iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** XII **Month of publication:** December 2018

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue XII, Dec 2018- Available at www.ijraset.com

Image Processing- An Overview

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Abstract: ***The birth of digital computer has introduced to the society a machine that is more powerful than Human beings in numerical computation. The pertinent question that raised was whether the human capability of processing non-numerical information received from the environment as well as society, of reasoning and decision making based on noon-numerical data could be incorporated in the machine with equal or more efficiency. This led to the evolution of a new concept called Artificial Intelligence, which includes large area of common interest and motivation with another concept called Patter Recognition. The process of receiving and analyzing visual information by the human species is referred to as sight, perception or understanding and the process of receiving and analyzing visual information by digital computer is called Digital Image Processing. This technology is now-a-days a demanding and interesting field and plays a major role in various fields. The concept of images may be divides into three major stages which are also considered as major sub-areas which includes Discretization and Representation, Processing and Analysis.***

Keywords: Image processing, Digital image.

I. INTRODUCTION

Image Processing is a technique which is used to enhance raw images captured from cameras or sensors that are placed on satellites, space probed and aircrafts or pictures which are taken in normal day-today life for various applications. This method performs some operations on a particular image in order to get an enhanced image or to derive some useful information from that image. It is also a kind of Signal Processing in which input is an image and the output may be an image or characteristics or features associated with that image. Digital signal processing incorporates mathematics, software programming, processing hardware to manipulate analog signals. In general a image maybe defines as a two dimensional function (x, y), where x and y are spatial(plane) co-ordinates. The amplitude of ‘f’ at any pair of co-ordinates (x, y) is called the intensity or Gray level of the image at that point. When (x, y) and amplitude values of ‘f’ are all finite, discrete quantities we assume the image as digital image. Digital image may be defined as a Discipline in which both input and output of a process are image and the process of extracting attributes from images up to the level till which we are able to recognize the individual object. Image Processing systems are becoming popular due to easy availability of powerful personnel computers, large size memory devices, graphics software etc.

