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Implementation of High Dynamic Range(HDR) System

1. Camera Radiometric Calibration

   This process is performed to obtain the raw image by reverse engineering the gamma correction. The g values are estimated for each of the channels (R,G, B) respectively. Following steps were taken to calculate the g values of each channel

   - Multiple images of a white sheet of paper were taken under uniform radiance. The images were taken at exposure times varying from $5 * 10^{-5}$ sec to $5 * 10^{-3}$ sec. The images are stored in the calibImages folder. They have been named from 0 to 13 indicating increasing exposure time.
   - The next step is to crop the central part of the image and use this part for the further analysis.
   - It is assumed that $B'=f(B)=B^{1/g}$. On taking logarithm we obtain

     $$\log(B'(T)) = \log(K*T_{1/g}) = \log(K) + (1/g)\log(T).$$

     We regress this in order to obtain the values for each color channels R,G and B respectively.
   - The code is present in the RadiometryCalibration.ipynb and results are shown in following pages-

   - The g values are listed below
     - g(R- channel) = 1.795
     - g(G- channel) = 1.857
     - g(B- channel) = 1.697

DELIVERABLES

- PICTURE STACK

(1)(.0005 sec)

(2)(0.00067 sec)

(3)(0.001 sec)

(4)(0.00133 sec)

(5)(0.002 sec)

(6)(0.002857 sec)

(7)(0.004 sec)

(8)(0.00556 sec)

(9)(0.008 sec)

(10)(0.011 sec)

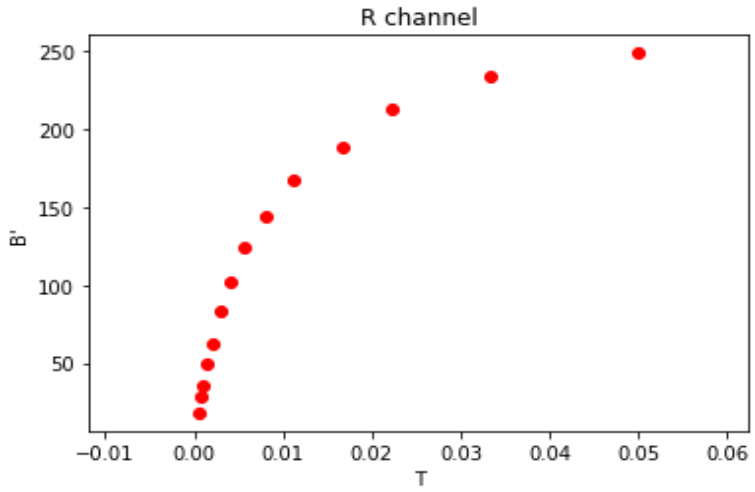
(11)(0.0167 sec)

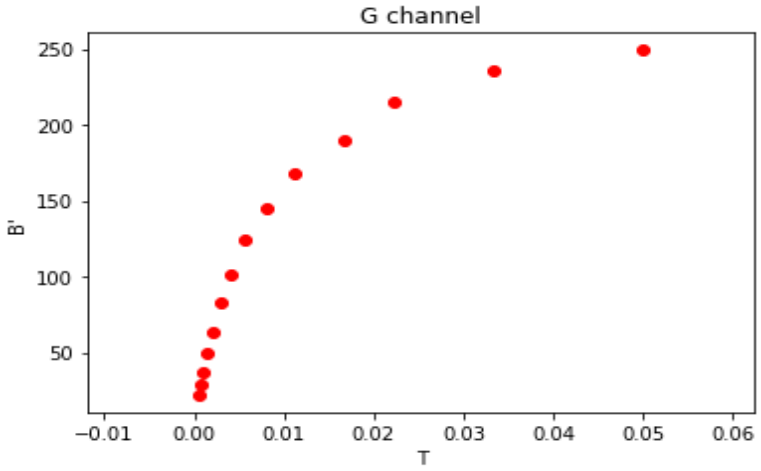
(12)(0.0222 sec)

