Volume 3, Issue 6, June 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Study on Detection and Removal of Ghost Artifacts in HDR Image

Baba Fakruddin Ali B H, Suresha D
Computer science Department, VTU
Tamilnadu , India

Kareemunisa S
Electronics Department, VTU
Tamilnadu , India

Abstract- ***Digital cameras can only capture a limited dynamic range, when taking a photograph of a scene bright areas tend to be over-exposed while dark regions tend to be under-exposed. These bright and dark regions appear saturated in the image, to enlarge the dynamic ranges panned by conventional cameras a very interesting and power full technique has been developed in the last few years high dynamic range imaging. The obtained images are called high dynamic range (HDR) images, We will use many techniques for fusion these low dynamic images to get high dynamic image here we discussing two methods namely fusion in radiance domain and fusion in image domain. The main limitation of the multiple exposures combination technique is the requirement of a complete static scene when capturing the images. Indeed, any object movement in the scene can cause ghosting artifacts in the resulting HDR image. Here we use four methods to detect the ghosting in HDR image namely Variance based ghost detection, Entropy based ghost detection, Prediction based ghost detection, Pixel order relation, Removing ghosting artifacts in the combined HDR image is the ultimate aim of any method that addresses the ghost problem. Different methods produce different results and can be classified into two main categories. Keeping a single occurrence of moving object, removing all moving objects. Methods that combine exposures in the radiance domain give a true HDR radiance map which might be useful for later processing or display applications, there is no single best method and the selection of an approach depends on the user's goal. For removing all moving objects in the final HDR image, hence further research is required.***

Keywords— ***Misalignment, Ghosting, dynamic range, Radiance, fusion.***

I. INTRODUCTION

Digital cameras can only capture a limited dynamic range and most monitors and displaying media also have limited dynamic range due to the limited capacity of digital sensors, when taking a photograph of a scene bright areas tend to be over-exposed while dark regions tend to be under-exposed. These bright and dark regions appear saturated in the image. Digital cameras can only capture a limited dynamic range and most monitors and displaying media also have limited dynamic range due to the limited capacity of digital sensors, when taking a photograph of a scene bright areas tend to be over-exposed while dark regions tend to be under-exposed. These bright and dark regions appear saturated in the image. HDR images can be obtained using either hardware or software methods. The most common method for HDR image generation is based on the combination of multiple distinct exposures the simple and easy to implement technique suffers from two main problems:

(i) Misalignment: global camera motion, from hand-held camera for instance, results in misaligned images that cause the combined HDR image to look blurry.

(ii) Ghosting: moving objects in the scene while capturing the images, will appear in different locations in the combined HDR image, creating what are called ghost or ghosting artifacts.

The first problem can be solved by placing the camera on a tripod or by using an image registration method.

The second problem is a more several limitation of the multiple exposures technique since motion is hardly avoidable in outdoor environments. This drawback limits the application of HDR imaging in practice.

II. THE MULTIPLE EXPOSURES COMBINATION TECHNIQUE AND THE GHOST PROBLEM

High dynamic range images may be captured from real scenes or rendered by computer graphics techniques. The most common approach to obtain an HDR image is to take multiple images of the same scene with different exposure times, and combine them into a single HDR image,

The multiple exposures technique is based on the observation that taking multiple images with different exposures, each pixel will be properly exposed in at least one image. There- fore, an HDR image is obtained by appropriately combining the LDR images.

DEFINITIONS & NOTATIONS

Dynamic range of an image can be defined as the ratio between the lightest and darkest pixels For a camera, the dynamic range is the ratio of the luminance that just saturates the sensor and the luminance that lifts the camera response to one standard deviation above the noise level**,**

Radiance is a radiometric quantity that measures the amount of light passing through or emitted from a particular point in a given direction,

Camera response function of a digital camera is a function that maps the radiance values of a scene to the pixel values in the captured image.