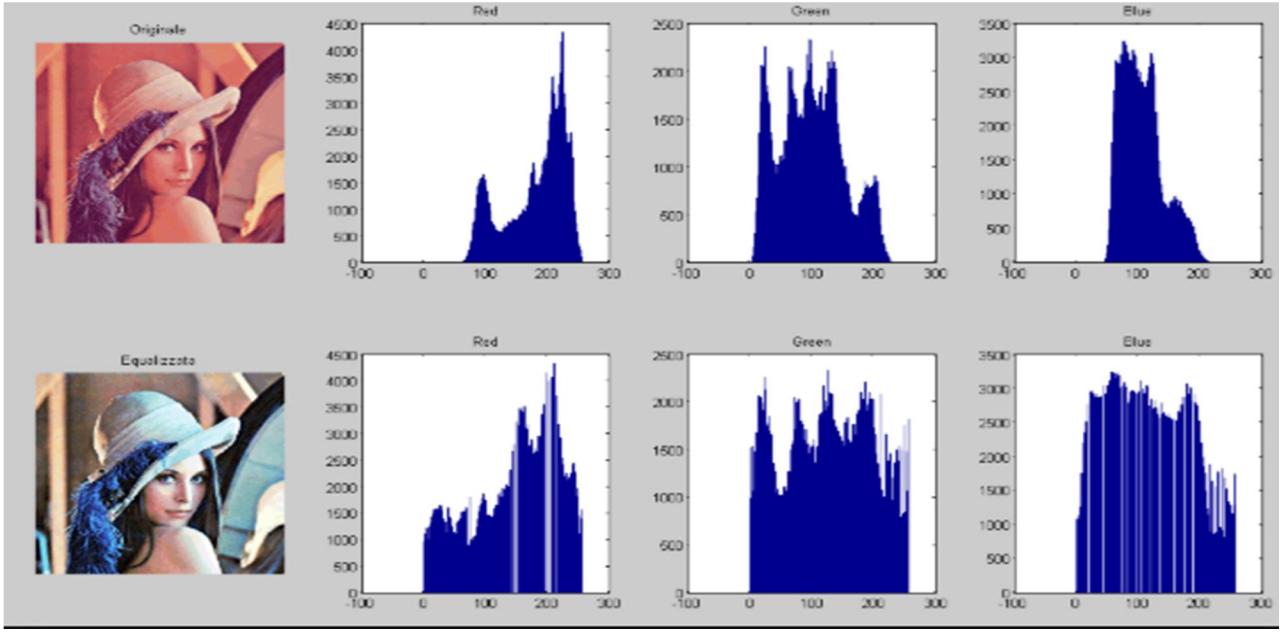


FIG. 1

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II. COMPONENTS OF AN IMAGE PROCESSING SYSTEM

The components of an Image Processing System differ according to the different types of images, for instance Satellite images and X-ray images cannot be processed by same type of image processing system. The general component of an Image Processing System includes the following.

1) *Image Sensor:* The first basic requirement in image processing system is Image sensor. It includes two basic parts.
a) A physical device that will senses the energy radiated by the object which we wish to image.
b) A second device that is called digitizer that will convert the output of physical device into a digital form.
2) *Image Processing Hardware:* The image processing hardware performs a specialized process on the image with high speed and it takes average of different samples of an image for reduction of noise.
3) *Intelligent Processing Machine:* It basically includes general purpose PC or a Supercomputer depending upon the task to be performed. The task of this is device is that it performs all digital images processing task offline. Once the image has been taken offline, we can apply different enhancement techniques and other digital processing task on that image.
4) *Image Processing Software:* It is a specially designed programming module that perform specific tasks. Some software provides the facility that a user can write programming codes for some purposes.
5) *Storing Device:* Storing device are used for storing of an image for different purposes. The storage device is of three types
a) Short-term storage for use during process
b) Online storage for relatively fast recall
c) Storage for frequent use
6) *Display Device:* Display device is generally a color Monitor.
7) *Image Recording:* It includes laser printers, inkjet units and CD-ROM etc.
8) *Networking:* In this process One system user can also process the system at another place. For an image we require high bandwidth so Optical fiber and broadband technologies are better options. [1]

III. METHODS OF IMAGE PROCESSING

Methods of image processing are classified into two types they are Analog Image processing and Digital Image Processing.

1) *Analog Image Processing:* Analog images are the type of images that includes photography, paintings, Tv images and all the medical related images recorded on film or displayed on various display device. In analog process the images are viewed in various levels of brightness or film density and color. It is generally continuous and not broken into many small pieces. Analog images are required for human viewing. The image processing task is conducted on two-dimensional analog signals by analog means. In analog processing wave formats can be named as analog image. For example, television broadcasting in older days which is processed through the dish antenna systems.
2) *Digital Image Processing:* Digital image processing is the process of using computer algorithms to perform image processing on digital images. As a subcategory of digital signal processing, digital image processing has many advantages over analog image processing. It allows a wide range of algorithms to be applied to the input data and it is used to avoid problems such as the build-up of noise and signal distortion during processing. The images in Digital image processing are defined over two dimensions, the digital image processing may be modeled the form of multidimensional systems. Digital image processing is also defined as processing of digital image in a digital manner meaning that uses a digital device like computer or others. The digital image processing is gaining more importance. It consists of two major application areas
3) Improvement of pictorial information for human interpretation.
4) Processing of image data for storage, transmission and representation for autonomous machine perception.

IV. IMAGE PROCESSING TECHNIQUE

Digital image processing comprises of the following techniques or steps in order to process an image.

1) *Image Acquisition:* It is the first step of digital image processing as it does the work of sensing of an image. An image is sensed by Illumination from source and Reflection or Observation from the sensors. It also involves preprocessing, such as Scaling
2) *Image Enhancement:* After the image has been captured by the camera it sometimes requires highlight for the feature of an image. The image enhancement does the work of highlighting certain features of an image by increasing the contrast of image for better appearance.

