



# Emmetra Assignment Report

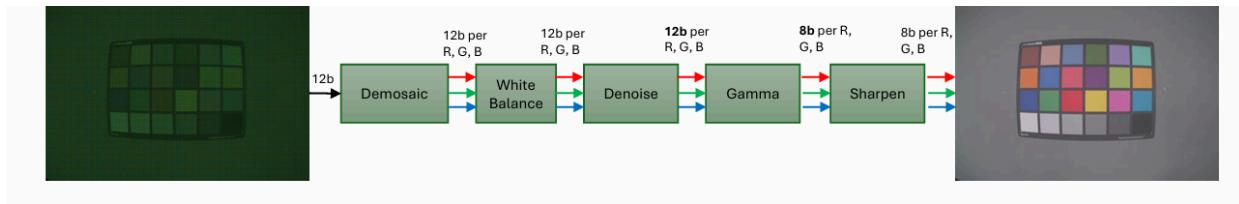
## *Assignment 1:*

Implement basic image signal processing routines for sensor raw image

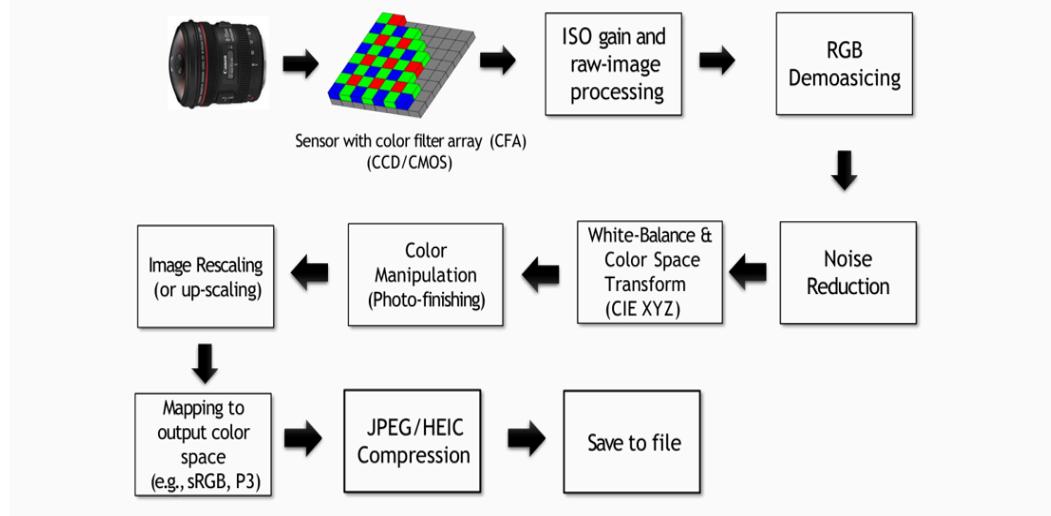
### Tasks:

Implement following routines with option to control the parameters of the algorithms

1. Demosaic – edge based interpolation (5x5) to compute missing channels
2. White balance – simple grey world algorithm to remove colour cast.
3. Denoise – Gaussian filter (5x5)
4. Gamma correction – use sRGB gamma (convert 12 bit to 8bit)
5. Sharpening filter – unsharp mask filter



