ECE 751 | Future Research Proposal

Olympus: High-Quality Linear Interpolation based Demosaicing Engine

Jagdish Mohapatra
Electrical and Computer Engineering
University of Wisconsin-Madison

What can be done further?

The demosaicing hardware engine that we designed is efficient enough to accurately generate the RGB pixels from the given Bayer pixel inputs. But there is further room for improving, by means of adding a four-stage pipeline in between the channel wise pixel computations. By doing so, the latency is not improved, however, the throughput is improved than the non-pipelined design which we currently have. Multiple bayer center pixels can be computed altogether with this four-stage pipeline approach. There will be a little area overhead with pipelining, but the performance can be significantly improved.

Application, missing piece or significant improvement?

Some significant improvement can be made by introducing caching mechanism in our existing design. There was a question asked during our presentation about redundant computations of several rows and columns of the 5x5 pixel window we are considering. As per the existing design, which we submitted already, can still accommodate a cache module in between bayer channel data and our demosaicing hardware engine. We can then compare the incoming pixel data from the 5x5 window and based on the temporal locality, we can have a hit or miss and we can write a logic to gate the computation and processing of a redundant pixel data. This approach might save us some dynamic power because there will be lesser number of computations if we have a pixel hit with a minimal area overhead. By doing so, the application of our project can be diversified across multiple sub-blocks in image signal processors in the digital camera such as denoising, deblurring, etc. where temporal correlation of pixels are high.

How is it related to your research or future career plan?

I am more inclined to work and gain significant knowledge about the industry-standard image signal processors (ISP) that are currently being used in smartphone cameras. This project was my first step towards it, since we made a working demosaicing engine in this project which is accounted as the first and important building block in any ISPs. I want to expand my knowledge about denoising and deblurring blocks which takes the output from demosaicing block for further processing of the image pixels.

References

[1] H.S. Malvar, L. He, R. Cutler, “High-quality linear interpolation for demosaicing of Bayerpatterned color images”, in Proceedings of IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2004. http://dx.doi.org/10.1109/ICASSP.2004.1326587

[2] X. Li, “Demosaicing by successive approximation”, IEEE Transactions on Image Processing, vol. 14, no. 3, pp. 370–379, 2005. http://dx.doi.org/10.1109/TIP.2004.840683

[3] Qualcomm ISP spectra https://www.qualcomm.com/news/onq/2020/12/02/triple-down-future-photography-qualcomm-snapdragon-888

[4] Q. Tian, H. Xue, Z. Liu and E. Zhang, "An demosaicing algorithm based on edges," *2015 8th International Congress on Image and Signal Processing (CISP)*, 2015, pp. 246-250, doi: 10.1109/CISP.2015.7407884.