FUSION IN THE RADIANCE DOMAIN

This HDR image generation method consists of three steps,

First, The camera response function is recovered to bring the pixel brightness values into the radiance domain. This function models the effect of nonlinearities introduced in the image acquisition process. Since the camera response function is not always provided by manufacturers, different methods are proposed for its estimation from a sequence of differently exposed images,

Second, All radiance maps are combined into an HDR image encoded specially to store the pixel values that span the entire tonal range of the scene.

Third, a tone mapping operator is used to make the HDR image display- able on common low dynamic range monitors,

let {Lk}k=1…N be a set of N images with exposure $\{\Delta t_k\}_{k=1...N}$. Given the camera response function f(), the HDR image is computed as the weighted average of pixels values across exposures using the following equation:

$$R_{uv} = \frac{\sum_{K=1}^{N} W(Z_{uv}^{k})f^{-1(z_{uv}^{k})}/\Delta t_k}{\sum_{K-1}^{N} W(Z_{uv}^{k})}$$

Where R is the combined radiance map, $Z_{\mu v}^{k}$ is the pixel value at location (u, v) in exposure Lk and $W(Z_{uv}^{K})$ is the weight of that pixel, The weighting function W () is designed to reduce the influence of unreliable pixels such as saturated ones.

In order to display the obtained HDR image on a low dynamic range monitor, a tone mapping operator is applied. Tone mapping techniques can be classified into global and local methods. Global methods specify one mapping curve that applies equally to all pixels, while local methods provide a space-varying mapping curve that takes into account the local content of the image.

FUSION IN THE IMAGE DOMAIN

(*Equations are referred by Abhilash Srikantha,De´ sire´ Sidibe****)***

They directly produce a tone mapped- like HDR image. However, methods that fuse the images in the radiance domain produce a true HDR radiance map in the combination step which contains the whole dynamic range of the captured scene. This radiance map can later be used for different processing or display applications.

This is the other methods combine multiple exposures directly without the knowledge of the camera response function These methods combine LDR images by preserving only the best parts of each exposure. The final HDR image is obtained as a weighted average of pixel values across exposures

$$I_{uv}^{C} = \sum_{K=1}^{N} W(Z_{uv}^{k})Z_{uv}^{k}$$

Where I^{C} is composite image

The choice of the weighting function is crucial to get good and accurate results. combine multiple exposures using contrast, saturation and well- exposedness as parameters for weighting functions. They also use a Laplacian pyramid blending framework to avoid artifacts in the composite image,

The two different HDR image generation processes are depicted in Fig. 1. The performance of the methods that combine images in the radiance domain highly relies on an accurate estimation of the camera response function, which is sensitive to image noise and misalignment. Moreover, these methods require tone mapping operators for HDR images reproduction. Methods that combine exposures in the image domain are more efficient since they avoid the estimation of the camera response function and do not require tone mapping.

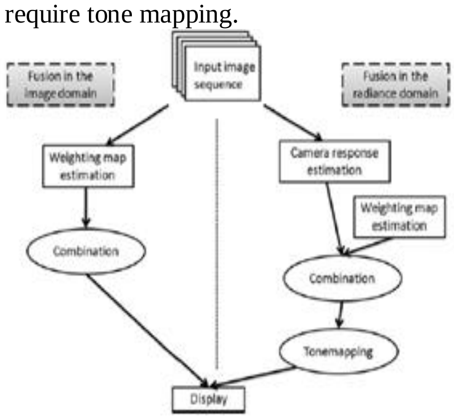


FIG 1HDR image generation process

THE GHOST PROBLEM

The main limitation of the multiple exposures combination technique is the requirement of a complete static scene when capturing the images. Indeed, any object movement in the scene can cause ghosting artifacts in the resulting HDR image. The ghosting problem is a severe limitation of the multiple exposures technique since motion can hardly be avoided in outdoor environment which contain moving entities such as automobiles, people and motion caused naturally; due to wind for example. Even a very small or limited movement will produce a noticeable artefact in the combined HDR image. Therefore, detecting and removing ghosting artifacts is an important issue for the automatic generation of HDR images of dynamic scenes.

