



OpenCV



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About the Tutorial

OpenCV is a cross-platform library using which we can develop real-time **computer vision applications**. It mainly focuses on image processing, video capture and analysis including features like face detection and object detection. In this tutorial, we explain how you can use OpenCV in your applications.

Audience

This tutorial has been prepared for beginners to make them understand the basics of OpenCV library. We have used the Java programming language in all the examples, therefore you should have a basic exposure to Java in order to benefit from this tutorial.

Prerequisites

For this tutorial, it is assumed that the readers have a prior knowledge of Java programming language. In some of the programs of this tutorial, we have used JavaFX for GUI purpose. So, it is recommended that you go through our JavaFX tutorial before proceeding further. <http://www.tutorialspoint.com/javafx/>

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1. OpenCV – Overview

OpenCV is a cross-platform library using which we can develop real-time **computer vision** applications. It mainly focuses on image processing, video capture and analysis including features like face detection and object detection.

Let's start the chapter by defining the term "Computer Vision".

Computer Vision

Computer Vision can be defined as a discipline that explains how to reconstruct, interrupt, and understand a 3D scene from its 2D images, in terms of the properties of the structure present in the scene. It deals with modeling and replicating human vision using computer software and hardware.

Computer Vision overlaps significantly with the following fields:

- **Image Processing:** It focuses on image manipulation.
- **Pattern Recognition:** It explains various techniques to classify patterns.
- **Photogrammetry:** It is concerned with obtaining accurate measurements from images.

Computer Vision Vs Image Processing

Image processing deals with image-to-image transformation. The input and output of image processing are both images.

Computer vision is the construction of explicit, meaningful descriptions of physical objects from their image. The output of computer vision is a description or an interpretation of structures in 3D scene.

Applications of Computer Vision

Here we have listed down some of major domains where Computer Vision is heavily used.

Robotics Application

- Localization – Determine robot location automatically
- Navigation
- Obstacles avoidance
- Assembly (peg-in-hole, welding, painting)
- Manipulation (e.g. PUMA robot manipulator)
- Human Robot Interaction (HRI): Intelligent robotics to interact with and serve people

Medicine Application

- Classification and detection (e.g. lesion or cells classification and tumor detection)

- 2D/3D segmentation
- 3D human organ reconstruction (MRI or ultrasound)
- Vision-guided robotics surgery

Industrial Automation Application

- Industrial inspection (defect detection)
- Assembly
- Barcode and package label reading
- Object sorting
- Document understanding (e.g. OCR)

Security Application

- Biometrics (iris, finger print, face recognition)
- Surveillance – Detecting certain suspicious activities or behaviors

Transportation Application

- Autonomous vehicle
- Safety, e.g., driver vigilance monitoring

Features of OpenCV Library

Using OpenCV library, you can –

- Read and write images
- Capture and save videos
- Process images (filter, transform)
- Perform feature detection
- Detect specific objects such as faces, eyes, cars, in the videos or images.
- Analyze the video, i.e., estimate the motion in it, subtract the background, and track objects in it.

OpenCV was originally developed in C++. In addition to it, Python and Java bindings were provided. OpenCV runs on various Operating Systems such as windows, Linux, OSx, FreeBSD, Net BSD, Open BSD, etc.

This tutorial explains the concepts of OpenCV with examples using Java bindings.

OpenCV Library Modules

Following are the main library modules of the OpenCV library.

Core Functionality

This module covers the basic data structures such as Scalar, Point, Range, etc., that are used to build OpenCV applications. In addition to these, it also includes the multidimensional array **Mat**, which is used to store the images. In the Java library of OpenCV, this module is included as a package with the name **org.opencv.core**.

Image Processing

This module covers various image processing operations such as image filtering, geometrical image transformations, color space conversion, histograms, etc. In the Java library of OpenCV, this module is included as a package with the name **org.opencv.imgproc**.

Video

This module covers the video analysis concepts such as motion estimation, background subtraction, and object tracking. In the Java library of OpenCV, this module is included as a package with the name **org.opencv.video**.

Video I/O

This module explains the video capturing and video codecs using OpenCV library. In the Java library of OpenCV, this module is included as a package with the name **org.opencv.videoio**.

calib3d

This module includes algorithms regarding basic multiple-view geometry algorithms, single and stereo camera calibration, object pose estimation, stereo correspondence and elements of 3D reconstruction. In the Java library of OpenCV, this module is included as a package with the name **org.opencv.calib3d**.

features2d

This module includes the concepts of feature detection and description. In the Java library of OpenCV, this module is included as a package with the name **org.opencv.features2d**.

Objdetect

This module includes the detection of objects and instances of the predefined classes such as faces, eyes, mugs, people, cars, etc. In the Java library of OpenCV, this module is included as a package with the name **org.opencv.objdetect**.

Highgui

This is an easy-to-use interface with simple UI capabilities. In the Java library of OpenCV, the features of this module is included in two different packages namely, **org.opencv.imgcodecs** and **org.opencv.videoio**.

A Brief History of OpenCV

OpenCV was initially an Intel research initiative to advise CPU-intensive applications. It was officially launched in 1999.

- In the year 2006, its first major version, OpenCV 1.0 was released.
- In October 2009, the second major version, OpenCV 2 was released.
- In August 2012, OpenCV was taken by a nonprofit organization OpenCV.org.

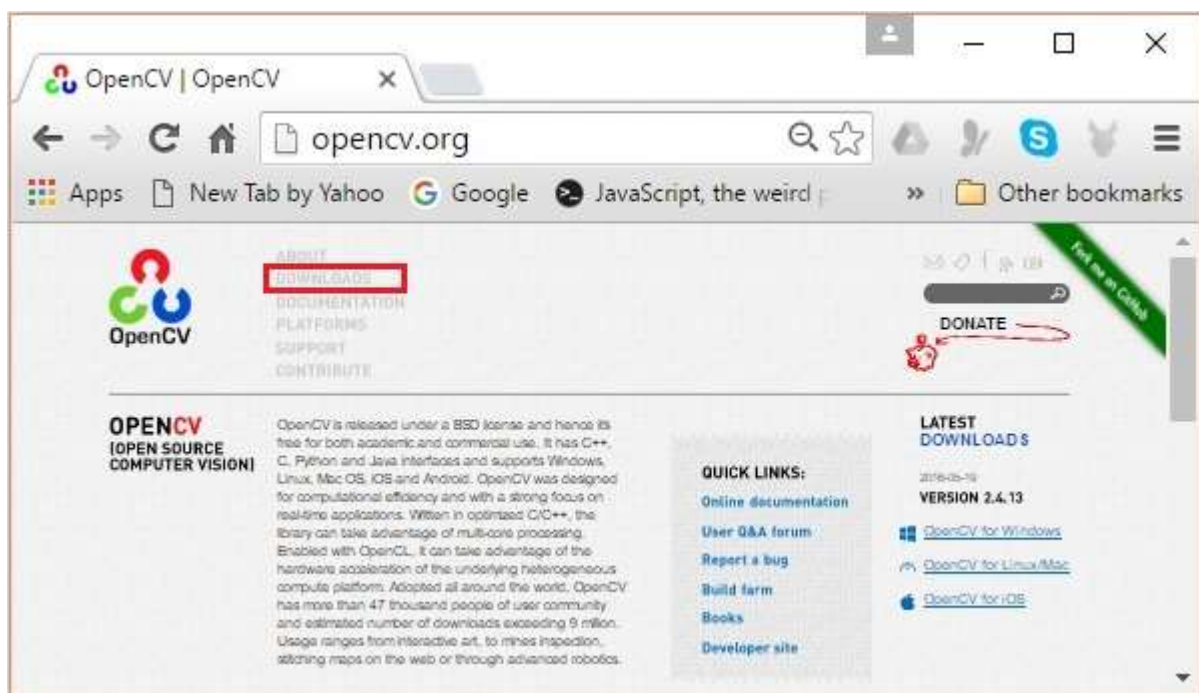
2. OpenCV – Environment

In this chapter, you will learn how to install OpenCV and set up its environment in your system.

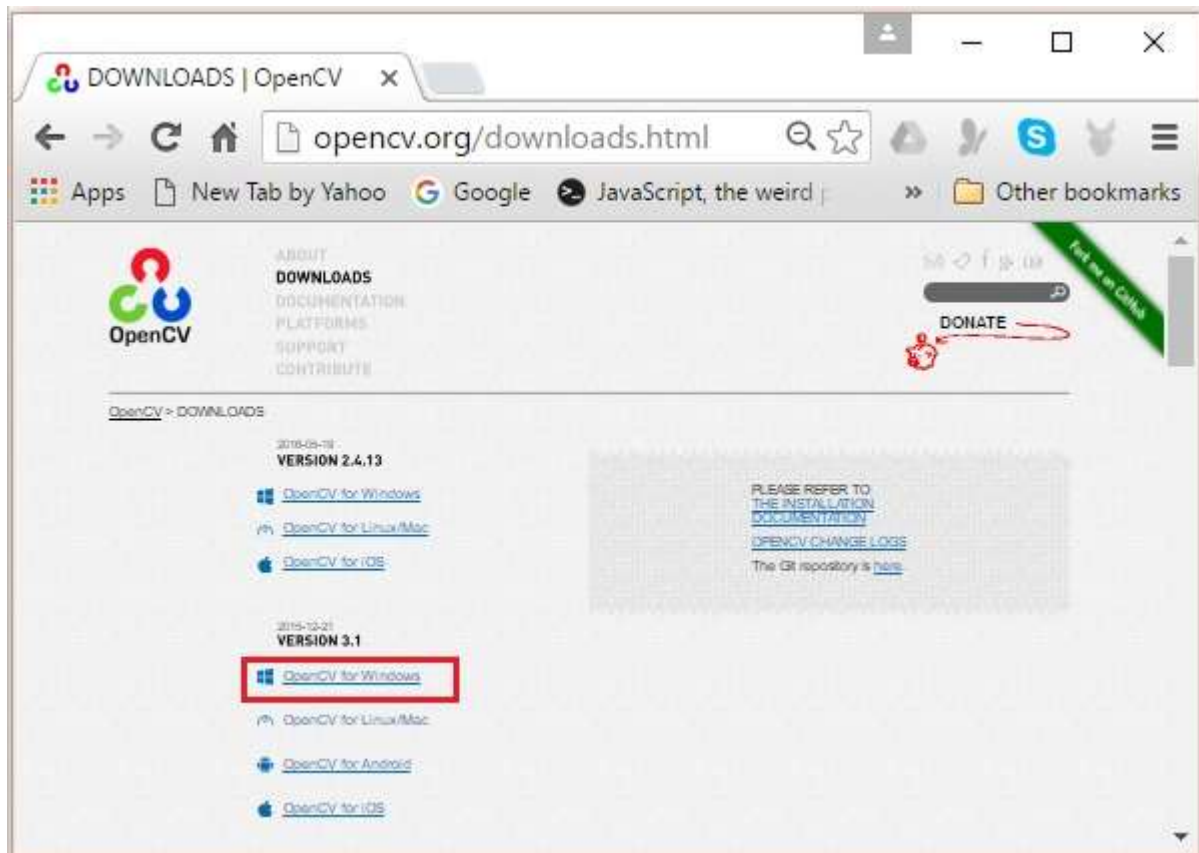
Installing OpenCV

First of all, you need to download OpenCV onto your system. Follow the steps given below.

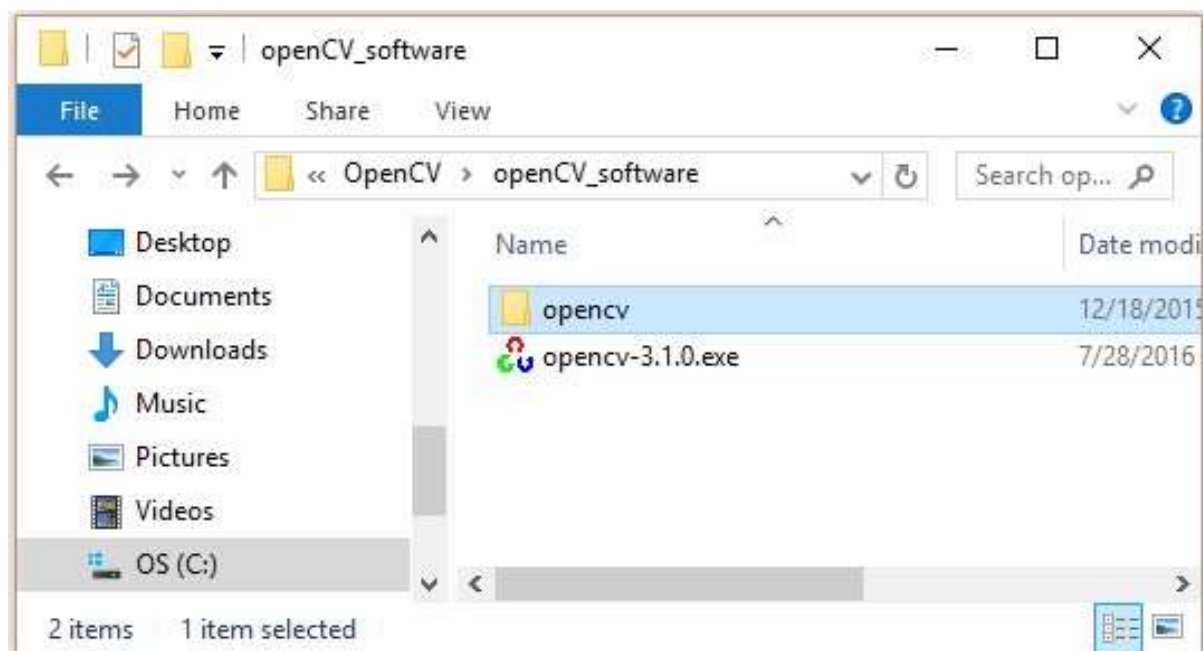
Step 1: Open the homepage of **OpenCV** by clicking the following link: <http://opencv.org/>. On clicking, you will see its homepage as shown below.



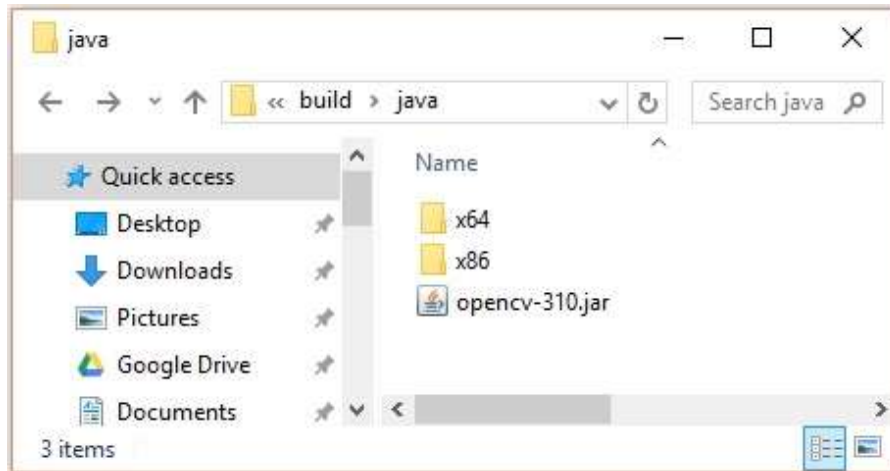
Step 2: Now, click the **Downloads** link highlighted in the above screenshot. On clicking, you will be directed to the downloads page of OpenCV.



Step 3: On clicking the highlighted link in the above screenshot, a file named **opencv-3.1.0.exe** will be downloaded. Extract this file to generate a folder **opencv** in your system, as shown in the following screenshot.



