Image Processing: Methods, Techniques, Applications Review

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ABSTRACT

Nowadays, image processing became very important especially in real-time where the results of real-time image processing failures can be severe; therefore, the study and research in methods of real-time image processing are of extreme significance. The main contribution of this paper is to provide an overview of the current state of real-time image processing research (Applications), the relevant techniques, and methods.

Keywords: Image processing techniques of image processing, applications image quality improvement

1 Introduction

Images are everywhere in our life We have many goals from image processing, but the important goal is recognition Where some images have information are inaccurate these need to improve image data so that human can understand it better, e.g., in medical images, we need to adjust and improve the images so the doctor can take the optimal treatment decision. Others need some pre-processing so that the machine can understand the image and make an appropriate decision without the intervention of the human element, e.g., treatment of medical images to detect diseases. We can see from these examples that real-time image processing has an important role in our lives that are constantly evolving. We have two Types of methods used for image processing: Analog Image Processing: Here we process analog signals that have two-dimensional representation only, where the images are modified by electrical signals, e.g., television images Digital Image Processing: Here we represent the image by a matrix of pixels where the image contains a set of elements that need to be processed, we can do that by many library and algorithms, e.g., image recognition.

In this paper, we need using Real-Time processing that it consists of two parts: Hard Real-Time Systems: These systems are highly sensitive to the time factor, so any delay may system collapse, significant physical damage or even loss of life as aircraft surveillance systems. Soft Real-Time Systems: These systems also have time constraints on the tasks they perform, but a small or a few delay times can be tolerated, so that the overruns do not result in system crashes or large losses compared to systems with hard restrictions.

In recent years, it has been observed that academic research to real-time image processing (RTIP) has attained positive development where Real-time processing has become an important part of digital image processing and it has a lot of applications in medical and Measuring Traffic Parameters...etc. One of the keys enablers of the rapid progress of academic real-time image processing research has more than library help us and make processing it simple as OpenCV. Real-time image processing applications are envisioned to grow rapidly due to entering all areas of our life. Some applications as Face Detection, Digital Video Processing, Biomedical Image Enhancement & Analysis, Character Recognition etc. In this paper will review most methods, techniques, and applications that may be used by new researchers to further develop the real-time image processing (image recognition). This paper was organized as follows: Section 2 we will

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show methods and algorithm that used in image (enhancement, restoration and compression). While in section 3, we will describe the new techniques using in real-time image processing like image segmentation, edge detection, corner detection...etc. Talk about applications of real-time image processing in section 4. After that, come to some challenges that facing RTIP, insection5. In section 6, we have a conclusion about this study.

2 Methods

2.1 Image Enhancement

Image Enhancement means elimination obstacles that prevent us from interpreting and analyzingtheimagesothatchangingthecontentofimageinformation(pixels)

(a) (b)

Figure 1. (a) Noisy image, (b) Enhanced image

Now we will point out some image enhancement techniques in the following sub- sections:

Interpolation

Image Interpolation is technique using for image scaling. Where it is a process of enlarging the image without distortion and it has two types are bilinear and bicubic (uses 2x2 neighborhoods of data points to calculate pixel color) Bilinear (uses 4x4 neighborhoods of data points to calculate pixel color between data points)

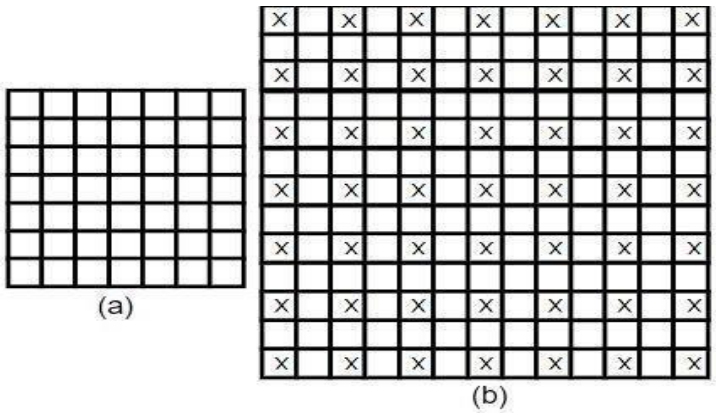

Figure 2. (a) Original image of M * N, (b) Expanded image of size (2M-1) * (2N-1)

Contrast enhancement

In contrast enhancement we are improving the quality of image information before the beginning processing it.

Figure 3. Contrast enhancement

Density slicing

Divide the image into regions (set of pixels) based on the density or threshold, then assigning each one to a color (N.R. Mudigonda, et al., 2001).