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3) *Image Restoration:* Restoration is defined as a Objective process. It is based upon Mathematical and Probabilistic models of image Degradation. It is the process of restoring an image that is not looking good due to some distortion such as Noise. It removes all those distortion for better appearance.
4) *Color Image Processing:* It deals with Modeling and Processing of the color image.
5) *Wavelets and Multiresolution Processing:* Wavelets acts as the foundation for representing images in various degree of resolution,
6) *Compression:* It is the technique that is used for reducing the storage space for saving an image and reducing the bandwidth required for transmission of image.
7) *Morphological Processing:* It basically deals with tools for extracting image components that are useful for representation and description of shape. The output of this process are image attributes.
8) *Segmentation:* It is the process in which image is converted into small segments so that we can extract more accurate image attributes. If the segments are properly autonomous then representation and description of image will be accurate and if we are taking rugged segmentation then the result will not be accurate.
9) *Representation and Description:* It involves two steps that extracts the attributes that are useful for processing through computer

a) Boundary representation that causes shaping of corners and inflections. It also separates one image from another
b) Regional representation that is basically focused on internal properties of image such as texture, contrast etc.

10) *Recognition:* It is a process that assigns a label to an object based on its descriptions.
11) *Knowledge Base:* It can be defined as the software that may help use proper image enhancement, restoration or compression technique. It acts as a base to synchronize all the process to each other.

V. IMAGE PROCESSING USING MATLAB

MATLAB commonly known as Matrix Laboratory. It is a high-level language and interactive environment that enables the user to perform computationally intensive tasks much faster than task done with traditional programming languages such as C, C++ and Fortran.

MATLAB acts an interactive and interpreted language that is designed for fast numerical matrix calculations. It is used to perform image segmentation, image enhancement, noise reduction, geometric transformations, image registration and 3D image processing operations.

Most of the IPT functions supports C/C++ code generation for desktop prototyping and it is embedded vision system deployment.

A. The MATLAB Environment

MATLAB consists of window components which includes the following

1) *Workspace:* It Displays all the defined variables
2) *Command Window:* It is used to execute commands in the MATLAB environment
3) *Command History:* It Displays record of the commands used
4) *File Editor Window:* It Define user function

B. MATLAB Help

1) MATLAB Help is an extremely powerful assistance to learning MATLAB
2) Help not only contains the theoretical background, but also shows demos for implementation
3) MATLAB Help can be opened by using the HELP pull-down menu
4) Any command description can be found by typing the command in the search field

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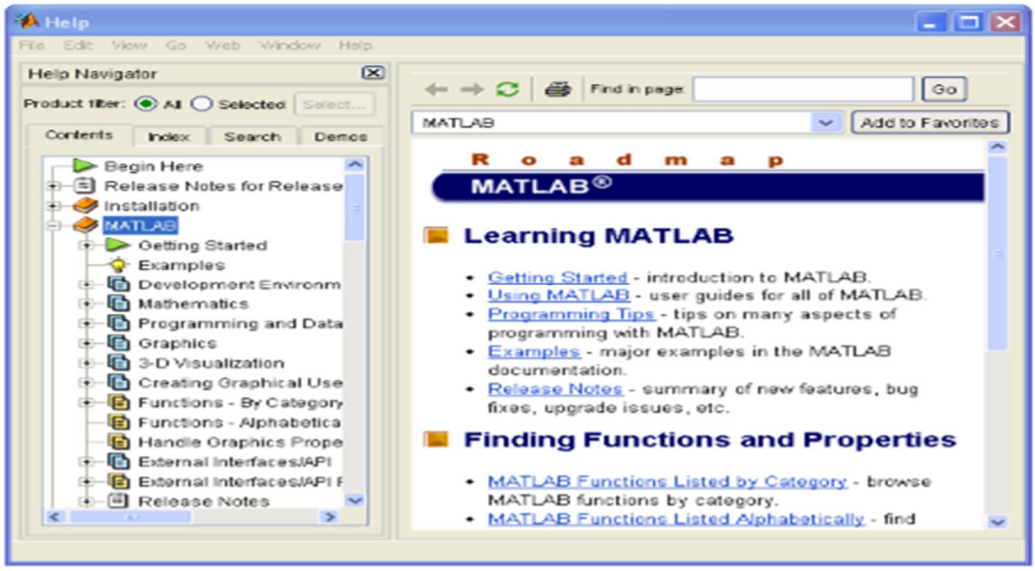