A typical color imaging pipeline



GitHub: <https://github.com/Rya-man/emmetra/tree/main/ISP>

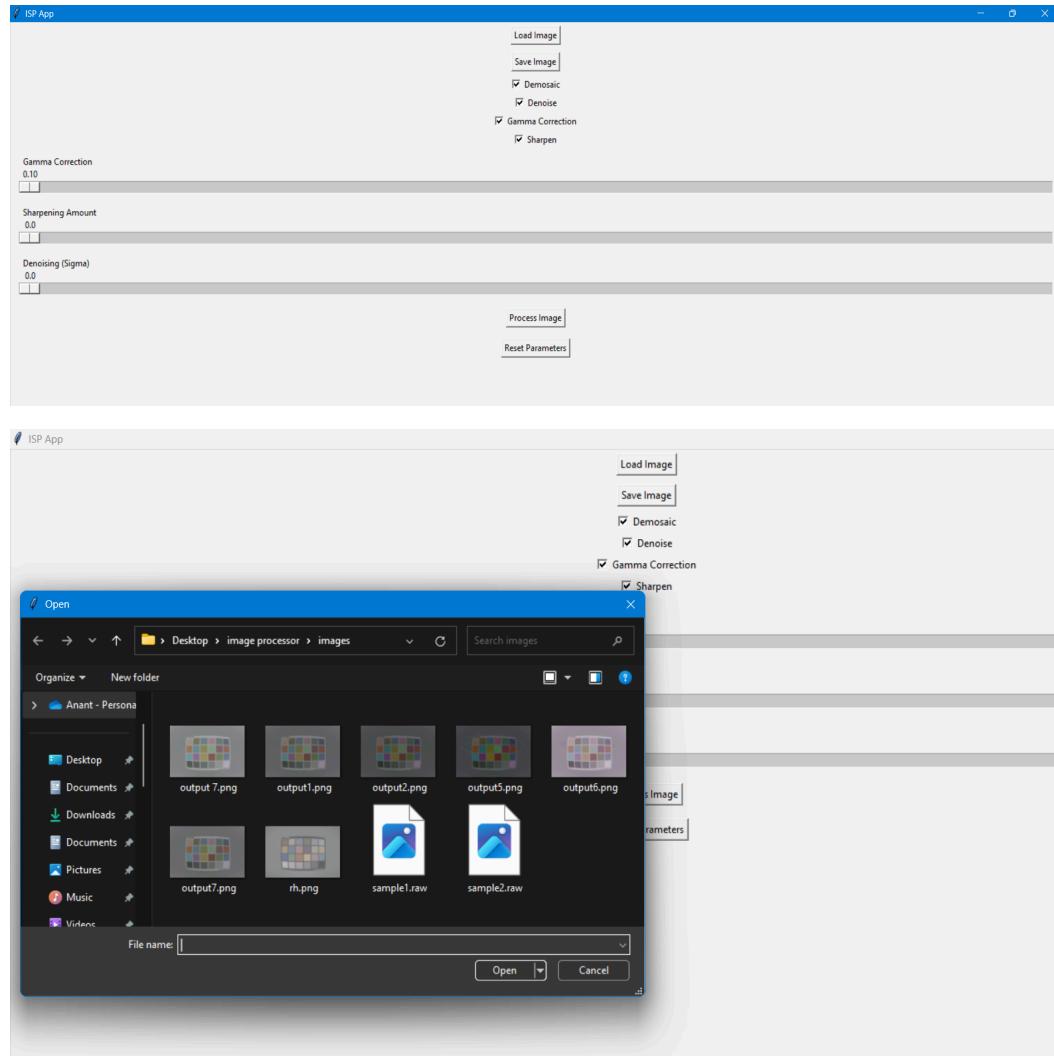
## 1. Features:

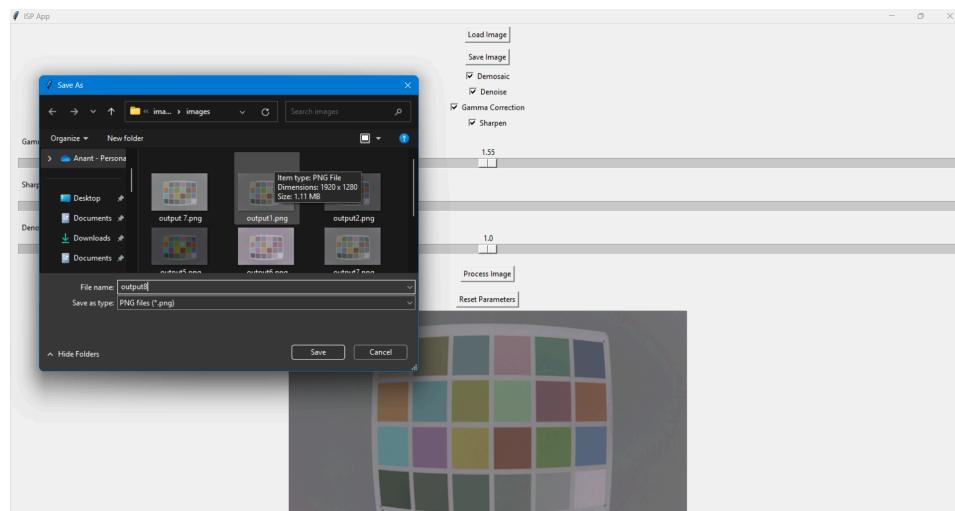
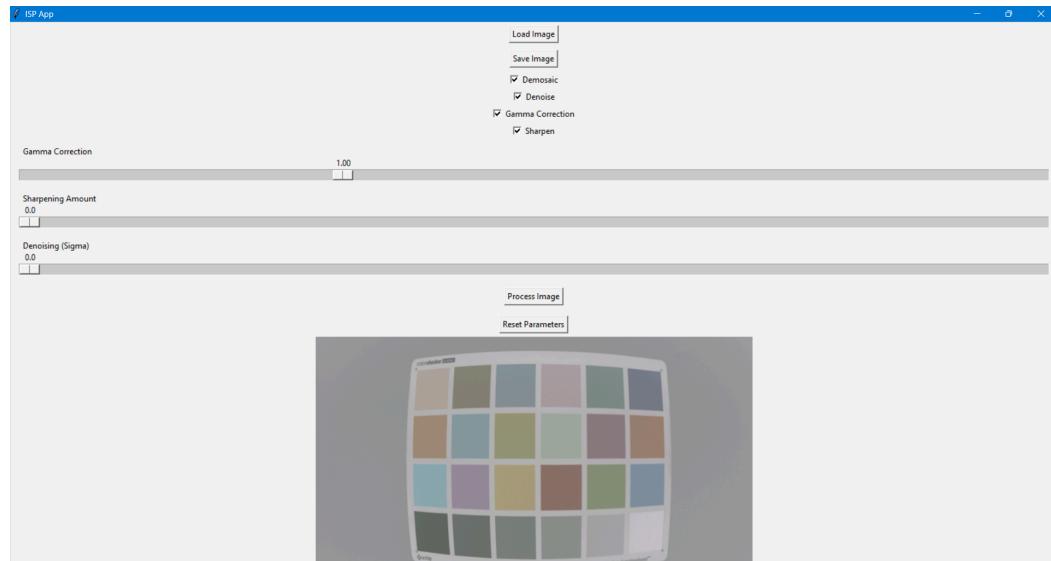
- Demosaic: Uses edge-based interpolation to compute missing channels.
- Gamma Correction: Adjustable gamma levels using sRGB gamma.
- Denoise: Applies a Gaussian filter with adjustable sigma.
- Sharpen: Applies an unsharp mask filter for edge enhancement.

- Parameter Control: Provides real-time control over processing parameters using sliders.
2. Installation: The project can be cloned from the GitHub repository and the required libraries can be installed using `pip install -r requirements.txt`.
3. Usage:
- Load a 12-bit Bayer Raw Image
  - Adjust parameters using the sliders
  - Process the image
  - Save the processed output
4. Processing Pipeline: The image is processed through the following steps:
- Demosaic
  - White Balance (currently inactive)
  - Denoise
  - Gamma Correction
  - Sharpen
5. Combination Outputs: The app can generate and save images for the following combinations:
- Demosaic + Gamma
  - Demosaic + White Balance + Gamma

- Demosaic + White Balance + Denoise + Gamma
- Demosaic + White Balance + Denoise + Gamma + Sharpen