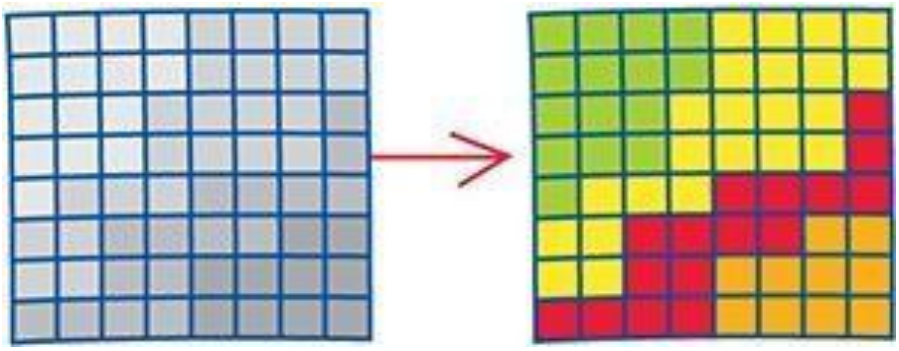

Figure 4. Density slicing

Edge enhancement

Edge enhancement is a filter using to illustrate the details of the image or video further by enhances the edge contrast. Thus, showing the objects (object edge) in the image more clearly through defines the sharp edge (where the color of the item has not to match the background color) then increases the contrast in the selected area around the edge

Figure 5. Edge Enhancement

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Noise removal

Noise removal is using techniques to remove the noise from inside the image in order to become clearer and more accurate. Where Images are often degraded by noises. This is because the pixel values are closed to the correct value that can occur by transferring the image via a medium or when moving hand when taking the image or removing the image compression may cause deformation (change the pixel correct value) ...etc.

We can remove noises by applying linear filters as Adaptive Filter and non-linear filters as Median filter or Wiener filter, but nonlinear filters are more effective

(a) (b)

Figure 6. (a) Noises image (b) After remove noises

There are many and many methods to image enhancement as:

- Intensity, hue, and saturation transformations
- Linear contrast adjustment
- Unsharp mask filtering
- Partial Differential Equation (PDE)Method
- Histogram Equalization (HE)
- Cellular Neural Networks (CNN)
- Algebraic Reconstruction Method (ARM)
- Directional Wavelet Transform (DWT)
- Spatially Adaptive Iterative Filtering
- Multi-Frame Super-Resolution
- Producing synthetic stereo images
- Alpha Rooting
- Dynamic Range Compression
- Making digital mosaics

3 Techniques

3.1 Corner Detection

Corner detection is a technique used to extract a specific feature from an image, where these corners include useful information. Corner detection is a kind of interest point detection and can be isolated into three groups: (1) Direct corner detection (2) Template- based corner detection (3) Contour-based corner detection. Corner detection has many methods where every method includes different mathematic

operations:

- Harris corner detector
- Susan Corner Detectors
- The Moravec corner detection algorithm
- The Förstner corner detector
- Robust Fuzzy Rule Corner Detector

For more information about it, you can see the flowing reference where had been highlighting their advantages and expressing their weaknesses

3.2 Focal Plane

This technique as circuit where the size, configuration, and coefficients of the spatial kernels are programmable. It has two types:

- Focal-plane SIMD: "capable of supporting real-time performances with sustained operation throughputs of 500–1500 Giga operations" (Gupta, et al.,2013).
- Focal-plane MIMD: "The chip employs a Multiple-Instruction-Multiple-Data (MIMD)architecture to provide five spatially processed images in parallel".

3.3 Image Segmentation

In Image Segmentation, we process the image by divide it into separate objects or component parts After we detected the object, each pixel is checked individually to see whether the pixel inside into the specific object or not. Segmentation can be divided into the following groups:

- **Region-Based Segmentation**

"A region is a group of connected pixels having similar properties. Region-based segmentation is a process of partitioning an image into regions. Regions are used to interpret images. A region may correspond to a particular object or different parts of an object". In addition, Region-Based can be considered as a pixel-based image segmentation method. Region-Based Segmentation Methods are: Region Growing and Region Splitting and Merging, for more information.

- **Pixel-Based Segmentation (Threshold)**

Depends on the intensity levels for image segmentation. In this technique, where the image is divided into regions and each local region has a different threshold according to its characteristics. After selecting the appropriate threshold, we convert the image into a binary image. Where to show the segmented image, we can use Histogram thresholding. For threshold segmentation, we can use techniques to post-processing and pre-processing as a visual technique, Edge Maximization technique, Histogram dependent technique, P- tile method and Mean method.

