IMAGE ENHANCEMENT FRAMEWORK FOR ARMY APPLICATIONS

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ABSTRACT

Image processing is widely known field of study gaining momentum with the daily requirement to enhance and improve the quality of images. Image processing is a core technology used in numerous fields. Its used in Defense and Military applications to improve image and video quality. Mostly images face problems like turbulence, noise, distortion, haziness due to which army people are unable to read the image. The army people also find difficulty in identifying objects in image to find intruders. Various techniques have been stated over the years in order to improve the quality of these images and video. In order to improve image quality we have implemented and assessed certain algorithms along with image quality assessment metrics. Several trails will be made using different techniques and the results for the same will be presented.

Keywords: Image Enhancement, Super Resolution, Turbulence, Noise Reduction, Contrast

1. INTRODUCTION

Image processing is a domain where we apply certain algorithms on an image to get some useful information for the image. Different hardware technologies have evolved to reduce the destortion in images but due to turbulence the need for software image processing techniques is prevelant. The image enhancement techniques can help to mitigate the problems caused by sensors or environment providing better task performance for operators. The military environment affects the quality of the image highly. For military purpose several techniques are being studied for the improvement of situational awareness. In military applications due to turbulence and moving stations distortion and haziness is high in images. Also the terrain and atmospheric turbulence play a vital role in this[1]. To give the observer a comfortable view various image processing techniques like contrast adjustment, super resolution, turbulence mitigation, artifact reduction, stabilization, automation can be used. These image enhancement techniques will also give us faster observations and long range vision which will reduce the stress for long range images. These techniques improves the visibility of the images making it comfortable for the army operator to read. These techniques will also help the army operator to identify suspicious objects or the movements of the intruders. The cost of sensors is also a major concern for most applications, high cost of sensors gives sensors with more precision this is where the super resolution comes into picture. The requirement is for these techniques to process data in short span to give enhanced results in real time. These techniques have been utilized on audio and video processing. Also various image quality assessment parameters have been tested to asses the quality of the algorithms. GNU Octave is highly used in image processing and for applying various numerical operations on images. The image data matrix will be processed using image processing algorithms and octave coding.

The main focus for army applications is high resolution of image and situational awareness. The main component for situational awareness is the camera as it captures every movement of the intruder. The resolution of the image is an important factor when it comes to situational awareness. Resolution of the image is mostly improved by combining the low resolution and high resolution images. Evaluating a high resolution image is hard due to some problems. The first problem is due to noise, it is difficult to make out difference between noise. Frequency plays important role when it comes to noise, therefore frequency should be evaluated properly. Super resolution involves various image enhancement techniques such as noise reduction and edge enhancement. The problem is that this image enhancement techniques noise reduction, edge enhancement, super resolution are dependent on each other therefore, they cannot be evaluated separately but it gives us some visible results[2]. Turbulence is mostly created due to atmospheric conditions. The Atmospheric conditions near the army base camps can be extreme sometimes which automatically leads to increase

the turbulence range in images. Therefore, turbulence mitigation becomes important factor to be resolved for army applications.

Human eye have visibly long range of vision as compared to camera. The human eye has higher dynamic range than camera which automatically decreases the visibility of objects seen in pictures compared to naked human vision. Human eye is capable to make out the details of the objects in both light and dark part of the landscape, but when the same landscape is captured in an image it fails to capture every detail of the image in landscape due to irregular lighting. Therefore, lighting is the major factor when it comes to images. So, it becomes important to improve the contrast of the image so that we can get visible amount of light in every part of the image making it easier to read. To make the objects more visible in the image various image enhancement techniques are used in which contrast is one of the technique. There are various contrast enhancement techniques used. The first technique to improve the contrast of an image is by using global contrast stretching where the image is adjusted to available range. This is the most easiest method but fails when the ranges are extended, it is beneficial only in available range. Global gamma correction can be carried out to enhance contrast in parts with available contrast range. Another technique for contrast enhancement is through histogram equalization where the luminance values are altered to get a flat histogram but, the main disadvantage of this technique is that it doesn't give a natural look to our output image[3].