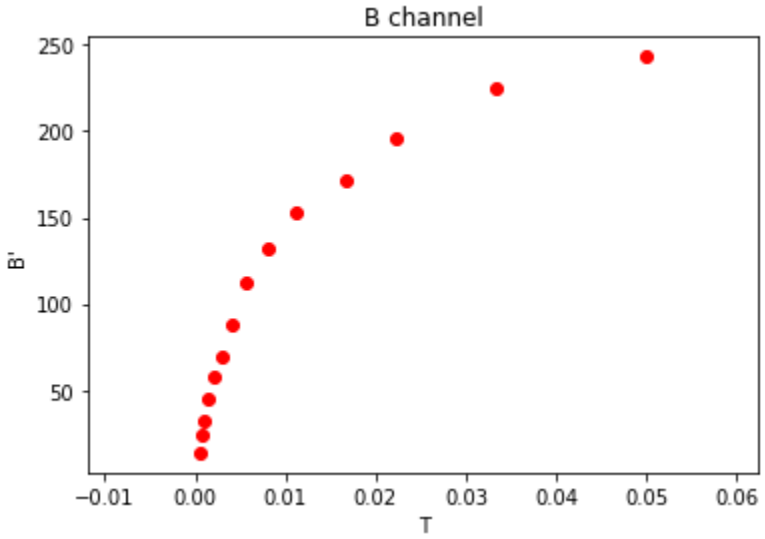
(13)(0.033 sec)

(14)(0.05 sec)

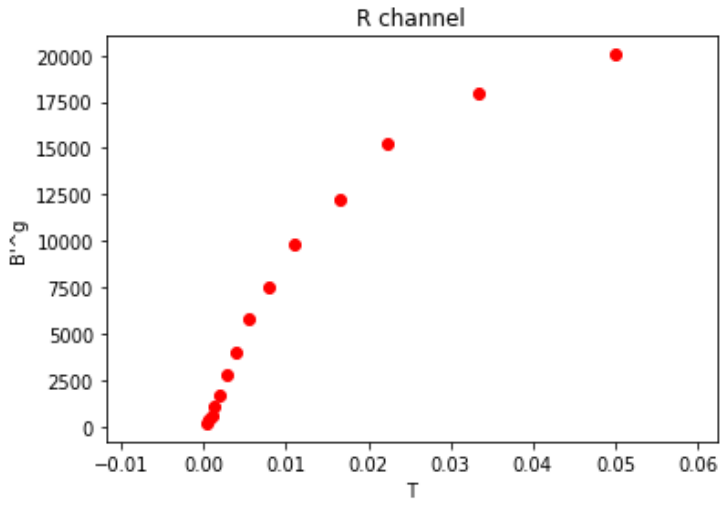
- B’(T) as a function of the T for the three channels are presented below:

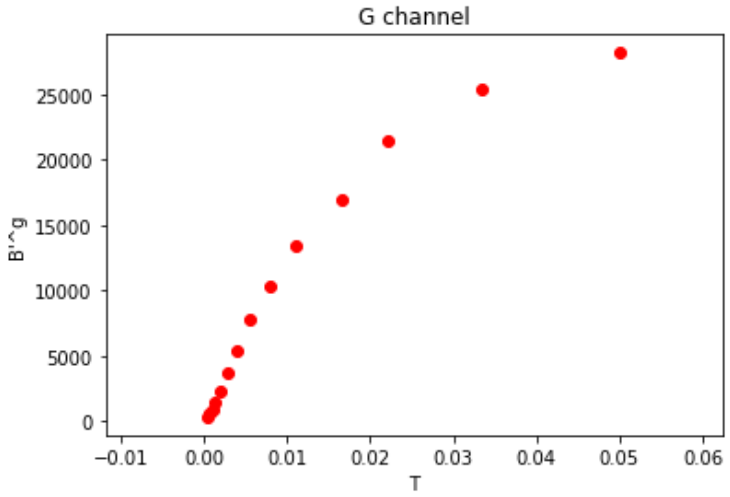


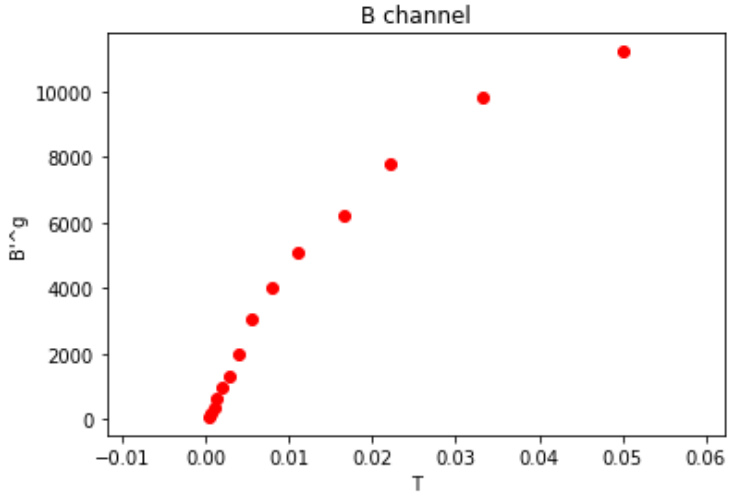


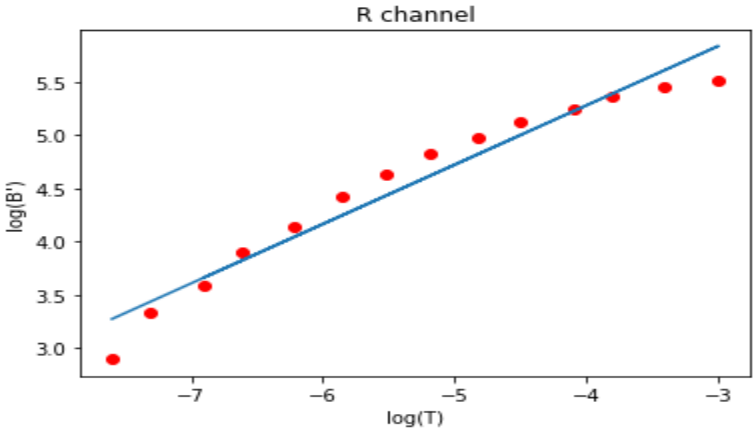


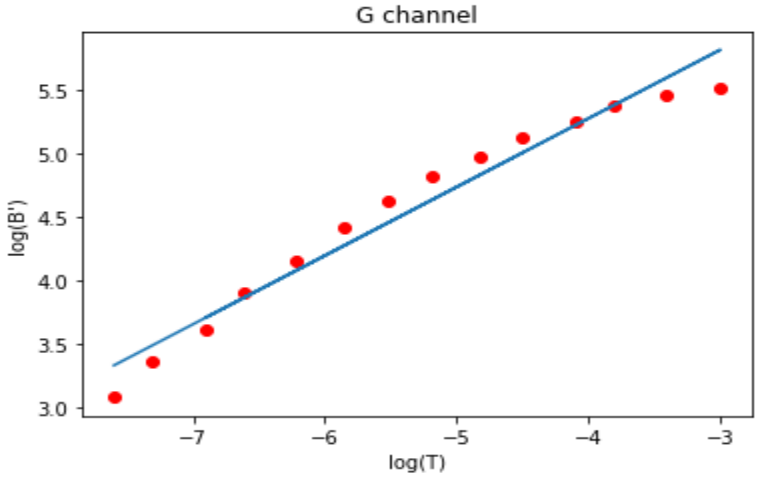
- Plots of B'^{g} (T) as a function of the T and linearity for all three channels are presented below:

