'ref'.
3. Create the tests; multiply each 2D light pattern by the obj matrix and sum to get the total transmitted intensity. You should get a vector with the length of N.
4. A simple reconstruction can be achieved by calculating the covariance:

$$rec = cov(ref, test) = \langle ref * test \rangle - \langle ref \rangle * \langle test \rangle$$

where  $\langle X \rangle$  denotes the mean value of X.

I suggest that for start you should write a simple simulation as see how the following parameters affect the reconstruction (maybe make a graph with the Signal-to-noise ratio as function of the parameters):

- a. The number of realizations (N)
- b. The dimensions of the object
- c. The size of the noise features in ref (this can be a little bit tricky, talk to me if there are any problems)

Later, I suggest that you try to introduce noise to the simulation and see what happens.

Good luck.