2. PROPOSED FRAMEWORK

To obtain deployment and implementation of various image enhancement techniques, an overall design is provided with different block diagrams and different techniques used.

2.1. Super Resolution

Super resolution algorithm is used to increase the ppi/dpi of an image thus attaining a superior quality image. It also provides a cost effective zoom.

In single super resolution the recordings of the same scene are combined to get a high resolution image. The difference between the recordings is calculated and depending on this difference we get a new and improved high resolution image. The visibility which lags in army field images is recovered by applying super resolution on that image. The details which are hardly visible in the original image are cleared after getting the resolved image which helps in faster object identification[4]. We consider a low-resolution image as two parts: one is the smooth image and the error image between the low-resolution image and the smoothing image. We get an intermediate high resolution image by performing bicubic interpolation on low resolution image. We then generate high resolution smoothing image using smoothing method. The high resolution image is the combination of high resolution smoothing image and high resolution error image[5].

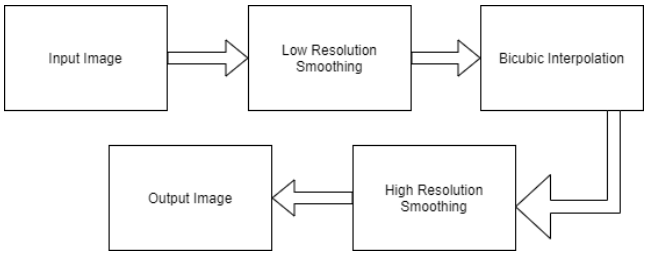


Figure 1: Block diagram for Single super resolution using bicubic interpolation.

2.2. Contrast Adjustment using LACE algorithm

LACE stands for Local Adaptive Contrast Enhancement. The dynamic range of a landscape imagery can lead to loss of information due to low lighting effects which reduces the contrast. Therefore, the visualization capacity of a particular display device decreases.To improve the visualization of the image and gather all the information present in the image we use Local Adaptive Contrast Enhancement technique. Local Adaptive Contrast Enhancement evaluates the overall dynamic range of an image and tries to maintain and give a natural look of a particular image. LACE allows us to get the details of darker as well as parts of an image. There are two versions of LACE mostly used: mild and medium. The mild version of LACE is used for situational awareness where we broadly focus on large scale details rather than small scale. The medium version of LACE is mostly used for detection where where we broadly focus on small scale details rather than large scale[1].

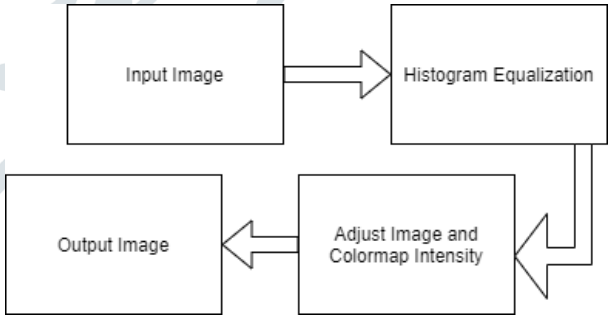


Figure 2: Block diagram for LACE.

2.3. Noise Reduction using Median Filtering

The median filter is a salt and pepper noise remover filter which is a non-linear digital filtering technique .It is greatly useful in pre-processing for reduction of the salt and pepper noise.The median filter increases the peak signal to noise ration value and mean square value thus increasing the the quality of the degraded image.By applying the median filter to the input image constantly the image quality is enhanced considerably[7].