Step 4: Open the folder **OpenCV** -> **build** -> **java**. Here you will find the jar file of OpenCV named **opencv-310.jar**. Save this file in a separate folder for further use.



Eclipse Installation

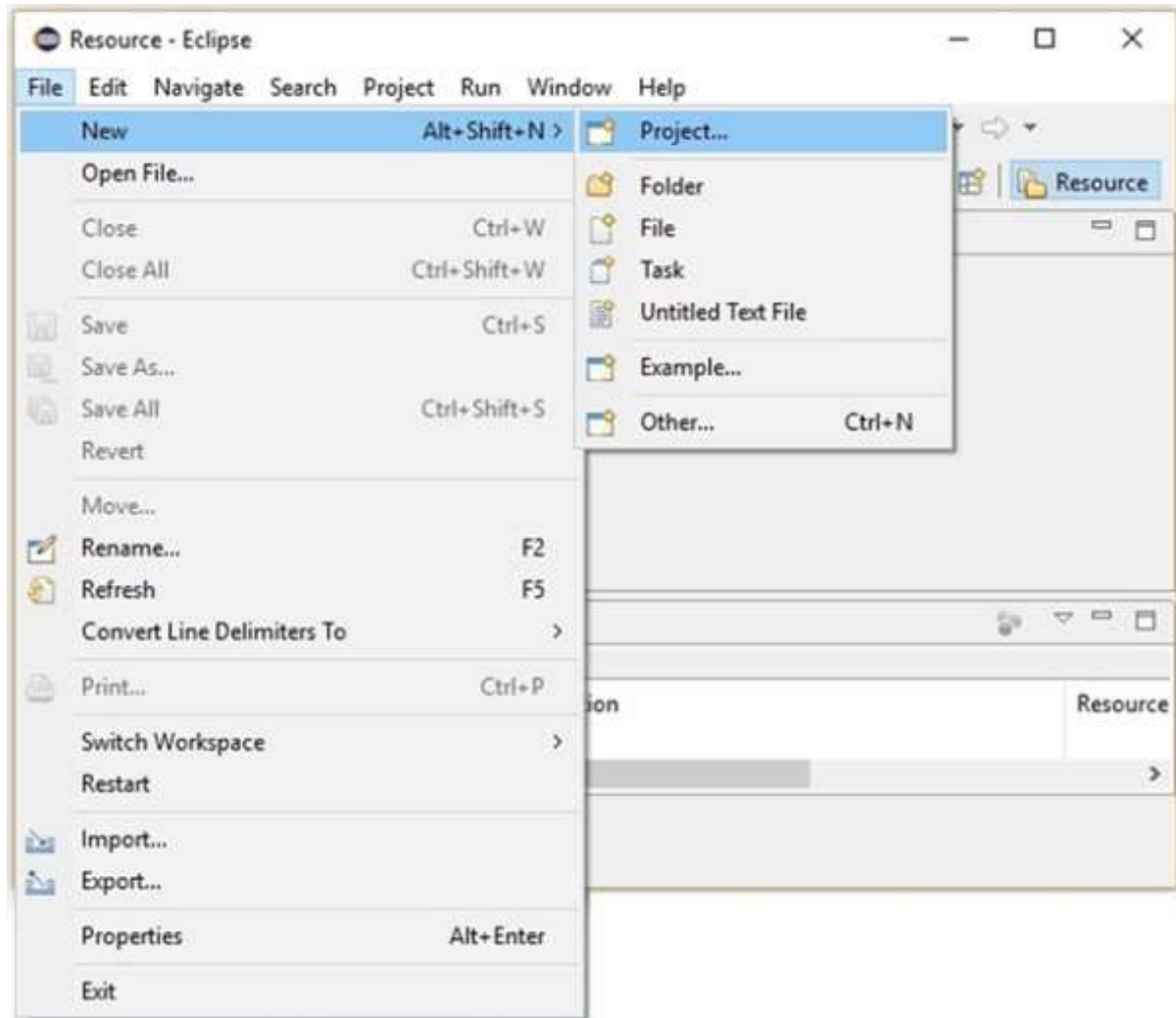
After downloading the required JAR files, you have to embed these JAR files to your Eclipse environment. You can do this by setting the Build Path to these JAR files and by using **pom.xml**.

Setting Build Path

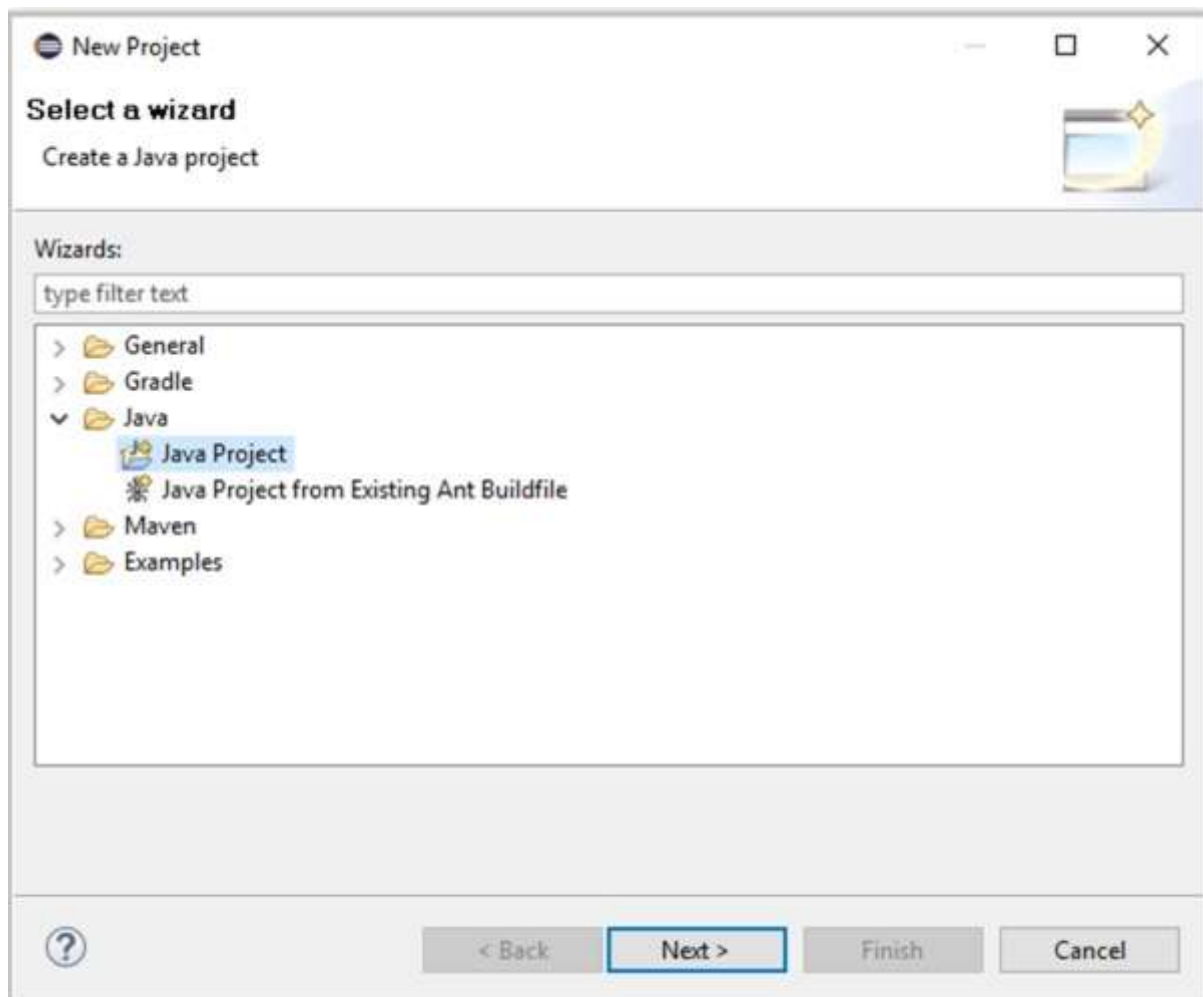
Following are the steps to set up OpenCV in Eclipse:

Step 1: Ensure that you have installed Eclipse in your system. If not, download and install Eclipse in your system.

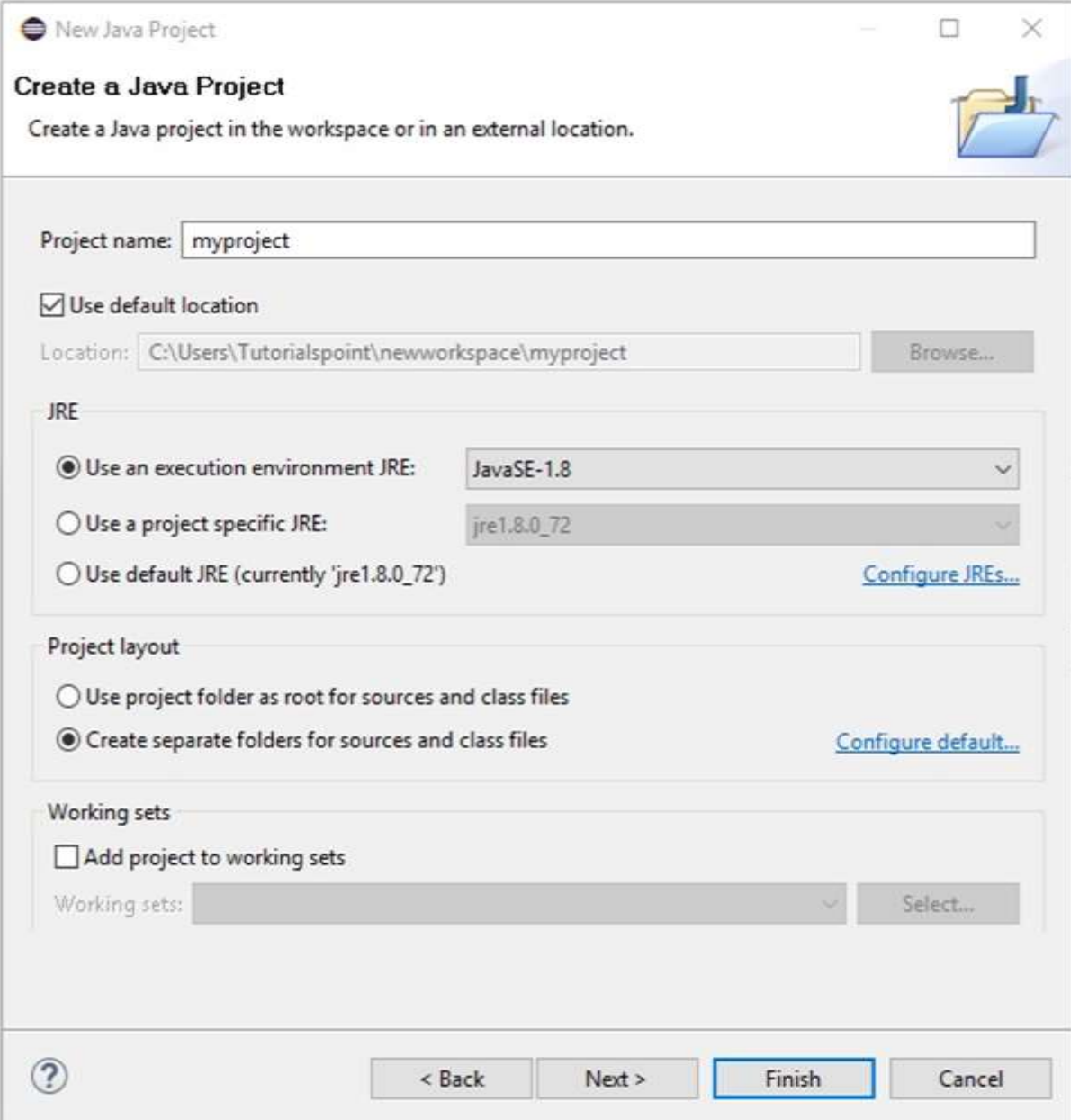
Step 2: Open Eclipse, click on File, New, and Open a new project as shown in the following screenshot.



Step 3: On selecting the project, you will get the **New Project** wizard. In this wizard, select Java project and proceed by clicking the **Next** button, as shown in the following screenshot.



Step 4: On proceeding forward, you will be directed to the **New Java Project wizard**. Create a new project and click **Next**, as shown in the following screenshot.



The screenshot shows the 'New Java Project' wizard in the Eclipse IDE. The window title is 'New Java Project'. The main heading is 'Create a Java Project' with a subtext 'Create a Java project in the workspace or in an external location.' and a folder icon.

Project name: myproject

☒ Use default location

Location: C:\Users\Tutorialspoint\newworkspace\myproject [Browse...](#)

JRE

- ☒ Use an execution environment JRE: JavaSE-1.8
- ☐ Use a project specific JRE: jre1.8.0_72
- ☐ Use default JRE (currently 'jre1.8.0_72') [Configure JREs...](#)

Project layout

- ☐ Use project folder as root for sources and class files
- ☒ Create separate folders for sources and class files [Configure default...](#)

