

# Real-Time Image Processing Review Paper: Methods, Techniques, and Applications

AKSHATHA J

M. Tech in Industrial Automation  
and Robotics  
Student of NIE College  
Mysuru, India  
2021mar\_akshathaj\_a@nie.ac.in

VIKRAM ATHREYA V

Assistant Professor  
Department of Mechanical  
Engineering  
The National Institute of  
Engineering Mysuru

**Abstract**—In modern days, Image processing is now of utmost importance, especially in real-time scenarios where errors in contemporaneous image processing could have disastrous results; the research and analysis methods of real-time image processing is therefore of extraordinary importance. Real-time image processing research and analysis methodologies are consequently of the utmost significance. This article's main aim is to provide an overview of the current state of real-time image processing research (Applications), useful methods, and practice.

**Keywords**— Processing images in real time, Applications of image processing, image processing techniques, and image enhancement methods.

## I. INTRODUCTION

In our daily lives, images are everywhere. In image processing, we have numerous objectives, but one of them is recognition [1]. If certain images contain inaccurate data, the image data needs to be enhanced for better human understanding, for example, in medical imaging, one must edit and to improve the photographs so the doctor can decide on the best course of treatment. Others require some pre-processing for the machine to comprehend the image and take the proper actions. In absence of human interference, such as processing of images related to medical therapy to detect diseases. From these examples, one can understand the processing of real-time image which plays a vital role in our ever-evolving life [2].

For image processing, there are two categories of techniques: 1. Analog image processing: In this step, we handle analogue signals with just a two-dimensional representation, such as television images, where the visuals are altered by electrical signals. 2. Digital image processing: In this case, the image is represented as a matrix of pixels with a set of features that need to be processed. This can be accomplished using a variety of libraries and techniques, including image recognition.

Real-time processing is required for this article and consists of two components: 1. Real-time system with aircraft tracking systems, real-time systems are extremely sensitive to timing, thus any delay can result in system failure, major physical harm, or even a loss of life. 2. Soft real-time systems: In contrast to hard-constrained systems, these systems are likewise subject to time limitations on the tasks they complete, but they can accept very little to no delay [3].

It has been noted recently that academic research on real-time image processing (RTIP) has made progress, with real-time processing now constituting a significant portion of

digital image processing and finding several uses in fields including traffic monitoring and medical parameters...etc.[4]. More than just a library and processing simplification like OpenCV, EmguCV is one of the essential requirements for the quick advancement of academic research on real-time image processing.

Applications for real-time image processing are anticipated to increase quickly as they permeate every aspect of our life. Face detection, digital video processing, biological image enhancement and analysis, character recognition, etc. are some examples of uses [5].

This article will discuss most of the approaches, tools, and software that fresh researchers might employ to advance real-time image processing (image recognition).

The structure of this article is as follows: We will demonstrate the techniques and algorithm utilized in the image in part 2. (Enhancement, restoration, and compression). New methods for real-time image processing, such as Image segmentation, edge detection, corner detection, etc., are discussed in Section 3. In Section 4, go over real-time image processing applications. then talk about some of the difficulties RTIP confronts in Section 5. We draw a conclusion on this study in section 6.

## II. METHODS

### A. Image Optimization

Image Optimization refers to removing barriers that restrict us from reading and interpreting the image in a way that modifies the information contained in the image. (Pixels)

Fig. 1. (a) Noisy image

(b) Enhanced image



Now, we'll highlight several image improvement methods in the subsections that follow:

- Interpolation
- Contrast Enhancement
- Density Slicing

- Edge Enhancement
- Noise Removal
- Otsu's Method

#### B. Restoration of Images

Information retrieval and image enhancement are both based on ideal criteria; however, image enhancement simply serves to improve understanding of the image by its visual appeal because there is no standard for gauging the success of enhancement [6].

#### C. Compression of Images

The cost of image storage and transfer can be reduced by using image compression techniques, which are used in conjunction with data compression in digital photographs.

There are two types of image compression: (1) Lossless image compression: By using techniques like (1) entropy encoding, (2) arithmetic coding, and (3) Lempel-Ziv-Welch encoding, we can properly restore the original data from compressed data without any modification. Run Length Encoding, Huffman Encoding, and four more. (2) Lossy Compression Methods: In this case, we can rebuild the image nearly identical to the original image owing to a change in the image data when it is restored from the compressed image. We can do this by using methods like predictive coding and transform coding [7].

### III. TECHNIQUES

#### A. Edge Detection

Corner or edge detection is a method for extracting a particular feature from an image when the corners contain important information. A type of interest point identification, corner detection can be divided into three categories. (1) Direct corner detection (2) Corner detection using templates (3) Corner detection using contours [8].

There are numerous approaches to corner identification, and each one uses various mathematical procedures:

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

You can view the flowing reference for additional details about it, where had been emphasizing their benefits and outlining their drawbacks [8].