FIG 2

C. Basic Operations Using MATLAB

In MATLAB a digital image is represented as:

$$f(x, y) = \begin{bmatrix} f(1,1) & f(1,2) & \cdots & f(1,N) \\ f(2,1) & f(2,2) & \cdots & f(2,N) \\ \vdots & \vdots & \vdots & \vdots \\ f(M,1) & f(M,2) & \cdots & f(M,N) \end{bmatrix}$$

FIG 3

In the above representation we can notify the shift in the origin. Images in MATLAB uses the function ‘imread’
Syntax of ‘imread’is: ‘imread(‘filename’),
Where ‘filename’ represents a string having the complete name of the image, including its extension. For instance
>>F= imread(Penguins_grey.jpg);
>>G= imread(penguins_RGB.jpg);
When path information is not included in ‘filename’, ‘imread’ then it reads the file from the current directory. When an image from another directory had to be read, the path of the image has to be specified. Including semicolon at the end of a statement is used to suppress the output. If it is not included, MATLAB display the result of the operation specified in that line on the screen. >> indicated the beginning of a command line as it appears in the MATKAB command window



Fig.3.1 Represenation Of Graysclae Image

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
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Fig. 3.2 representation of rgb image

Figs 3.1 and 3,2 show grayscale and RGB images of penguins, respectively. These images can be downloaded from the EFY website and it is stored in the current working directory. imread, imshow and imwrite functions in MATLAB are used to read images in MATLAB environment and display them on MATLAB desktop and write them to the current director. [2]

VI. IMAGE SAMPLING AND QUANTIZATION

In digital processing, an image function f(x,y) is digitized both spatially and in amplitude. Typically, a frame grabber or digitizer is used to sample and quantize the analogue video signal and in order to create an image that is digital, we need to covert continuous data into digital form which includes two steps

A. Sampling
B. Quantization

The sampling rate is used to determine the spatial resolution of the digitized image and the quantization level is used to determine the number of grey levels in the digitized image. A magnitude of the sampled image is expressed as a digital value in image processing and the transition between continuous values of the image function and its digital equivalent is called quantization. The quantization levels should be high enough for human perception of fine shading details in the image. The occurrence of false contours acts as the main problem in image which has been quantized with insufficient brightness levels. [3]

VII. IMAGE MORPHING

Morphing is a technique in image processing that is used for the metamorphosis from one image to another. The main idea is to get a sequence of intermediate images which when put together with the original images would represent the change from one image to the other. It follows a simplest method of transforming one image into another is to cross-dissolve between them. In this method, the color of each pixel is interpolated over time from the first image value to the corresponding second image value and it is not so effective in suggesting the actual metamorphosis. In order to morphs between faces, the metamorphosis does not look good if the two faces do not have the same shape approximately. The morphing process consists of a warping stage before cross-dissolving so that the two images have the same shape. The wrapping is specified by a mapping between lines in the first and second images. [4]