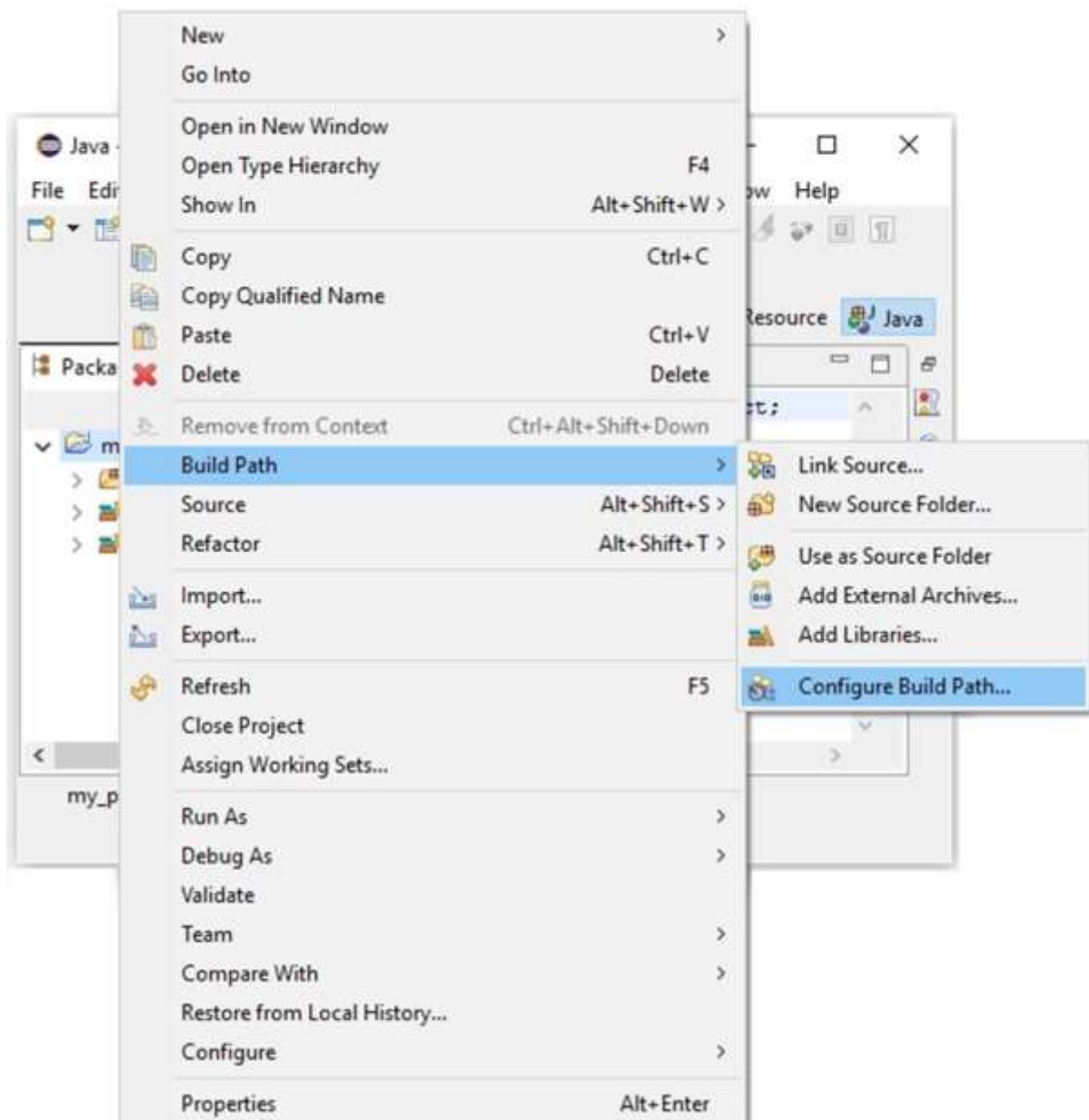
Working sets

☐ Add project to working sets

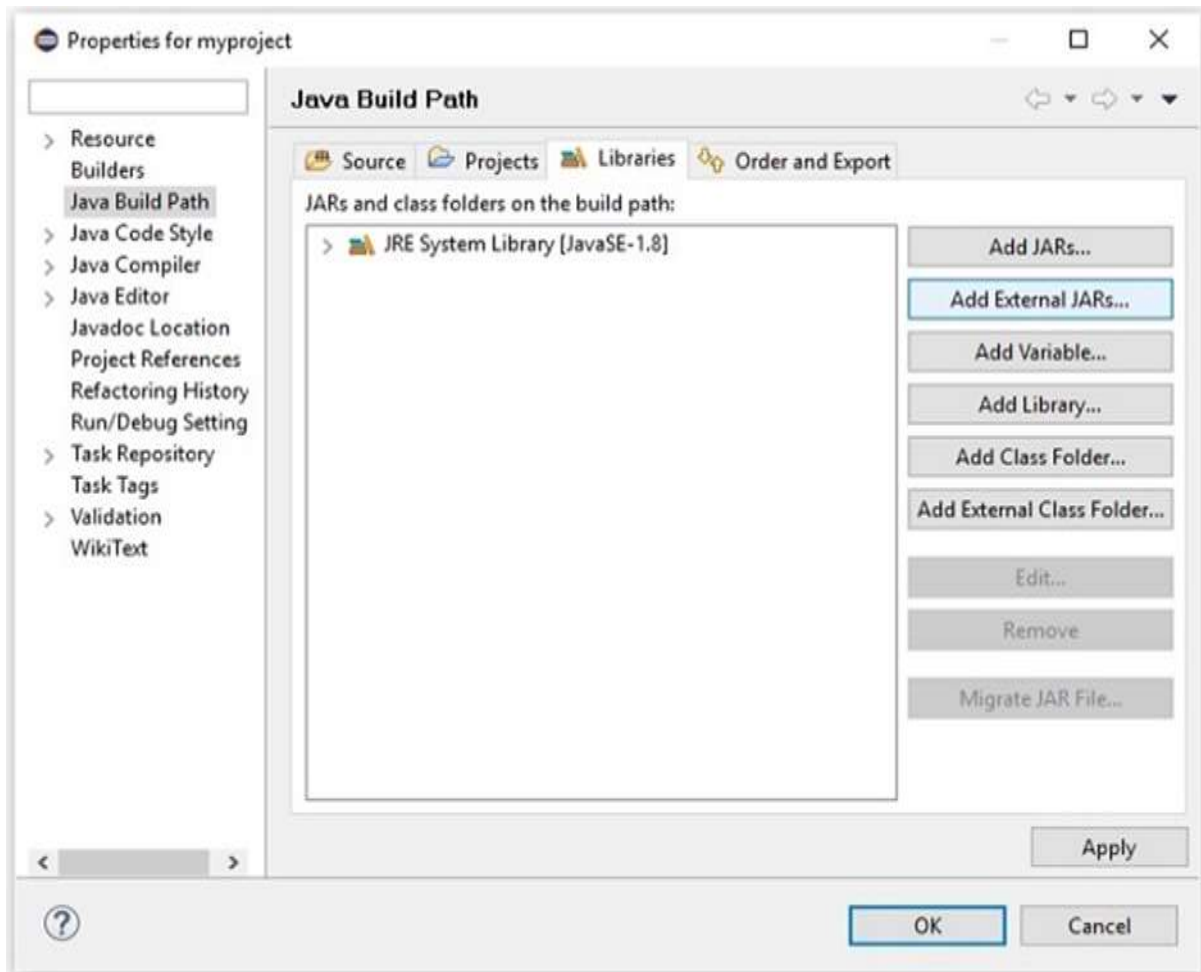
Working sets: [Select...](#)

At the bottom, there are navigation buttons: '< Back', 'Next >', 'Finish' (highlighted with a blue border), and 'Cancel'. A help icon (?) is also present on the left.

Step 5: After creating a new project, right-click on it. Select **Build Path** and click **Configure Build Path...** as shown in the following screenshot.

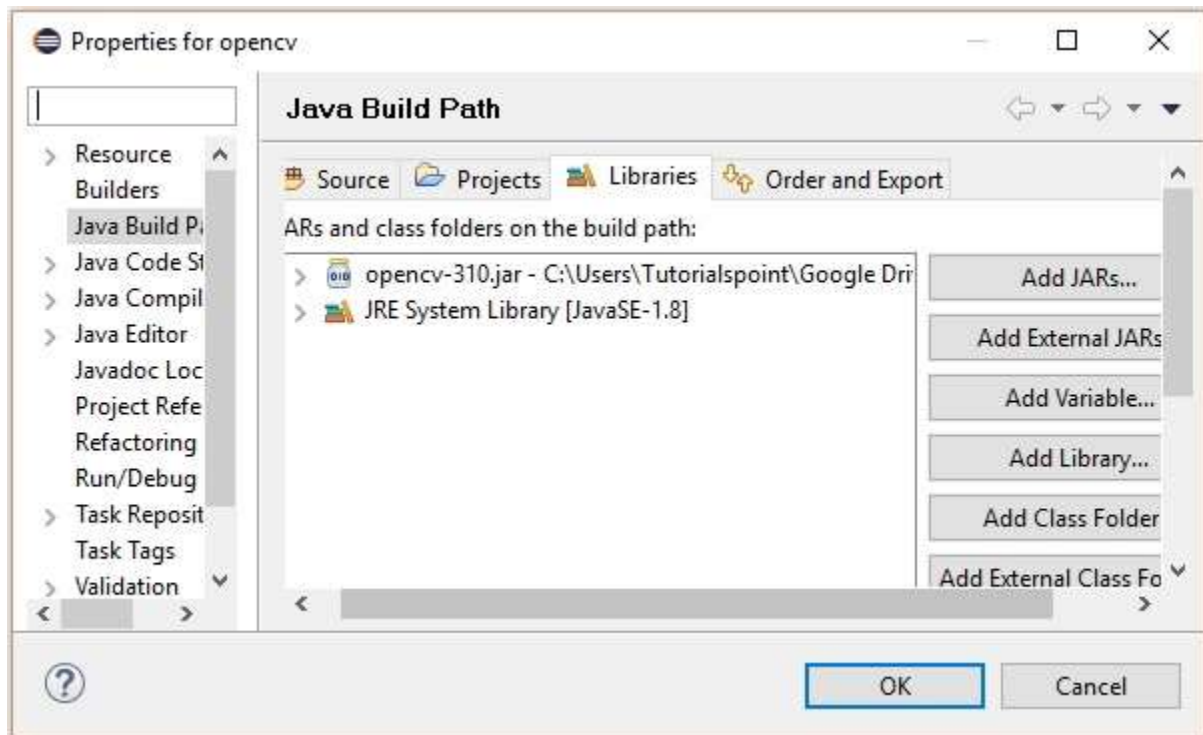


Step 6: On clicking the **Build Path** option, you will be directed to the **Java Build Path wizard**. Click the **Add External JARs** button, as shown in the following screenshot.

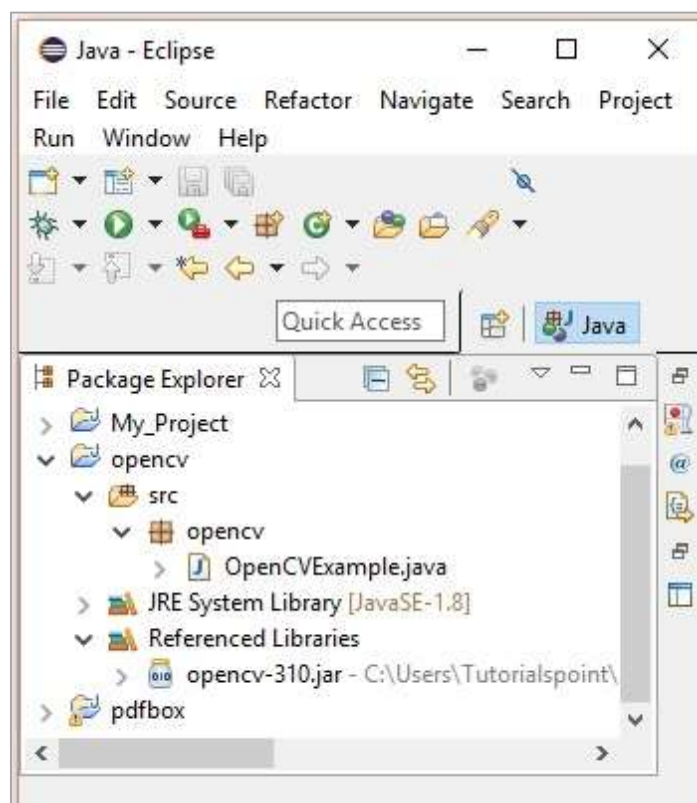


Step 7: Select the path where you have saved the file **opencv-310.jar**.

Step 8: On clicking the **Open** button in the above screenshot, those files will be added to your library.



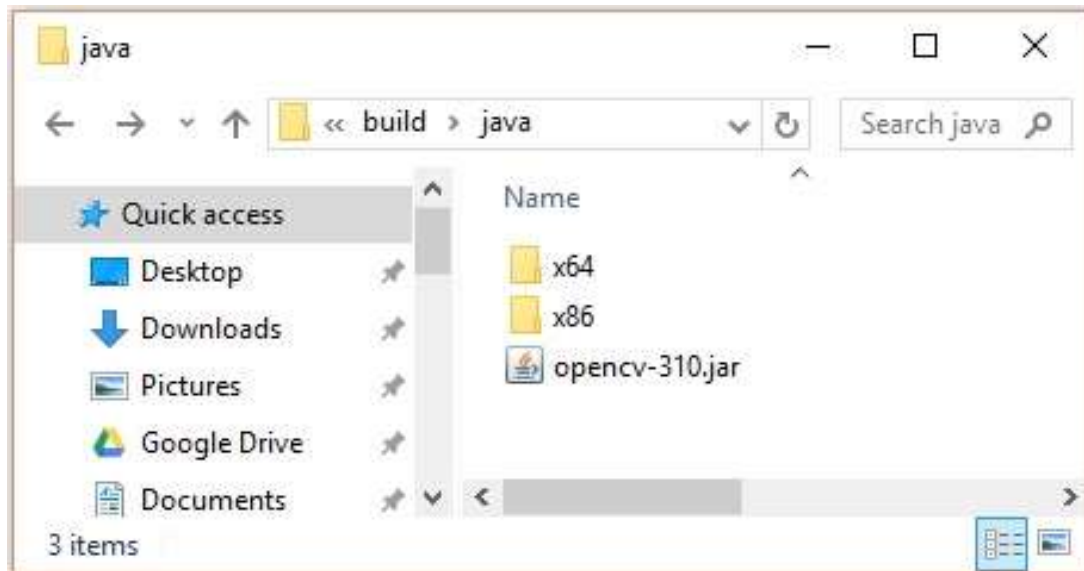
Step 9: On clicking **OK**, you will successfully add the required JAR files to the current project and you can verify these added libraries by expanding the Referenced Libraries.



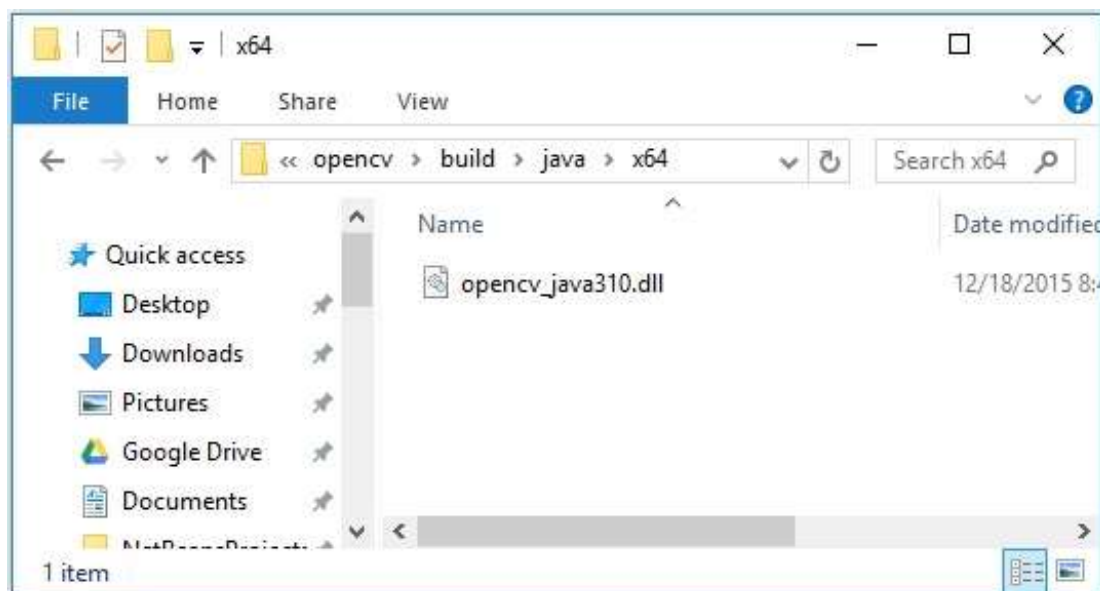
Setting the Path for Native Libraries

In addition to the JAR files, you need to set path for the native libraries (DLL files) of OpenCV.

Location of DLL files: Open the installation folder of **OpenCV** and go to the sub-folder **build -> java**. Here you will find the two folders **x64** (64 bit) and **x86** (32 bit) which contain the **dll** files of OpenCV.

