P-HGRMS: A Parallel Hypergraph Based Root Mean Square Algorithm for Salt and Pepper Image Denoising

Tejaswi Agarwal, Saurabh Jha and B. Rajesh Kanna
School of Computing Sciences and Engineering, VIT University
Chennai , India
tejaswi.agarwal2010@vit.ac.in, saurabh.jha2010@vit.ac.in, rajeshkanna.b@vit.ac.in

Abstract

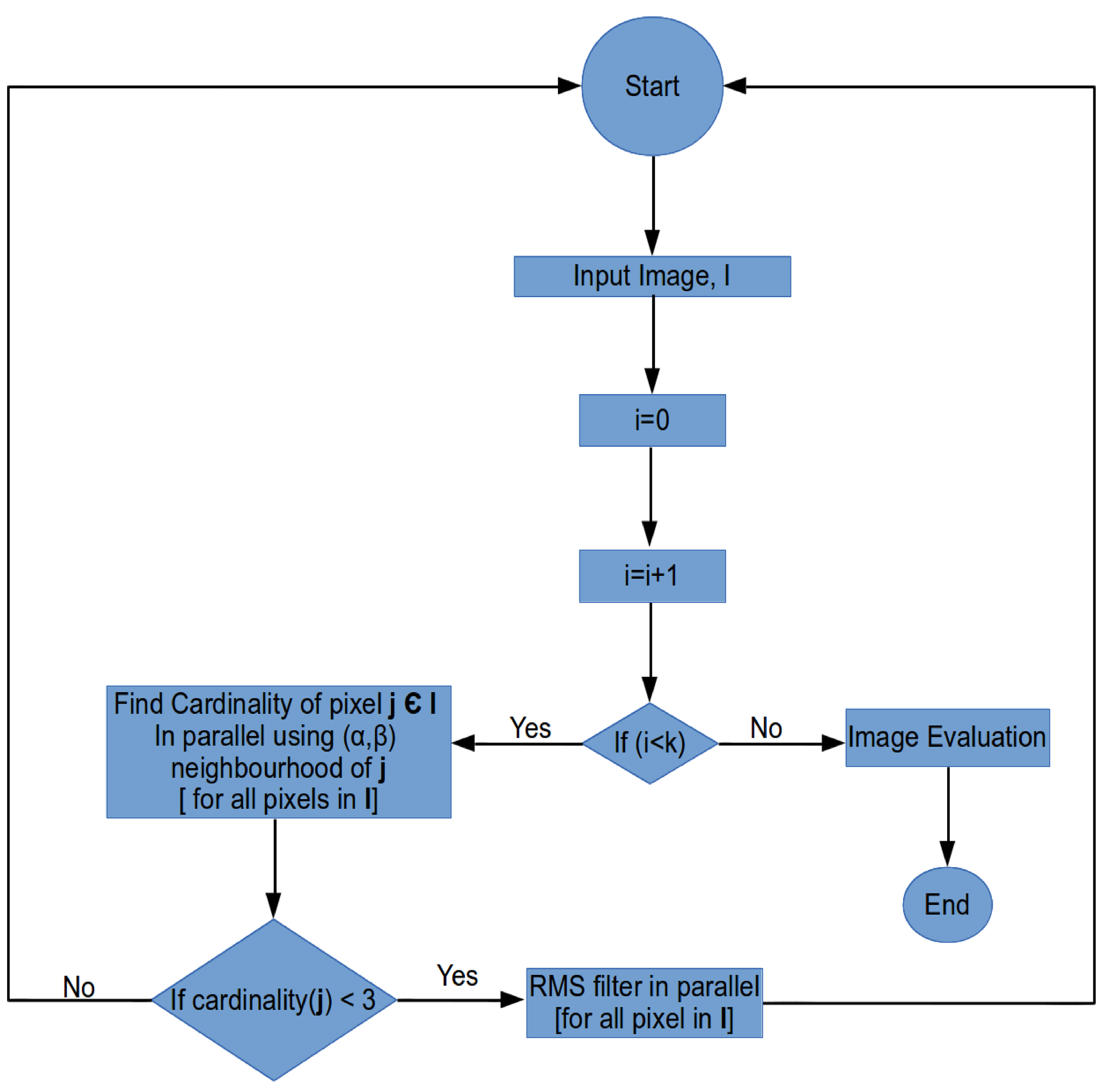
This poster presents a parallel Salt and Pepper (SP) noise removal algorithm in a gray level digital image based on the Hypergraph Based Root Mean Square (HGRMS) approach. HGRMS is generic algorithm for identifying noisy pixels in any digital image using a two level hierarchical serial approach. However, for SP noise removal, we reduce this algorithm to a parallel model by introducing a cardinality matrix and an iteration factor, *k*, which helps us reduce the dependencies in the existing approach. We compare and evaluate the performance characteristics and PSNR values of the proposed P-HGRMS algorithm with the existing HGRMS algorithm. Results with the proposed method show consistency in noise removal with a considerable increase in performance.