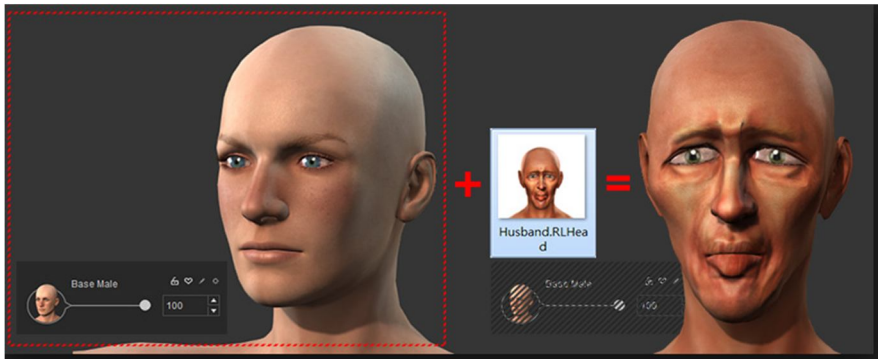


FIG .4 IMAGE MORPGING

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VIII. APPLICATIONS OF IMAGE PROCESSING

Digital image processing and analysis techniques are used now a days in various real time environments.

1) *Bio-Medical:* ECG, EEG, EMG analysis, Cytological, Histological and Stereological applications, Automated Radiology and Pathology, X-ray image analysis, Mass Screening of medical images such as chromosome slides for detection of various diseases, mammograms, cancer smears, CAT, MRI, PET, SPECT, USG and other tomographic images, routine screening of planet samples; 3-d reconstruction and analysis etc.
2) *Remote-Sensing:* Natural resources survey and management, estimation related to agriculture, hydrology, forestry, mineralogy, urban planning, environment and pollution control, cartography, registration of satellite images with terrain maps, monitoring traffic along roads, docks and air filed etc.
3) *Scientific Applications:* High energy physics, bubble chamber and other forms of track analysis etc.
4) *Criminology:* Finger print identification, human face registration and matching, forensic investigation etc.
5) *Astronomy and Space Applications:* Restoration of images suffering from geometric and photometric distortions, computing close-up picture of planetary surfaces etc.
6) *Meteorology:* Short-term weather forecasting. Long-term climatic change detection from satellite and other remote sensing data, cloud pattern analysis etc.
7) *Information Technology:* Facsimile image transmission, videotext, video conferencing and videophones etc.
8) *Entertainment and Consumer Electronics:* HDTV multimedia and video-editing etc.
9) *Printing and Graphics Arts:* Color fidelity in desktop publishing, art conservation and dissemination etc.
10) *Military Applications:* Missile guidance and detection, target identification, navigation pf pilotless vehicle, reconnaissance and range finding**.** [5]

IX. FUTURE SCOPE IN IMAGE PROCESSING

The future of image processing involves scanning the heavens for other intelligent life out in space and new intelligent, digital species created entirely by research scientists in various nations all round the world will include advances in image processing applications. The advances in image processing and related technologies will lead to the invention of millions and millions of robots in the world in a few decades time thus transforming the way in which the world is managed. Advances in image processing and artificial intelligence involves the spoken commands, anticipating the information requirements of governments, translating languages, recognizing and tracking people and things, diagnosing medical conditions, performing surgery by reprogramming defects in human DNA, and automatic driving all forms of transport. The increasing power and sophistication of modern computing, the concept of computation can go beyond the present limits and in future, image processing technology will advance and the visual system of man can be replicated. The future trend in remote sensing will lead towards the improved sensors that record the same scene in many spectral channels. Graphics data is becoming increasingly important in image processing app1ications. The future image processing applications of satellit based imaging ranges from planetary exploration to surveillance applications. [6]