FIG 2 (A) six low dynamic exposures, (b) hdr image by combining ldr images

The ghosting artifacts created by the moving cyclist are visible in Fig.2. An example of HDR image generated with moving object

III.GHOST DETECTION METHODS

Ghost detection methods are based on motion detection in the exposures sequence. Basically, we can identify two type of motions in a dynamic scene:

(i) a moving object on a Static back ground, e.g. moving people or cars;

(ii) a moving background with static or dynamic objects, e.g. windblown Leaves or waves. Some of the following methods can detect only the first type of motion while others can detect both

VARIANCE BASED GHOST DETECTION

This method detects ghost regions based on a weighted Variance measure First, the camera response function is estimated and the radiance maps are computed. Then, a Variance Image is generated by evaluating the variance of radiance values at each spatial location (u, v)

$$VI_{uv} = \frac{\frac{\sum_{k=1}^{N} W(Z_{uv}^{k})(E_{uv}^{k})^2}{\sum_{k=1}^{N} W(Z_{uv}^{k})}}{\left(\frac{\sum_{k=1}^{N} W(Z_{uv}^{k})(E_{uv}^{k})^2}{\sum_{k=1}^{N} W(Z_{uv}^{k})}\right)^2} - 1$$

Z_{uv}^{k} =pixel value at the position (u,v) in exposure L_k

E_{uv}^{k} =estimated radiance value at the position(u,v) in exposure L_k.

$$W(Z_{uv}^{k}) = \begin{cases} Z_{uv}^{k} & if\ Z_{uv}^{k} \leq 127 \\ 255 - Z_{uv}^{k} & if\ Z_{uv}^{k} > 127 \end{cases}$$

As regions affected by movement exhibit high variance, the VI can, be used as a likelihood measure for intra-image movements .Regions where this local variance measure is above defined threshold are detected as ghost regions

$$G_{uv} = \begin{cases} 1 & if\ VI_{uv} \geq threshold \\ 0 & otherwise \end{cases}$$

The threshold is set to 0.18 for the normalized VI. For colour images, the VI is calculated as the maximum over the three colour channels. Morphological operations (erosion and dilation) are then applied to remove outliers, false detections and to obtain closed and well defined structures

ENTROPY BASED GHOST DETECTION

There are two types of motions: high contrast movement and low contrast movement. The former type of motion occurs when the moving object is different from the background and can be detected using the variance measure above. The latter type of motion occurs when the dynamic object and the background are similar in colour and cannot be detected by the variance measure.

Hence, they introduce another measure derived from entropy. First ,a local neighbourhood based entropy map is computed for each LDR image .For each pixel (u, v) in Lk, the entropy is calculated from a local histogram computed in the window of size (2r+1) X (2r+1) around (u, v)

$$H_{uv}^{k} = -\sum_{x=0}^{B-1} P(X=x) \log P(X=x)$$

where B is the total number of histogram and the probability is obtained from the normalized histogram. It is to be noted that the product term in above Eq. is set to zero if P(X=x)=0.

An Uncertainty Image (UI) is then derived from the weighted difference of the pre computed entropy images as follows:

$$\mathrm{UI}_{uv} = \sum_{k-1}^{N} \sum_{l-1}^{l<k} \frac{V^{kl}}{\sum_{k-1}^{N} \sum_{k-1}^{l<k} V^{kl}} h_{uv}^{kl}$$

With $h_{uv}^{kl} = |H_{uv}^{k} - H_{uv}^{l}|$ and
$V^{kl} = min(W(Z_{uv}^{k})W(Z_{uv}^{l}))$

The weighting function is defined by

$$W(Z_{uv}^{k}) = \begin{cases} \left(Z_{uv}^{k} \times \frac{0.9}{127}\right) + 0.05 & if Z_{uv}^{k} \leq 127 \\ (225 - Z_{uv}^{k}) \times \frac{0.9}{127} + 0.05 & if Z_{uv}^{k} > 127 \end{cases}$$

This uncertainty image is used to find ghost regions based on thresholding

$$G_{uv} = \begin{cases} 1 & if\ UI_{uv} \geq threshold \\ 0 & otherwise \end{cases}$$

