Emmetra

Shaping the future of Imaging

"Exploring Camera Systems: From Fundamentals to Advanced Electronic Imaging"

Assignments

October 24th-26th 2024

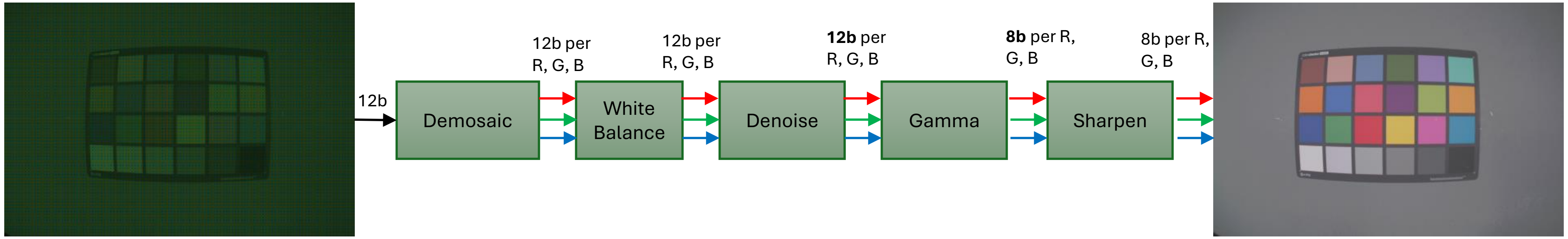
Unlocking the potential of every embedded camera for perfect vision systems

Assignment

- 3 tasks on the topics discussed.
- Link - https://app.box.com/s/6e28fusm4hdvi9xf61szdhgkzgc7h8wa
- Programming/SW – Python, C/C++, OpenCV, your preferred language
- Use of UI/visualization in encouraged
- Tools – Laptop, Smartphone
- What will be provided
  - Problem statement
  - Required input data
  - Expected results
- What is expected from students?
  - Source code delivered via Github. Instruction guide to run the demo/implementation.
  - Report explaining the approach/design and summary of results
  - Create separate folder (source code, test data and docs) for each of the assignments within the GitHub repo.
  - Time line – 1 week. Submit by Nov 5th 2024
  - Can make a group of max 4
- Once assignments are completed, please fill this form to submit the details.
- All participants who successfully submits the assignments eligible for certificates
- Top 3 winners will be receiving attractive reward !!

Assignment -1 : Implement basic ISP

- Objective – Implement basic image signal processing routines for sensor raw image
- Task – Implement following routines with option to control the parameters of the algorithms
  - Demosaic – edge based interpolation (5x5) to compute missing channels
  - White balance – simple gray world algorithm to remove color cast.
  - Denoise – Gaussian filter (5x5)
  - Gamma correction – use sRGB gamma (convert 12b to 8b)
  - Sharpening filter – unsharp mask filter
- **Bonus : Implement UI tool to control the various parameters of the algorithm blocks to visualise/compare (mini tuning tool)**
- Input – 12bit Bayer Raw image. Output – RGB channel with 24 bits per pixel (8 bits for each channels)
- Tools to view RAW
  - PixelViewer
  - Irfanview with RAW plugin
  - Configuration to be used for input – Bayer – 12bits, GRBG, 1920x1280
- Generate outputs with following combinations and record observations with summary in the report
  - Demosaic + Gamma
  - Demosaic + White balance + Gamma
  - Demosaic + White Balance + Denoise + Gamma
  - Demosaic + White Balance + Denoise + Gamma + Sharpen