2.4. Image stitching

Camera gives us only limited field of view but for the army applications we require overall field of view just like a panorama where small parts of fields or images are stitch together to give more prominent view of the field. For stitching we take various images of the field as input images then we find the key points of every image. After finding the key points we try to match the key points of various images. The images are stitched together once the key points are matched. The results of the stitched images will immediately show us some interesting objects in the surrounding enhancing the awareness of the task operator[6].

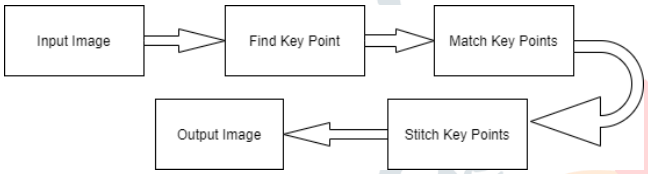


Figure 3: Block diagram for Stitching.

2.5. Turbulence Mitigation

Turbulence usually takes place due to extreme atmospheric conditions. This deteriorates the imagery which is captured in cameras over long range. As the visualization of cameras is weak as compared to human eye, we have to perform certain operations to increase the visualization capacity. Army people work mostly in extreme weather conditions therefore, turbulence mitigation is important for army applications.

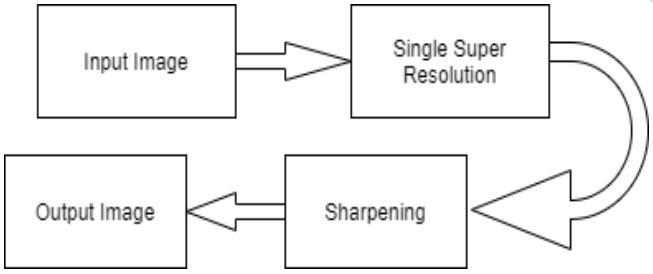


Figure 4: Block diagram for Turbulence Mitigation.

For turbulence mitigation we take the input of the image and then apply the algorithm of single super resolution on the image. After getting the high resolution image we sharpen the image using image sharpening technique. After sharpening the image we get the output result which deteriorates the turbulence effect from the image and gives it a clear vision.

2.6. Filtering

2.6.1. Median Filter

Median filters are basically used to reduce the noise present in an image, which is achieved by sliding a window over an image. It helps in preserving useful information of the image. The filtered image is obtained by determining the median value from the sorted neighbouring pixels. Median filters are said to be more robust in nature compared to average. As an edge is crossed, one side or the other dominates the window, and the output switches sharply between the values. Thus, the edge is not blurred. These filters are particularly easy to implement, by performing successive operation over the rows and columns of the image.

2.6.2. Average Filter

The Average filter is also called as mean filter. Average filter is also required to reduce the noise in the image. Average filter is a linear filter. The mean is determined by calculating the sum of all pixels in the kernel and then dividing by the number of pixels in the kernel. Edge pixels which are located near the edge of an image are replicated. This method smooths the appearance of the image.

2.7. Target Acquisition

Target Acquisition is acquired by performing object recognition, object detection and image segmentation. All of these methods helps us to identify and detect the objects, people present in the image. All these methods helps the army soldiers to check the presence of an intruder or to detect suspicious object present in the image as well as video.

2.7.1. Object recognition

An object recognition system recognizes the objects that are present in the image using object models, datasets which are created previously. Object recognition is performed easily and instantaneously by human eye and brain but, for a electronic machine we have to apply some computational algorithms to recognize objects. Giving intelligence to a computational device is a difficult task. Also, the algo- rithmic descriptions for implementing intelligence is difficult. Features are the main attributes in object recognition.Features help in describing and recognizing an image.

2.7.2. Object detection

Object detection is a computer technique which locates instances of objects in an image or video. Object detection is performed easily and instantaneously by human eye and brain but, for a electronic machine we have to apply some com- putational algorithms to detect objects. Object detection is a crucial part for army applications, our soldiers require object detection to detect if any intruder is present. so, if the intruder is present it alarm the army soldiers.

