A Review on Applications of Real Time Image Processing

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Abstract

Image processing has become very important especially in real-time where the results of real-time image processing failures can be critical; therefore, the research in the methods of real-time image processing is important. The main aim of this paper is to provide a review of the current state of real-time image processing research (Applications), methods and relevant techniques.

Keywords – Methods of Image Processing, Techniques of Image Processing, Application of Image Processing, Image Enhancement.

I. INTRODUCTION

Images are all around in our life. We have many goals from image processing, but the important goal is recognition (Russ, 2007). 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 better and adjust 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. (Qiu, 2005). We have used two types for image processing: [1] Analog Image Processing: Here we process analog signals that have two-dimensional representation only, where the images are modified by electrical waves.

[2] 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 (Kulkarni, et al., 2015).

In this paper, we need using Real-Time processing that it has two parts: [1] Hard Real-Time Systems: These are highly sensitive to the time factor, so any delay can collapse the system, physical damage or even loss of life .

[2] Soft RealTime 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 (Shin, 1987).

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. (Mertes, et al., 2013). 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 (EmguCV) (EmguCV, 2012).Real-time image processing applications are envisioned to grow rapidly due to entering all areas of our life (Steelle, 2019). Some applications as Face Detection, Digital Video Processing, Biomedical Image Enhancement & Analysis, Character Recognition…etc. (S.Padmappriya & K.Sumalatha, 2018).

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 show methods and algorithm that used in image (enhancement, restoration and compression). While in section 3, we will describe the new techniques using in realtime 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, in section 5. In section 6, we have a conclusion about this study.

II. METHODS

A. Image Enhancement:

Image Enhancement means elimination obstacles that prevent us from interpreting and analyzing the image so that changing the content of image information (pixels) (Kuruvilla, et al., 2016; Iwasokun & Akinyokun, 2014).

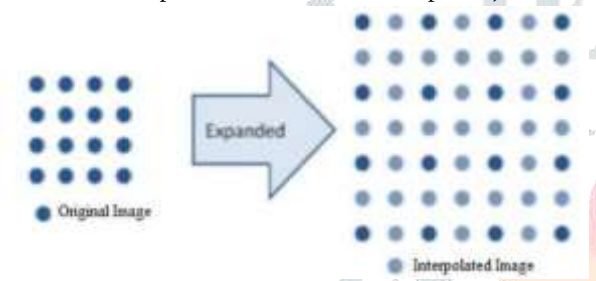
a) b)

Fig 1. *a) Noisy image, b) Enhanced image*

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

1. 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).



a) b)

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

2. Contrast enhancement:

In contrast enhancement we are improving the quality of image information before the beginning processing it (Haldar, 2013; Montoya, 2017).

Fig3. *Contrast enhancement*

3. 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).

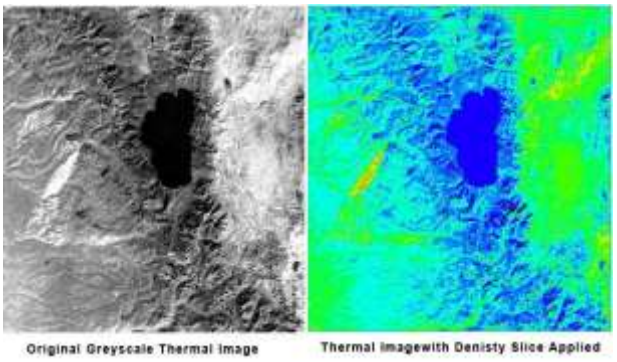


Fig4. *Density slicing*

4. 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 (JorgeL. Flores, et al., 2012; Howse, et al., 2015).

Fig 5. *Edge Enhancement*

5. 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).

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 (Hambal1, et al., 2015; Tien, et al., 2017).

Fig 6. *(a) Noises image (b) After remove noises*

There are many methods used for 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

B. Image Restoration:

The process of image enhancement and retrieval of information based on optimal criterion while in the image enhancement it was only in order to better understand the image through its visual appearance as there is no criterion for measuring the results of enhancement (Deborah & Arymurthy, 2010).

C. Image Compression:

The storage and transfer image have a high cost, to reduce the cost we can use image compression technique where it is a part of the data compression applied in digital images.

The image compression has two types:

(1) Lossless image compression: In this way, we can recover the original data from compressed data perfectly without any modifying, where we can use much technique as (1) Entropy Encoding (2) Arithmetic Coding (3) Lempel– Ziv–Welch Coding (4) Run Length Encoding (5) Huffman Encoding.

(2) Lossy Compression Techniques: Here we can reconstruct the image almost like the original image due to some change in image data when it is restored from the compressed image where we can use much technique as Predictive coding and Transform coding (Surabhi N & Unnithan, 2017).

III. TECHNIQUES

A. 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 (Trupti P. Patel & Sandip R. Panchal, 2014).

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 (Trupti P. Patel & Sandip R. Panchal, 2014).

B. Field-Programmable Gate Array (FPGA):

FPGA is an IC i.e., integrated circuit which allows us to reprogram it after manufacture, where it like programmable read-only memory (PROM) chip. We can use it in real-time image processing applications effectively because of it contains parallel programming technology like an implementation of a real-time video smoothing algorithm (Djemal, et al., 2017).

FPGA implementation uses many filters and techniques as:

- Median Filter
- Sorting Module
- Expanded
- Smoothing Filter
- Sobel Edge Detection
- Motion Blur
- Emboss Filter

C. Focal-plane:

This is a type of technique where it's similar to circuit the configuration, size, and coefficients of the spatial kernels are programmable. It has two types:

- Focal-plane SIMD: "The 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" (Cai & Etienne-Cummings, 2001).

