Enhancement of Context by Image Fusion

Jagpal Singh Ubhi, Jaspreet Kaur

***Abstract*—This paper presents the algorithm required to fuse the images during the night time so as to give the proper context to the low quality image. As in the night, the traffic is not clear and also the nearby surroundings, hence the proper background is provided to make them more informative. Mainly, the moving objects are to be captured from the low quality image which is the main challenge. The basic algorithm called frame subtraction based (FSB) image fusion is presented. In the results, smooth background fusion is achieved with the low quality image.**

***Index Terms*—image fusion, background fusion, foreground extraction, binarization and filteration.**

I. Introduction

FOR traffic surveillance, night time images are not informative from security point of view as they lack the high contrast background due to poor illumination. While looking into the image it is difficult to understand from which region this image has been taken It is also difficult to decipher any nearby information about surroundings. So the main thing to be done is to give proper illuminated background to the night time image taking into consideration the artifacts that may occur during the fusion such as aliasing, haloing and ghosting [1] [2]. Two main steps need to be followed in this, are background fusion and foreground extraction. These two technologies are required to be developed in such a way so as to maintain the proper quality of the image along with the defects that may arise during the fusion process. In this prototype, the traffic camera can observe the scene all day long and create a high quality background. Then, we can simply enhance the context of the low quality image by fusing this background.

In the next section, the previous related work is discussed. In the section 3, the basic algorithm for extraction and fusion is detailed and after that the final results and conclusion are presented.

II. Related Work

The image fusion idea was first invented by Marey and Murbridge in 19th century [1], but the main work was done in 2002 by UK ministry of defence to guide the pilots in the night. The basic algorithm first developed, processes the basic source image itself which reduces the contrast of the final image. After that pyramid based technique is evolved which makes use of pyramid transforms to get the fused image. These transforms have the advantage of providing sharp contrast and also the spatial and spectral information of the pixel is retained [3]. But the problem that may arise with this transform is its inability to work on real time. Also the artifacts may occur on the edges as some part of the image is not taken into the transform. Then the wavelet and region based transforms are evolved. These two give satisfactory results in the image fusion but in both of them the main part is the selection criteria of the pixel which has to be retained from the entire captured images to final fused image. Mostly, the maximum absolute amplitude is selected from the component which leads to the high fluctuations on the edges of the image [4]. Along with this, the wavelet transform consumes lot of time when implemented on the real time videos. When wavelet transform is used alone it does not provide good results, however, with Intensity Hue Saturation (IHS) transform the results become smoother [5]. IHS, Principle Component Analysis (PCA), filter fusion techniques are not giving good results. They have to deal with the each pixel of the image so some part of the image is good and some not [6]. Along with this, segment based fusion is giving satisfactory results in remote sensing but in image fusion for static scene or for videos it consumes large memory and time [7]. Taking into consideration the real life examples to implement, our algorithm is developed which considers whole frame at once and not each pixel.

Moreover, to get more information during the night time, the use of high resolution cameras everywhere is also not cost effective. Applying the high intensity light sources on the roads pose problems for the drivers in the night. While capturing the image, it not only takes the image of road but nearby surroundings also, which is important as those contain perceptual cues to be preserved during the fusion. So capturing that image properly by applying light sources in the surroundings may disturb the owners. Also, in some of the buildings which are important from security point of view, security equipments used in them mostly work efficiently during the day because during night time noise becomes more significant. So the main objective of this work is to make such an algorithm which is cost effective, fast and gives proper results so that highly enhanced image can be obtained.

III. Image Fusion Methodology

Image fusion is the basic technique by which the images taken under different illuminations are combined to get

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higher informative image. The main objective of fusion is to extract the high informative part from the image, reduce the artifacts and give reliable results. It increases reliability by the redundant information and capability by complimentary information.

In the system process, the base image is extracted from the sequence of images captured during the day and same process is done on the night time images. After this, the fusion on the two is done.

A. Background Extraction from Day and Night Time Image

Firstly, the images are captured from the model. The difference of all the images is computed so as to detect the changes occurring in them. These difference images are changed to black and white image by binarization. The filter is used to remove the noise. Then, this binary image is fused with first image to compute the background for fusion.

Acquisition of Images

First and important part of the algorithm is to acquire the images and use them in MATLAB platform. For this, the camera has to be interfaced using Image Acquisition Toolbox. An object is created in it which makes the images captured and uses them in prototype for processing.