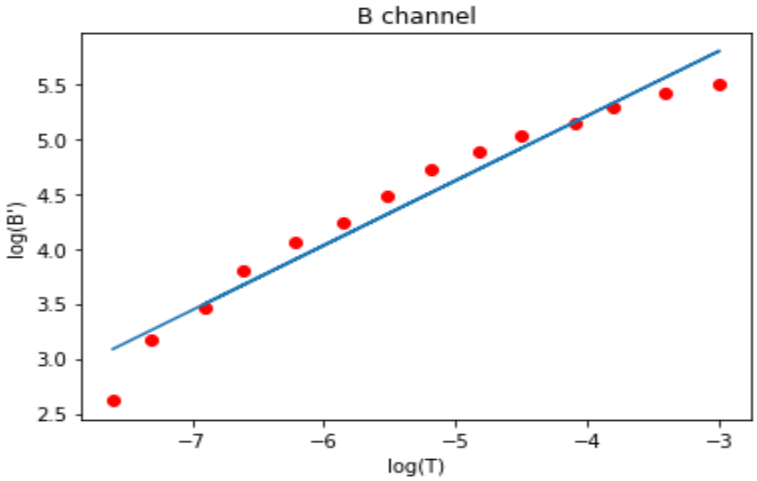






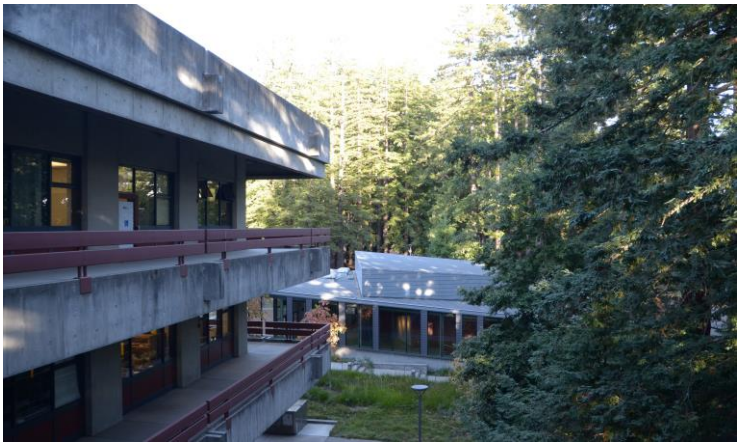

R channel
log(B')
log(T)
5.5
5.0
4.5
4.0
3.5
3.0
−7
−6
−5
−4
−3


G channel
log(B')
log(T)
5.5
5.0
4.5
4.0
3.5
3.0
−7
−6
−5
−4
−3