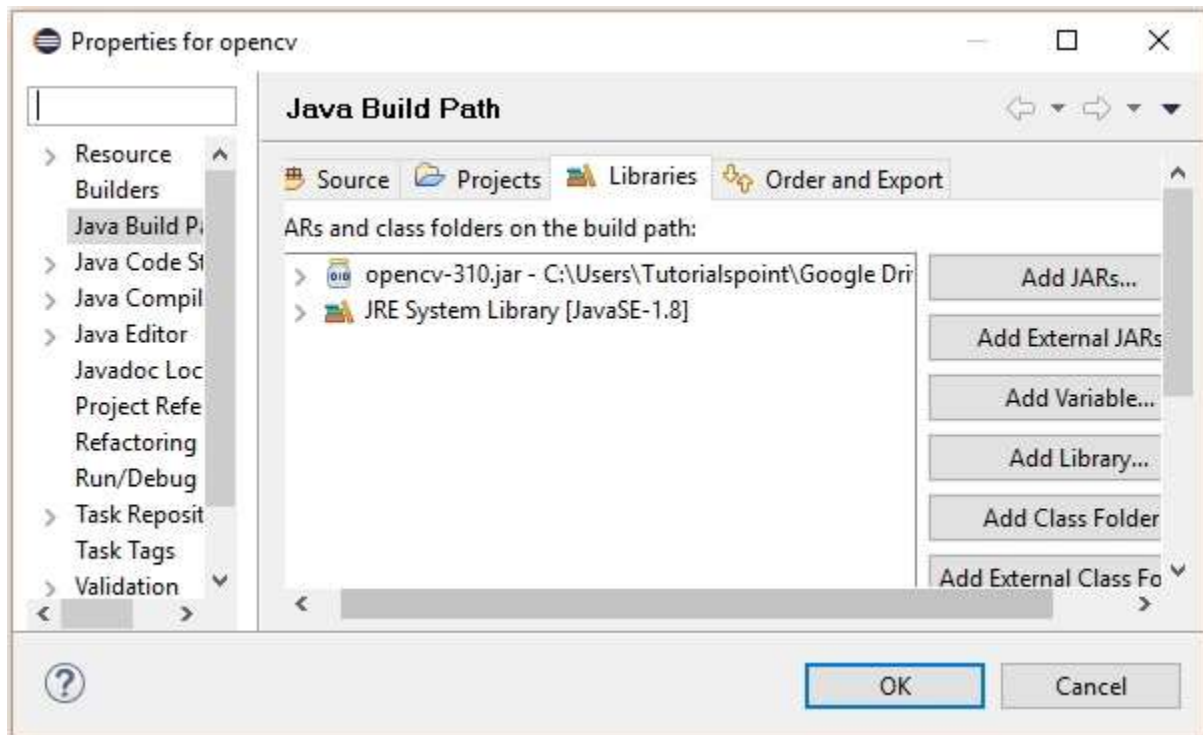


Open the respective folder suitable for your operating system, then you can see the **dll** file, as shown in the following screenshot.

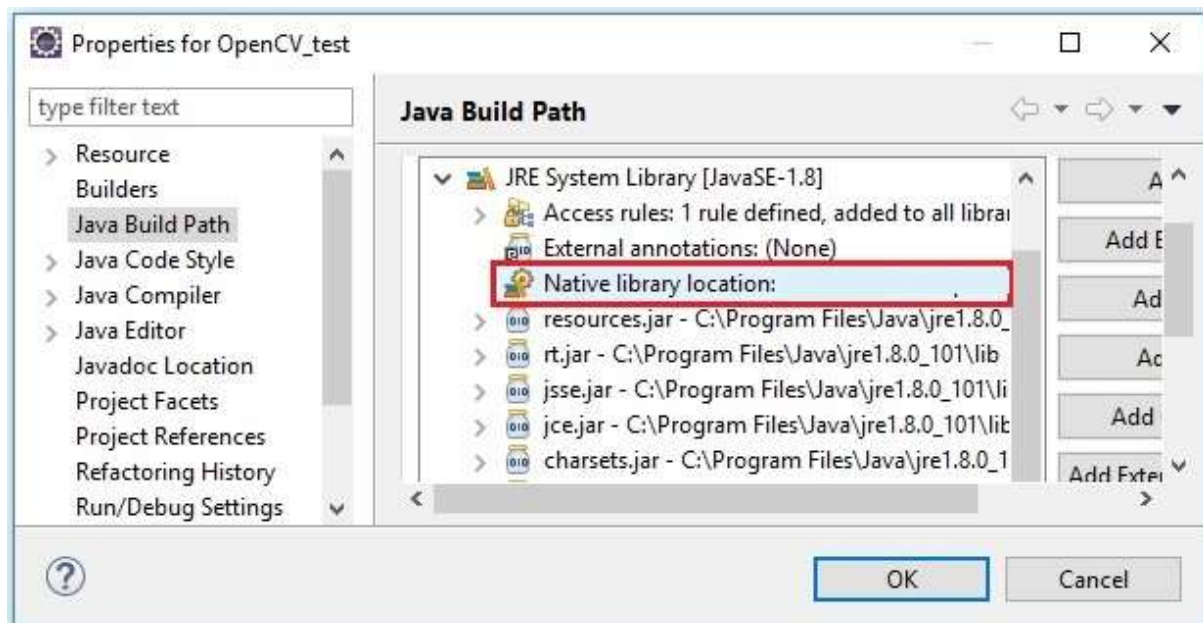


Now, set the path for this file too by following the steps given below—

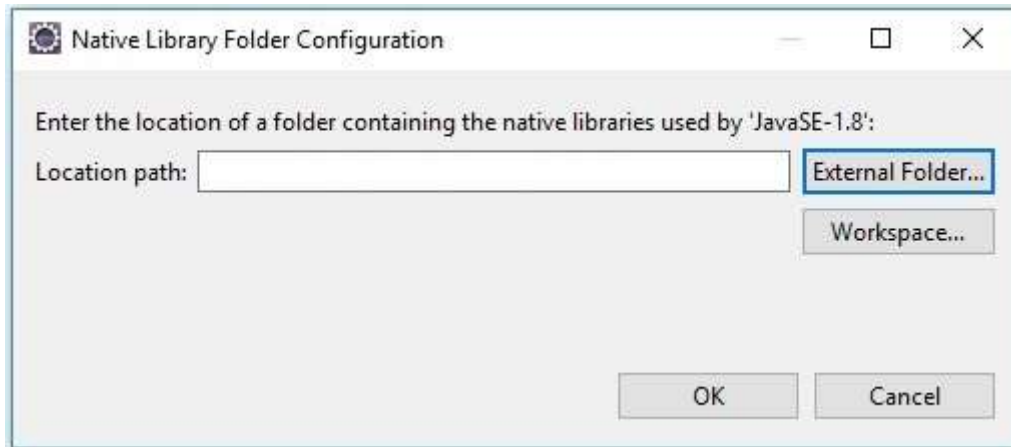
Step 1: Once again, open the JavaBuildPath window. Here you can observe the added JAR file and the **JRE System Library**.



Step 2: On expanding it, you will get the system libraries and **Native library location**, as highlighted in the following screenshot.



Step 3: Double-click on the **Native library location**. Here, you can see the **Native Library Folder Configuration window** as shown below—



Here, click the button **External Folder...** and select the location of the **dll** file in your system.

3. OpenCV — Storing Images

To capture an image, we use devices like cameras and scanners. These devices record numerical values of the image (Ex: pixel values). OpenCV is a library which processes the digital images, therefore we need to store these images for processing.

The **Mat** class of OpenCV library is used to store the values of an image. It represents an n-dimensional array and is used to store image data of grayscale or color images, voxel volumes, vector fields, point clouds, tensors, histograms, etc.

This class comprises of two data parts: the **header** and a **pointer**

- **Header:** Contains information like size, method used for storing, and the address of the matrix (constant in size).
- **Pointer:** Stores the pixel values of the image (Keeps on varying).

The Mat Class

The OpenCV Java library provides this class with the same name (**Mat**) within the package **org.opencv.core**.

Constructors

The Mat class of OpenCV Java library has various constructors, using which you can construct the Mat object.

S.No	Constructors and Description
1.	Mat() This is the default constructor with no parameters in most cases. We use this to constructor to create an empty matrix and pass this to other OpenCV methods.
2.	Mat(int rows, int cols, int type) This constructor accepts three parameters of integer type representing the number of rows and columns in a 2D array and the type of the array (that is to be used to store data).
3.	Mat(int rows, int cols, int type, Scalar s) Including the parameters of the previous one, this constructor additionally accepts an object of the class Scalar as parameter.

4.	Mat(Size size, int type) This constructor accepts two parameters, an object representing the size of the matrix and an integer representing the type of the array used to store the data.
5.	Mat(Size size, int type, Scalar s) Including the parameters of the previous one, this constructor additionally accepts an object of the class Scalar as parameter.
6.	Mat(long addr)
7.	Mat(Mat m, Range rowRange) This constructor accepts an object of another matrix and an object of the class Range representing the range of the rows to be taken to create a new matrix.
8.	Mat(Mat m, Range rowRange, Range colRange) Including the parameters of the previous one, this constructor additionally accepts an object of the class Range representing the column range.
9.	Mat(Mat m, Rect roi) This constructor accepts two objects, one representing another matrix and the other representing the Region Of Interest .

Note:

- Array type. Use CV_8UC1, ..., CV_64FC4 to create 1-4 channel matrices, or CV_8UC(n), ..., CV_64FC(n) to create multi-channel (up to CV_CN_MAX channels) matrices.
- The type of the matrices were represented by various fields of the class **CvType** which belongs to the package **org.opencv.core**.

Methods and Description

Following are some of the methods provided by the Mat class.

S.No	Methods and Description
1.	Mat col(int x) This method accepts an integer parameter representing the index of a column and retrieves and returns that column

2.	Mat row(int y) This method accepts an integer parameter representing the index of a row and retrieves and returns that row
3.	int cols() This method returns the number of columns in the matrix
4.	int rows() This method returns the number of rows in the matrix
5.	Mat setTo(Mat value) This method accepts an object of the Mat type and sets the array elements to the specified value.
6.	Mat setTo(Scalar s) This method accepts an object of the Scalar type and sets the array elements to the specified value.

Creating and Displaying the Matrix

In this section, we are going to discuss our first OpenCV example. We will see how to create and display a simple OpenCV matrix.

Given below are the steps to be followed to create and display a matrix in OpenCV.

Step 1: Load the OpenCV native library

While writing Java code using OpenCV library, the first step you need to do is to load the native library of OpenCV using the **loadLibrary()**. Load the OpenCV native library as shown below.

```
//Loading the core library
System.loadLibrary(Core.NATIVE_LIBRARY_NAME);
```

Step 2: Instantiate the Mat class

Instantiate the Mat class using any of the functions mentioned in this chapter earlier.

```
//Creating a matrix
Mat matrix = new Mat(5, 5, CvType.CV_8UC1, new Scalar(0));
```


Step 3: Fill the matrix using the methods

You can retrieve particular rows/columns of a matrix by passing index values to the methods **row()/col()**.

And, you can set values to these using any of the variants of the **setTo()** methods.

```
//Retrieving the row with index 0
Mat row0 = matrix.row(0);

//setting values of all elements in the row with index 0
row0.setTo(new Scalar(1));

//Retrieving the row with index 3
Mat col3 = matrix.col(3);

//setting values of all elements in the row with index 3
col3.setTo(new Scalar(3));
```

Example

You can use the following program code to create and display a simple matrix in Java using OpenCV library.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.CvType;
import org.opencv.core.Scalar;

class DisplayingMatrix{

    public static void main(String[] args) {

        //Loading the core library
        System.loadLibrary(Core.NATIVE_LIBRARY_NAME);

        //Creating a matrix
        Mat matrix = new Mat(5, 5, CvType.CV_8UC1, new Scalar(0));

        //Retrieving the row with index 0
        Mat row0 = matrix.row(0);
```

```

        //setting values of all elements in the row with index 0
        row0.setTo(new Scalar(1));

        //Retrieving the row with index 3
        Mat col3 = matrix.col(3);

        //setting values of all elements in the row with index 3
        col3.setTo(new Scalar(3));

        //Printing the matrix
        System.out.println("OpenCV Mat data:\n" + matrix.dump());
    }
}

```

On executing the above program, you will get the following output.

```

OpenCV Mat data:
[  1,   1,   1,   3,   1;
   0,   0,   0,   3,   0;
   0,   0,   0,   3,   0;
   0,   0,   0,   3,   0;
   0,   0,   0,   3,   0]

```

Loading Image using JavaSE API

The **BufferedImage** class of the **java.awt.image.BufferedImage** package is used to store an image and the **ImageIO** class of the package **import javax.imageio** provides methods to read and write Images.

Example

You can use the following program code to load and save images using JavaSE library.

```

import java.awt.image.BufferedImage;
import java.io.File;
import java.io.IOException;
import javax.imageio.ImageIO;

public class LoadingImage_JSE_library {

```

```
public static void main( String[] args ) throws IOException {  
  
    //Input File  
    File input = new File("C:/EXAMPLES/OpenCV/sample.jpg");  
  
    //Reading the image  
    BufferedImage image = ImageIO.read(input);  
  
    //Saving the image with a different name  
    File ouptut = new File("C:/OpenCV/sample.jpg");  
    ImageIO.write(image, "jpg", ouptut);  
  
    System.out.println("image Saved");  
}  
}
```

On executing the above program, you will get the following output.

```
image Saved
```

If you open the specified path, you can observe the saved image as follows—



4. OpenCV – Reading Images

The **Imgcodecs** class of the package **org.opencv.imgcodecs** provides methods to read and write images. Using OpenCV, you can read an image and store it in a matrix (perform transformations on the matrix if needed). Later, you can write the processed matrix to a file.

The **read()** method of the **Imgcodecs** class is used to read an image using OpenCV. Following is the syntax of this method.

```
imread(filename)
```

It accepts an argument (**filename**), a variable of the String type representing the path of the file that is to be read.

Given below are the steps to be followed to read images in Java using OpenCV library.

Step 1: Load the OpenCV native library

Load the OpenCV native library using the **load()** method, as shown below.

```
//Loading the core library  
System.loadLibrary(Core.NATIVE_LIBRARY_NAME);
```

Step 2: Instantiate the Imgcodecs class

Instantiate the **Imgcodecs** class.

```
//Instantiating the Imgcodecs class  
Imgcodecs imageCodecs = new Imgcodecs();
```

Step 3: Reading the image

Read the image using the method **imread()**. This method accepts a string argument representing the path of the image and returns the image read as **Mat** object.

```
//Reading the Image from the file  
Mat matrix = imageCodecs.imread(Path of the image);
```

Example

The following program code shows how you can **read an image** using OpenCV library.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;

import org.opencv.imgcodecs.Imgcodecs;

public class ReadingImages {

    public static void main(String args[]){

        //Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        //Instantiating the Imagecodecs class
        Imgcodecs imageCodecs = new Imgcodecs();

        //Reading the Image from the file
        String file ="C:/EXAMPLES/OpenCV/sample.jpg";
        Mat matrix = imageCodecs.imread(file);

        System.out.println("Image Loaded");
    }
}
```

On executing the above program, OpenCV loads the specified image and displays the following output.

```
Image Loaded
```

5. OpenCV — Writing an Image

The **write()** method of the **Imgcodecs** class is used to write an image using OpenCV. To write an image, repeat the first three steps from the previous example.

To write an image, you need to invoke the **imwrite()** method of the **Imgcodecs** class.

Following is the syntax of this method.

```
imwrite(filename, mat)
```

This method accepts the following parameters –

- **filename:** A **String** variable representing the path where to save the file.
- **mat:** A **Mat** object representing the image to be written.

Example

Following program is an example to **write an image** using Java program using OpenCV library.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;

public class WritingImages {

    public static void main(String args[]){

        //Loading the OpenCV core library
        System.loadLibrary(Core.NATIVE_LIBRARY_NAME);

        //Instantiating the imagecodecs class
        Imgcodecs imageCodecs = new Imgcodecs();

        //Reading the Image from the file and storing it in to a Matrix object
        String file = "C:/EXAMPLES/OpenCV/sample.jpg";

        Mat matrix = imageCodecs.imread(file);

        System.out.println("Image Loaded .....");
```

```
String file2 = "C:/EXAMPLES/OpenCV/sample_resaved.jpg";

//Writing the image
imageCodecs.imwrite(file2, matrix);
System.out.println("Image Saved .....");
}
}
```

On executing the above program, you will get the following output.