Storing and Difference of Images

The images are captured from the camera and stored in an array. All these images are used to calculate the difference in order to detect the change occurring among the images. The change then has to be removed as fixed background is required for fusion process. For extracting the change, the difference is calculated in backward direction also so that every change in adjacent images is also detected.

Binarization

This is the process of converting the image into black and white having the pixel values of 0 or 1. With the binary image, it is easy to distinguish objects from the background. The grayscale image is converted to a binary image via thresholding. The output binary image has values of 0 (black) for all pixels in the original image with luminance less than threshold level and 1 (white) for all other pixels. Thresholds are often determined based on surrounding lighting conditions. After observing many images of different illumination, a threshold value of 30 was found to be effective. Fig. 1 shows the binary image of the difference image. The criteria used in choosing the correct threshold was based on the idea that the binary image of the static background should be majority white, allowing a black portion where change is occurring.

Filtration

Removing the noise from the binary image is very important as noise leads to the distortion in the fused image. It might happen frequently that binary image may contain some unnecessary pixels. Some commands in MATLAB have been used for filtration of the binary images [8]. Fig. 2 shows the filtered image of the binary image.

Final Image

Now this filtered image has to be used for extracting the fixed base image. All the images are compared, binarized, filtered and multiplied with the first image from the array and are summed to get one final image containing all changes occurring in the images. The format of the data in which the image is represented in MATLAB is very important as it may give undesirable results. Till the summation point, the whole data is in double format and after that the mean of that image is done so as to make the pixel value within the range of 0 to 255 unless it poses the problem as discussed in section IV. To show the image, the data is converted to uint8 format. This is the final day time reference image and same procedure is done for extracting the night time reference image used for fusion.

Fig. 1. Binary image

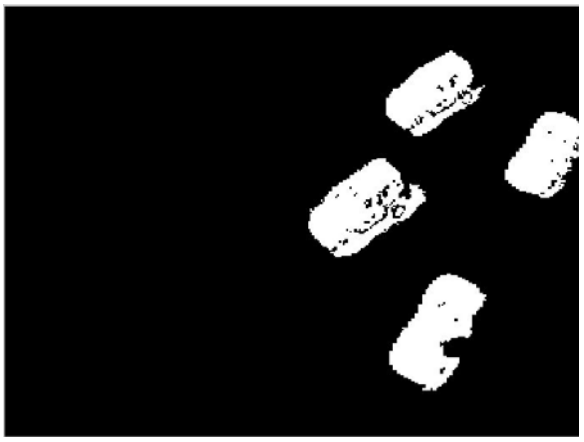

Fig. 2. Filtered image

B. Fusion Process

After extracting both the base images the fusion prototype is implemented to get the fused image. Firstly, the image which is to be enhanced is captured from the camera. After doing the binarization and filtration on this image the binary image is multiplied with the new image to extract the fore ground which means the moving traffic on the image which is used as it is in the fused image. After this, the binary image is multiplied with day time referenced image to get the enhanced background with the change black in color. At last, these two, the extracted foreground and enhanced background image are fused together to get final

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result. Fig. 3 explains the whole flowchart of fusion process.

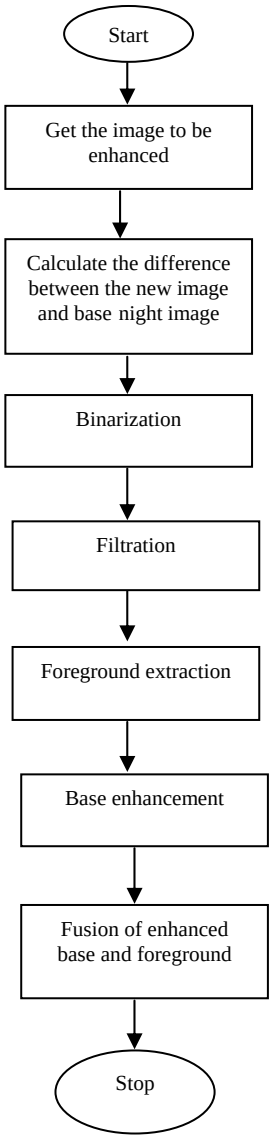

Fig. 3: Flow chart of fusion process

IV. Challenges Faced

This section explains the problems faced while implementing the algorithm.

