**Python based GUI for computer vision and/or image processing applications**

*A Dissertation submitted in partial fulfillment of the requirements for the degree*

*Of*

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**In**

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**CERTIFICATE BY THE EXAMINER**

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This is to certify that the dissertation entitled “Python based GUI for computer vision and/or image processing applications” submitted by **Nihar** **Kashyap** bearing Roll no: **CSM20005** is carried out by him under my supervision and guidance for partial fulfillment of the requirements and the regulations for the award of the degree of Master of Computer Applications during the session 2020-2022 at Tezpur University. To the best of my knowledge, the matter embodied in the dissertation has not been submitted to any other university/institute for the award of any Degree or Diploma.

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I hereby declare that the dissertation work titled submitted to the Department of Computer Science & Engineering, Tezpur University is prepared by me and was not submitted to any other institution for award of any other degree.

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**ABSTRACT**

Image processing can be defined as a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. Various libraries in languages like python and C++ are available for image processing applications. However, those libraries are complex and beyond the understanding of the common man. It is also time consuming as we have to install the libraries and setup the required environment. There are not many applications that can help users carry out real time image processing tasks. We aim to reduce this gap by developing a web based Image Processing applications that will be publicly available for everyone to carry out image processing tasks. Users can upload an image and see the results in real time. They will also be able to control different thresholds to get the required result. The proposed project will help researchers as well as developers to apply image processing techniques to a given image quickly and efficiently. It will save valuable time that can be better utilized in solving business problems.

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7. **Introduction**

**1.1 What is an image?**

An image is defined as a two-dimensional function,F(x,y), where x and y are spatial coordinates, and the amplitude of F at any pair of coordinates (x,y) is called the intensity of that image at that point. When x,y, and amplitude values of F are finite, we call it a digital image. 

In other words, an image can be defined by a two-dimensional array specifically arranged in rows and columns. 

Digital Image is composed of a finite number of elements, each of which elements have a particular value at a particular location.These elements are referred to as picture elements,image elements,and pixels.A Pixel is most widely used to denote the elements of a Digital Image.

**1.2 Types of an image**

1. Binary image: The binary image as its name suggests, contain only two pixel elements i.e 0 & 1,where 0 refers to black and 1 refers to white. This image is also known as Monochrome.

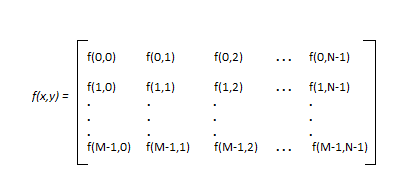
2. Black and white image: The image which consist of only black and white color is called black and white image.

3. 8 bit color format: It is the most famous image format.It has 256 different shades of colors in it and commonly known as Grayscale Image. In this format, 0 stands for Black, and 255 stands for white, and 127 stands for gray.

4. 16 bit color format: It is a color image format. It has 65,536 different colors in it.It is also known as High Color Format. In this format the distribution of color is not as same as Grayscale image.

**1.3 Image as a Matrix**

As we know, images are represented in rows and columns we have the following syntax in which images are represented:



**1.4 What is Image Processing**

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. The field of digital image processing refers to processing digital images by means of a digital computer

**1.5 Types of Image Processing**

There are no clear-cut boundaries in the continuum from image processing

at one end to computer vision at the other. However, one useful paradigm is

to consider three types of computerized processes in this continuum: low-,

mid-, and high-level processes. Low-level processes involve primitive operations such as image preprocessing to reduce noise, contrast enhancement, and

image sharpening. A low-level process is characterized by the fact that both

its inputs and outputs are images. Mid-level processing on images involves

tasks such as segmentation (partitioning an image into regions or objects), description of those objects to reduce them to a form suitable for computer processing, and classification (recognition) of individual objects. A mid-level process is characterized by the fact that its inputs generally are images, but its outputs are attributes extracted from those images (e.g., edges, contours, and the identity of individual objects). Finally, higher-level processing involves “making sense” of an ensemble of recognized objects, as in image analysis, and, at the far end of the continuum, performing the cognitive functions normally associated with vision.