The threshold value is set to 0.7 for a normalized UI computed from the entropy images obtained with r=40 and B=200. Similar to the variance measure, for colour images the UI is calculated as the maximum over the three colour channels

PREDICTION BASED GHOST DETECTION

In this method, the deviation between the predicted intensity value of a pixel and the actual intensity is used as a measure to decide between ghost and non ghost pixels. More precisely, given two images L_k and L_l, one tests if the value of a pixel in L_l is well approximated by the predicted value from L_k using the estimated camera response function. The prediction is based on the following equation:

$$Z_{uv}^{-1} = f\left(\frac{\Delta t1}{\Delta tk} f^{-1}(Z_{uv}^{k})\right)$$

Where f () is the camera response function and, Δtk and $\Delta t1$ are the exposure times of Lk and Ll, respectively.

For each pair of consecutive input LDR images, pixels that show a significant difference between the predicted value and the actual one, are marked as ghost pixels in the corresponding ghost map

$$G_{uv} = \begin{cases} 1 & if |Z_{uv}^{k} - Z_{uv}^{k}| \geq threshold \\ 0 & otherwise \end{cases}$$

Using above equation we can find the threshold.

PIXEL ORDER RELATION

This method relies on the order relation between pixels values in differently exposed images to find ghost areas .More precisely, it is possible to relate pixel values to radiance values using the camera response function

$$Z_{uv}^{k} = f(E_{uv}^{k} \Delta t_{k})$$

Then, assuming that f() is monotonic, which is a reasonable assumption since an increase in radiance values always produces an increased or equal recorded pixel values , it can be shown that for each pixel location(u, v) the intensity values in different exposures must satisfy

$$Z_{uv}^{k} \leq Z_{uv}^{l} \; if \Delta t_k < \Delta t_l$$

Therefore, if the input LDR images are arranged in increasing order of exposure times, the ghost map is generated by the following equation:

$$G_{uv} = \begin{cases} 0 & \text{if } Z_{uv}^{1} \leq Z_{uv}^{2} \leq \cdots \leq Z_{uv}^{N} \\ 1 & \text{otherwise} \end{cases}$$

As the above order relation works only if the pixel is not under- or over-exposed, saturated pixels are excluded from the ghost map computation

IV. DEGHOSTING ALGORITHM

(Equations are referred by Artefact-free High Dynamic Range Imaging Orazio Gallo, Natasha Gelfandz,)

To create an HDR image without duplication or ghosting artifacts are present. Duplication can be avoided by using a single image from the stack as a reference. Additionally, if its dynamic range is extended exclusively with consistent regions from the rest of the stack, ghosting artifacts will not be introduced. Assume that the input images are aligned and that we have an estimate of the camera response function.

REFERENCE IMAGE SELECTION

Reference image from the stack so we can determine and omit inconsistencies of the rest of the exposures with respect to it. Consistency with the rest of the exposures means absence of ghosting artifacts; additionally, because the reference is a single image rather than a combination, it is guaranteed to be self-consistent, thus no duplication artifacts are possible. On the other hand, even with a moderate amount of motion in the scene, it is virtually impossible to automatically generate a self-consistent reference frame by pasting regions from different images in the stack, Because the final result is an HDR version of the reference frame, it is often useful to let the user select it. In this way, undesired objects can be removed, provided that there is at least one exposure where they do not appear, if every exposure in the stack is acceptable to the user, the reference frame should be chosen carefully for it strongly impacts the final result. Note that the picture with the overall best exposure, typically the middle one, is not necessarily the optimal choice: an image that is globally over or under exposed in which, however, texture is completely preserved, should be preferred to one that is perfectly exposed, apart from one or more completely saturated regions. Regions that are over or under saturated, in fact, do not provide any valuable information to avoid ghosting.

Find the saturated pixels in each image of the stack to suggest a good reference frame, then remove small saturated regions with morphological operators (erosion followed by dilation) because, for such areas, the neighbourhood usually contains enough information to avoid artifacts. Finally we pick the exposure with the fewest remaining Saturated pixels.