Goal

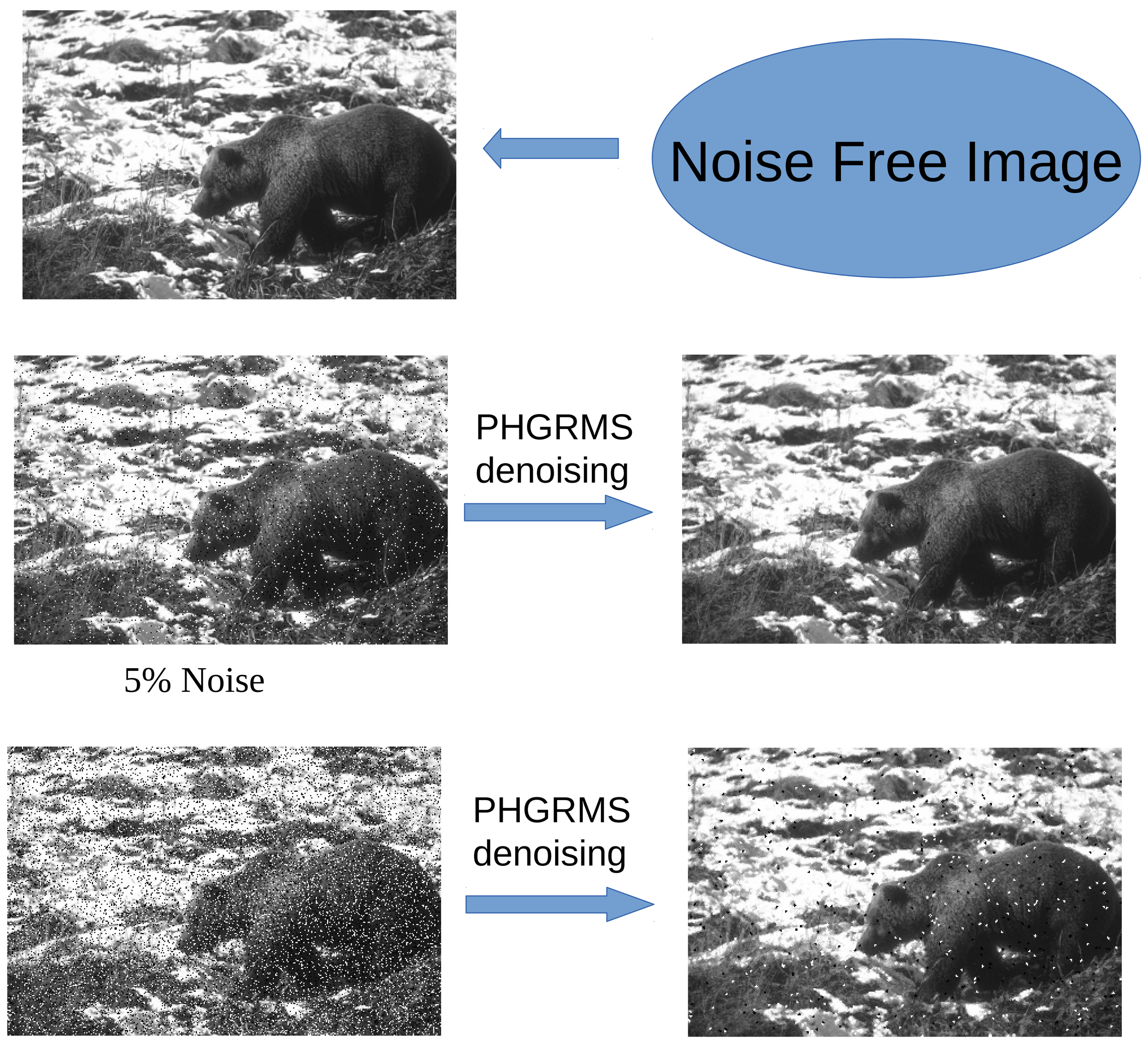
1. To parallelize HGRMS algorithm

2. To maintain the noise removal efficiency of the HGRMS algorithm in P-HGRMS

Proposed Algorithm



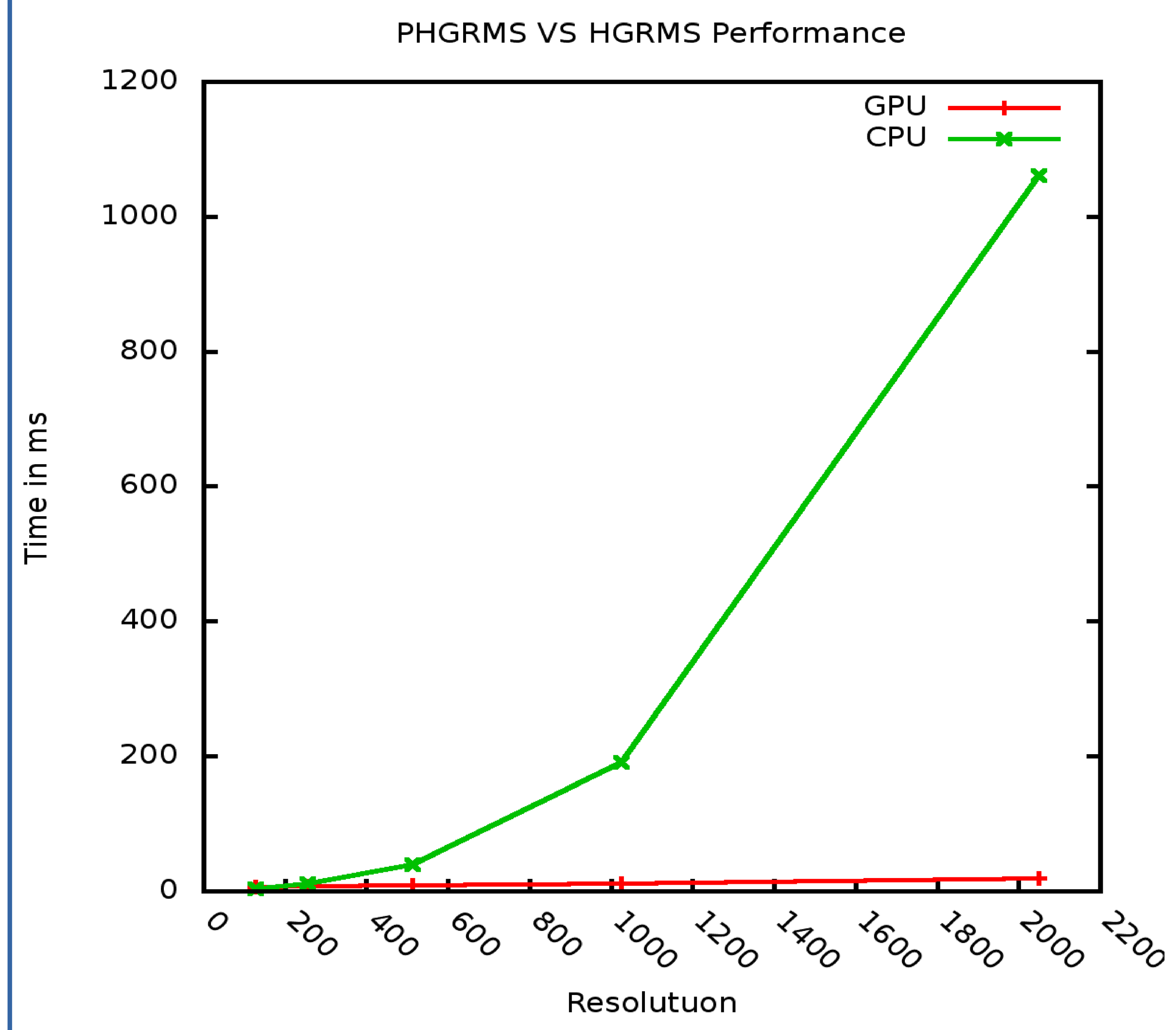
Results



PSNR TABLE

Noise/ Image	Image - 1		Image - 2		Image - 3		Image - 4		Image - 5	
	PH	H	PH	H	PH	H	PH	H	PH	H
5.00%	26.94	26.97	29.12	29.15	31.7	31.69	29.76	29.91	28.97	28.96
10.00%	24.6	24.55	30.78	30.76	27.96	27.91	26.82	26.83	26.11	26.06
15.00%	22.17	22.11	25.89	25.86	24.3	24.31	23.64	23.63	23.46	23.39
20.00%	19.67	19.64	22.45	22.4	21.19	21.18	20.66	20.62	20.76	20.74

		Number of Cores	Clock Speed (MHz)	Memory Clock (MHz)
CPU	2 x Intel Xeon X5570	2	2660	1600
GPU	2 x NVIDIA Tesla M2050 GPUs	448	1150	1546



As shown above even with a small image size of 128 X 128 we observe a speed up of 6x. As we scale higher images, the parallel CUDA implementation is 18x faster with an image resolution of 2048x2048.