**1.6 Phases of image processing:**

1. Acquisition: It could be as simple as being given an image which is in digital form. The main work involves:

a) Scaling   
b) Color conversion(RGB to Gray or vice-versa) 

1. Image enhancement: It is amongst the simplest and most appealing in areas of Image Processing it is also used to extract some hidden details from an image and is subjective.
2. Image restoration: It also deals with appealing of an image but it is objective(Restoration is based on mathematical or probabilistic model or image degradation).
3. Color image processing: It deals with pseudocolor and full color image processing color models are applicable to digital image processing.
4. Wavelets and multi-resolution processing: It is foundation of representing images in various degrees.
5. Image compression: It involves in developing some functions to perform this operation. It mainly deals with image size or resolution.
6. Morphological processing: It deals with tools for extracting image components that are useful in the representation & description of shape.
7. Segmentation procedure: It includes partitioning an image into its constituent parts or objects. Autonomous segmentation is the most difficult task in Image Processing.
8. Representation and description: It follows output of segmentation stage, choosing a representation is only the part of solution for transforming raw data into processed data.

10. Object detection and recognition: It is a process that assigns a label to an object based on its descriptor.

**2. Problem Statement and Objective**

This project aims to create a web based Graphical User Interface (GUI) using python to apply:-

1. Image enhancement functions like brightness enhancement, contrast enhancement.
2. segmentation functions like thresholding, edge detection

c) morphological operations like erosion and dilation

Objectives:

* To create a python based GUI for various image processing tasks.
* Make image processing functions accessible at a single click
* Make the application easy to use for non expert users
* Make the application web based so that users can use it without additional dependencies.

**3. Implementation**

**3.1 Libraries**

This project was developed utilizing the various libraries in python. The plethora of libraries available in python made it a suitable candidate for our application. The libraries used in the project are:

**3.1.1 Streamlit:**

Streamlit is an open-source python framework for building web apps for Machine Learning and Data Science

**3.1.2 OpenCV:**

OpenCV is an open-source library for computer vision, machine learning, and image processing. OpenCV supports a wide variety of programming languages like Python, C++, Java, etc. It can process images and videos to identify objects, faces, or even the handwriting of a human.

**3.1.3 Skimage:**

scikit-image is a collection of algorithms for image processing and computer vision.

**3.1.4 Sklearn:**

Scikit-learn is a [free software](https://en.wikipedia.org/wiki/Free_software" \o "Free software) [machine learning](https://en.wikipedia.org/wiki/Machine_learning" \o "Machine learning) [library](https://en.wikipedia.org/wiki/Library_(computing)" \o "Library (computing)) for the [Python](https://en.wikipedia.org/wiki/Python_(programming_language)" \o "Python (programming language)) [programming language](https://en.wikipedia.org/wiki/Programming_language" \o "Programming language). It features various [classification](https://en.wikipedia.org/wiki/Statistical_classification" \o "Statistical classification), [regression](https://en.wikipedia.org/wiki/Regression_analysis" \o "Regression analysis) and [clustering](https://en.wikipedia.org/wiki/Cluster_analysis" \o "Cluster analysis) algorithms including [support vector machines](https://en.wikipedia.org/wiki/Support_vector_machine" \o "Support vector machine), [random forests](https://en.wikipedia.org/wiki/Random_forests" \o "Random forests), [gradient boosting](https://en.wikipedia.org/wiki/Gradient_boosting" \o "Gradient boosting), [k-means](https://en.wikipedia.org/wiki/K-means_clustering" \o "K-means clustering) and [DBSCAN](https://en.wikipedia.org/wiki/DBSCAN" \o "DBSCAN).

**3.1.5 Numpy:**

NumPy is an open source project aiming to enable numerical computing with Python. It was created in 2005, building on the early work of the Numeric and Numarray libraries.

**3.1.6 PIL:**

The Python Imaging Library adds image processing capabilities to your Python interpreter. This library provides extensive file format support, an efficient internal representation, and fairly powerful image processing capabilities.

**3.2 Function Implementation**

We have categorized the image processing functions into two categories:

1. **Image Pre-Processing**

Image pre-processing is the name for operations on images whose aim is an improvement of the image data that suppress undesired distortions or enhances some image features important for further processing

1. **Image Segmentation**

In [digital image processing](https://en.wikipedia.org/wiki/Digital_image_processing" \o "Digital image processing) and [computer vision](https://en.wikipedia.org/wiki/Computer_vision" \o "Computer vision), image segmentation is the process of partitioning a [digital image](https://en.wikipedia.org/wiki/Digital_image" \o "Digital image) into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and [boundaries](https://en.wikipedia.org/wiki/Boundary_tracing" \o "Boundary tracing) (lines, curves, etc.) in images

A brief description of each of the processes are given below:

**3.2.1 Image Denoising:**

Denoising is the process of removing or reducing the noise or artefacts from the image. Denoising makes the image more clear and enables us to see finer details in the image clearly. It does not change the brightness or contrast of the image directly, but due to the removal of artifacts, the final image may look brighter.

