

## LOW LIGHT IMAGE ENHANCEMENT

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### **Abstract—**

When anyone captures a image in low light conditions the image lacks light and may not visible clearly. These images can have low dynamic ranges with high noise levels which effects the whole image quality. In this project we try to improve quality of these low light image using digital image processing methods and using MATLAB inbuilt toolbox of image processing[7]. Digital image processing is the use of a digital computer or other digital device to process digital images through an algorithm or code which makes the image to have better visibility[3]. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems. The generation and development of digital image processing are mainly affected by three factors: first, the development of computers; second, the development of mathematics (especially the creation and improvement of discrete mathematics theory); third, the demand for a wide range of applications in environment, agriculture, military, industry and medical science has increased. Our project uses a simple but efficient code which focuses on increasing the visibility, contrast, reduce noise, and have more details in the enhanced image than that of the original image.

**Keywords—** Image Processing, MATLAB, Image, low- light Image, Digital Image Processing, Enhancement, Multi- Dimensions, Dynamic Ranges, Algorithm, Toolbox, Noise, Distortion .

## Introduction

Image is representation of something or someone or a photograph or an idea you are thinking in your head or the way you think or others think of you or something they imagine. Image word originates from latin imago, image is an artifact or artificial resemblance either in painting or sculpture or in any other digital form. Image always represents the thing we capture or that depicts visual perception, such as a photograph or other two dimensional picture, that resembles a subject usually a physical object and thus provide depiction of it. In the context of signal processing, an image is a distributed or spread amplitude of color or colors. Images can be two dimensional or three dimensional like a picture on a paper or a sculpture or hologram. The images can be captured by using optical devices such as mirrors, lenses, cameras, microscope, telescope, etc. and natural objects or phenomena like water or human eye[12]. The word image is also known in wider sense of two-dimensional figure such as a graph, a painting, a pie-chart or banner.

A visual image exists in a person's mind, of something the person thinks or imagines or remembers. The subject of an image always may not be real; it may be an abstract concept or an idea, such as a function, graph, or imaginary thing.

Different scholars from psychoanalysis sector or the social sciences or in any other science such as Slavoj Žižek and Jan Berger manipulating visual images either for ideological purposes or religious purposes. Digital image is a image that has many small components such as picture elements also known as pixels[11]. Where every individual pixel has limited discrete quantities of numeric representation of gray scale level, contrast, intensity which is a two dimensional image representing two dimensional functions taken as input by its spatial coordinates denoted with x-axis and y-axis represented respectively. The digital image always has a set number of rows and columns of pixels. Pixels are smallest elements in a image which are different in values which show how much light intensity is present at that particular point where the individual pixel is present. Typically these pixels are stored in computer memory as a raster map or simply pixel matrix, which is a two dimensional array matrix composing of integers which are nothing but pixel values like light intensity[10] and colour these are normally in the compressed form and stored or transmitted in this compressed form. These raster images are created by optical devices and digital devices like a digital camera, smartphone using a raw input format[5]. The Universal Photographic Imaging Guidelines

(UPDIG) advises these formats to be used since raw files reproduce the finest quality images. These file formats allow the photographers or photoeditors or photoanalyzers to have a great level of control on the image and best accuracy for better output. There are many types of formats for images which are displayed by computers or any other digital device. Some of these formats are PNG, JPG, JPEG, GIF, SVG, W3C.

### Literature Survey

Low Light Image means a image which lacks light and may not be clearly visible. The intensity of individual pixels may be very less and this results in less intensity[1] image where the image lacks in light. These low light images have very low dynamic ranges with very high noise levels which effects the image quality and may also produce a grainy image[14] with very less details and having high noise Enhancement is the process of improving or incresing the quality of something. Enhancing a image means improving the image quality in terms of pixels or increasing the specifications of the image such as intensity[16] or gray scale level. And this type of enhancement of image falls under the subject of digital image processing which is turn a sub field of digital signal processing. Digital signal processing is the usage of digital processing, including with the aid of computers or extra specialized virtual sign processors, to carry out an extensive variety of signal processing operations. Digital signal processing and analog signal processing are the major subfields of the signal processing used in different ways. In digital electronics, a virtual sign is represented as a pulse educate that's generally generated with the aid of the switching of a transistor. The software of virtual computation to sign processing lets in for many advantages over analog processing in many programs, inclusive of error detection and correction in transmission as well as statistics compression. Digital image processing is a subject in electric engineering and in mathematics that deals with evaluation and processing of analog[8] and virtual indicators, and offers with storing, filtering, and different operations on indicators. Out of a majority of these alerts, the sector that offers with the type of alerts for which the input is an photograph and the output is also an image is accomplished in picture processing. because it call shows, it offers withthe processing on pictures. In a digital picture, all of the coordinates on 2-d characteristic and the corresponding values are finite. each cost to be had in each location is considered as a pixel. In different words, a pixel is the smallest a part of an photo.