EXTENDING THE DYNAMIC RANGE

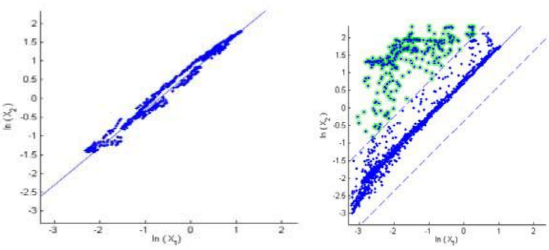
The reciprocity assumption states that, if the radiance of the scene does not change, the exposure time X and the irradiance E are linearly related through the exposure time Δt:

$$X = E. \Delta t.$$

In other words, given the value at the pixels p_i in the I th image of the stack, the exposure at all corresponding pixels in the jth image with relative exposure ev_{ij} should satisfy

$$X(pi) = X(pj).ev_{ij}$$

Aside from over and under saturated pixels, shown in above Eq. should only break when the scene changes, and can therefore be used to decide if the irradiance at a given pixel in the reference frame can be combined with that of the corresponding pixel in another image in the stack. In practice, however, a small misalignment or imprecise estimation of the camera response function can produce large deviations from this behavior. To obviate this lack of robustness at the pixel level, instead compare patches.



(a) (b)

Fig 3. The values at the pixels in one patch are plotted versus those of the corresponding pixels in an image which is one stop brighter. For matching patches, (a), the data points should lie on the line y = x + ln(evij). We can measure the ghosting value of two patches by computing the percentage of points that are more distant than a given threshold from the line. In (b) such points are indicated by green circles and the threshold by the dashed line.

Figure 3shows the log-exposure of each pixel in one patch of one image, plotted versus the log-exposure of the corresponding pixels in an image one stop brighter. Each dot in a plot corresponds to one colour channel for a pixel, thus an RGB pixel produces three dots. Figure 3(a) shows a result when the scene within a patch aligns well. Taking the logarithm of Eq shown above.

we get

$$\ln(X(p_2)) = \ln(X(p_1)) + \ln(ev_{12}),$$

That is each log-exposure value in a patch should be offset by a constant value.

The ideal transfer function is marked by the straight 45^0 line, and the corresponding pixels cluster very close to the line. However, when the scene changes within the patch, the exposure values at the same pixel coordinates do not follow this simple relation, as shown in Figure 3(b). Based on this observation, we define the ghosting value, a measure of the deviation of the exposure in a patch from the model predicted from another patch. We first detect the set of outliers, samples that are farther than a threshold from the expected line (see circled samples in Figure 3 (b)).The ghosting value for the pair of patches is the maximum, over the three colour channels, of the number of outliers over the total number of pixels in the patch. In other words, the ghosting value measures the percentage of pixels that can cause ghosting in a patch.

Then determine whether the patch pair is consistent by using a second threshold, this time on the ghosting value. Both thresholds can be selected by the user to adjust the sensitivity to ghosting: while more conservative thresholds may be required in some situations to remove subtle ghosting, they potentially limit the dynamic range of the final image. In the results presented in this paper, because the different exposures were at least one stop apart, the first threshold was set to 0.75, and the patch was accepted when containing less than 0:5% of outliers.

With this approach, we can find, for a given patch in the reference frame, all the consistent patches in the other images in the stack.

BLENDING

The log-irradiance $L_i(p)$ of each input image i at pixel p can be estimated, given the camera response function g as:

$$Li(p) = g\left(Ii(p)\right) - \ln(ti);$$

where I_i denotes the i^{-th} input image and t_i is the correspondent exposure time.

Multiple exposures for each pixel p can be combined with a weighted average to get the HDR irradiance map L_H.for each patch find the largest set I of input images that are consistent with the reference image; two neighbouring patches should therefore merge seamlessly, even if they are computed from different subsets of exposures, L being a property of the scene.