## App Screenshots :

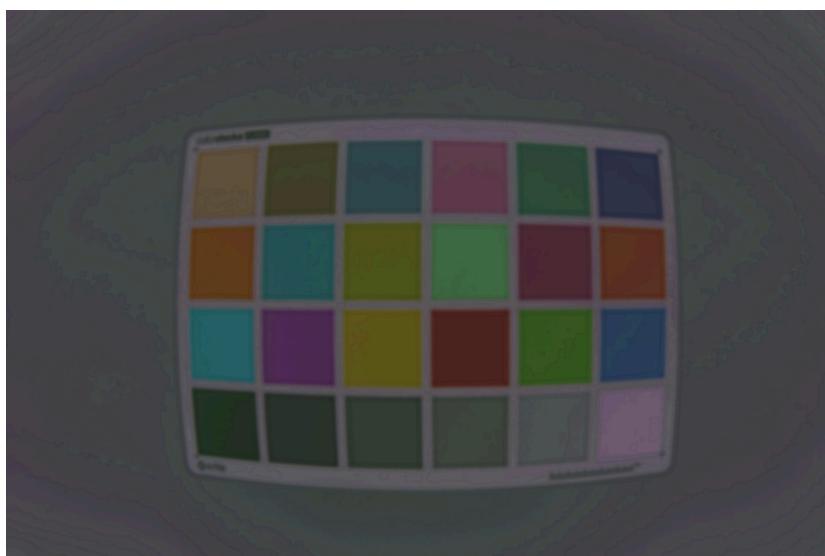
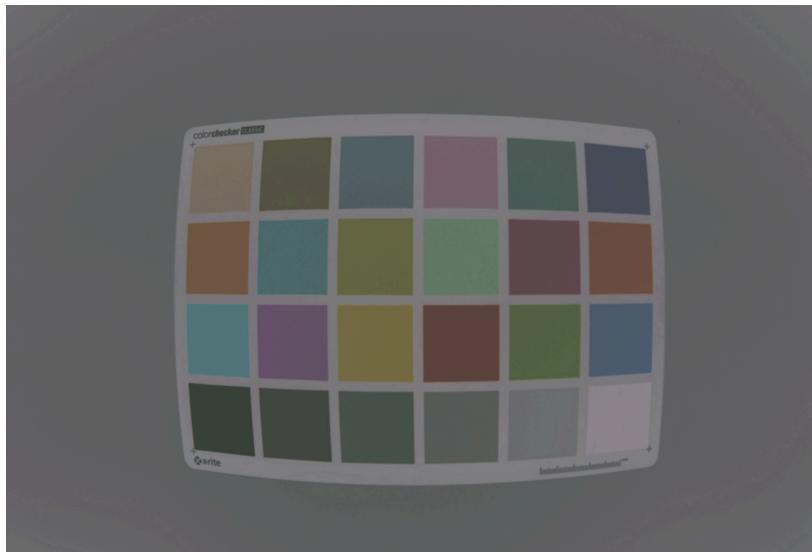




Initial outputs:

- *Demosaic + Gamma*
- *Demosaic + White balance + Gamma*
- *Demosaic + White Balance + Denoise + Gamma*

- *Demosaic + White Balance + Denoise + Gamma + Sharpen*





*Final Output and result from the pipeline:*



Observations:

**White Balance Sensitivity:** Manual adjustments showed that slight changes in white balance significantly affect colour accuracy, especially in skin tones and nature scenes.

**Demosaicing Algorithm:** Reconstructing images from Bayer data requires sophisticated algorithms. Gradient-based methods preserve edges and reduce artefacts better than bilinear interpolation.

**Dynamic Range Management:** Adaptive tone-mapping effectively compresses dynamic range while maintaining contrast. Logarithmic tone mapping excels in scenes with high brightness variation, preserving detail in highlights.

*This project seems to be a great starting point for anyone interested in learning about or working on Image Signal Processing (ISP) for raw Bayer images. The ability to control the various processing parameters and see the results in real-time is a valuable feature for experimentation and learning.*

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