2.7.3. Image segmentation

Image segmentation is also an important and commonly used technique in image processing, where the objects are getting highlighted. Image segmentation helps us to separate objects in an image into set of regions, often based on the characteristics of the pixels in the image. Group of pixels in an image having border and a particular shape are called regions. When an intruder or any suspicious object do not cover the whole image, we can the apply image segmentation.

3. EXPERIMENTAL RESULTS

For Analysing out outputs we have made used of histogram. Histogram analysis in image processing normally refers to the number of pixel intensity values and how these values are spread on the graph.

3.1. Super Resolution

In Super Resolution we have studied two different algorithms i.e. SSR and ISR.We have compared these two algorithms using PSNR values of the output image ofboth the algorithms. PNSR value is directly proportional to the quality of image.Therefore, the output image with highest PSNR value gives better results. ThePSNR value we have got for SSR is 21.424 and for ISR is 22.754. Therefore, wecan say that Image Super resolution algorithm provides better results and quality.

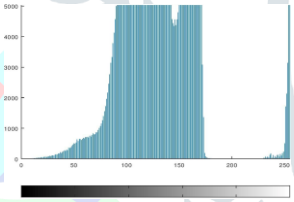
3.1.1. Single Super Resolution

The mechanism behind resolution enhancement is that temporal resolution of image sequences is exchanged for spatial resolution while improving signal to noise ratio. Here, recordings of the same scenes are combined to get high resolution image. Also, the edges of the image are shown more appropriately. The PSNR value we get for the outputimage of SSR is 21.424.

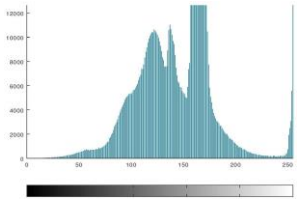
(a) color original image

(b) intermediate image

(c)high resolution image



(e) Input histogram



(f)Output histogram

Figure 5: Single Super resolution results.

We can see that input histogram goes beyond range for some interval where as output histogram is scattered all over the scale and gives us almost proper curve, which indicates that we have got correct output.

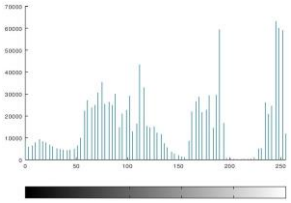
3.1.2. Image Super Resolution

In super resolution the recordings of the same scene are combined to get a high resolution image. The difference between the recordings are calculated and depending on its difference we get a new and improved high resolution image. Interpolation works by using known data to estimate values at unknown points. Here, we have used bicubic interpolation. The PSNR value we get for the output image of SSR is 22.754.


(a)Original Image


(b)Image after lossy compression


(c)Contrast adjusted


(d) Histogram


(c)Resolved image of the compressed image after noise cancellation


(d) Resampled image of the compressed image


(e) Contrast with stretch limits

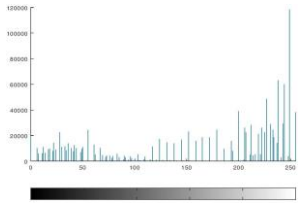

(f) Histogram

Figure 7: LACE results.

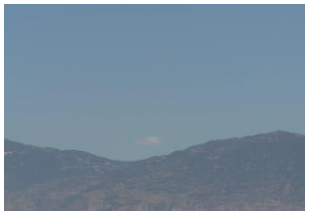

(e) Image after resampling after bicubic interpolation

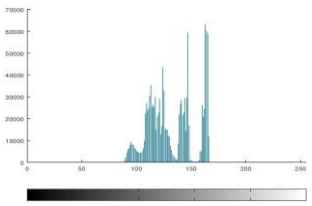

(f)Super resolved image after ISR prediction

Figure 6: Image Super resolution results.

3.2. Contrast Adjustment using LACE algorithm

LACE retains small amplitude details while compressing the overall dynamic range of image and tries to maintain overall natural look. We have calculated histograms for original image as well as contrast adjusted images. The points in histogram increases as contrast levels are increased giving more appropriate output.

