



researchers have neglected many issues like no strategy is perfect for several type of circumstances.[6]

With the pervasive use of handheld digital devices such as camera phones and PDAs, people have started to capture images as a way of recording information. [7]

Detail enhancement is needed by many problems in the field of digital image processing. The available detail enhancement algorithms first divide a source image into a base layer and then into a detail layer via an edge preserving smoothing algorithm, and augment the detail layer to produce a detail enhanced image. [8]

Images of outdoor scenes are usually degraded under bad weather conditions and bad environment which results in a hazy image. The most of haze removal methods based on a single image have ignored the effects of sensor blur and noise. [9]

This paper describes a novel neural network based multiscale image restoration approach. The method uses a Multilayer Perceptron (MLP) trained with synthetic gray level images of artificially degraded co-centered circles. [9]

We present a supervised learning approach for object-category specific restoration, recognition, and segmentation of images which are blurred using an unknown kernel. [10]

### 3. Algorithm

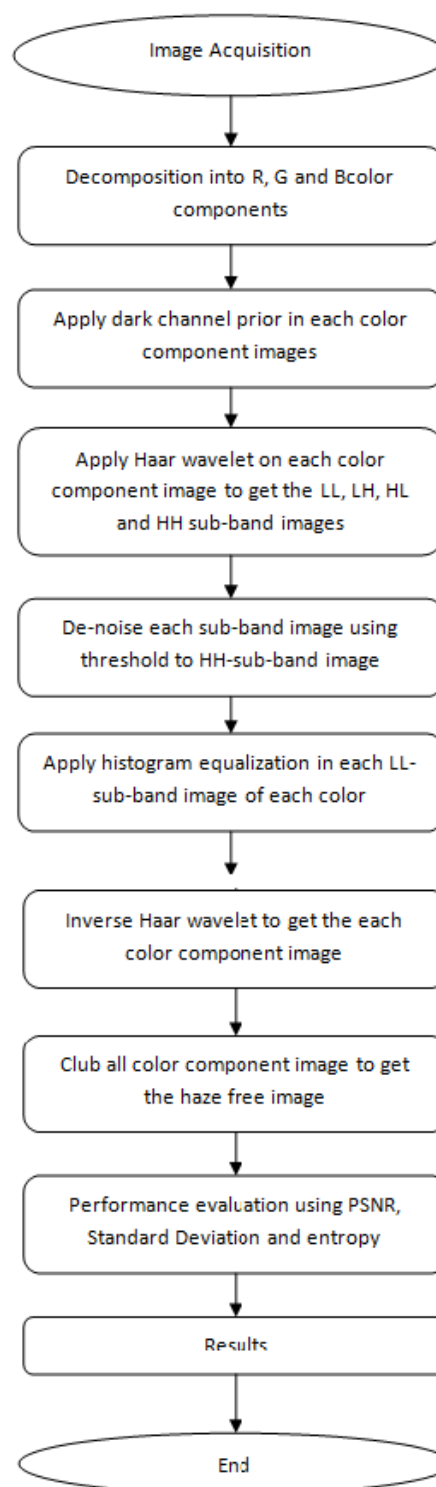
The dark channel prior is a kind of statistics of outdoor haze-free images. It is based on a key observation - most local patches in outdoor haze-free images contain some pixels whose intensity is very low in at least one color channel. Using this prior with the haze imaging model, we can directly estimate the thickness of the haze and recover a high quality haze-free image. Results on a variety of hazy images demonstrate the power of the proposed prior. Moreover, a high quality depth map can also be obtained as a by-product of haze removal.

The proposed work consists of the following steps:

1. Image Acquisition
2. Image decomposition into R-, G- and B-color components
3. Apply dark channel prior in each color component images
4. Apply Haar wavelet on each color component image to get the LL, LH, HL and HH sub-band images
5. De-noise each sub-band image using threshold to HH-sub-band image
6. Apply histogram equalization in each LL-sub-band image of each color component
7. Inverse Haar wavelet to get the each color component image
8. Club all color component image to get the haze free image
9. Performance evaluation using PSNR, Standard Deviation and entropy.

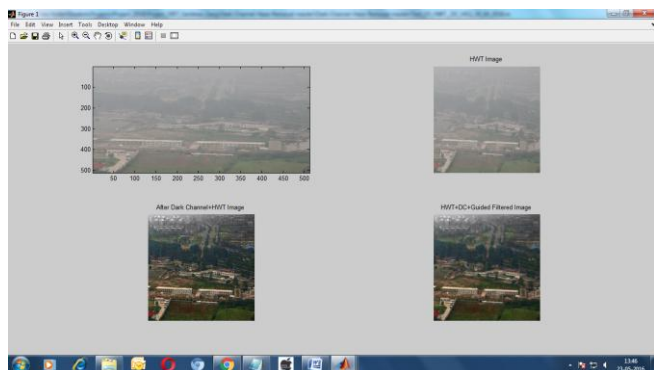
Histogram equalization often produces unrealistic effects in photographs; however it is very useful for scientific images like thermal, satellite or x-ray images, often the same class of images that user would apply false-colour to. Also histogram equalization can produce undesirable effects (like visible image gradient) when applied to images with low colour depth. For example, if applied to 8-bit image displayed with 8-bit gray-scale palette it will further reduce colour depth (number of unique shades of gray) of the image.