So a virtual photograph can be concept as 2-d array of pixels. Each pixel has a few intensity fee that is known as grey degree or grey value[12] those values are typically represented in eight-bit int and depending on the value these images are classified as binary, grayscale. A binary image has only feasible gray values or intensities 0 and 255, there aren't any intermediate values. Binary photographs are used as mask for indicating the pixels of hobby in many photograph processing responsibilities. Grayscale photograph has variety of values from zero to 255 i.e, each pixel place will have any cost among 0 and 255. in case you watch vintage movies around the Fifties, you're looking grayscale pix. MATLAB (an abbreviation of "MATrix LABoratory") is a proprietary multi-paradigm programming language[7] and numeric computing surroundings evolved via way of means of MathWorks. MATLAB permits matrix manipulations, plotting of capabilities and data, implementation of algorithms, the introduction of person interfaces, and interfacing with packages[10] written in different languages. MATLAB changed into first launched as an industrial product in 1984 at the Automatic Control Conference in Las Vegas. MathWorks, Inc. changed into based to expand software program and the MATLAB programming language changed into launched. MATLAB is widely used in academia, the government and industry (almost 1 million users by some estimates) and has emerged as an important tool used by many Signal and Image Processing (SIP) scientists and engineers. We majorly use MATLAB ToolBox for image related topics as it is predefined and easy to work with. A toolbox is a package deal of capabilities and/or classes. They offer you tools, commonly for a particular topic (like sign evaluation or photo processing). There is not a completely strict definition. Some toolboxes are furnished through Mathworks and require a license, others may be downloaded[10] without cost from the report exchange. There are many types of toolboxes some of them are as follows

- Statistics and Machine Learning Toolbox
- Curve Fitting Toolbox
- Control System Toolbox
- Signal Processing Toolbox
- Mapping Toolbox
- System Identification Toolbox
- Deep Learning Toolbox

- DSP System Toolbox
- Datafeed Toolbox
- Financial Toolbox
- Image Acquisition Toolbox
- Image Processing Toolbox
- Text Analytics Toolbox
- Predictive Maintenance Toolbox

## I. Methodology

Image processing is the main part of our project and much research is going on in recent times to make it more efficient. There are many steps involved in image processing. Some of them are given below

- Image Acquisition
- Image Preprocessing
- Image Enhancement
- Image Restoration
- Morphological Processing
- Image Segmentation
- Object Recognition
- Image Data Compression

An photograph may be defined as a  $n$ -dimensional feature,  $f(u, v)$ , where  $u$  and  $v$  are aircraft coordinates, and the amplitude of  $f$  at any pair of coordinates  $(u, v)$  is called the depth or gray stage of the photo at that factor. We can name an picture as digital photo, whilst  $u, v$  and the amplitude values of  $f$  are all finite, discrete[9] quantities . Image acquisition performs a major function in photograph processing, seeing that if the pics are not acquired properly the numerous picture processing techniques might not be an awful lot powerful, despite the presence of diverse enhancement techniques. A essential step in photograph processing and laptop vision is Image preprocessing. The goal of picture preprocessing is the development of image records by means of improving a few capabilities while suppressing some unwanted distortions. enhancing the features relies upon on particular applications. picture statistics recorded through sensors on a satellite, include mistakes associated with geometry and

brightness values of the pixels. In Image preprocessing, these errors are corrected the usage of suitable mathematical[13] fashions that are either specific or statistical fashions. photograph preprocessing also consists of primitive operations to lessen noise, contrast enhancement, photograph Image preprocessing, these errors are corrected the usage of suitable mathematical fashions[15] that are either specific or statistical fashions. photograph preprocessing also consists of primitive operations to lessen noise, contrast enhancement, photograph segmentation. In line with the size of the pixel community that is used for the calculation of a new pixel brightness the image preprocessing strategies can be labeled. The pictures captured from a few traditional digital cameras and satellite tv for pc pix can also lack in comparison and brightness, because[4] of the restrictions of imaging subsystems and illumination conditions whilst taking pictures an image. Image enhancement is one of the handiest and alluring approach to triumph over this issue.