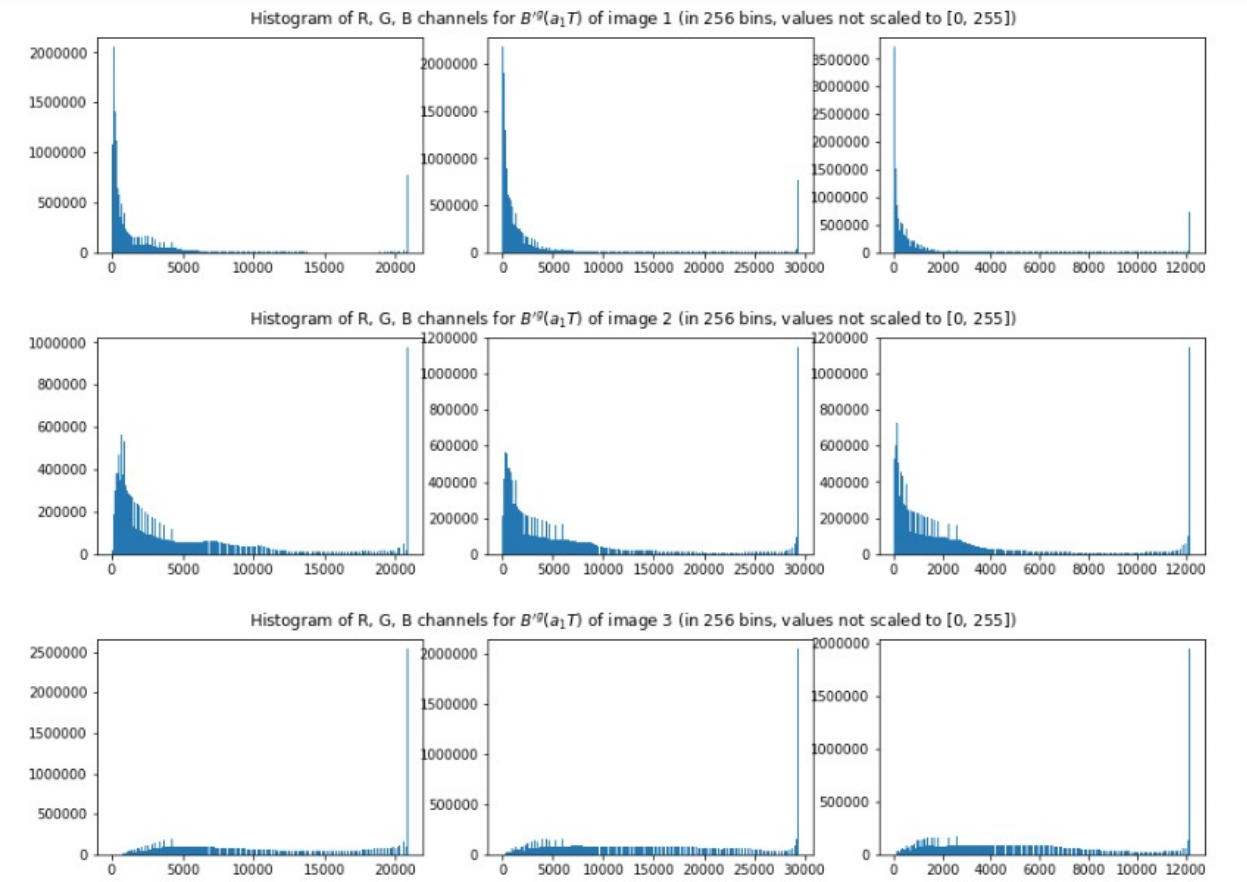

B channel
log(B')
log(T)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
−7
−6
−5
−4
−3

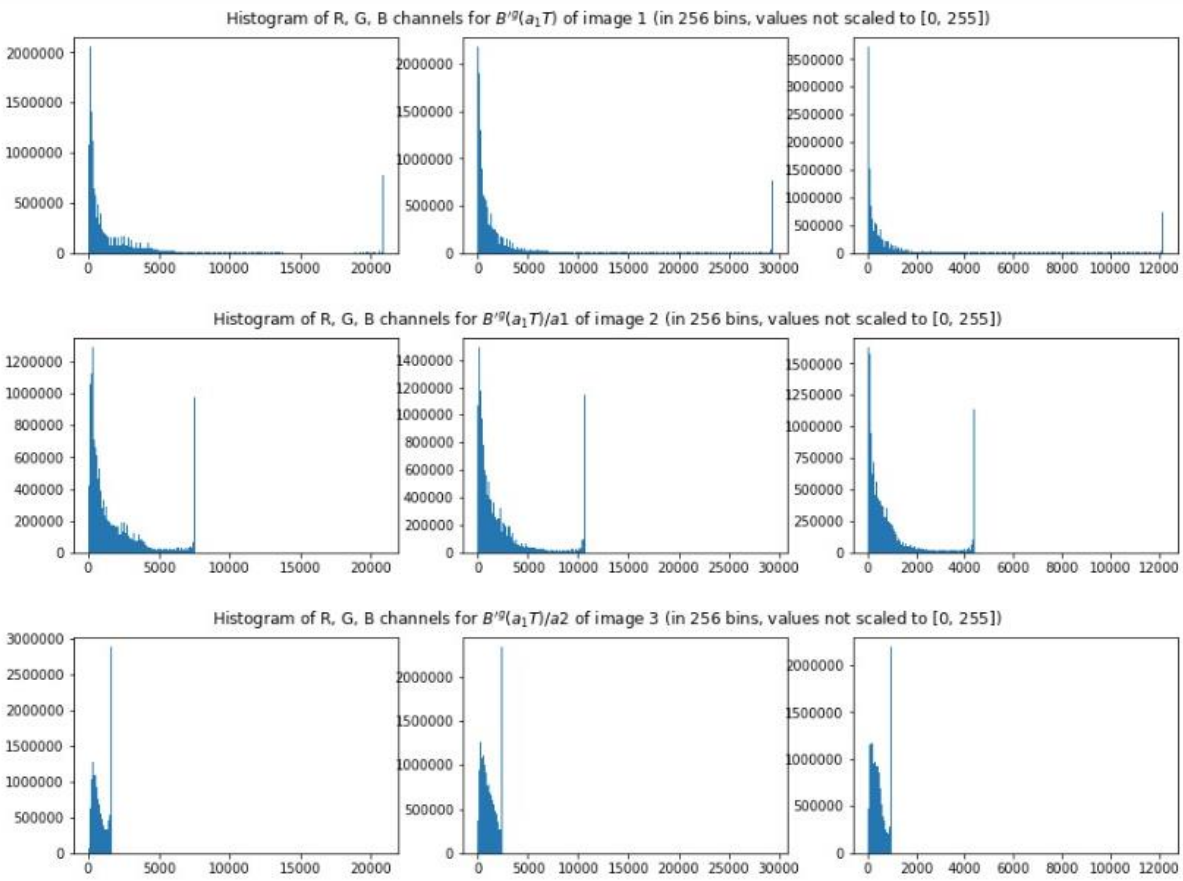
PLOTTING HISTOGRAM OF THE STACK OF IMAGES