D. Cloud:

We can benefit from the advantage of features cloud computing in real-time image processing where become less costly, optimal storage and faster to process, especially in real-time. Image processing applications we can put it on the cloud where become serves on the internet and then we can use it from other applications, e.g.

Image processing and machine vision applications designed for cell analysis we can put it on the cloud (server) then from the fix shop (client) can use it (Yan & Huang, 2014; Wilson, 2018).

E. Image Segmentation:

In Image Segmentation, we process the image by divide it into separate objects or component parts (Mcandrew, 2004). After we detected the object, each

pixel is checked individually to see whether the pixel inside into the specific object or not (Jahne, 2005). Segmentation can be divided into the following groups: Region-Based Segmentation:

"A region is a group of connected pixels which have same properties. Region-based segmentation is a process of spliting an image into regions. Regions are interpreted by images. A region may relate to a particular object or different parts of an object" (Kuruvilla, et al., 2016). In addition, Region-Based can be considered as a pixel- based image segmentation method (Jahne, 2005). Region-Based Segmentation Methods are: Region Growing and Region Splitting and Merging, for more information (Kaur & Goyal, 2015).

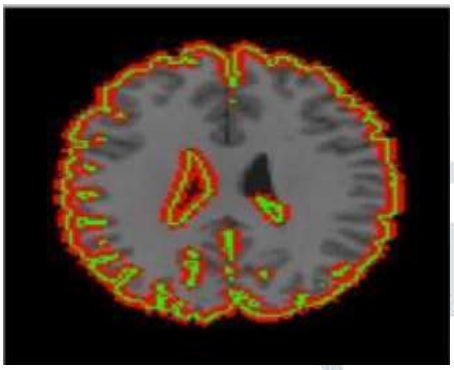


Fig 8. Region-Based Segmentation

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

It depends on the intensity levels for image segmentation. In this technique, the images are 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 preprocessing as a visual technique, Edge Maximization technique, Histogram dependent technique, P- tile method and Mean method (Mcandrew, 2004; Kuruvilla, et al., 2016; K.; E.A.Zanaty & Ghoniemy, 2016).

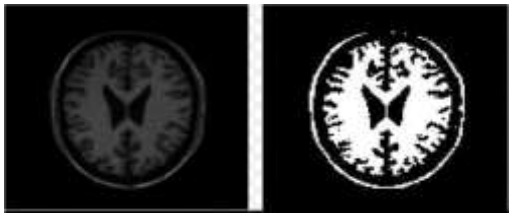


***Fig9.** Thresholding Segmentation*

- **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 sudden change in the brightness or intensity ethics have an edge (Jahne, 2005).

The filters using in edge detection has been classified into two class (Mcandrew, 2004; Qiu, 2005):

- 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.

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.

- **Model-Based Segmentation:**

Here in this technique, we have the geometric shapes that we will look for, 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 (Jahne, 2005).

- **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

Fig 10. Edge Detection

IV. APPLICATIONS

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 analyse, diagnose, recognize and treat the illness or disease. We can use image processing in the medical field in these departments

- Radiography
- Magnetic resonance Imaging (MRI)
- Endoscopy
- Stereo Endoscope
- Computer Tomography
- Electrocardiography (ECG)
- Medical ultrasound
- Positron Emission Tomography (PET).

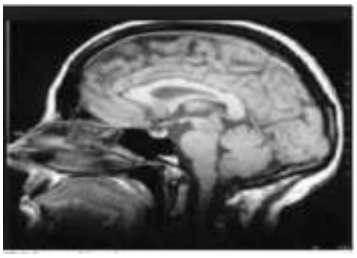


Fig 11. *MRI Image*

2) Pedestrian Protection:

"Obstacle Detection and Pedestrian Recognition *Using A 3D PMD Camera*": in this paper provide pedestrian recognition by using a 3D-camera system and appropriate algorithms for the image processing (B. Fardi, et al., 2006).

"Saliency-Based Pedestrian Detection in Far Infrared Images": this paper, it is relies on visual saliency-based pedestrian detection algorithm.

Fig 12. *Pedestrian Detection*

3) Biometrics:

Biometrics specializes in the detection of biological properties related to the features of human beings, they are voice waves, DNA etc.

The types of biometric techniques are (P. Jonathan Phillips, et al., 1998):

- Fingerprint Detection
- Face Recognition
- Iris Recognition
- Human scent recognition
- EEG biometrics
- Skin spectroscopy
- Knuckles texture

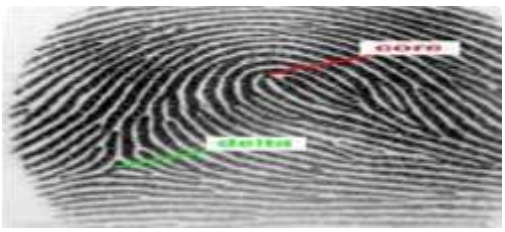


Fig 13. *Fingerprint detection*

Fig 14. *Biometrics*

We have a lot of image processing applications, some of them are mentioned below:

- Vehicle Detection and Monitoring
- Image Traffic Monitoring
- Motion Detection
- Handwriting Recognition System
- Agriculture
- Signature Verification (Pre-processing, feature Extraction, Verification)
- Object Tracking
- Automatic Target Recognition
- Traffic queue detection algorithm

V. CHALLENGES

The meaning of real-time applications means that the applications must permanently interact with the changes that occur in the environment it controls. They take the input from the environment, react with it, processing it and generate an appropriate output or change its internal state. So that we have some challenges:

- Response time
- Require growing computational power

VI. 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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