Here it enhances a few functions which might be hid or highlight certain features of interest, for subsequent evaluation of an picture. we can categorize the photo enhancement strategies into two they are i)spatial domain technique and ii)frequency area method. Spatial area technique offers with the amendment or aggregation of pixels that forms the photo and frequency area method complements image in a linear way through positioning the invariant operator.

The process of convalescing degraded or corrupted picture by using putting off the noise or blur, to improve the appearance of the photo is known as photograph healing. The degraded picture is the convolution of the original photograph, degraded feature, and additive noise. recuperation of the photo is performed with the help of prior knowledge of the noise or the disturbance that causes the degradation in the picture. it could be carried out in domains: spatial area and frequency domain. In spatial area the filtering movement for restoring the images is finished immediately on the running pixels of the virtual picture and in frequency area the filtering motion is carried out by mapping the spatial area into the frequency domain, by using fourier rework. After the filtering, the photograph is remapped via inverse fourier transform into spatial area, to achieve the restored photo. we can select any of the domain names primarily based on the applications required.

Morphological processing is a collection of linear operations that is used for extracting photo additives which can be beneficial in the representation and description of shape. Structuring

element is a small set to probe an photograph underneath have a look at. Structuring element is as compared with the corresponding community of pixels by using positioning it, at all possible locations within the photo. some operations test whether or not the element suits in the neighborhood, at the same time as others test whether or not it "hits" or intersects the community. The basic morphological operations are dilation, erosion and their mixtures. Erosion is useful for the removal of structures of positive shape and size, that's given through the structuring detail even as dilation is useful in filling of holes of sure length and shape given by means of the structuring detail.

Image Segmentation or Image Segmentation is the procedure of partitioning a virtual photo into a couple of segments, to simplify and/or trade the representation of an photograph into something this[2] is more meaningful and simpler to analyze. it is able to make use of statistical class, thresholding , side detection, vicinity detection, or any combination of those techniques. Normally a hard and fast of categorised factors is obtained because the output of the segmentation step. Segmentation techniques can be classified as both location-primarily[6] based or area- based. The former techniques depend on not unusual patterns in depth values inside a cluster of neighboring pixels, and the goal of the segmentation set of rules is to group areas consistent with their anatomical or useful roles. the brink-primarily based techniques depend upon discontinuities in photo values between[6] wonderful areas, and the goal of the segmentation algorithm is to accurately demarcate the boundary setting apart these regions.

Object Recognition or Item Recognition is the process that gives a label to an item in a digital image or video ,based totally on its descriptors.eg:-car. object reputation offers with education the computer to identify[13] a specific item from various views, in diverse lights conditions, and with diverse backgrounds. Due to scene muddle, photometric results, modifications in form and viewpoints of the item, the arrival of an item can be numerous.

It has extensive packages inside the field of monitoring and surveillance, robotic localization and navigation, clinical analysis and many others.

Compression, because the call implies, deals with strategies for decreasing the garage required to store an photograph, or the bandwidth required to transmit it, with out degrading the high-quality of an picture to an unacceptable stage Compression permits to keep extra pics in a given quantity disk or memory space. It also reduces the time required for pics to be transmitted over the net or downloaded from net pages. Compression techniques can be of two kinds:- lossy and lossless compression. Lossy compressions are irreversible, a few statistics from the authentic photo file is misplaced. Lossy strategies are in particular suitable for natural pics which include snap shots in programs where minor loss of fidelity is perfect to acquire a sizeable reduction in bit charge. In lossless compression, we will reduce the size of an image without any fine loss. Lossless compression is preferred for archival purposes and frequently for scientific imaging, technical drawings, clip art, or comics. Image Acquisition Toolbox presents capabilities and blocks for connecting cameras[7] to MATLAB and Simulink. It consists of a MATLAB app that helps you to interactively stumble on and configure hardware properties. You can then generate equal MATLAB code to automate your acquisition in destiny sessions. The toolbox allows acquisition modes along with processing in- the-loop, hardware triggering, historical past acquisition, and synchronizing acquisition throughout a couple of devices. Image Acquisition Toolbox helps all the most important requirements and hardware vendors, such as USB3 Vision, GigE Vision, and GenICam GenTL. You can connect with device imaginative and prescient cameras and body grabbers, in addition to high-quit clinical and business devices.