#### Flow Chart



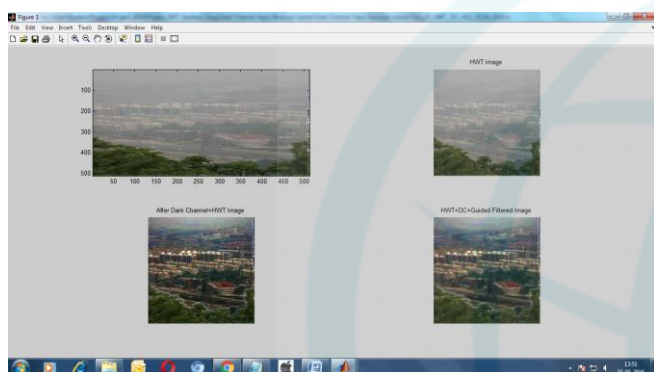
#### 4. Experiments and Results

The algorithm has been implemented on no. of images and following snap shots confirm the efficiency of the proposed algorithm.



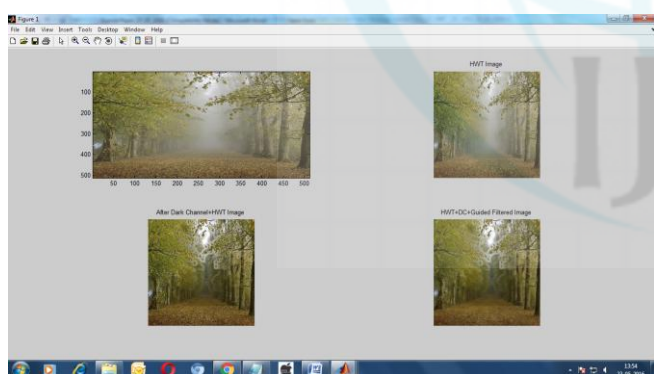
**Figure 1:**

(a) Hazy Image (b) After Noise Removal  
(c) After Dark Channel (d) Final Haze Free Image



**Figure 2:**

(a) Hazy Image (b) After Noise Removal  
(c) After Dark Channel (d) Final Haze Free Image



**Figure 3:**

(a) Hazy Image (b) After Noise Removal (c) After Dark Channel  
(d) Final Haze Free Image

**Table 1: PSNR, SD and Entropy**

Fig. No.	PSNR	SD	Entropy
1	67.56	2.099	4.675
2	69.70	3.921	5.543
3	68.76	2.987	5.871

#### 5. Conclusion

The presented work has shown fine improvement over the base paper work in terms of the peak-signal-to-noise

ratio, standard deviation, variance, time, entropy and mean intensity. The time attribute may further be improved by making the algorithm independent of the image size under test. This will greatly reduce the size burden from the algorithm. The improvements in performance evaluating features may be observed in the result tables. The enhancement in entropy shows the increase in information content in the haze free image over the hazy image. This indicates itself that the haze free image is more informative in terms of its clarity over the hazy image.

#### References

- [1] Jeffrey O. Coleman, Arda Yurdakul, "Fractions in the Canonical-Signed-Digit Number System", 2001 Conference on Information Sciences and Systems, The Johns Hopkins University, March 21–23, 2001
- [2] Reid M. Hewlitt, Earl S. Swartzlander, Jr., "CANONICAL SIGNED DIGIT REPRESENTATION FOR FIR DIGITAL FILTERS", 0-7803-6488-01001\$10.00 0 2000 IEEE
- [3] Linda S. DeBrunner, Victor E. DeBrunner, Deepak Bhogaraju, "Defining Canonical-Signed-Digit Number Systems as Arithmetic Codes", 0-7803-7576-9/02\$17.00 0 2002 IEEE
- [4] R. Mahesh and A. P. Vinod., "An Architecture For Integrating Low Complexity and Reconfigurability for Channel filters in Software Defined Radio Receivers", 1-4244-0921-7/07 \$25.00 © 2007 IEEE.
- [5] Erik Backenius and Erik S'all, "Two's Complement Conversion to Minimal Signed Digit Code"
- [6] R. Mahesh and A. P. Vinod, "New Reconfigurable Architectures for Implementing FIR Filters with Low Complexity", IEEE TRANSACTIONS ON COMPUTER-AIDED DESIGN OF INTEGRATED CIRCUITS AND SYSTEMS, VOL. 29, NO. 2, FEBRUARY 2010
- [7] Antonia Azzinia, Matteo Bettonia, "Evolutionary Design and FPGA Implementation of Digital Filters"
- [8] Yair Linn, "Efficient Loop Filter Design in FPGAs for Phase Lock Loops in High-Data rate Wireless Receivers – Theory and Case Study", 1-4244-0697-8/07/00 ©2007 IEEE.
- [9] R. Mahesh and A. P. Vinod, "A New Common Subexpression Elimination Algorithm for Realizing Low-Complexity Higher Order Digital Filters", IEEE TRANSACTIONS ON COMPUTER-AIDED DESIGN OF INTEGRATED CIRCUITS AND SYSTEMS, VOL. 27, NO. 2, FEBRUARY 2008.
- [10] P. Vinod and Edmund M-K. Lai, "Low Power and High-Speed Implementation of FIR Filters for Software Defined Radio Receivers", IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, VOL. 5, NO. 7, JULY 2006.
- [11] R. Mahesh and A. P. Vinod, "RECONFIGURABLE LOW COMPLEXITY FIR FILTERS FOR SOFTWARE RADIO RECEIVERS", The 17th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC'06)

#### Author's Profile

The author is pursuing her M.Tech. (ECE) thesis work in ECE from DIET, Kharar, Mohali, Punjab INDIA. His field of interest is in DSP based signal conditioning and image processing based applications.