Proper Thresholding

In this work, while doing thresholding main problem is faced to get the proper value for thresholding. If proper value is not detected then the proper change occurring in the image is not determined. Also, while combining all the three components of the image which are obtained after thresholding, logical operation 'OR' will work properly. If logical 'AND' operation is used then very little change is detected. If an 'addition' operation is performed, pixel values get changed in the binary image and the detected change is not retained. It means that the image becomes coloured instead black and white.

Change in Format

Another problem in extracting the base image of day time when the binary image is added with the first image is that it becomes black and white without removing the change that is present in the first frame. This arises due to change in format of the image data which is stored in the matrix. To overcome this problem, backward difference is also calculated to remove the change in the image.

Rounding of Pixel Values

Another major problem faced is, at the end, almost white image is obtained because after doing addition of all images most of the pixel values go above 255, and all those pixel values are rounded to this value. 255 means white color so most of the image becomes white. This problem is removed by averaging the image data with the number of frames used to get the image.

V. Results

The images are compared and evaluated on the basis of mean, standard deviation and entropy. Entropy mostly deals with the information content of the image, more the entropy value more the information [9]. Each result is in accordance with R, G and B components separately. The evaluation parameters are presented in Table I which show that frame subtraction based image fusion technique adds good information in images, as it is clear from the entropy values. But the image evaluated on the basis of entropy alone cannot provide the quality assessment of the image. More entropy means more information content but it is not clear that the information content added is actually the required image content or the noise. So in order to make good comparison, about the image quality, the Image Noise Index (INI) [10] is also calculated as shown in Table II. From INI, the enhanced information can be decided as proper information or the noise. If INI is going positive it shows that the proper quality is being added and if it is negative it shows noise content is more significant.

TABLE I
Evaluation Parameters

Image	Band	Mean	Standard Deviation	Entropy
Frame subtraction based fused image	R	100.727	10.938	6.94
	G	94.038	12.328	6.85
	B	90.536	16.305	6.95

Table I shows that frame subtraction based image fusion technique adds good level of information in images, as it is clear from the entropy values. But to get the clear idea about the image quality, the INI is calculated shown in Table II.

TABLE II
INI values of Fusion

Image	Entropy of fused image	Entropy of restored image	Enhanced image content	Noise	Signal	INI
FSB-R	6.94	4.31	2.63	1.84	0.79	0.429
FSB-G	6.85	2.90	3.95	1.44	2.51	1.74
FSB-B	6.95	2.51	4.44	1.32	3.12	2.36

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Table II shows that INI values of the image are positive which means that increase in image content is actually the information content and not the noise.

The images next give the final results of the algorithm. Fig. 4 shows the night time image needed to be enhanced. The day and night time reference images are shown in Figs. 5 and 6. Fig. 7 represents the foreground extraction, which is the traffic during the night time needed to be fused at the end. Base enhancement is shown is Fig. 8 which is extracted using the day time reference image. Finally, the fused result is shown in Fig. 9.

Fig. 4: Night time image to be enhanced

Fig. 5: Day time reference image

Fig. 6: Night time reference image

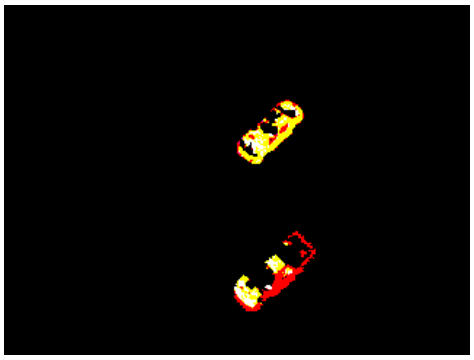

Fig. 7: Foreground extraction

Fig. 8: Base enhancement

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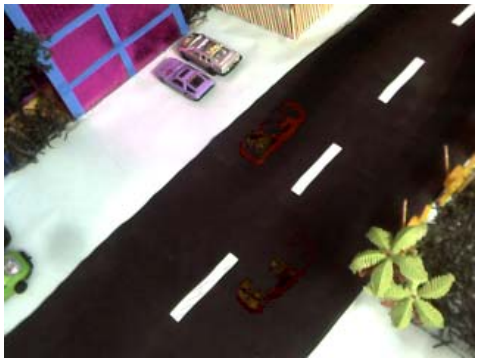

Fig. 9: Fused image

VI. Conclusion

The new technique frame subtraction based image fusion, explained above gets highly enhanced night time images which are cost effective and fast enough to give reliable results as shown in tabular form. This method also consumes less memory as compared to the previous methods.

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