There are 3 approaches to collect pics programmatically:

- i) The videoinput item, to be used with any kind of supported hardware.
- ii) The gigeacam item, to be used with GigE Vision hardware only.
- iii) The matroxcam item, to be used with Matrox hardware only.

Image Processing Toolbox presents a complete set of reference-popular algorithms and workflow apps for photograph processing, analysis, visualization, and set of rules development. You can carry out photograph segmentation, photograph enhancement, noise reduction, geometric transformations, and photograph registration through the usage of deep mastering and conventional photograph processing techniques. The toolbox helps the



processing of 2D, 3-d, and arbitrarily massive images. The fundamental statistics[7] shape in MATLAB, the array, is obviously appropriate to the illustration of photos. Using toolbox functions, you could import picture statistics into the workspace from supported snapshots[10] documents or clinical record formats. Conversely, you could export statistics from the workspace to a record in a supported snapshots record or clinical record layout. In addition, you could convert photos from one layout to another, or from one statistics kind to another. We can read and write Image data from files, High dynamic range images, Blocked images, Image type conversion, Image sequences and branch processing, synthetic images.

Geometric Transformation and Image Registration is the toolbox that helps features to carry out easy geometric transformations, including resizing, rotating, and cropping, in addition to extra complicated affine and projective geometric transformations. The toolbox additionally offers gear for aligning a couple of pictures routinely the usage of depth correlation, characteristic matching or manage factor mapping techniques. It does common geometric transformations like resize, rotate, crop, and carry out different not unusual place photograph geometric photograph modifications. Generic Geometric Transformations perform well-known geometric modifications using the imwarp workflow. Image Registration alignes the two images with the use of depth correlation, function matching, or manipulate factor mapping.

Image Filtering and Enhancement is the system of changing pictures or images so that the outcomes are more appropriate for display or similarly to picture analysis. For example, you may dispose of noise, sharpen, or alter the contrast of a picture, making it less complicated to[8] discover key features convolution and correlation, predefined and custom filters, nonlinear filtering, edge-maintaining filters Contrast adjustment, histogram equalization, decorrelation stretching define and function on areas of interest dilate, erode, reconstruct, and carry out different morphological operations, deconvolution for deblurring define neighborhoods and blocks for filtering and I/O operations. Image segmentation and analysis is the procedure of extracting significant facts from photographs along with locating shapes, counting objects, figuring out colors, or measuring object properties.

Flow chart



## Algorithm

### Working

In this we use haze removal, image filtering and many other techniques to modify the low light image into a image which is better at visibility and has better contrast. We first read a low light image into MATLAB and then we invert the image into grayscale and then apply the required enhancement techniques and again invert back the image from grayscale to colored image which is our required output. Image filtering is a major step in image processing as it performs major tasks that bring the most visual changes to the image that are required. Filtering is a method for editing or improving[4] an image. For example, you could clear out a photo to emphasise certain functions or cast off different functions. Image processing operations implemented with filtering encompass smoothing, sharpening, and edge enhancement. In a spatially filtered image, the price of every output pixel is the weighted sum of neighbouring enter pixels. The weights are supplied through a matrix known as the convolution kernel or filter. Filter Images Using Predefined Filter. This instance indicates a way to create a sort of unique filter known as an unsharp masking filter, which makes edges and elements in a photograph seem sharper. imfilter Boundary Padding Options When a part of the convolution or correlation kernel extends beyond the edge of a photo, you could extrapolate photo values with the aid of using zero-padding the photo or with the aid of using replicating boundary pixels. Noise refers to random mistakes in pixel values obtained all through picture acquisition or transmission. Removing noise can enhance picture quality. Image deblurring is a system that eliminates distortion from a blurry image, the usage of understanding of the way the optical device blurs a single factor of light. Images may be distorted with the aid of using blurs, along with motion blur or blur as a result of an out-of-recognition lens. Blur is represented with the aid of using a distortion operator, additionally referred to as the factor unfold function (PSF). Different deblurring algorithms estimate and dispose of blur primarily based totally on how a good deal of information you've got of the PSF and noise withinside the image.