#### B. Field-Programmable Gate Array (FPGA)

FPGA is an integrated circuit (IC) like a programmable read-only memory (PROM) chip in that it may be modified after production. Because it incorporates parallel programming technologies, such as an implementation of a real-time video smoothing method, we may utilize it successfully in real-time image processing applications. FPGA implementations employ numerous filters and methods, including:

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

#### C. Segmentation of Images

When processing an image, we break it into individual objects or component elements [9]. Each pixel is verified separately after the object has been spotted to determine whether it is a part of that object or not. The following categories can be used to categorize segmentation:

##### ➤ Segmentation Based on Region

A region is a collection of related pixels that are connected. An image is divided into regions by a process called region-based segmentation. Images are interpreted using regions. A region could represent a specific object or various components of an object. Region-Based can also be viewed as a pixel-based image segmentation technique. Methods for Region-Based Segmentation are Region for Growing, Splitting and combining, for higher information [10]

##### ➤ Segmentation Based on Pixel (Threshold)

Depending on the segmentation of images intensity levels. This method divides the image into local regions, each of which has a unique threshold based on its features. We turn the image into a binary image after choosing the proper threshold. We can utilize Histogram thresholding to determine where to display the segmented image. The Edge Maximization technique, the Histogram dependent technique, the P-tile method, and the Mean method are all visual post-processing and pre-processing techniques that can be used for threshold segmentation. [9][11][12].

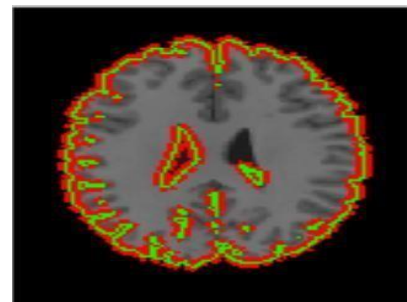


Fig. 2. Region-Based Segmentation



Fig. 3. Thresholding Segmentation

#### ➤ Segmentation Based on Model

In model-based segmentation, geometric shapes are searched for in the photos and matched to previously gathered local knowledge about the images. The "Hough transform" can be utilized if the anticipated forms of the image's items are already known.

#### ➤ Segmentation Based on Edge

When it comes to image analysis, edge detection is the main issue. The edges of an item in an image must be defined during image processing to define the object. This is accomplished by presuming that the brightness difference or hue change near the edge is noticeably high. To determine an edge, this method comprises three steps: image enhancement and filtering, edgepoint detection, and edge identification.

Two categories have been established for the filters used in edge detection [9][2]:

First-Order derivatives filters:

- (1) Prewitt Horizontal filter
- (2) Prewitt vertical filter
- (3) Roberts cross filter
- (4) Scharr Vertical filter
- (5) Scharr Horizontal filter
- (6) Sobel filter

Second-Order derivatives:

- (1) Zero-Crossing filter
- (2) Laplacian filter
- (3) Difference of Gaussian filter.

### IV. APPLICATIONS

#### A. Medical Application

The primary goal of image processing applications in the medical industry is to locate or reveal the internal organs of the body that are covered by skin or, in some circumstances, disguised by bones. Additionally, it is used to identify, diagnose, and treat the disease or condition. At this time, image processing can be used by the medical specialties listed below:

- a) Radiography
- b) Stereo Endoscope
- c) Endoscopy
- d) Magnetic Resonance Imaging (MRI)
- e) Positron Emission Tomography (PET)
- f) Electrocardiography (ECG)
- g) Medical Ultrasound
- h) Computer Tomography.

#### B. Transport

Recent development in the field of Autonomous Vehicles has given rise to a field that deals with the goal of making driving easy and safe, or in other cases studying the techniques to achieve unmanned autonomous driving.

For this, the image processing is used to identify the roads, pathways, obstacles, pedestrians and other vehicles.



Fig. 4. (a) Endoscopy image

(b) MRI image

#### C. Pedestrian Protection Application

"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 [13].

"Saliency-Based Pedestrian Detection in Far Infrared Images": in this paper, proposed a visual saliency-based pedestrian detection algorithm [14].

#### D. Application in Biometrics

The field of biometrics focuses on the identification of biological traits that are connected to human features, such as voice waves, DNA, etc. The following are a few biometric methods [15]:

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

Comparison of different biometric techniques [16]

Biometrics	Accuracy	Cost	Size of template	Long term stability	Security level
Facial Recognition	Low	High	Large	Low	Low
Iris Scan	High	High	Small	Medium	Medium
Finger Print	Medium	Low	Small	Low	Low
Finger Vein	High	Medium	Medium	High	High
Voice Recognition	Low	Medium	Small	Low	Low
Lip Recognition	Medium	Medium	Small	Medium	High

TABLE I. COMPARISON OF BIOMETRIC TECHNIQUES



The following images depict Iris recognition and Fingerprint Recognition.



**FIG. 4.** (A) IRIS RECOGNITION (B) FINGERPRINT RECOGNITION

### CHALLENGES AND CONCLUSION

Real-time applications are crucial, which means they must constantly interact with adjustments to the environment they regulate. They receive input from the environment, process it, respond, and then either produce the desired output or alter internal state. so, there are some difficulties:

- Require growing computational power
- Get rid of the shadow
- Response time

By giving a thorough overview of real-time image processing techniques, methodologies, and applications that can help researchers working in this area, this review has successfully served its intended objective.