12b

Demosaic

12b per R, G, B

White Balance

12b per R, G, B

Denoise

12b per R, G, B

Gamma

8b per R, G, B

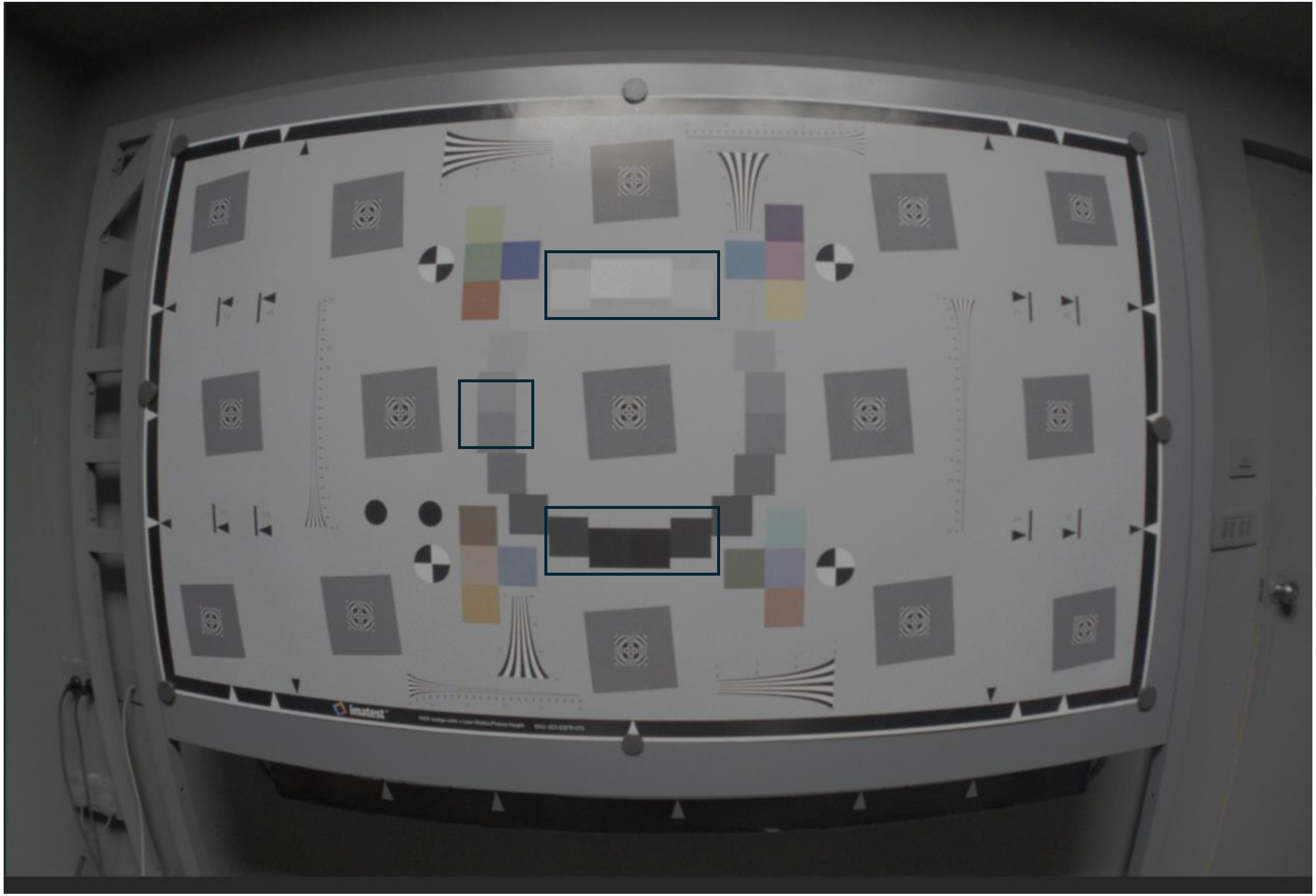
Sharpen

8b per R, G, B

Assignment -2: Denoise and Sharpness Techniques

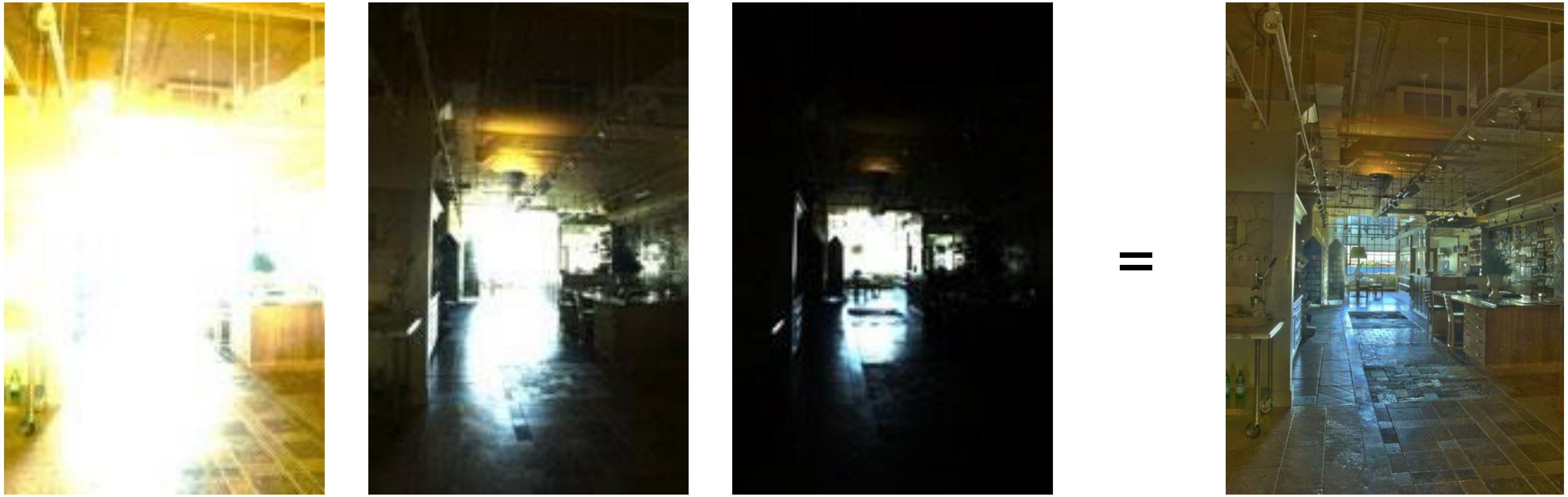
- Objective – Implement different techniques of denoise and sharpness and assess **image quality**
- Task –
  - Denoise
    - Implement median and bilateral filter. Compare with gaussian filter implemented in Assignment 1
    - Implement **AI model** to denoise image and compare with above traditional methods
    - Compute spatial Signal to noise ratio for 3 different gray tones as shown **(in next slide)** for each of the methods implemented. Refer https://www.imatest.com/imaging/noise/
  - Edge enhancement
    - Implement Laplacian filter based enhancement and compared with the method implemented in Assignment 2.
    - Compute edge strength based on gradient based approach for each of the methods implemented
  - Use ISP pipeline from Assignment 1 for processing the input raw image
- Input – 12bit Bayer Raw image. Output – RGB channel with 24 bits per pixel (8 bits for each channels).
- Tools to view RAW and output image (select appropriate formats).
  - PixelViewer
  - Irfanview with RAW plugin
  - Configuration to be used for input – Bayer – 12bits, GRBG, 1920x1280
  - AI model - Tensorflow for denoise CNN model. Optional to use training process else use pre-trained models such as U-net, FFDNet etc.
- Generate report with all the comparison and image quality metrics computed