Fig 1: Example of image deblurring.

Contrast adjustment remaps photograph intensity values to the whole display range of the data type. A photograph with true assessment has sharp variations among black and white. To illustrate, the photograph at the left has negative assessment, with depth values restrained [4] to the center part of the range. The photograph at the proper has better assessment, with depth values that fill the complete depth variety [0, 255]. In the excessive assessment photograph, highlights appearance brighter and shadows appearance darker. The capabilities defined in this phase practice mostly to grayscale pics. However, a number of those capabilities may be implemented to colour pics as well. For facts approximately how those capabilities paintings with colour pics, see the reference pages for the character capabilities.

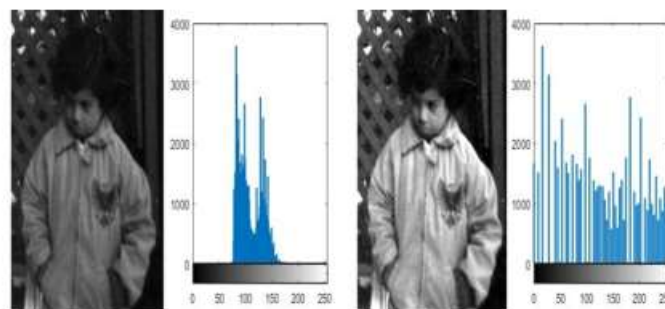


Fig 2: Example of contrast adjustment.

First, the low-light image is segmented into superpixels, and the ratio between the local standard deviation and [1] the local gradients is utilized to estimate the noisetexture level of each superpixel. Then the image is inverted to be processed in the following steps. Based on the noisetexture level, a smooth base layer is adaptively extracted by the median filter or guided image filter, and another detail layer is extracted by the first order differential of the inverted image and smoothed with the structural filter. These two layers are adaptively

combined to get a noise-free and detail-preserved image. At last, an adaptive enhancement parameter is adopted into the dark channel prior dehazing process to enlarge contrast and prevent over or under enhancement.

The image-guided filter characteristic plays a part in keeping the smoothing of a picture, the usage of the content material of a 2nd picture, known as a steering picture, to persuade the filtering. The steering picture may be the picture itself, an exceptional [10] model of the picture, or a very exceptional picture. Guided picture filtering is a neighbourhood operation, like different filtering operations, however, takes into consideration the records of an area within the corresponding spatial neighbourhood within the steering picture whilst calculating the price of the output pixel.

## RESULTS

The initial low light images which are considered for this are as given



Fig 3: First input image in low light.



Fig 4: Second low light input image. The results for these input images are as follows



Fig 5: Enhanced image of 1<sup>st</sup> input image

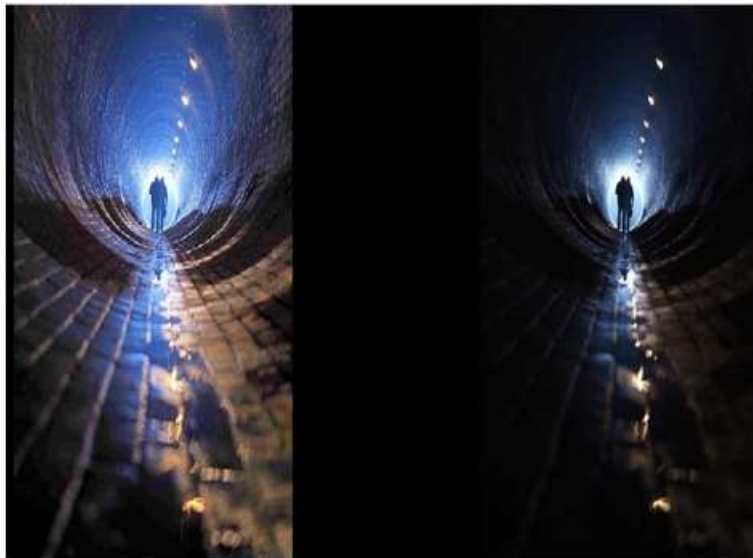


Fig 6: Enhanced images of 2<sup>nd</sup> input image.

Comparison of the input images to the results



Fig 7: Comparison of the 1<sup>st</sup> input and enhanced image.



Fig 8: Comparison of 2<sup>nd</sup> input and enhanced image.

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