```
Image Loaded .....
Image Saved .....
```

If you open the specified path, you can observe the saved image as shown below—



6. OpenCV— GUI

In the earlier chapters, we have discussed how to read and save an image using OpenCV Java library. In addition to it, we can also display the loaded images in a separate window using GUI libraries such as AWT/Swings and JavaFX.

Converting Mat to Buffered Image

To read an image we use the method **imread()**. This method returns the image read in the form of **Matrix**. But, to use this image with GUI libraries (AWT/Swings and JavaFX), it should be converted as an object of the class **BufferedImage** of the package **java.awt.image.BufferedImage**.

Following are the steps to convert a **Mat** object of OpenCV to **BufferedImage** object.

Step 1: encode the Mat to MatOfByte

First of all, you need to convert the matrix to matrix of byte. You can do it using the method **imencode()** of the class **Imgcodecs**. Following is the syntax of this method.

```
imencode(ext, image, matOfByte);
```

This method accepts the following parameters –

- **Ext:** A String parameter specifying the image format (.jpg, .png, etc.)
- **image:** A Mat object of the image
- **matOfByte:** An empty object of the class MatOfByte

Encode the image using this method as shown below.

```
//Reading the image
Mat image = Imgcodecs.imread(file);

//instantiating an empty MatOfByte class
MatOfByte matOfByte = new MatOfByte();

//Converting the Mat object to MatOfByte
Imgcodecs.imencode(".jpg", image, matOfByte);
```

Step 2: Convert the MatOfByte object to byte array

Convert the **MatOfByte** object into a byte array using the method **toArray()**

```
byte[] byteArray = matOfByte.toArray();
```


Step 3: Preparing the InputStream object

Prepare the InputStream object by passing the byte array created in the previous step to the constructor of the **ByteArrayInputStream** class.

```
//Preparing the InputStream object
InputStream in = new ByteArrayInputStream(byteArray);
```

Step 4: Preparing the InputStream object

Pass the Input Stream object created in the previous step to the **read()** method of the **ImageIO** class. This will return a BufferedImage object.

```
//Preparing the BufferedImage
BufferedImage bufImage = ImageIO.read(in);
```

Displaying Image using AWT/Swings

To display an image using the AWT/Swings frame, first of all, read an image using the **imread()** method and convert it into **BufferedImage** following the above-mentioned steps.

Then, instantiate the **JFrame** class and add the buffered image created to the ContentPane of the JFrame, as shown below—

```
//Instantiate JFrame
JFrame frame = new JFrame();

//Set Content to the JFrame
frame.getContentPane().add(new JLabel(new ImageIcon(bufImage)));
frame.pack();
frame.setVisible(true);
```

Example

The following program code shows how you can **read** an image and **display** it through swing window using OpenCV library.

```
import java.awt.image.BufferedImage;
import java.io.ByteArrayInputStream;
import java.io.InputStream;

import javax.imageio.ImageIO;
import javax.swing.ImageIcon;
import javax.swing.JFrame;
```

```
import javax.swing.JLabel;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfByte;
import org.opencv.imgcodecs.Imgcodecs;

public class DisplayingImagesUsingSwings {

    public static void main(String args[]) throws Exception{

        //Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        //Reading the Image from the file and storing it in to a Matrix object
        String file ="C:/EXAMPLES/OpenCV/sample.jpg";
        Mat image = Imgcodecs.imread(file);

        //Encoding the image
        MatOfByte matOfByte = new MatOfByte();
        Imgcodecs.imencode(".jpg", image, matOfByte);

        //Storing the encoded Mat in a byte array
        byte[] byteArray = matOfByte.toArray();

        //Preparing the Buffered Image
        InputStream in = new ByteArrayInputStream(byteArray);
        BufferedImage bufImage = ImageIO.read(in);

        //Instantiate JFrame
        JFrame frame = new JFrame();

        //Set Content to the JFrame
        frame.getContentPane().add(new JLabel(new ImageIcon(bufImage)));
        frame.pack();
        frame.setVisible(true);
    }
}
```

```
        System.out.println("Image Loaded");  
    }  
}
```

On executing the above program, you will get the following output.

```
Image Loaded
```

In addition to that, you can see a window displaying the image loaded, as follows—



Displaying Image using JavaFX

To display an image using JavaFX, first of all, read an image using the **imread()** method and convert it into **BufferedImage**. Then, convert the **BufferedImage** to **WritableImage**, as shown below.

```
WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);
```

Pass this **WritableImage** object to the constructor of the **ImageView** class.

```
ImageView imageView = new ImageView(writableImage);
```

Example

The following program code shows how to **read** an image and **display** it through JavaFX window using OpenCV library.

```
import java.awt.image.BufferedImage;
import java.io.ByteArrayInputStream;
import java.io.IOException;
import java.io.InputStream;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;
import javax.imageio.ImageIO;
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfByte;
import org.opencv.imgcodecs.Imgcodecs;

public class DisplayingImagesJavaFX extends Application {

    @Override
    public void start(Stage stage) throws IOException {

        WritableImage writableImage = loadImage();

        //Setting the image view
        ImageView imageView = new ImageView(writableImage);

        //Setting the position of the image
        imageView.setX(50);
        imageView.setY(25);

        //setting the fit height and width of the image view
        imageView.setFitHeight(400);
        imageView.setFitWidth(500);
```

```

//Setting the preserve ratio of the image view
imageView.setPreserveRatio(true);

//Creating a Group object
Group root = new Group(imageView);

//Creating a scene object
Scene scene = new Scene(root, 600, 400);

//Setting title to the Stage
stage.setTitle("Loading an image");

//Adding scene to the stage
stage.setScene(scene);

//Displaying the contents of the stage
stage.show();

}

public WritableImage loadImage() throws IOException{

    //Loading the OpenCV core library
    System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

    //Reading the Image from the file and storing it in to a Matrix object
    String file ="C:/EXAMPLES/OpenCV/sample.jpg";
    Mat image = Imgcodecs.imread(file);

    //Encoding the image
    MatOfByte matOfByte = new MatOfByte();
    Imgcodecs.imencode(".jpg", image, matOfByte);

    //Storing the encoded Mat in a byte array
    byte[] byteArray = matOfByte.toArray();

```

```
//Displaying the image
InputStream in = new ByteArrayInputStream(byteArray);
BufferedImage bufImage = ImageIO.read(in);

System.out.println("Image Loaded");

WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);
return writableImage;
}

public static void main(String args[]) {
    launch(args);
}
}
```

On executing the above program, you will get the following output.

Image Loaded

In addition to that, you can see a window displaying the image loaded, as follows—



Types of Images

7. OpenCV — The IMREAD_XXX Flag

OpenCV supports various types of images such as colored, binary, grayscale, etc. Using the **imread()** method and predefined fields of the **Imgcodecs** class, you can read a given image as another type.

The flags parameter of imread() method (IMREAD_XXX)

In the earlier chapters, we have seen the syntax of **imread()** method of the **Imgcodecs** class. It accepts a string argument representing the location of the image that is to be read.

```
imread(filename)
```

The **imread()** method has another syntax.

```
imread(filename, int flags)
```

This syntax accepts two parameters:

- **filename:** It accepts an argument (**filename**), a variable of the String type representing the path of the file that is to be read.
- **flags:** An integer value representing a predefined flag value. For each value, this reads the given image as a specific type (gray scale color etc.)

Following is the table listing various fields provided in the **Imgproc** class as values for this parameter.

S.No	Fields and Description
1.	IMREAD_COLOR If the flag is set to this value, the loaded image will be converted to a 3-channel BGR (Blue Green Red) color image.
2.	IMREAD_GRAYSCALE If the flag is set to this value, the loaded image will be converted to a single-channel grayscale image.
3.	IMREAD_LOAD_GDAL If the flag is set to this value, you can load the image using the gdal driver.

4.	IMREAD_ANYCOLOR If the flag is set to this value, the image is read in any possible color format.
5.	IMREAD_REDUCED_COLOR_2 IMREAD_REDUCED_COLOR_4 IMREAD_REDUCED_COLOR_8 If the flag is set to this value, the image is read as three-channel BGR, and the size of the image is reduced to $\frac{1}{2}$, $\frac{1}{4}$ th or $\frac{1}{8}$ th of the original size of the image with respect to the field used.
6.	IMREAD_REDUCED_GRAYSCALE_2 IMREAD_REDUCED_GRAYSCALE_4 IMREAD_REDUCED_GRAYSCALE_8 If the flag is set to this value, the image is read as a single-channel grayscale image, and the size of the image is reduced to $\frac{1}{2}$, $\frac{1}{4}$ th or $\frac{1}{8}$ th of the original size of the image with respect to the field used.
7.	IMREAD_UNCHANGED If the flag is set to this value, the loaded image is returned as it is.

8. OpenCV — Reading an Image as Grayscale

The following program demonstrates how to read a colored image as grayscale and display it using JavaFX window. In here, we have read the image by passing the flag **IMREAD_GRAYSCALE** along with the String holding the path of a colored image.

```
import java.awt.image.BufferedImage;
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;

import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

public class ReadingAsGrayscale extends Application {

    @Override
    public void start(Stage stage) throws Exception {

        WritableImage writableImage = loadAndConvert();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // Setting the position of the image
        imageView.setX(10);
        imageView.setY(10);

        // setting the fit height and width of the image view
        imageView.setFitHeight(400);
        imageView.setFitWidth(600);
    }
}
```

```

        // Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);

        // Creating a scene object
        Scene scene = new Scene(root, 600, 400);

        // Setting title to the Stage
        stage.setTitle("Reading image as grayscale");

        // Adding scene to the stage
        stage.setScene(scene);

        // Displaying the contents of the stage
        stage.show();

    }

    public WritableImage loadAndConvert() throws Exception{

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Instantiating the imagecodecs class
        Imgcodecs imageCodecs = new Imgcodecs();

        String input = "C:/EXAMPLES/OpenCV/sample.jpg";

        // Reading the image
        Mat src = imageCodecs.imread(input, Imgcodecs.IMREAD_GRAYSCALE);

        byte[] data1 = new byte[src.rows() * src.cols() * (int)(src.elemSize())];
        src.get(0, 0, data1);
    }

```

```

        // Creating the buffered image
        BufferedImage bufImage = new BufferedImage(src.cols(),src.rows(),
        BufferedImage.TYPE_BYTE_GRAY);

        // Setting the data elements to the image
        bufImage.getRaster().setDataElements(0, 0, src.cols(), src.rows(), data1);

        // Creating a WritableImage
        WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);
        System.out.println("Image Read");
        return writableImage;
    }

    public static void main(String args[]) throws Exception{
        launch(args);
    }
}

```

Input Image

Assume that following is the input image **sample.jpg** specified in the above program.



Output Image

On executing the program, you will get the following output.



9. OpenCV — Reading Image as BGR

The following program demonstrates how to read a colored image as BGR type image and display it using JavaFX window. In here, we have read the image by passing the flag **IMREAD_COLOR** to the method **imread()** along with the String holding the path of a colored image.

```
import java.awt.image.BufferedImage;
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;

import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

public class ReadingAsColored extends Application {

    @Override
    public void start(Stage stage) throws Exception {

        WritableImage writableImage = loadAndConvert();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // Setting the position of the image
        imageView.setX(10);
        imageView.setY(10);

        // setting the fit height and width of the image view
        imageView.setFitHeight(400);
        imageView.setFitWidth(600);
```

```
// Setting the preserve ratio of the image view
imageView.setPreserveRatio(true);

// Creating a Group object
Group root = new Group(imageView);

// Creating a scene object
Scene scene = new Scene(root, 600, 400);

// Setting title to the Stage
stage.setTitle("Reading as colored image");

// Adding scene to the stage
stage.setScene(scene);

// Displaying the contents of the stage
stage.show();

}

public WritableImage loadAndConvert() throws Exception{

    // Loading the OpenCV core library
    System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

    String input = "C:/EXAMPLES/OpenCV/sample.jpg";

    Mat dst = new Mat();

    // Reading the image
    Mat src = Imgcodecs.imread(input, Imgcodecs.IMREAD_COLOR);

    byte[] data1 = new byte[src.rows() * src.cols() * (int)(src.elemSize())];
    src.get(0, 0, data1);
```

```

    // Creating the buffered image
    BufferedImage bufImage = new BufferedImage(src.cols(),src.rows(),
    BufferedImage.TYPE_3BYTE_BGR);

    // Setting the data elements to the image
    bufImage.getRaster().setDataElements(0, 0, src.cols(), src.rows(), data1);

    // Creating a WritableImage
    WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);

    System.out.println("Image read");
    return writableImage;
}

public static void main(String args[]) throws Exception{
    launch(args);
}
}

```

Input Image

Assume that following is the input image **sample.jpg** specified in the above program.



Output Image

On executing the program, you will get the following output.



Image Conversion

10. OpenCV — Colored Images to GrayScale

In the earlier chapters, we discussed how to read an input image as different types (binary, grayscale, BGR, etc.). In this chapter, we will learn how to convert one type of image to another.

The class named **Imgproc** of the package **org.opencv.imgproc** provides methods to convert an image from one color to another.

Converting Colored Images to Grayscale

A method named **cvtColor()** is used to convert colored images to grayscale. Following is the syntax of this method.

```
cvtColor(Mat src, Mat dst, int code)
```

This method accepts the following parameters –

- **src**: A matrix representing the source.
- **dst**: A matrix representing the destination.
- **code**: An integer code representing the type of the conversion, for example, RGB to Grayscale.

You can convert colored images to gray scale by passing the code **Imgproc.COLOR_RGB2GRAY** along with the source and destination matrices as a parameter to the **cvtColor()** method.

Example

The following program demonstrates how to read a colored image as a grayscale image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
```

```
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

public class ColorToGrayscale extends Application {

    @Override
    public void start(Stage stage) throws Exception {

        WritableImage writableImage = loadAndConvert();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // Setting the position of the image
        imageView.setX(10);
        imageView.setY(10);

        // setting the fit height and width of the image view
        imageView.setFitHeight(400);
        imageView.setFitWidth(600);

        // Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);

        // Creating a scene object
        Scene scene = new Scene(root, 600, 400);

        // Setting title to the Stage
        stage.setTitle("Colored to grayscale image");

        // Adding scene to the stage
        stage.setScene(scene);

        // Displaying the contents of the stage
```

```

        stage.show();
    }

    public WritableImage loadAndConvert() throws Exception{

        //Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        String input = "C:/EXAMPLES/OpenCV/sample.jpg";

        //Reading the image
        Mat src = Imgcodecs.imread(input);

        //Creating the empty destination matrix
        Mat dst = new Mat();

        //Converting the image to gray scale and saving it in the dst matrix
        Imgproc.cvtColor(src, dst, Imgproc.COLOR_RGB2GRAY);

        //Extracting data from the transformed image (dst)
        byte[] data1 = new byte[dst.rows() * dst.cols() * (int)(dst.elemSize())];
        dst.get(0, 0, data1);

        //Creating Buffered image using the data
        BufferedImage bufImage = new BufferedImage(dst.cols(),dst.rows(),
        BufferedImage.TYPE_BYTE_GRAY);

        //Setting the data elements to the image
        bufImage.getRaster().setDataElements(0, 0, dst.cols(), dst.rows(), data1);

        //Creating a WritableImage
        WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);
        System.out.println("Converted to Grayscale");
        return writableImage;
    }

    public static void main(String args[]) throws Exception{

```

```
    launch(args);  
}  
}
```

Input Image

Assume that following is the input image **sample.jpg** specified in the above program.