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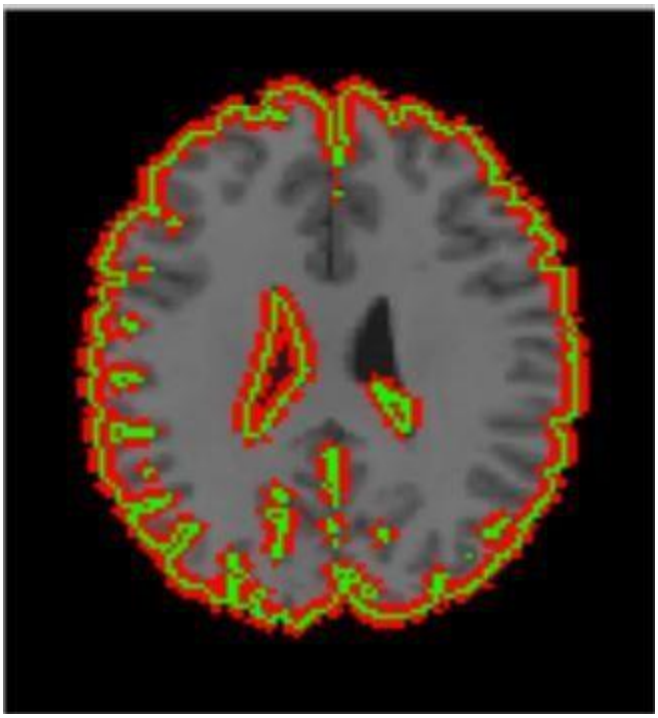

Figure 8. Region-Based Segmentation

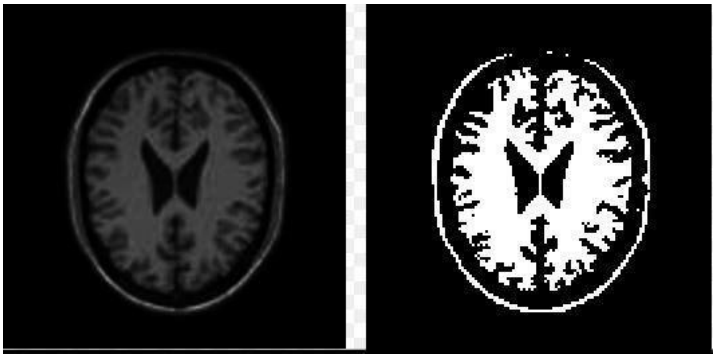

Figure 9. Thresholding Segmentation

- **Model-Based Segmentation**

Here in this technique, we have the geometric shapes that we will look for, and then compare the shapes with the local image information. We can use "Hough transform" if we have been known the exact shape of the objects contained in the image.

- **Feature-Based Clustering**

Dividing into groups where each group has specific attributes, this process called clustering. If we applied this in image processing, we produce groups with pixels where each group belongs to a specific element. We can use some methods as fuzzy C-means algorithm and K-means algorithm.

- **Edge-Based Segmentation**

In image analysis, the problem of the primary value is edge detection; here we rely on defining the desired object by specifying the edges of the objects within the processed image where it is assumed that when we have an abrupt change in the brightness or intensity value have an edge. In this technique, we have three steps to determine the edge: the first things we need is filtering and enhancement the image after that detection of edge points then edge localization. The filters using in edge detection has been classified

into two class

- First-Order derivatives filters:(1) Prewitt Horizontal filter (2) Prewitt vertical filter (3) Roberts cross filter (4) Sobel filter (5) Scharr Horizontal filter (6) Scharr Vertical filter.
- Second-Order derivatives: (1) Laplacian filter (2) Zero-Crossing filter (3) Difference of Gaussian filter.

- **Canny Edge Detection**

In 1986 the Canny Edge Detection was developed by John F., where we can use it to edge detection. To implement it we need several steps: Noise Reduction, Finding Intensity Gradient of the Image, Non-maximum Suppression and Hysteresis Thresholding.

4 Applications

4.1 Medical

Medical Imaging mainly concentrates on uncovering and revealing internal structures, which are hidden by the skin and bones. In addition, it is used to analyze, diagnose, recognize and treat the illness or disease. We can use image processing in the medical field in these departments Example Radiography, Magnetic resonance Imaging (MRI), Endoscopy, Stereo Endoscope, Computer Tomography, Electrocardiography (ECG) , Medical ultrasound, Positron Emission Tomography(PET).

5 Biometrics

Biometrics specializes in the detection of biological properties related to the characteristics of human beings, such as voice waves, DNA etc. Some biometric techniques are Example Finger print Detection, Face Recognition, Iris Recognition, Human scent recognition, EEG biometrics, Skin spectroscopy, Knuckles texture…etc.

6 Conclusion

The purpose of this review has been accomplished by giving an adequate overview of methods, techniques, and applications of real-time image processing that can help researchers working in this field.

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