### REFERENCES

- [1] Russ, J., 2007. The Image Processing Handbook. Canada: Taylor & Francis Group.
- [2] Qiu, P., 2005. Image processing and jump regression analysis. Hoboken, NJ: John Wiley & Sons, Inc.
- [3] Shin, K., 1987. Introduction to Real-Time Systems Special Issue. IEEE TRANSACTIONS ON COMPUTERS, Volume C-36, p.2.
- [4] Mertes, J., Marranghello, N. & Pereira, A., 2013. Real-time Module for Digital Image Processing Developed on a FPGA. Velké Karlovice, Czech Republic, s.n
- [5] S. Padmappriya, K.Sumalatha, "Digital Image Processing Real Time Applications", International Journal of Engineering Science Invention (IJESI), ISSN (Online): 2319 – 6734, pp. 46 - 51, 2018.
- [6] Deborah, h. & Arymurthy, A. M., 2010. Image enhancement and image restoration for old document image using genetic algorithm. Jakarta, s.n.E.A.Zanaty & Ghoniemy, S., 2016. Medical Image Segmentation Techniques: An Overview.
- [7] Surabhi N & Unnithan, S., 2017. Image Compression Techniques: A Review. IJDER, 5(1), pp. 585-589.
- [8] Trupti P. Patel, Sandip R. Panchal, "Corner Detection Techniques: An Introductory Survey", International Journal of Engineering Development and Research (IJEDR), ISSN:2321-9939, Volume.2, Issue 4, pp.3680-3686, Dec 2014
- [9] McAndrew, Alasdair. "An Introduction to Digital Image Processing with Matlab Notes for SCM2511 Image Processing 1 Semester 1, 2004." (2004).
- [10] Kaur, M. & Goyal, P., 2015. An overview of region-wise segmentation. International Journal of Scientific Research (IJSR), 4(4), pp. 3194-3197.
- [11] K. Ramudu, G. Raghotham Reddy, A. Srinivas & T. Radha Krishna, 2012. Global regional segmentation of satellite and medical images with active contours and evolution of level sets on noisy images. International Journal of Applied Physics and Mathematics, 2(6), pp. 449-453.
- [12] E.A.Zanaty & Ghoniemy, S., 2016. Medical Image Segmentation Techniques: An Overview.
- [13] B. Fardi, et al., 2006. Obstacle detection and pedestrian recognition using a 3D PMD camera.
- [14] Cai, D. & Etienne-Cummings, R., 2001. A programmable focal plane MIMD image processor chip. IEEE Journal of Solid-State Circuits, 36(1), pp. 64-73.
- [15] P. Jonathan Phillips, R. Michael McCabe & Chellappa, R., 1998. Biometric processing and image recognition. Rhodes, Greece, s.n.
- [16] Saini, Rupinder, and Narinder Rana. "Comparison of various biometric methods." International Journal of Advances in Science and Technology 2.1 (2014): 24-30.
- [17] IEEE Transactions On Pattern Analysis And Machine Intelligence, 29(9), pp. 1485-1490.
- [18] Bhatt, P., Shah, A., Patel, S. & Patel, S., 2012. Image enhancement using different interpolation methods. International Journal of Computer Science and Information Technology & Security (IJCSITS), 2(2249-9555), pp. 799-803.
- [19] Hardik Pandit & D. M. Shah, "Application of Digital Image Processing & Analysis in Healthcare Based on Medical Palmistry", Proc. of International Conference on Intelligent Systems & Data Processing, pp. 56-59, 2011.
- [20] Naseera, Shaik, Rajini, G K, Venkateswarlu, B & Priyadarisini, Jasmin Pemeena M, 2017. A Review of Image Processing Applications in the Medical Field. Research Journal of Pharmacy and Technology, 10(10), pp. 3456-3460.
- [21] International Journal of Engineering Science Invention (IJESI), Issue 2319-6726, pp. 46-51
- [22] N.R. Mudigonda, R.M. Rangayyan & J.E. Leo Desautels, 2001. Breast mass detection in mammograms using density slices and texture flow analysis. IEEE Transactions on Medical Imaging, 20(12), pp. 1215 - 1227.
- [23] Journal of Advances in Science and Technology (IJAST), 2(1), pp. 24-30
- [24] D Kalyani et al, —An Improved Lung Cancer Prediction System using Image Processing", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Vol.8, Issue-4, November 2019
- [25] Rafael C. Gonzalez and Richard E. Woods, A text book on "Digital Image Processing", Publications of Pearson, Second Edition, 2002.
- [26] Ansari, Uzma Bano, and Tanuja Sarode. "Skin cancer detection using image processing." Int Res J Eng Technol 4.4 (2017): 2875-2881.
- [27] Santosh Achakanalli & G. Sadashivappa, Statistical Analysis Of Skin Cancer Image –A Case Study, International Journal of Electronics and Communication Engineering (IJECE), Vol. 3, Issue 3, May 2014.
- [28] Digital image processing by jayaraman. Page 244,254-247,270-273. (gray level, median filter).