In this denoising process, we choose a 2-D box and slide it over the image. The intensity of each and every pixel of the original image is recalculated using the box.

**3.2.2 Contrast Enhancement:**

Contrast enhancement processes adjust the relative brightness and darkness of objects in the scene to improve their visibility. The contrast and tone of the image can be changed by mapping the gray levels in the image to new values through a gray-level transform.

**3.2.3 Brightness Enhancement:**

Brightness Enhancement is shifting of intensity values to a higher level. The darker and the lighter pixels both get their values shifted by some constant value.

**3.2.4 Sharpness Enhancement:**

Image sharpening refers to any enhancement technique that highlights edges and fine details in an image.

**3.2.5 Thresholding:**

Thresholding is a very popular segmentation technique, used for separating an object from its background. In the article below, I have described various techniques used to threshold grayscale images (8-bit).

The process of thresholding involves, comparing each pixel value of the image (pixel intensity) to a specified threshold. This divides all the pixels of the input image into 2 groups:

1. Pixels having intensity value lower than threshold.
2. Pixels having intensity value greater than threshold.

These 2 groups are now given different values, depending on various segmentation types

**3.2.6 Edge detection**

Edge detection is a technique of image processing used to identify points in a digital image with discontinuities, simply to say, sharp changes in the image brightness. These points where the image brightness varies sharply are called the edges (or boundaries) of the image.

**3.2.7 Region based Segmentation**

The region-based segmentation method looks for similarities between adjacent pixels. That is, pixels that possess similar attributes are grouped into unique regions. ... Regions are grown by grouping adjacent pixels whose properties, such as intensity, differ by less than some specified amount.

**3.2.8 Watershed based Segmentation**

In watershed segmentation an image is regarded as a topographic landscape with ridges and valleys. The elevation values of the landscape are typically defined by the gray values of the respective pixels or their [gradient magnitude](https://www.sciencedirect.com/topics/computer-science/gradient-magnitude" \o "Learn more about Gradient Magnitude from ScienceDirect's AI-generated Topic Pages). Based on such a 3D

representation the [watershed transform](https://www.sciencedirect.com/topics/computer-science/watershed-transform" \o "Learn more about Watershed Transform from ScienceDirect's AI-generated Topic Pages) decomposes an image into [catchment basins](https://www.sciencedirect.com/topics/computer-science/catchment-basin" \o "Learn more about Catchment Basin from ScienceDirect's AI-generated Topic Pages). For each local minimum, a catchment basin comprises all points whose path

of [steepest descent](https://www.sciencedirect.com/topics/computer-science/steepest-descent" \o "Learn more about Steepest Descent from ScienceDirect's AI-generated Topic Pages) terminates at this minimum. Watersheds separate basins from each other.

**3.2.9 Cluster based segmentation**

Clustering algorithms are used to group closer the data points that are more similar to each other, from other group data points. In case of an image clustering can be used to group similar pixels together.

**4. Future Work**

This application has been developed in a limited amount of time and with limited knowledge. It can be extended further to include more functions and improve the existing ones. Considering the plethora of image processing algorithms that are being developed this application may soon get outdated. Regular update and inclusion of powerful algorithms will make this application more robust in the long run. Performance of the existing algorithms can be improved by optimizing the code so that the algorithms run faster. Since this is a web based application procuring better servers to host the application will increase throughput.

**5. Conclusion**

Image Processing is an important part of any pattern recognition tasks. Especially in Machine Learning models the quality of image has huge impact on the results. The demand for applications that can process images fast and efficiently is constantly on the rise. With the application we developed users can carry out image processing tasks without worrying about expertise or hardware support. Since this will be a web based app users do not have to install any additional software to run the application. This will further cut down the time user has to spend installing prerequisites. By bringing all the major functions under one hood this app can also server as a single point solution for all image processing needs. With the inclusion of more algorithms and functions this app can be pushed to greater heights in the future.

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