Output Image

On executing the program, you will get the following output.



11. OpenCV — Colored Image to Binary

A method called **threshold()** is used to convert grayscale images to binary image. Following is the syntax of this method.

```
threshold(Mat src, Mat dst, double thresh, double maxval, int type)
```

This method accepts the following parameters –

- **mat:** A **Mat** object representing the input image.
- **dst:** A **Mat** object representing the output image.
- **thresh:** An integer representing the threshold value.
- **maxval:** An integer representing the maximum value to use with the THRESH_BINARY and THRESH_BINARY_INV thresholding types.
- **type:** An integer code representing the type of the conversion, for example, RGB to Grayscale.

You can convert a grayscale image to binary image by passing the code **Imgproc.THRESH_BINARY** along with the values to the remaining parameters.

Example

The following program demonstrates how to read a colored image as a binary image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;
```

```

public class ColorToBinary extends Application {
    @Override
    public void start(Stage stage) throws Exception {

        WritableImage writableImage = loadAndConvert();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // Setting the position of the image
        imageView.setX(10);
        imageView.setY(10);

        // setting the fit height and width of the image view
        imageView.setFitHeight(400);
        imageView.setFitWidth(600);

        // Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);

        // Creating a scene object
        Scene scene = new Scene(root, 600, 400);

        // Setting title to the Stage
        stage.setTitle("Loading an image");

        // Adding scene to the stage
        stage.setScene(scene);

        // Displaying the contents of the stage
        stage.show();
    }

    public WritableImage loadAndConvert() throws Exception{

```



```

// Loading the OpenCV core library
System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

// Instantiating the Imgcodecs class
Imgcodecs imageCodecs = new Imgcodecs();

// File input = new File("C:/EXAMPLES/OpenCV/sample.jpg");
String input = "C:/EXAMPLES/OpenCV/sample.jpg";

// Reading the image
Mat src = imageCodecs.imread(input);

// Creating the destination matrix
Mat dst = new Mat();

// Converting to binary image...
Imgproc.threshold(src, dst, 200, 500, Imgproc.THRESH_BINARY);

// Extracting data from the transformed image (dst)
byte[] data1 = new byte[dst.rows() * dst.cols() * (int)(dst.elemSize())];
dst.get(0, 0, data1);

// Creating Buffered image using the data
BufferedImage bufImage = new BufferedImage(dst.cols(),dst.rows(),
BufferedImage.TYPE_BYTE_GRAY);

// Setting the data elements to the image
bufImage.getRaster().setDataElements(0, 0, dst.cols(), dst.rows(), data1);

// Creating a Writable image
WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);

System.out.println("Converted to binary");
return writableImage;
}

public static void main(String args[]) throws Exception{

```

```
        launch(args);  
    }  
}
```

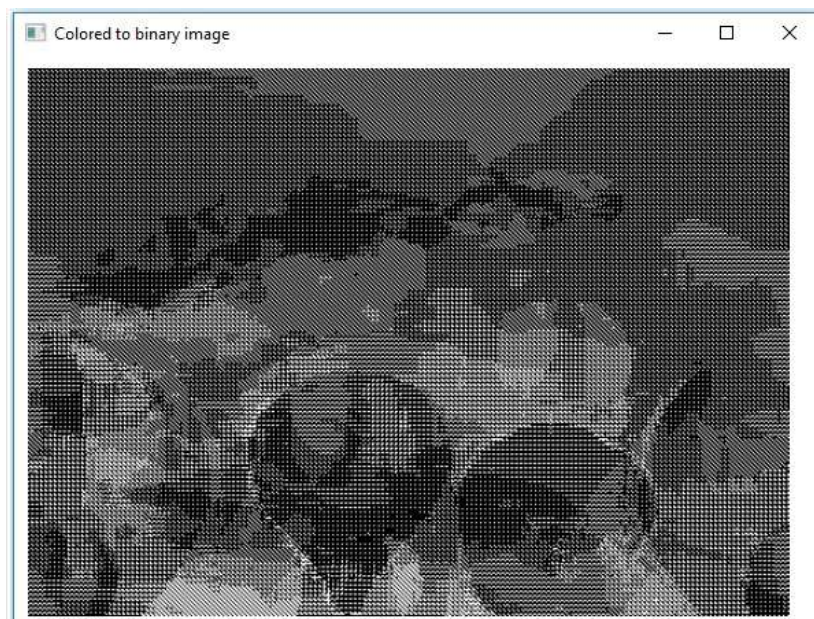
Input Image

Assume that following is the input image **sample.jpg** specified in the above program.



Output Image

On executing the program, you will get the following output.



12. OpenCV — Grayscale to Binary

You can use the same method mentioned in the previous chapter to convert a grayscale image to a binary image. Just pass the path for a grayscale image as input to this program.

Example

The following program demonstrates how to read a grayscale image as a binary image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

public class GrayScaleToBinary extends Application {

    @Override
    public void start(Stage stage) throws Exception {

        WritableImage writableImage = loadAndConvert();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // Setting the position of the image
        imageView.setX(10);
        imageView.setY(10);
    }
}
```

```

    // Setting the fit height and width of the image view
    imageView.setFitHeight(400);
    imageView.setFitWidth(600);
    // Setting the preserve ratio of the image view
    imageView.setPreserveRatio(true);

    // Creating a Group object
    Group root = new Group(imageView);

    // Creating a scene object
    Scene scene = new Scene(root, 600, 400);

    // Setting title to the Stage
    stage.setTitle("Grayscale to binary image");

    // Adding scene to the stage
    stage.setScene(scene);

    // Displaying the contents of the stage
    stage.show();

}

public WritableImage loadAndConvert() throws Exception{

    // Loading the OpenCV core library
    System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

    // Instantiating the imagecodecs class
    Imgcodecs imageCodecs = new Imgcodecs();

    String input = "E:/OpenCV/chap7/grayscale.jpg";

    // Reading the image
    Mat src = imageCodecs.imread(input);

    // Creating the destination matrix

```

```

    Mat dst = new Mat();

    // Converting to binary image...
    Imgproc.threshold(src, dst, 200, 500, Imgproc.THRESH_BINARY);

    // Extracting data from the transformed image (dst)
    byte[] data1 = new byte[dst.rows() * dst.cols() * (int)(dst.elemSize())];
    dst.get(0, 0, data1);

    // Creating Buffered image using the data
    BufferedImage bufImage = new BufferedImage(dst.cols(),dst.rows(),
    BufferedImage.TYPE_BYTE_BINARY);

    // Setting the data elements to the image
    bufImage.getRaster().setDataElements(0, 0, dst.cols(), dst.rows(), data1);

    // Creating a Writable image
    WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);

    System.out.println("Converted to binary");
    return writableImage;
}

public static void main(String args[]) throws Exception{
    launch(args);
}
}

```

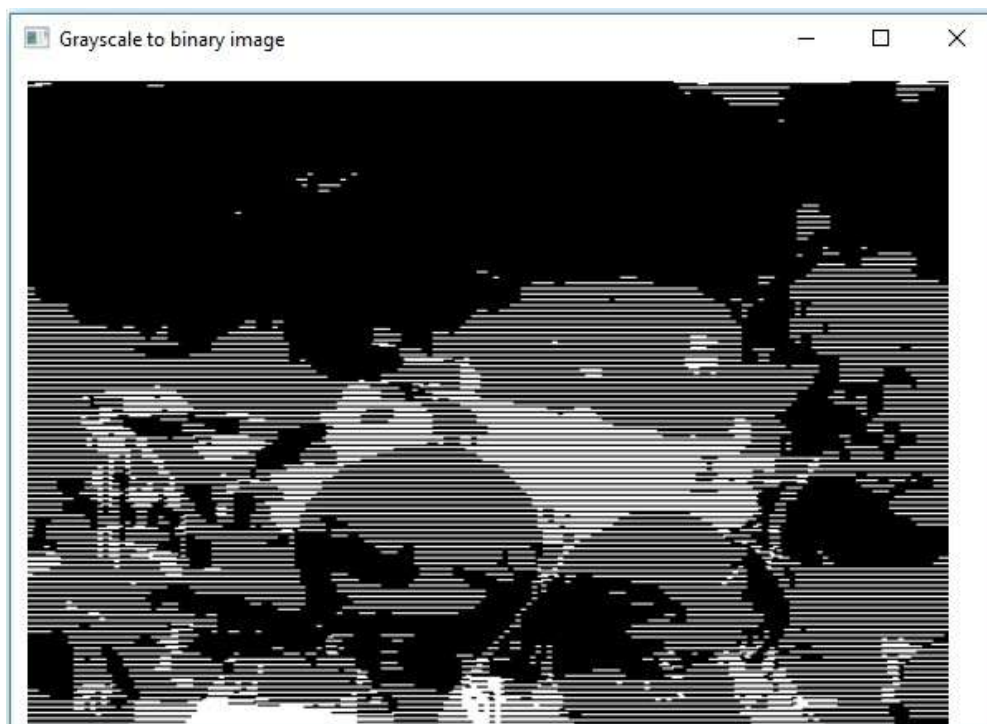
Input Image

Assume that following is the input image **sample.jpg** specified in the above program.



Output Image

On executing the program, you will get the following output.



Drawing Functions

13. OpenCV – Drawing a Circle

You can draw various shapes like Circle, Rectangle, Line, Ellipse, Polyline, Convex, Polyline, Polyline on an image using the respective methods of the **org.opencv.imgproc** package.

You can draw a circle on an image using the method **circle()** of the **imgproc** class. Following is the syntax of this method:

```
circle(img, center, radius, color, thickness)
```

This method accepts the following parameters –

- **mat:** A **Mat** object representing the image on which the circle is to be drawn.
- **point:** A **Point** object representing the center of the circle.
- **radius:** A variable of the type **integer** representing the radius of the circle.
- **scalar:** A **Scalar** object representing the color of the circle. (BGR)
- **thickness:** An **integer** representing the thickness of the circle; by default, the value of thickness is 1.

Example

The following program demonstrates how to draw a circle on an image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;

import java.io.ByteArrayInputStream;
import java.io.InputStream;
import javax.imageio.ImageIO;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfByte;
```



```
import org.opencv.core.Point;
import org.opencv.core.Scalar;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class DrawingCircle extends Application {

    Mat matrix = null;

    @Override
    public void start(Stage stage) throws Exception {

        // Capturing the snapshot from the camera
        DrawingCircle obj = new DrawingCircle();
        WritableImage writableImage = obj.LoadImage();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // setting the fit height and width of the image view
        imageView.setFitHeight(600);
        imageView.setFitWidth(600);

        // Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);

        // Creating a scene object
        Scene scene = new Scene(root, 600, 400);

        // Setting title to the Stage
        stage.setTitle("Drawing Circle on the image");
```

```

        // Adding scene to the stage
        stage.setScene(scene);

        // Displaying the contents of the stage
        stage.show();
    }

    public WritableImage loadImage() throws Exception{

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap8/input.jpg";
        Mat matrix = Imgcodecs.imread(file);

        //Drawing a Circle
        Imgproc.circle(matrix, //Matrix obj of the image
            new Point(230, 160), //Center of the circle
            100, //Radius
            new Scalar(0, 0, 255), //Scalar object for color
            10); //Thickness of the circle

        // Encoding the image
        MatOfByte matOfByte = new MatOfByte();
        Imgcodecs.imencode(".jpg", matrix, matOfByte);

        // Storing the encoded Mat in a byte array
        byte[] byteArray = matOfByte.toArray();

        // Displaying the image
        InputStream in = new ByteArrayInputStream(byteArray);
        BufferedImage bufImage = ImageIO.read(in);

        this.matrix = matrix;
    }

```

```
// Creating the Writable Image
WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);

return writableImage;
}

public static void main(String args[]) {
    launch(args);
}
}
```

On executing the above program, you will get the following output:



14. OpenCV – Drawing a Line

You can draw a line on an image using the method **line()** of the **imgproc** class. Following is the syntax of this method.

```
line(img, pt1, pt2, color, thickness)
```

This method accepts the following parameters –

- **mat:** A **Mat** object representing the image on which the line is to be drawn.
- **pt1 and pt2:** Two **Point** objects representing the points between which the line is to be drawn.
- **scalar:** A **Scalar** object representing the color of the circle. (BGR)
- **thickness:** An integer representing the thickness of the line; by default, the value of thickness is 1.

Example

The following program demonstrates how to draw a line on an image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;

import java.io.ByteArrayInputStream;
import java.io.InputStream;
import javax.imageio.ImageIO;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfByte;
import org.opencv.core.Point;
import org.opencv.core.Scalar;
import org.opencv.imgcodecs.Imgcodecs;
```

```
import org.opencv.imgproc.Imgproc;
public class DrawingLine extends Application {

    Mat matrix = null;

    @Override
    public void start(Stage stage) throws Exception {
        // Capturing the snapshot from the camera
        DrawingLine obj = new DrawingLine();
        WritableImage writableImage = obj.LoadImage();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // setting the fit height and width of the image view
        imageView.setFitHeight(600);
        imageView.setFitWidth(600);

        // Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);

        // Creating a scene object
        Scene scene = new Scene(root, 600, 400);

        // Setting title to the Stage
        stage.setTitle("Drawing a line on the image");

        // Adding scene to the stage
        stage.setScene(scene);

        // Displaying the contents of the stage
        stage.show();
    }
}
```

```

public WritableImage loadImage() throws Exception{
    // Loading the OpenCV core library
    System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

    // Reading the Image from the file and storing it in to a Matrix object
    String file = "E:/OpenCV/chap8/input.jpg";
    Mat matrix = Imgcodecs.imread(file);

    // Drawing a line
    Imgproc.line(matrix,      //Matrix obj of the image
    new Point(10, 200),      //p1
    new Point(300, 200),     //p2
    new Scalar(0, 0, 255),   //Scalar object for color
    5);                      //Thickness of the line

    // Encoding the image
    MatOfByte matOfByte = new MatOfByte();
    Imgcodecs.imencode(".jpg", matrix, matOfByte);

    // Storing the encoded Mat in a byte array
    byte[] byteArray = matOfByte.toArray();

    // Displaying the image
    InputStream in = new ByteArrayInputStream(byteArray);
    BufferedImage bufImage = ImageIO.read(in);

    this.matrix = matrix;

    // Creating the Writable Image
    WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);
    return writableImage;
}

```

```
public static void main(String args[]) {  
    launch(args);  
}  
}
```

On executing the above program, you will get the following output.



15. OpenCV — Drawing a Rectangle

You can draw a rectangle on an image using the method **rectangle()** of the **imgproc** class. Following is the syntax of this method:

```
rectangle(img, pt1, pt2, color, thickness)
```

This method accepts the following parameters –

- **mat:** A **Mat** object representing the image on which the rectangle is to be drawn.
- **pt1 and pt2:** Two **Point** objects representing the vertices of the rectangle that is to be drawn.
- **scalar:** A **Scalar** object representing the color of the rectangle. (BGR)
- **thickness:** An integer representing the thickness of the rectangle; by default, the value of thickness is 1.