- Stack Of Images



- The histogram of the values $B'_g(a_i * T)$ for each color channel for each of the 3 pictured in the stack. (In this notation, i=0,1,2, and $a_0=1$). When you compute the histograms, use a set of 25 uniform bins between 0 and 255_g (which is the largest possible value of B'_g)
- • For the second and the third image in the stack, also plot, for each color channel, the histogram of the values $B'_g(a_1 * T) / a_1$ (for the second image) and $B'_g(a_2 * T) / a_2$ (for the third image). Use the same bins as for the previous histograms.

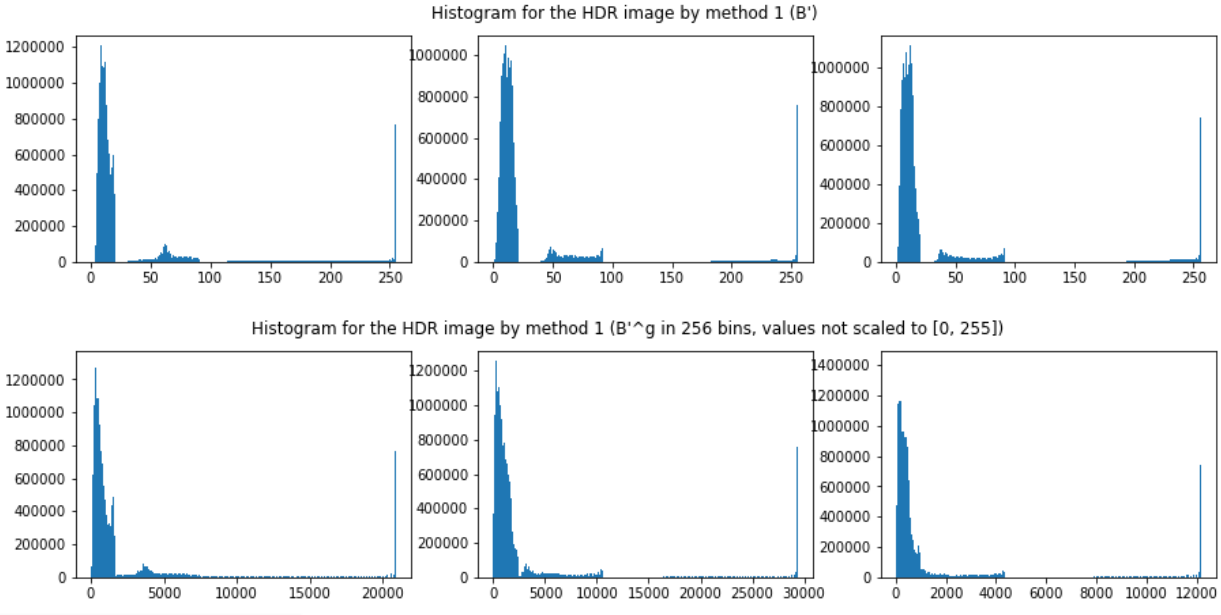


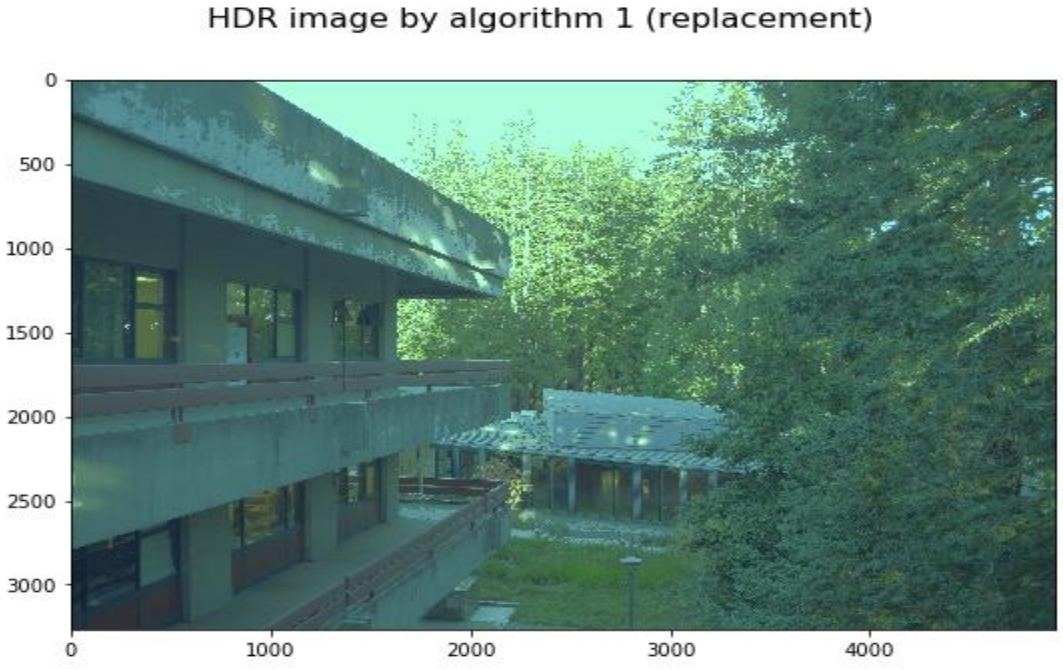

Histogram of R, G, B channels for $B'^{g}(a_1T)$ of image 1 (in 256 bins, values not scaled to [0, 255])
Histogram of R, G, B channels for $B'^{g}(a_1T)/a1$ of image 2 (in 256 bins, values not scaled to [0, 255])
Histogram of R, G, B channels for $B'^{g}(a_1T)/a2$ of image 3 (in 256 bins, values not scaled to [0, 255])

CREATING A COMPOSITE HDR IMAGE

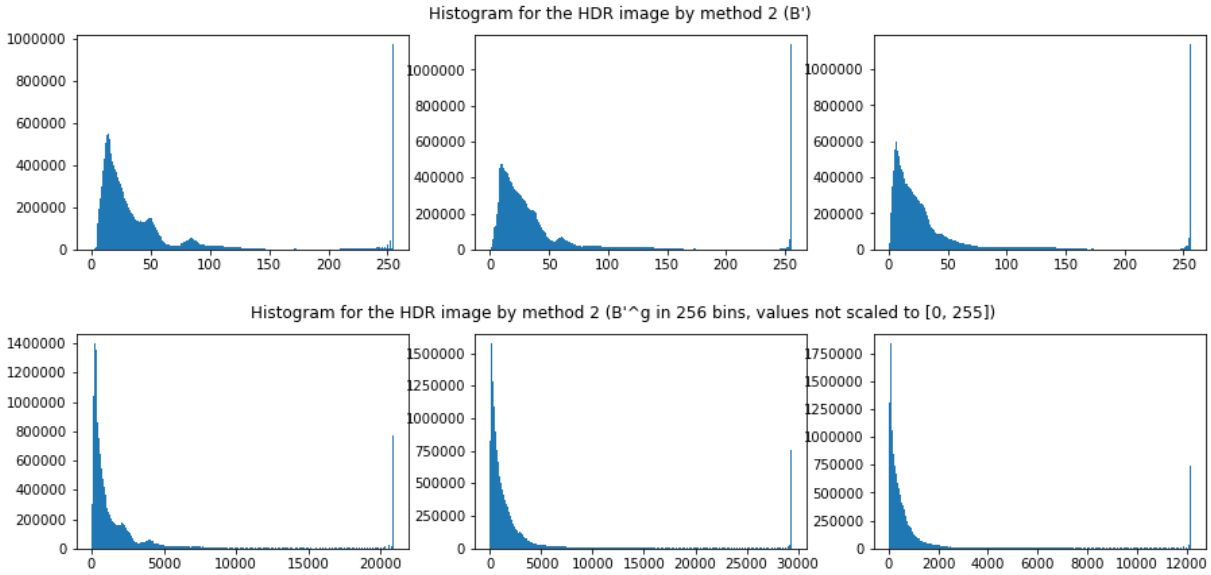
The stack of three images were used to develop the HDR using two different composition algorithms.