In practice, significant artifacts are often visible at the boundaries of blocks averaged from different sets of input images because of inaccuracies in the camera response function estimation. To compute the final radiance image with no visible boundary,

First, the gradient G(p) of the log-irradiance image is estimated at each pixel in a block as

$$\boldsymbol{G(p) = \nabla L_H(p)},$$

Where $L_H(p)$is computed from the exposures in I only, and G (p) = [Gx (p); Gy (p)] is the numerically estimated gradient field of the sought log-irradiance image inside the block.

Next, G is extended over the entire image by pasting the gradient fields of all image blocks. The value of the gradient at the boundary of the patches needs to be hallucinated, for example by replicating its last row and column. In order to avoid additional artifacts before detecting potential ghosts, extending the patches by one row and one column. In addition to providing the real gradient at each location of the patch, this strategy also benefits the consistency of the gradient between neighbouring patches, as it causes nearby blocks, which are already consistent with the reference image, to overlap in the log-irradiance domain.

The final log-irradiance image L_H can be estimated by integrating the gradient field G(p) over the image domain. To do this, we aim to estimate an image whose gradient is closest to G, in the mean squared error sense. Formally, the solution LH must minimize

$$\iint \|\nabla L_H - G(P)\|^2$$

where the integration is done over the entire image. According to variational analysis theory, the solution to above Eq. must satisfy the following Euler-Lagrange equation at each pixel location p:

$$\Delta L_H^*(p) = divG(p),$$

Where Δ and div stand for Laplace and divergence operators, respectively. Above Equation is known as Poisson equation, for which various numerical solutions have been described. for solving the differential equation Neumann boundary conditions is Imposed . In other words, the gradient of L_H is assumed zero at the boundary of the image along the boundary normal.

Because solving above Eq for each colour channel separately, also correct the colour balance of the output. After converting L_H to the estimated irradiance E, pick a pixel $\hat{P}$ that is not affected by ghosting when averaged over all the exposures and calculate its irradiance$\hat{E}$. Pick a pixel $\hat{P}$ that is not affected by ghosting when averaged over all the exposures and calculate its irradiance$\hat{E}$. Then scale E so that E ($\hat{P}$) =$\hat{E}$.

V. CONCLUSION

The ghost problem in high dynamic range (HDR) imaging is presented and recently proposed methods to solve this problem are reviewed. Each method is described in detail and a comparison and classification of the reviewed ethods is proposed. The comparison is based on a quantitative evaluation of the accuracy of the different methods in detecting ghost regions in a given sequence of exposures. We classify the methods based on the fusion domain, the need for a ghost map computation, the number of exposures required, the setting of parameters and the removal of ghost in the final HDR image. The results show that high contrast movement, i.e. a moving object different from the background, can be correctly detected while small and low contrast movements, i.e. similarity in colours between the object and the back-ground, which are more difficult to find, are detected by entropy, pixel order, multiple thresholding and prediction based methods. It can also be inferred that methods such as pixel order, multiple thresholding, graph-cuts based and prediction based methods well localize the ghosts whereas methods based on entropy have poor ghost localization in the scene. Methods that combine exposures in the image domain are time-efficient as they avoid the camera response function estimation and tone mapping. On the other hand, methods that combine exposures in the radiance domain give a true HDR radiance map which might be useful for later processing or display applications

Generally speaking, there is no single best method and the selection of an approach depends on the user's goal. For removing all moving objects in the final HDR image, iterative methods achieve good results but are computationally expensive. Methods that discard exposures affected by ghost in the combination, thus using a subset of the input exposures sequence, provide good results with low complexity. For keeping the moving object at a fixed location in the combined HDR image, a good ghost map is required at the ghost detection stage, To remove ghosting artifacts this paper presented an algorithm capable of capturing as much dynamic range of a scene as possible, without introducing ghosting. When the scene is static, this approach is equivalent to standard HDR techniques; otherwise it successfully determines which regions can be combined with the reference image from other exposures in the stack so that consistency is preserved. This algorithm proved successful on a variety of different scenarios, even when the motion affects a substantial part of the scene. In addition to preventing artifacts, it also allows the user to select the reference frame so as to remove potentially unwanted objects. The idea can be extended to other applications requiring a stack of pictures, as we showed by de noising images affected by ISO noise.