Example

The following example demonstrates how to draw a rectangle on an image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;

import java.io.ByteArrayInputStream;
import java.io.InputStream;
import javax.imageio.ImageIO;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfByte;
import org.opencv.core.Point;
import org.opencv.core.Scalar;
```



```
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;
public class DrawingRectangle extends Application {

    Mat matrix = null;

    @Override
    public void start(Stage stage) throws Exception {

        // Capturing the snapshot from the camera
        DrawingRectangle obj = new DrawingRectangle();
        WritableImage writableImage = obj.LoadImage();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // setting the fit height and width of the image view
        imageView.setFitHeight(600);
        imageView.setFitWidth(600);

        // Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);

        // Creating a scene object
        Scene scene = new Scene(root, 600, 400);

        // Setting title to the Stage
        stage.setTitle("Drawing Rectangle on the image");

        // Adding scene to the stage
        stage.setScene(scene);
```

```

        // Displaying the contents of the stage
        stage.show();
    }

    public WritableImage LoadImage() throws Exception{

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap8/input.jpg";
        Mat matrix = Imgcodecs.imread(file);

        // Drawing a Rectangle
        Imgproc.rectangle(matrix,    //Matrix obj of the image
            new Point(130, 50),        //p1
            new Point(300, 280),      //p2
            new Scalar(0, 0, 255),    //Scalar object for color
            5);                       //Thickness of the line

        // Encoding the image
        MatOfByte matOfByte = new MatOfByte();
        Imgcodecs.imencode(".jpg", matrix, matOfByte);

        // Storing the encoded Mat in a byte array
        byte[] byteArray = matOfByte.toArray();

        // Displaying the image
        InputStream in = new ByteArrayInputStream(byteArray);
        BufferedImage bufImage = ImageIO.read(in);

        this.matrix = matrix;

        // Creating the Writable Image
        WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);
        return writableImage;
    }

```

```
public static void main(String args[]) {  
    launch(args);  
}  
}
```

On executing the above program, you will get the following output:



16. OpenCV – Drawing an Ellipse

You can draw an ellipse on an image using the method **rectangle()** of the **imgproc** class. Following is the syntax of this method:

```
ellipse(img, box, color, thickness)
```

This method accepts the following parameters –

- **mat:** A **Mat** object representing the image on which the Rectangle is to be drawn.
- **box:** A RotatedRect object (The ellipse is drawn inscribed in this rectangle.)
- **scalar:** A **Scalar** object representing the color of the Rectangle. (BGR)
- **thickness:** An integer representing the thickness of the Rectangle; by default, the value of thickness is 1.

The constructor of the **RotatedRect** class accepts an object of the class **Point**, an object of the class **Size**, and a variable of the type double, as shown below.

```
RotatedRect(Point c, Size s, double a)
```

Example

The following program demonstrates how to draw an ellipse on an image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;

import java.io.ByteArrayInputStream;
import java.io.InputStream;
import javax.imageio.ImageIO;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfByte;
```

```
import org.opencv.core.Point;
import org.opencv.core.RotatedRect;
import org.opencv.core.Scalar;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class DrawingEllipse extends Application {

    Mat matrix = null;

    @Override
    public void start(Stage stage) throws Exception {

        // Capturing the snapshot from the camera
        DrawingEllipse obj = new DrawingEllipse();
        WritableImage writableImage = obj.LoadImage();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // setting the fit height and width of the image view
        imageView.setFitHeight(600);
        imageView.setFitWidth(600);

        // Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);

        // Creating a scene object
        Scene scene = new Scene(root, 600, 400);

        // Setting title to the Stage
        stage.setTitle("Drawing Ellipse on the image");
```

```

// Adding scene to the stage
stage.setScene(scene);

// Displaying the contents of the stage
stage.show();
}

public WritableImage loadImage() throws Exception{

// Loading the OpenCV core library
System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

// Reading the Image from the file and storing it in to a Matrix object
String file ="E:/OpenCV/chap8/input.jpg";
Mat matrix = Imgcodecs.imread(file);

// Drawing an Ellipse
Imgproc.ellipse(matrix, //Matrix obj of the image
new RotatedRect( new Point(200, 150),new Size(260, 180), 180 ),

// RotatedRect(Point c, Size s, double a)
new Scalar(0, 0, 255), //Scalar object for color
10); //Thickness of the line

// Encoding the image
MatOfByte matOfByte = new MatOfByte();
Imgcodecs.imencode(".jpg", matrix, matOfByte);

// Storing the encoded Mat in a byte array
byte[] byteArray = matOfByte.toArray();

// Displaying the image
InputStream in = new ByteArrayInputStream(byteArray);
BufferedImage bufImage = ImageIO.read(in);

this.matrix = matrix;
}

```

```
// Creating the Writable Image
WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);

return writableImage;

}

public static void main(String args[]) {
    launch(args);
}
}
```

On executing the above program, you will get the following output



17. OpenCV – Drawing Polyline

You can draw Polyline on an image using the method **polylines()** of the **imgproc** class. Following is the syntax of this method.

```
polylines(img, pts, isClosed, color, thickness)
```

This method accepts the following parameters –

- **mat:** A **Mat** object representing the image on which the Polyline are to be drawn.
- **pts:** A **List** object holding the objects of the type **MatOfPoint**.
- **isClosed:** A parameter of the type boolean specifying whether the polylines are closed.
- **scalar:** A **Scalar** object representing the color of the Polyline. (BGR)
- **thickness:** An integer representing the thickness of the Polyline; by default, the value of thickness is 1.

The constructor of the **MatOfPoint** class accepts objects of the class **Point**.

```
MatOfPoint(Point... a)
```

Example

The following program demonstrates how to draw polylines on an image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;

import java.io.ByteArrayInputStream;
import java.io.InputStream;
import java.util.ArrayList;
import java.util.List;

import javax.imageio.ImageIO;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
```



```
import javafx.stage.Stage;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfByte;
import org.opencv.core.MatOfPoint;
import org.opencv.core.Point;
import org.opencv.core.Scalar;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class DrawingPolyLines extends Application {

    Mat matrix = null;

    @Override
    public void start(Stage stage) throws Exception {

        // Capturing the snapshot from the camera
        DrawingPolyLines obj = new DrawingPolyLines();
        WritableImage writableImage = obj.LoadImage();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // setting the fit height and width of the image view
        imageView.setFitHeight(600);
        imageView.setFitWidth(600);

        // Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);
```

```

    // Creating a scene object
    Scene scene = new Scene(root, 600, 400);

    // Setting title to the Stage
    stage.setTitle("Drawing Polygons on the image");

    // Adding scene to the stage
    stage.setScene(scene);

    // Displaying the contents of the stage
    stage.show();
}

public WritableImage loadImage() throws Exception{
    // Loading the OpenCV core library
    System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

    // Reading the Image from the file and storing it in to a Matrix object
    String file ="E:/OpenCV/chap8/input.jpg";
    Mat matrix = Imgcodecs.imread(file);

    List<MatOfPoint> list = new ArrayList();
    list.add(new MatOfPoint(
        new Point(75, 100), new Point(350, 100),
        new Point(75, 150), new Point(350, 150),
        new Point(75, 200), new Point(350, 200),
        new Point(75, 250), new Point(350, 250) ));

    // Drawing polygons
    Imgproc.polygons(matrix, // Matrix obj of the image
    list, // java.util.List<MatOfPoint> pts
    false, // isClosed
    new Scalar(0, 0, 255), // Scalar object for color
    2); // Thickness of the line

    // Encoding the image

```

```
MatOfByte matOfByte = new MatOfByte();
Imgcodecs.imencode(".jpg", matrix, matOfByte);

// Storing the encoded Mat in a byte array
byte[] byteArray = matOfByte.toArray();

// Displaying the image
InputStream in = new ByteArrayInputStream(byteArray);
BufferedImage bufImage = ImageIO.read(in);

this.matrix = matrix;

// Creating the Writable Image
WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);
return writableImage;
}

public static void main(String args[]) {
    launch(args);
}
}
```

On executing the above program, you will get the following output.



18. OpenCV – Drawing Convex Polygons

You can draw convex polygons on an image using the method **fillConvexPoly()** of the **imgproc** class. Following is the syntax of this method.

```
fillConvexPoly(Mat img, MatOfPoint points, Scalar color)
```

This method accepts the following parameters –

- **mat:** A **Mat** object representing the image on which the convex Polygons are to be drawn.
- **points:** A **MatOfPoint** object representing points between which the convex polygons are to be drawn.
- **scalar:** A **Scalar** object representing the color of the convex Polygons. (BGR)

The constructor of the **MatOfPoint** class accepts objects of the class **Point**.

```
MatOfPoint(Point... a)
```

Example

The following program demonstrates how to draw convex polygons on an image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;
import java.io.ByteArrayInputStream;
import java.io.InputStream;

import javax.imageio.ImageIO;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfByte;
```

```

import org.opencv.core.MatOfPoint;
import org.opencv.core.Point;
import org.opencv.core.Scalar;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class FillConvexPoly extends Application {

    Mat matrix = null;

    @Override
    public void start(Stage stage) throws Exception {

        // Capturing the snapshot from the camera
        FillConvexPoly obj = new FillConvexPoly();
        WritableImage writableImage = obj.LoadImage();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // setting the fit height and width of the image view
        imageView.setFitHeight(600);
        imageView.setFitWidth(600);
        //Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);

        // Creating a scene object
        Scene scene = new Scene(root, 600, 400);

        // Setting title to the Stage
        stage.setTitle("Drawing convex Polygons (fill) on the image");

        // Adding scene to the stage
    }
}

```

```

stage.setScene(scene);

// Displaying the contents of the stage
stage.show();
}

public WritableImage LoadImage() throws Exception{

    // Loading the OpenCV core library
    System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

    // Reading the Image from the file and storing it in to a Matrix object
    String file ="E:/OpenCV/chap8/input.jpg";
    Mat matrix = Imgcodecs.imread(file);

    MatOfPoint matOfPoint = new MatOfPoint(
        new Point(75, 100), new Point(350, 100),
        new Point(75, 150), new Point(350, 150),
        new Point(75, 200), new Point(350, 200),
        new Point(75, 250), new Point(350, 250) );

    // Drawing polylines
    Imgproc.fillConvexPoly(matrix, // Matrix obj of the image
        matOfPoint, // java.util.List<MatOfPoint> pts
        new Scalar(0, 0, 255) // Scalar object for color
    );

    // Encoding the image
    MatOfByte matOfByte = new MatOfByte();
    Imgcodecs.imencode(".jpg", matrix, matOfByte);

    // Storing the encoded Mat in a byte array
    byte[] byteArray = matOfByte.toArray();

    // Displaying the image
    InputStream in = new ByteArrayInputStream(byteArray);
    BufferedImage bufImage = ImageIO.read(in);

```

```
this.matrix = matrix;

// Creating the Writable Image
WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);
return writableImage;
}

public static void main(String args[]) {
    launch(args);
}
}
```

On executing the above program, you will get the following output.



19. OpenCV—Drawing Arrowed Lines

You can draw an arrowed line on an image using the method **arrowedLine()** of the **imgproc** class. Following is the syntax of this method:

```
arrowedLine(Mat img, Point pt1, Point pt2, Scalar color)
```

This method accepts the following parameters –

- **mat:** A **Mat** object representing the image on which the arrowed line is to be drawn.
- **pt1 and pt2:** Two **Point** objects representing the points between which the arrowed line is to be drawn.
- **scalar:** A **Scalar** object representing the color of the arrowed line. (BGR)

Example

The following program demonstrates how to draw arrowed line on an image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;

import java.io.ByteArrayInputStream;
import java.io.InputStream;
import javax.imageio.ImageIO;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfByte;
import org.opencv.core.Point;
import org.opencv.core.Scalar;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class DrawingArrowedLine extends Application {
```

```

Mat matrix = null;

@Override
public void start(Stage stage) throws Exception {

    // Capturing the snapshot from the camera
    DrawingArrowedLine obj = new DrawingArrowedLine();
    WritableImage writableImage = obj.LoadImage();

    // Setting the image view
    ImageView imageView = new ImageView(writableImage);

    // setting the fit height and width of the image view
    imageView.setFitHeight(600);
    imageView.setFitWidth(600);

    // Setting the preserve ratio of the image view
    imageView.setPreserveRatio(true);

    // Creating a Group object
    Group root = new Group(imageView);

    // Creating a scene object
    Scene scene = new Scene(root, 600, 400);

    // Setting title to the Stage
    stage.setTitle("Drawing a line on the image");

    // Adding scene to the stage
    stage.setScene(scene);

    // Displaying the contents of the stage
    stage.show();

}

public WritableImage LoadImage() throws Exception{

```

```

// Loading the OpenCV core library
System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

// Reading the Image from the file and storing it in to a Matrix object
String file ="C:/EXAMPLES/OpenCV/Aish.jpg";
Mat matrix = Imgcodecs.imread(file);

//Drawing a line
Imgproc.arrowedLine(matrix,      // Matrix obj of the image
new Point(10, 200),              // p1
new Point(590, 200),            // p2
new Scalar(0, 100, 255)         // Scalar object for color
);

// arrowedLine(Mat img, Point pt1, Point pt2, Scalar color)

// Encoding the image
MatOfByte matOfByte = new MatOfByte();
Imgcodecs.imencode(".jpg", matrix, matOfByte);

// Storing the encoded Mat in a byte array
byte[] byteArray = matOfByte.toArray();

// Displaying the image
InputStream in = new ByteArrayInputStream(byteArray);
BufferedImage bufImage = ImageIO.read(in);

this.matrix = matrix;

// Creating the Writable Image
WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);

return writableImage;
}

public static void main(String args[]) {
    launch(args);
}

```

```
}  
}
```

On executing the above program, you will get the following output.



20. OpenCV – Adding Text

You can add text to an image using the method **putText()** of the **imgproc** class. Following is the syntax of this method.

```
putText(img, text, org, fontFace, fontScale, Scalar color, int thickness)
```

This method accepts the following parameters –

- **mat:** A **Mat** object representing the image to which the text is to be added.
- **text:** A **string** variable of representing the text that is to be added.
- **org:** A **Point** object representing the bottom left corner text string in the image.
- **fontFace:** A variable of the type integer representing the font type.
- **fontScale:** A variable of the type double representing the scale factor that is multiplied by the font-specific base size.
- **scalar:** A **Scalar** object representing the color of the text that is to be added. (BGR)
- **thickness:** An integer representing the thickness of the line by default, the value of thickness is 1.

Example

The following program demonstrates how to add text to an image and display it using JavaFX window.