Conclusion

1. P-HGRMS maintains the noise removal efficiency of HGRMS algorithm as evident from PSNR values.

2. It outperforms HGRMS by 6 to 18 times (6x - 18x) in computational efficiency.

Future Work

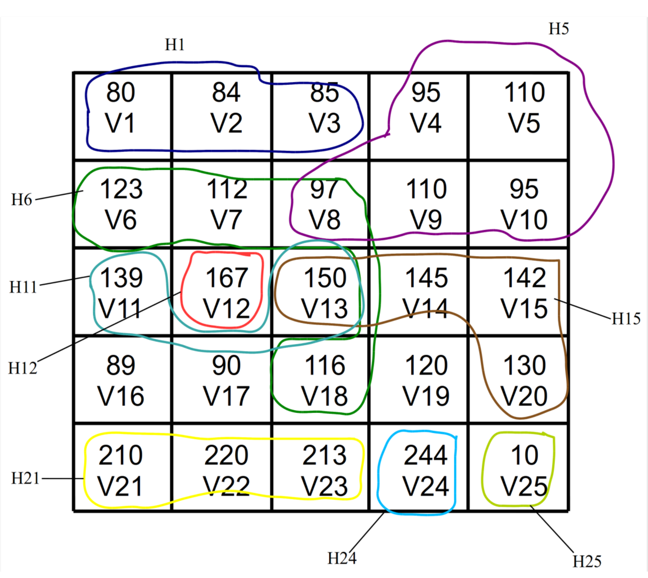
1. Determining the value of iteration factor, k based on the input image.

2. Generalizing the algorithm for all types of Gaussian noise.

3. Testing the algorithm with color images.

80 V_1	84 V_2	85 V_3	95 V_4	110 V_5
123 V_6	112 V_7	97 V_8	110 V_9	95 V_{10}
139 V_{11}	167 V_{12}	150 V_{13}	145 V_{14}	142 V_{15}
89 V_{16}	90 V_{17}	116 V_{18}	120 V_{19}	130 V_{20}
210 V_{21}	220 V_{22}	213 V_{23}	244 V_{24}	10 V_{25}

1. Input Image
Set, Geometrical parameter =15
Topological parameter =2



2. Construct Image neighbourhood hypergraph. Not all hyperedges marked here.

3	5	6	7	5
3	6	10	8	6
2	1	4	4	4
3	3	6	5	5
3	3	3	1	1

3. Find cardinality and mark isolated hyperedges with cardinality less than 3

80 V_1	84 V_2	85 V_3	95 V_4	110 V_5
123 V_6	112 V_7	97 V_8	110 V_9	95 V_{10}
140 V_{11}	142 V_{12}	150 V_{13}	145 V_{14}	142 V_{15}
89 V_{16}	90 V_{17}	116 V_{18}	120 V_{19}	130 V_{20}
210 V_{21}	220 V_{22}	213 V_{23}	145 V_{24}	148 V_{25}

4. $f(x,y)=\sqrt{\frac{1}{mn}\sum_{s,t}(g(s,t))^2} \quad (s,t)\in S_{x,y}$

3	5	6	7	5
5	6	10	8	6
3	5	7	7	6
3	3	6	5	6
3	3	3	7	5

5. Continue from step 2. At this stage no isolated hyperedges were found. So STOP.

References

[1] K. Kannan, B. Rajesh Kanna, and C. Aravindan (2010), Root mean square filter for noisy images based on hypergraph model, Image and Vision Computing, 28 (9), 1329-1338, Elsevier, DOI: 10.1016/j.imavis.2010.01.013, 5- Year impact factor- 1.84

[2] D. Martin, C. Fowlkes, D. Tal, and J. Malik, "A Database of Human Segmented Natural Images and its Application to Evaluating Segmentation Algorithms and Measuring Ecological Statistics", ICCV 2001. (Berkeley Segmentation Dataset)

About The Authors

Tejaswi Agarwal is a junior year undergraduate student majoring in Computer Science and Engineering. His research interests are Parallel Computing, Computer Architecture, and Multi-core Systems. Email: tejaswi.agarwal2010@vit.ac.in

Saurabh Jha is a junior year undergraduate student majoring in Computer Science and Engineering. His research interests are Parallel Computing, Heterogeneous Systems and Distributed Computing. Email: saurabh.jha2010@vit.ac.in

Rajesh Kanna B is a professor at VIT University, India. His research interests are Image Processing and its applications. Email: rajeshkanna.b@vit.ac.in

The authors acknowledge Amazon Web Services for providing their EC2 Cloud services for testing and analysis of the proposed algorithm.