ACKNOWLEDGMENT

As I present before you this paper on "STUDY ON DETECTION AND REMOVAL OF GHOST ARTIFACTS IN HDR IMAGE", I take this opportunity to thank those, who have helped and encouraged me through this work. But behind the work done are the invisible help, support and guidance of a large number of well wishers. I would like to thank first and foremost Lord Almighty and our parents.

I would like to express my deep gratitude to my guide Prof.SURESHA, Dept of CSE, for their invaluable help and support who has extended his wholehearted support, guidance and assistance for the successful completion of the report.

I extend my thanks to**,** Head, Prof. SHIVAKUMAR K.M DEPARTMENT OF CSE, and all the lecturers and staff of the Department of Computer Science and Engineering, Canara Engineering College, for their advice, kind co-operation and help during the development of this paper.

I would owe a great debt to our Principal, Dr. NAGESH PRABHU for giving me meticulous support during the development of the paper.

I would like to thank my FAMILY MEMBERS and FRIENDS for their unfailing moral support and encouragement.

REFERENCES

[1] Artefact-free High Dynamic Range Imaging Oration Gallo, Natasha Gelfandz, Wei-Chao Chenz, Marius Tico z, and Kari Pulli.

[2] Ghost detection and removal for high dynamic range images: Recent advances Abhilash Srikanth, De´ sire´ Sidibe

[3] T. Mitsunaga, S.K. Nayar, High dynamic range imaging: spatially varying pixel exposures, in: Proceedings of the IEEE International Conference on Computer Vision and Pattern Recognition, 2000,

[4] R.A. Street, High Dynamic Range Segmented Pixel Sensor Array, US Patent, 1998.

[5] J. Tumblin, A. Agrawal, R. Raskar, Why I want a gradient camera, in: Proceedings of the IEEE International Conference on Computer Vision and Pattern Recognition.

[6] G. Ward, Robust image registration for compositing high dynamic range photographs from hand-held exposures, Journal of Graphics Tools 8 (2003).
[7] C. Harris, M. Stephens, A combined corner and edge detector, in: Proceedings of the 4th Alvey Vision Conference, 1988.
[8] Agarwala, M. Dontcheva, M. Agrawala, S. Drucker, A. Colburn, B. Curless, D. Salesin, and M.Cohen. Interactive digital photomontage. ACM Trans. Graph, 2004
[9] J. D. Hoffman. Numerical Methods for Engineers and Scientists. CRC Press, 2001.
[10] E. Reinhard, G. Ward, S. Pattanaik, P. Debevec, and High Dynamic Range Imaging: Acquisition, Display and Image-Based Lighting, Morgan Kauffman, 2005.

AUTHORS PROFILES

Mr. Baba Fakruddin Ali B H received his B.E degree in Electronics and communication engineering from Islamiah Institute of Technology, Bangalore in 2011. Currently he is perusing M.Tech degree in Computer Science and Engineering at Canara Engineering College, Mangalore. His areas of interest are Image processing, embedded system.

Ms. Kareemunisa S received her B.E degree in Electronics and communication engineering from Islamiah Institute of Technology, Bangalore in 2011. Currently she is perusing M.Tech degree in Electronics Engineering at HKBK Engineering College, Bangalore. Her areas of interest are Image processing, embedded system, RTOS, and Vxworks

Mr. Suresha D, Asst Professor, is a Faculty of Canara engineering college, Mangalore at visvesvaraya Technological University Belgum, Karnataka. Prof. Suresha D obtained his B.E (computer science and engineering) from Kuvempu University, Jnanasahyadri, Shankaragatta and M.Tech (computer network engineering) from visvesvaraya Technological University Belgum, Karnataka. his research area include image processing, information and network security and Adhoc Networks. He has published 6 international journal and 2 national conference paper.

