To simulate the captured image of a camera, noise is added to the recorded interferogram. Noise in a camera image is the aggregate spatial and temporal variation in the measured signal, assuming constant, uniform illumination. There are several components of noise which are photon shot noise, read noise, and dark noise. Photon shot noise is the statistical noise associated with the randomness of emission of photons at the pixel. Due to this random emission, photon measurement obeys Poisson distribution. This noise is dependent on the signal level measured and is independent of sensor temperature. Read noise is the uncertainty in measuring the detected signal in a camera, determined by the speed of readout and quality of electronic design. It is independent of signal level but is dependent on the temperature of the sensor. However, read noise is only significant in low light imaging. Dark noise is caused by the appearance of the dark current that flows even though no photons are incident on camera. It is thermal noise that builds up during the duration of an exposure caused by electrons spontaneously generated within the silicon chip. Like the read noise, dark noise is also independent of signal level but is dependent on the temperature of the sensor. Therefore, when a cooled camera is chosen to capture the images, this significantly reduces these two types of noise. The camera used is a 14-bit cooled CCD camera (BITRAN BU-42-14) [16]. Hence, the photon shot noise becomes the dominant one in terms of these three types of noise, and it is added to the recorded interferogram.

Not all the photons arriving at the pixels generate a signal level, but only a portion is converted to a signal level. This portion is the number of photons generating electrons or photoelectrons. The relation between the number of photons, p, hitting the pixels and the generated electrons, $e-$, is called quantum efficiency (Q.E). From the datasheet of the chosen camera, the absolute Q.E for the red wavelength is approximately 0.35

$$e^{-} = Q.E \times p. \tag{12}$$

As mentioned, the arriving photons follow the Poisson distribution, and the photoelectrons also follow the same distribution based on the equation above. The formula to compute the necessary number of generated electrons stored in each pixel from a recorded interferogram $I(\Delta x, \Delta y, \Delta z)$ is

$$e^{-}(\Delta x, \Delta y, \Delta z) = \frac{I(\Delta x, \Delta y, \Delta z) \times F_w}{R} \tag{13}$$

where R is the possible grayscale level values derived from the bit depth of the camera, and F_w is full well capacity defining the number of photoelectrons an individual pixel can hold before saturating which means the signal level reaches the maximum grayscale level. The larger the bit depth is, the larger the value of the full well capacity is since the increasing of the maximum grayscale level allows more photoelectrons that can be stored in a pixel. After the necessary number of photoelectrons at each pixel is computed, this number is considered as a mean value to generate a random number of photoelectrons, e^{-}_{noise}, following the Poisson distribution to simulate the shot noise. Then, the noisy recorded interferogram is computed by using the equation below which is based on Eq. (13)

$$I_{noise}(\Delta x, \Delta y, \Delta z) = \frac{e^{-}_{noise}(\Delta x, \Delta y, \Delta z) \times R}{F_w} = \frac{Pois(e^{-}(\Delta x, \Delta y, \Delta z)) \times R}{F_w} \tag{14}$$

where $Pois(\cdot)$ represents the generation of a random number following the Poisson distribution. Based on the chosen camera, the bit depth is 14, which yields 16383 grayscale levels. The full well capacity is not specified in the datasheet, so it is chosen in such a way that the Signal to Noise Ratio (SNR) is about 18 dB, its value is set to be 500000 e-/gray. In addition, a small noise following a normal distribution accounting for the noise in experiment is added to the noisy image $I_{noise}(\Delta x, \Delta y, \Delta z)$. The function used for computing the SNR is shown below

$$SNR = 10\log_{10}\left[\frac{\mu_{I(\Delta x,\Delta y,\Delta z)}}{\sigma_{noise}}\right] \quad (15)$$

where $\mu_{I_{noise}}$ represents the expected value of the ideal recorded interferogram, σ_{noise} is the variance of the noise added to the ideal recorded interferogram.