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# Image Resolution Enhancement Methods for Different Applications

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**Abstract**

In this paper various enhancement techniques are discussed and compared. Various methods for image resolution enhancement had been discussed which shows we can enhance the images on color scale by using different techniques nowadays. Different areas in which image enhancement can be used are compared in this paper. We will discuss the methods which can enhance the resolution of MR images, images taken by regular cameras, Built-in camera image of a Mobile phone, vehicle camera images and an aerial image.

## Introduction

Image enhancement is the name of the technique that can be used to enhance the perception or in other words the interpretability of data information in images which is present in the pixels for creating a good quality for human viewers and also better "input" generated for other automated or programmed techniques of image processing. The main objective of image enhancement or augmentation is to modify the characteristics of an image in order to increase its quality so that it is better suitable for a particular task and also for the specific watcher or viewer. For this improvement to take place some of the attributes of the image are needed to be changed or improved by using certain methods such as; the spatial domain method is a method in which it works by dealing directly with the pixels of the image. For getting the desired improvement, values of the pixels are manipulated. Second is the frequency domain methods, the image file are needed to be converted into frequency domain before operating on it. First of all, image is calculated for the Fourier transform [1][2].

Resolution has been frequently referred as an important aspect of an image. Images are being processed in order to obtain more enhanced resolution.[14] Image

resolution enhancement techniques can be classified into two major classes according to the domain they are applied in: 1) image-domain; and 2) transform-domain. The techniques in image-domain use the statistical and geometric data directly extracted from the input image itself, while transform-domain techniques use transformations to achieve the image resolution enhancement.[17] There are many conventional image resolution enhancement methods like Nearest neighbour, linear, quadratic and cubic interpolation functions. But these methods suffer from problems like blurring of edges, ringing around edges and loss of texture [13] this is because they do not utilize any information relevant to edges in the original image.[15] The decimated discrete wavelet transform (DWT) has been widely used for performing image resolution enhancement.[19].

Image resolution enhancement is one of the most common methods of low-level digital image processing. Digital image processing field defines the treatment of digital images by means of a digital computer. A process of low-level enhancement has both its inputs and outputs as images. Low-level processes involve primitive operations such as noise reduction, contrast enhancement and image sharpening [2]. The goal of image enhancement is to provide a more appealing image, with easier differentiation of objects, and improved clarity of object features and surface details [4].

To check the quality of a visual image best method is via subjective evaluation. However, subjective evaluation is inconvenient, time-consuming and expensive. Thus we can use objective image quality assessment to measure the quality of an image as it can automatically predict the image quality [9].

**Classification and basic techniques of Image Enhancement**

The main objective of image enhancement is to modify the given image so that it can be more suitable for a particular task or a particular observer as required. During image enhancement process, one or more attributes of the image are amended. The choice of attributes that are to be modified and the way how they will be modified are different for different tasks. Also, factors related to observers, such as the observers visual system and the observer's experience, is also a deciding factor to the choice of image enhancement methods. There are many techniques that can enhance an image without spoiling it. The two main categories into which enhancement methods can be divided are:

1. Spatial Domain Methods
2. Frequency Domain Methods

In spatial domain methods, we deal directly with the pixels of an image. The values of the pixels are used to achieve required enhancements. In frequency domain techniques, the image is first changed into the frequency domain. To do this, the Fourier Transform of an image is calculated first. The enhancement operations are performed on this Fourier transform of the image and then to get the resultant image Inverse Fourier transform is performed. These enhancement operations can be performed to change many attributes like, image brightness, contrast or the

distribution of the grey levels. As a result the pixel value of the output image gets modified according to the transformation functions that are applied on the input values [11], [12].

**Basic steps performed for Image Enhancement**

There are many different techniques that could be used an image. But the basic steps used by each of these techniques could be defined as follows:-

**A. Identification:-**

The First and foremost step in image enhancement is to identify the image and the transformation that is to be used. Let *f* is the image and it has to be converted into image *g* by using the transformation *T*.

**B. Getting the Pixel values:-**

In this step we have to get the values of Pixels. Different techniques use different methods to get these values. Let *r* be the pixel value of image *f* and *s* be the pixel value of image *g*. Then r and s are related to each other as,

$s = T(r)$

Here *T* is a transformation that maps the value *r* into value *s*.

**C. Mapping:-**

In the last, results of the transformation are mapped back into the image range, which can be defined as [0, L-1], where L=2k, k being the number of bits of the image being enhanced. For instance, for an 8-bit image the range of pixel values will be from 0 to 255[11],[12].

**Review on Image Enhancement Techniques**

1. Resolution enhancement in MRI
2. Mean and Variance Adjustment
3. Road Image Enhancement Technique
4. Unmixing-Based Fusion Approach

**Comparative review of techniques discussed**

Performance evaluation of an image enhancement technique is quite difficult, as usually subjective evaluation is used in practice. But there are some objective evaluation techniques also. The “Resolution enhancement in MRI” technique gave a lot of improvement; it gave improvement from a factor of 3 to a factor of 17. But the problems with this technique were error control mechanism problem and Optimization problems.[5] The second technique we discussed was Mean and Variance Adjustment. This algorithm gave better results in terms of high speed, Low Memory etc. and also gave blur free images, but the main problem with this technique

was to select the appropriate exposure time.[6]

The third technique was Road Image Enhancement Technique. This technique achieved resolution improvement and occlusions removal, and also succeeded in update of a large road image, but there were some problems like large ego-motion, obstacles without movement and also failure in some cases.[7] The last technique was Unmixing-Based Fusion Approach. This technique showed best results compared to other fusion Techniques. It enhanced the spatial resolution with very small spectral distortion and also it is easy to implement.[8]

**Table 1:Comparision Between Various Techniques**

| Technique | Information or process used | Advantages | Disadvantages | Major applications |
|---|---|---|---|---|
| *Resolution enhancement in MRI[5]* | Intensity of each voxel | Enhances without noise | error control and Optimization problem | MRI Images |
| *Mean and Variance Adjustment[6]* | Mean and variance | High speed, Low memory | Exposure time problem | Poor mobile phone images |
| *Road Image Enhancement[7]* | mosaicing | occlusions removal | ego-motion and obstacles | Larger images like maps |
| *Unmixing-Based Fusion Approach[8]* | spectral information | Good spatiak and spectral pweformance | distortion due to the unconstrained unmixing | all kinds of images |

**Conclusion**

In this paper, we have discussed several approaches for image enhancement. All the techniques and operations defined above are provide an efficient working and the output image is enhanced according to the user's requirements. These techniques are user friendly and can be accessible without many hassles.

In this table the quality evaluation metric of image zooming in our method uses is as follows: MOS image quality is as subjective visual evaluation; MSE (mean error) demonstrates whether the zoomed image is just the same as the original one; LVE (luminance error) reflects the luminance difference of zoomed image and the original one [11]; SFE (spectrum flatness) reflects the image smoothness[12]; PSNR(peak signal-noise ratio) is just the most similar to human visual effects.

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