Assignment -2: Denoise and Sharpness Techniques

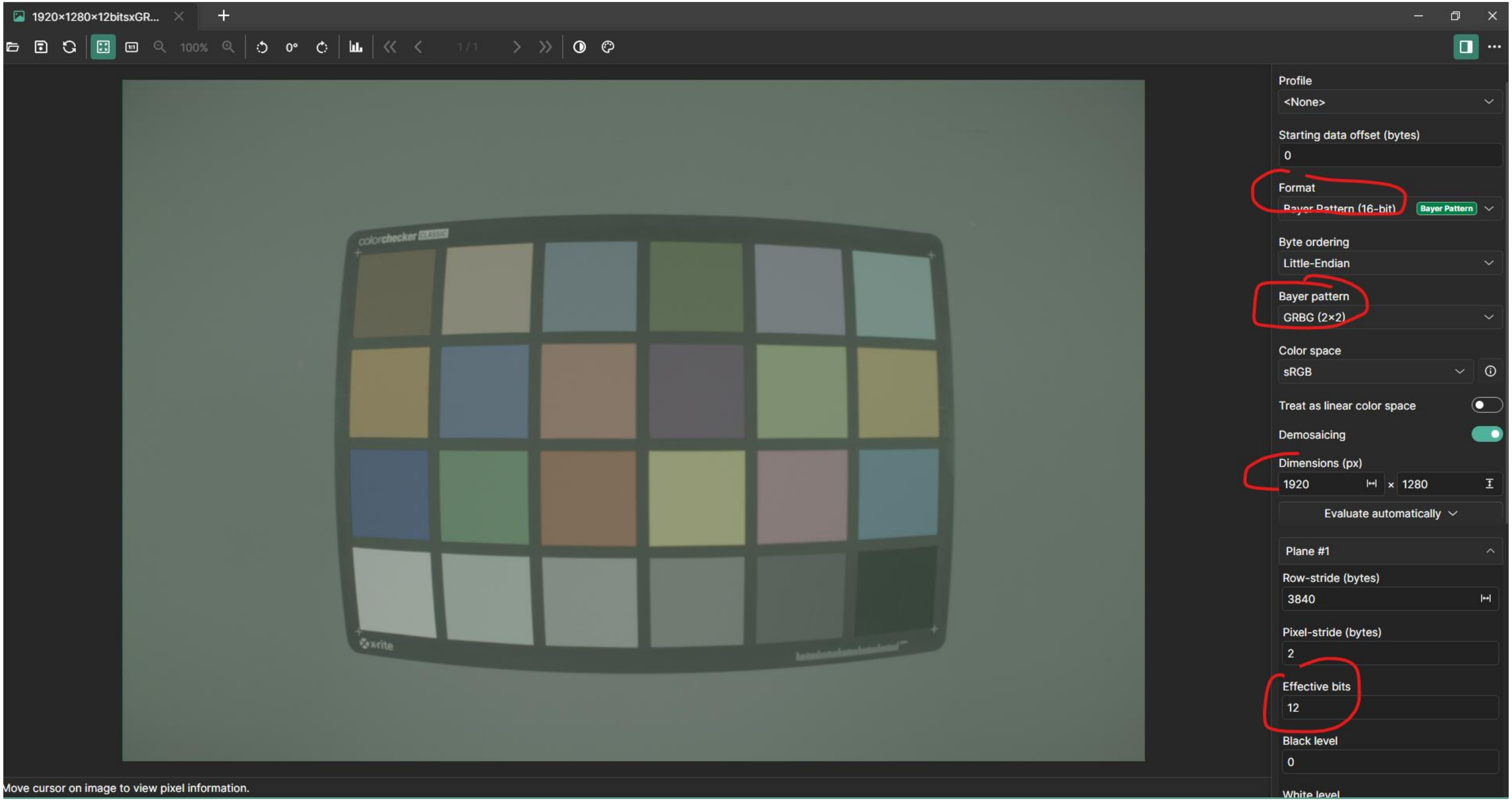


Assignment -3: HDR Imaging

- Objective – Implement HDR imaging algorithm
- Task – Implement HDR imaging algorithm to merge and tone map 3 differently exposed LDR images for high contrast scene
  - Capture 3 differently exposed image of LDR scene from your phone. Preferably day light outdoor or indoor having both bright, shadow and low light scene (e.g. sample images shown below for just reference, do not use as input to your algorithm)
  - Exposure can be controlled from your phone in manual mode (I assume you guys know now ☺)
  - Implement both merge of 3 images and tone mapping to 8bit for display.
- Report containing implementation details with observations



Example Configuration for Raw file in PixelViewer



Profile
<None>

Starting data offset (bytes)
0

Format
Bayer Pattern (16-bit) Bayer Pattern

Byte ordering
Little-Endian

Bayer pattern
GRBG (2×2)

Color space
sRGB

Treat as linear color space ○

Demosaicing ●

Dimensions (px)
1920 × 1280

Evaluate automatically

Plane #1

Row-stride (bytes)
3840

Pixel-stride (bytes)
2

Effective bits
12

Black level
0

White level

Move cursor on image to view pixel information.

All the Best!