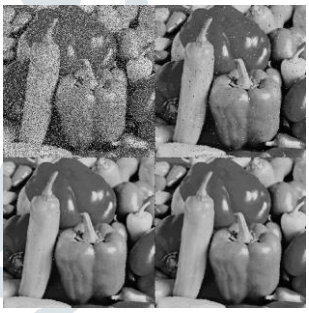


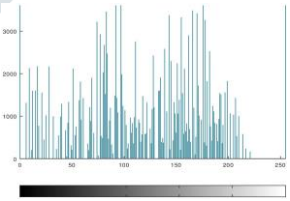


(a) Original Image (b) Histogram result for original image

3.3. Noise Reduction using Median Filtering

The noise that is the pepper salt texture in the image is removed and clear output image is obtained. The histogram shows the difference between the input image and the output image. More points are precisely plotted in the output of the histogram for output image.


(a) Noise reduction


(b) Input histogram

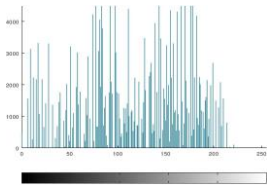

(c) Output histogram

Figure 8: Noise Reduction using Median Filtering results.

3.4. Image stitching

Image Stitching is combining multiple images or we can also say as overlapping the field of view to produce a panorama. Image stitching requires nearly exact overlaps or the exact key points to produce correct results.

(a) Left input

(b) Right input

(c) Stitched image

Figure 9: Image stitching results.

3.5. Turbulence Mitigation

(a) Input Image

(b) Intermediate

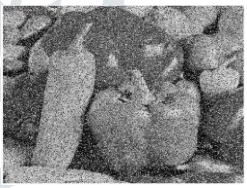
(c) Output Image

Figure 10: Turbulence Mitigation results.

The main of Turbulence mitigation is to stabilize and sharpen the recorded images sequence based on the image data. The results reduce the turbulence and provide more seamless results.

3.6. Filtering

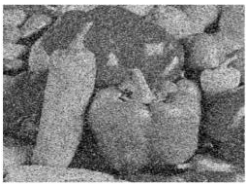
Applying median filter which is a non linear filter we see that the output which we get in figure 10(c) shows slight dotted lines after concatenating the original image which is firstly broken into four. Whereas, in case of average filtering which is a linear filter the dotted lines disappear and we get a proper image just by using 25concatenating operation. Figure 5.10(d) gives the output for average filter. This also shows that the output we get by applying local average filtering is better than local median filtering. We can also say that, in this case linear filters give a better output than non linear filter.



(a) Input Image

(b) Global median filtering

(c) Local median filtering



(d) Global Average filtering (e) Local Average filtering Figure 11: Filtering results.

3.7. Target Acquisition

Object recognition is refers to a collection of related tasks for identifying objects in digital photographs. From figure 11(a) we can see that the program predicts the image of a dog as German shepherd with a probability of 0.99 which is nearly equal to 1 which says we got correct output. From Figure 11(b) we can see that the program detects the objects present in the image such as dog and people along with the probability of that object being dog or a human.

(a) Object recognition

(b) Object detection/Image segmentation Figure 12: Target Acquisition results.

4. CONCLUSION

We have implemented different image enhancement techniques like components of LACE, single image super resolution, noise reduction, stitching and turbulence mitigation algorithm that are required in the army context. The his- togram analysis shows the difference between the input and output images, where the histogram for output images be- come more appropriate after applying image enhancement techniques. These image enhancement techniques provide better observation over long range, better observation in foggy and rainy conditions and also cost effective. We have also seen that linear filters give better results than non-linear fil- ter for local filtering. We have also performed several algo- rithms required to acquire target i.e. intruder or suspicious objects at army fields. Above tasks helps make army task operator easier so that they can perform better on field.

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