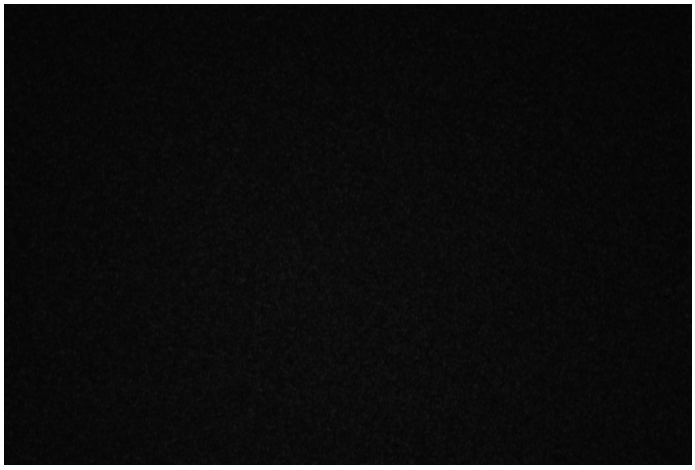
Encryption Problem

PROBLEM

An encrypted image is provided, with some information encrypted in it. A pattern/ sample was subjected to laser light, and as a response to this light, a pattern was created which was then recorded by a camera. This process is called optical encryption

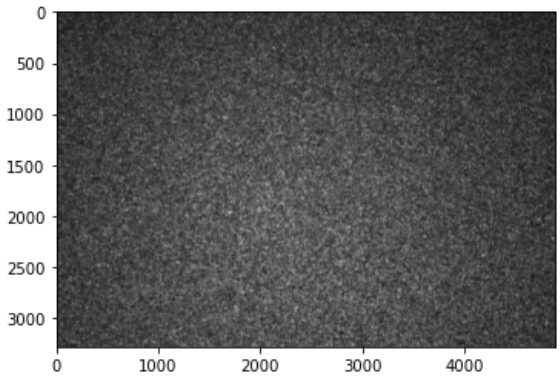


The goal is to extract some meaningful information from this image.

APPROACH USED:

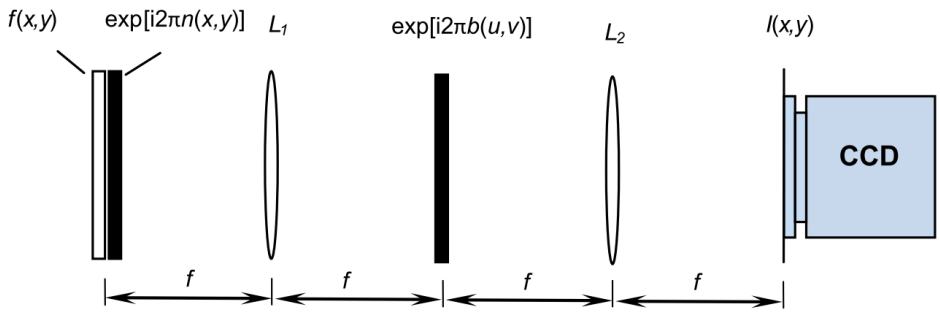
The code is given in the Submit.ipynb

The first step is to enhance the signal to noise ratio. Since the image consists of a laser light shone onto the pattern, a Gaussian filter is used to filter the image.



The Gaussian beam profile created by the laser is somewhat visible now.

Amongst different approaches for solving this problem, I found the one proposed in "Single-intensity-recording optical encryption technique based on phase retrieval algorithm and QR code " (http://dx.doi.org/10.1016/j.optcom.2014.06.070), most appropriate.



This **Phase retrieval algorithm** uses the information from the intensity distribution I(x,y) on the camera to find the phase distribution, best representing the real data.

The decryption processes is an iterative process, which requires an initial estimate of the original image. The choice this estimate was challenging for me. Due to lack of a better idea here, I chose to go with the Fourier transform of the filtered image, but I believe a better choice would significantly impact the final result.
As given in the above work, the intensity distribution (in the k-th iteration) on the camera is described as:

$$g_k(x,y) = FT^{-1}\{FT\{f_k(x,y)\exp[i2\pi n(x,y)]\} \times \exp[i2\pi b(u,v)]\}$$

The phase component is preserved but the amplitude is changed corresponding to the output image, which is called as cipher text.

$$g_{mk}(x,y) = [I(x,y)]^{1/2} \times [g_k(x,y)/|g_k(x,y)|]$$

The inverse process of the encryption of modified light distribution and distribution function on the input plane.

$$f_{gk}(x,y) = FT^{-1}\{FT[g_{mk}(x,y)] \times \exp[-i2\pi b(u,v)]\} \times \exp[-i2\pi n(x,y)]$$

Changing f_{gk} and f_{k+1} iteratively until the figure of merit, i.e., correlation coefficient attains a threshold value . Higher number of iterations would be needed for convergence of the correlation coefficient.