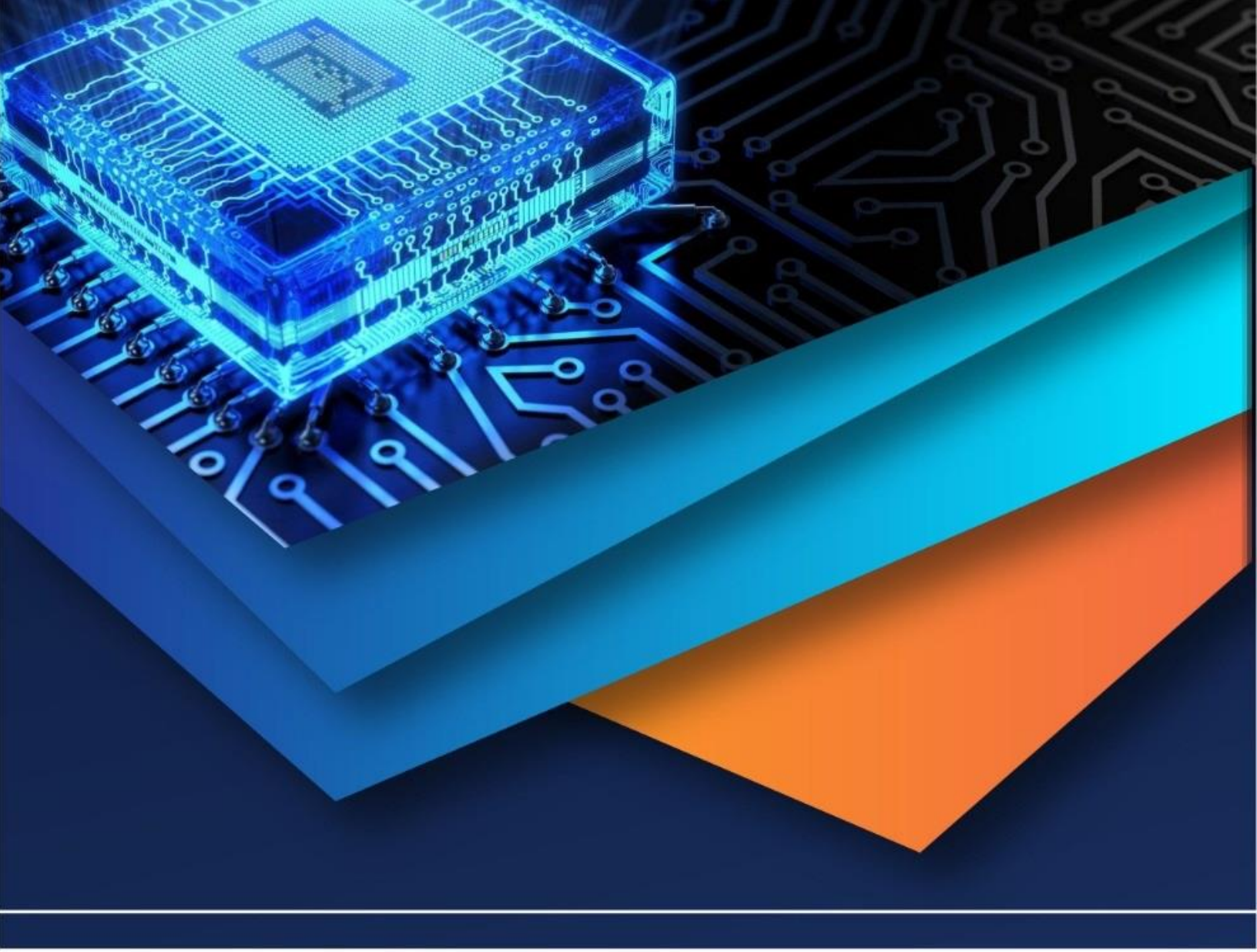
X. CONCLUSION

The processing of images is faster and it is also cost-effective. It requires less time for processing as well as less film and other photographing equipment. It is more ecological to process images as no processing or fixing chemicals are needed to take and process digital image. The advances in image processing and related technologies will lead to the invention of millions and millions of robots in the world in a few decades time thus transforming the way in which the world is managed. Advances in image processing and artificial intelligence involves the spoken commands, anticipating the information requirements of governments, translating languages, recognizing and tracking people and things, diagnosing medical conditions, performing surgery by reprogramming defects in human DNA, and automatic driving all forms of transport. The increasing power and sophistication of modern computing.

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