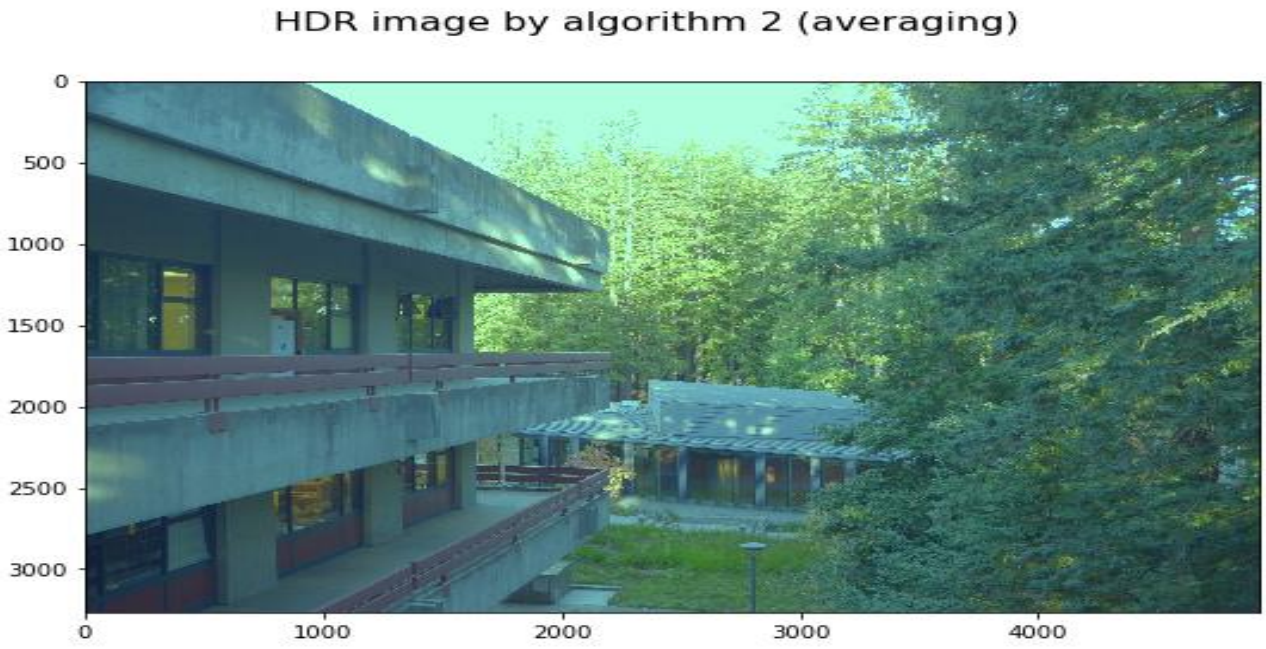
Composition Algorithm1: Each pixel is taken in such a way that it is not saturated and is with the largest exposure time. The histograms found for the R,G and B channels and Final HDR image is shown below :





Composition Algorithm2 : Each pixel is taken in such a way that it is not saturated and is with the largest exposure time with a liitle modification. This time the pixel values are replaced by the average of the values in the images for which this pixel is not saturated. The stograms found for the R,G and B channels generated is shown below.






HDR image by Merge Mertens technique
0
500
1000
1500
2000
2500
3000
0
1000
2000
3000
4000