```
import java.awt.image.BufferedImage;

import java.io.ByteArrayInputStream;
import java.io.InputStream;
import javax.imageio.ImageIO;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

import org.opencv.core.Core;
```

```
import org.opencv.core.Mat;
import org.opencv.core.MatOfByte;
import org.opencv.core.Point;
import org.opencv.core.Scalar;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class AddingTextToImage extends Application {

    Mat matrix = null;

    @Override
    public void start(Stage stage) throws Exception {

        // Capturing the snapshot from the camera
        AddingTextToImage obj = new AddingTextToImage();
        WritableImage writableImage = obj.LoadImage();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // setting the fit height and width of the image view
        imageView.setFitHeight(600);
        imageView.setFitWidth(600);

        // Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);

        // Creating a scene object
        Scene scene = new Scene(root, 600, 400);

        // Setting title to the Stage
        stage.setTitle("Adding text to an image");
```

```

    // Adding scene to the stage
    stage.setScene(scene);

    // Displaying the contents of the stage
    stage.show();
}

public WritableImage LoadImage() throws Exception{

    // Loading the OpenCV core library
    System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

    // Reading the Image from the file and storing it in to a Matrix object
    String file ="E:/OpenCV/chap8/input.jpg";
    Mat matrix = Imgcodecs.imread(file);

    // Adding Text
    Imgproc.putText(matrix,          // Matrix obj of the image
        "Ravivarma's Painting",      // Text to be added
        new Point(10, 50),           // point
        Core.FONT_HERSHEY_SIMPLEX ,  // front face
        1,                           // front scale
        new Scalar(0, 0, 0),         // Scalar object for color
        4);                          // Thickness

    // Encoding the image
    MatOfByte matOfByte = new MatOfByte();
    Imgcodecs.imencode(".jpg", matrix, matOfByte);

    // Storing the encoded Mat in a byte array
    byte[] byteArray = matOfByte.toArray();

    // Displaying the image
    InputStream in = new ByteArrayInputStream(byteArray);
    BufferedImage bufImage = ImageIO.read(in);

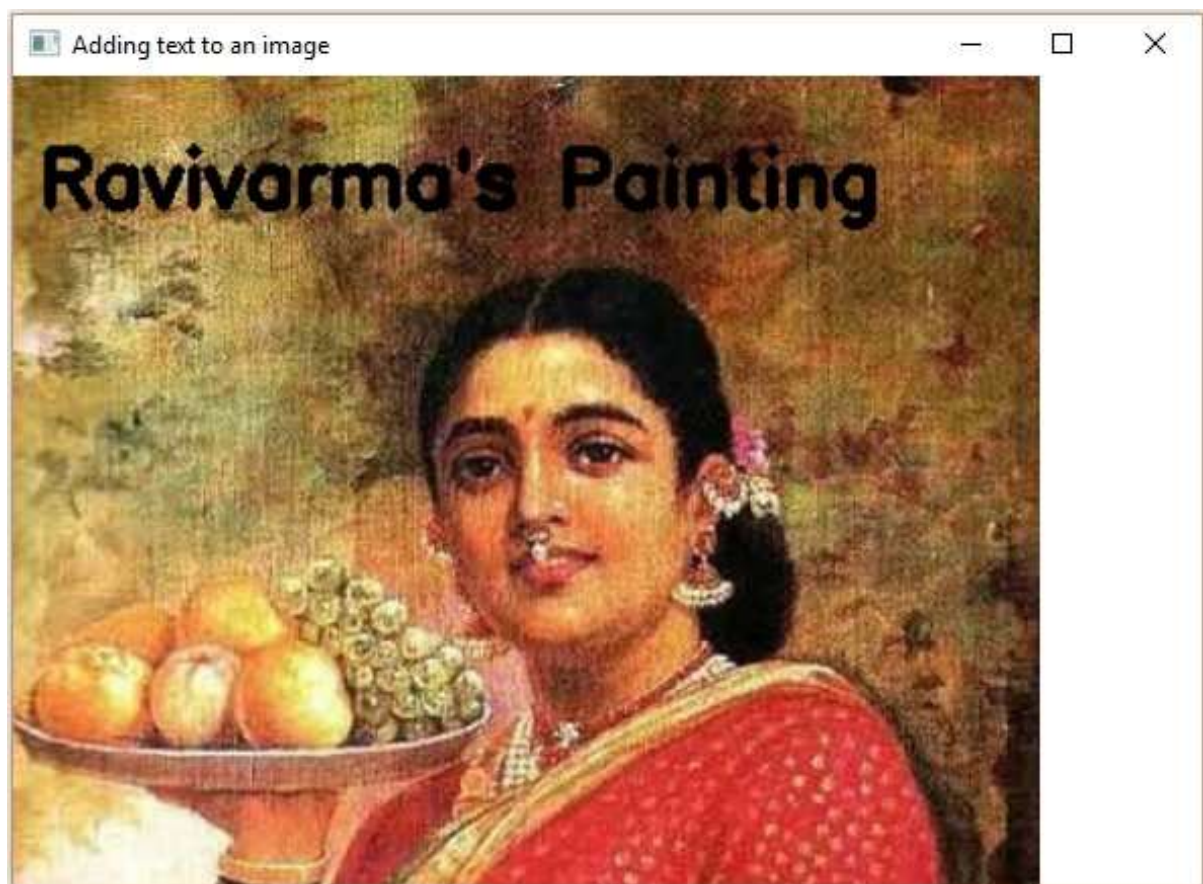
```

```
this.matrix = matrix;

//Creating the Writable Image
WritableImage writableImage = SwingFXUtils.toFXImage(bufImage, null);
return writableImage;
}

public static void main(String args[]) {
    launch(args);
}
}
```

On executing the above program, you will get the following output.



Blur Operations

21. OpenCV – Blur (Averaging)

Blurring (smoothing) is the commonly used image processing operation for reducing the image noise. The process removes high-frequency content, like edges, from the image and makes it smooth.

In general blurring is achieved by convolving (each element of the image is added to its local neighbors, weighted by the kernel) the image through a low pass filter kernel.

Blur (Averaging)

During this operation, the image is convolved with a box filter (normalized). In this process, the central element of the image is replaced by the average of all the pixels in the kernel area.

You can perform this operation on an image using the method **blur()** of the **imgproc** class. Following is the syntax of this method:

```
blur(src, dst, ksize, anchor, borderType)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **ksize:** A **Size** object representing the size of the kernel.
- **anchor:** A variable of the type integer representing the anchor point.
- **borderType:** A variable of the type integer representing the type of the border to be used to the output.

Example

The following program demonstrates how to perform the averaging (blur) operation on an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.Point;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class BlurTest {
    public static void main(String args[]){
```

```
// Loading the OpenCV core library
System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

// Reading the Image from the file and storing it in to a Matrix object
String file ="C:/EXAMPLES/OpenCV/sample.jpg";
Mat src = Imgcodecs.imread(file);

// Creating an empty matrix to store the result
Mat dst = new Mat();

// Creating the Size and Point objects
Size size = new Size(45, 45);
Point point = new Point(20, 30);

// Applying Blur effect on the Image
Imgproc.blur(src, dst, size, point, Core.BORDER_DEFAULT);

// blur(Mat src, Mat dst, Size ksize, Point anchor, int borderType)

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap9/blur.jpg", dst);
System.out.println("Image processed");
}
}
```

Assume that following is the input image **sample.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



22. OpenCV – Gaussian Blur

In Gaussian Blur operation, the image is convolved with a Gaussian filter instead of the box filter. The Gaussian filter is a low-pass filter that removes the high-frequency components are reduced.

You can perform this operation on an image using the **Gaussianblur()** method of the **imgproc** class. Following is the syntax of this method:

```
GaussianBlur(src, dst, ksize, sigmaX)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **ksize:** A **Size** object representing the size of the kernel.
- **sigmaX:** A variable of the type double representing the Gaussian kernel standard deviation in X direction.

Example

The following program demonstrates how to perform the Gaussian blur operation on an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;

import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class GaussianTest {

    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary(Core.NATIVE_LIBRARY_NAME);

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="C:/EXAMPLES/OpenCV/sample.jpg";
        Mat src = Imgcodecs.imread(file);
        // Creating an empty matrix to store the result
```

```
Mat dst = new Mat();

// Applying GaussianBlur on the Image
Imgproc.GaussianBlur(src, dst, new Size(45, 45), 0);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap9/Gaussian.jpg", dst);
System.out.println("Image Processed");
}
}
```

Assume that following is the input image **sample.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



23. OpenCV – Median Blur

The Median blur operation is similar to the other averaging methods. Here, the central element of the image is replaced by the median of all the pixels in the kernel area. This operation processes the edges while removing the noise.

You can perform this operation on an image using the **medianBlur()** method of the **imgproc** class. Following is the syntax of this method:

```
medianBlur(src, dst, ksize)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **ksize:** A **Size** object representing the size of the kernel.

Example

The following program demonstrates how to perform the median blur operation on an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class MedianBlurTest {

    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="C:/EXAMPLES/OpenCV/sample.jpg";
        Mat src = Imgcodecs.imread(file);

        // Creating an empty matrix to store the result
        Mat dst = new Mat();
```



```
// Applying MedianBlur on the Image
Imgproc.medianBlur(src, dst, 15);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap9/median.jpg", dst);

System.out.println("Image Processed");
}
}
```

Assume that following is the input image **sample.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



Filtering

24. OpenCV – Bilateral Filter

Image filtering allows you to apply various effects to an image. In this chapter and the subsequent three chapters, we are going to discuss various filter operations such as Bilateral Filter, Box Filter, SQR Box Filter and Filter2D.

Bilateral Filter

The Bilateral Filter operation applies a bilateral image to a filter. You can perform this operation on an image using the **medianBlur()** method of the **imgproc** class. Following is the syntax of this method.

```
bilateralFilter(src, dst, d, sigmaColor, sigmaSpace, borderType)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **d:** A variable of the type integer representing the diameter of the pixel neighborhood.
- **sigmaColor:** A variable of the type integer representing the filter sigma in the color space.
- **sigmaSpace:** A variable of the type integer representing the filter sigma in the coordinate space.
- **borderType:** An integer object representing the type of the border used.

Example

The following program demonstrates how to perform the Bilateral Filter operation on an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class BilateralFilter {
    public static void main(String args[]){
        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );
    }
}
```

```
// Reading the Image from the file and storing it in to a Matrix object
String file ="E:/OpenCV/chap11/filter_input.jpg";
Mat src = Imgcodecs.imread(file);

// Creating an empty matrix to store the result
Mat dst = new Mat();

// Applying Bilateral filter on the Image
Imgproc.bilateralFilter(src, dst, 15, 80, 80, Core.BORDER_DEFAULT);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap11/bilateralfilter.jpg", dst);

System.out.println("Image Processed");
}
}
```

Assume that following is the input image **filter_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



25. OpenCV – Box Filter

The Box Filter operation is similar to the averaging blur operation; it applies a bilateral image to a filter. Here, you can choose whether the box should be normalized or not.

You can perform this operation on an image using the **boxFilter()** method of the **imgproc** class. Following is the syntax of this method:

```
boxFilter(src, dst, ddepth, ksize, anchor, normalize, borderType)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **ddepth:** A variable of the type integer representing the depth of the output image.
- **ksize:** A **Size** object representing the size of the blurring kernel.
- **anchor:** A variable of the type integer representing the anchor point.
- **Normalize:** A variable of the type boolean specifying whether the kernel should be normalized.
- **borderType:** An integer object representing the type of the border used.

Example

The following program demonstrates how to perform the Box Filter operation on an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.Point;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class BoxFilterTest {

    public static void main( String[] args ) {
        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap11/filter_input.jpg";
```

```
Mat src = Imgcodecs.imread(file);

// Creating an empty matrix to store the result
Mat dst = new Mat();

// Creating the objects for Size and Point
Size size = new Size(45, 45);
Point point = Point(-1, -1);

// Applying Box Filter effect on the Image
Imgproc.boxFilter(src, dst, 50, size, point, true, Core.BORDER_DEFAULT);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap11/boxfilter.jpg", dst);

System.out.println("Image Processed");
}
}
```

Assume that following is the input image **filter_input.jpg** specified in the above program.

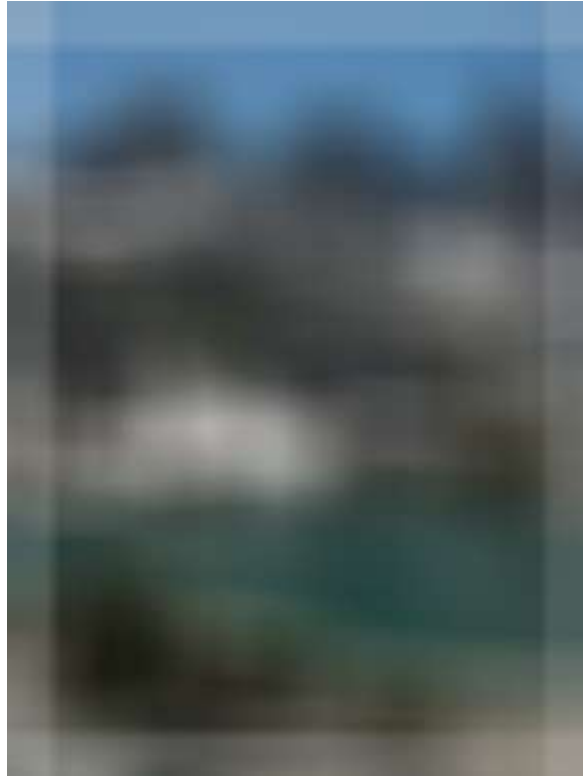


Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



26. OpenCV – SQRBox Filter

You can perform the SQRBox Filter operation on an image using the **boxFilter()** method of the **imgproc** class. Following is the syntax of this method:

```
sqrBoxFilter(src, dst, ddepth, ksize)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **ddepth:** A variable of the type integer representing the depth of the output image.
- **ksize:** A **Size** object representing the size of the blurring kernel.

Example

The following program demonstrates how to perform Sqrbox filter operation on a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class SqrBoxFilterTest {

    public static void main( String[] args ) {

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file = "E:/OpenCV/chap11/filter_input.jpg";
        Mat src = Imgcodecs.imread(file);

        // Creating an empty matrix to store the result
        Mat dst = new Mat();
```

```
// Applying Box Filter effect on the Image
Imgproc.sqrBoxFilter(src, dst, -1, new Size(1, 1));

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap11/sqrboxfilter.jpg", dst);

System.out.println("Image Processed");
}
}
```

Assume that following is the input image **filter_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



27. OpenCV – Filter2D

The Filter2D operation convolves an image with the kernel. You can perform this operation on an image using the **Filter2D()** method of the **imgproc** class. Following is the syntax of this method:

```
filter2D(src, dst, ddepth, kernel)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **ddepth:** A variable of the type integer representing the depth of the output image.
- **kernel:** A **Mat** object representing the convolution kernel.

Example

The following program demonstrates how to perform the Filter2D operation on an image.

```
import org.opencv.core.Core;
import org.opencv.core.CvType;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class Filter2D {

    public static void main( String[] args ) {

        //Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        //Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap11/filter_input.jpg";
        Mat src = Imgcodecs.imread(file);

        //Creating an empty matrix to store the result
        Mat dst = new Mat();
```

```
// Creating kernel matrix
Mat kernel = Mat.ones(2,2, CvType.CV_32F);

for(int i=0; i<kernel.rows(); i++){
    for(int j=0; j<kernel.cols(); j++){
        double[] m = kernel.get(i, j);
        for(int k =1; k<m.length; k++){
            m[k] = m[k]/(2 * 2);
        }
        kernel.put(i,j, m);
    }
}
Imgproc.filter2D(src, dst, -1, kernel);
Imgcodecs.imwrite("E:/OpenCV/chap11/filter2d.jpg", dst);
System.out.println("Image Processed");
}
}
```

Assume that following is the input image **filter_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



28. OpenCV—Dilation

Erosion and dilation are the two types of morphological operations. As the name implies, morphological operations are the set of operations that process images according to their shapes.

Based on the given input image a "structural element" is developed. This might be done in any of the two procedures. These are aimed at removing noise and settling down the imperfections, to make the image clear.

Dilation

This procedure follows convolution with some kernel of a specific shape such as a square or a circle. This kernel has an anchor point, which denotes its center.

This kernel is overlapped over the picture to compute maximum pixel value. After calculating, the picture is replaced with anchor at the center. With this procedure, the areas of bright regions grow in size and hence the image size increases.

For example, the size of an object in white shade or bright shade increases, while the size of an object in black shade or dark shade decreases.

You can perform the dilation operation on an image using the **dilate()** method of the **imgproc** class. Following is the syntax of this method.

```
dilate(src, dst, kernel)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **kernel:** A **Mat** object representing the kernel.

Example

You can prepare the kernel matrix using the **getStructuringElement()** method. This method accepts an integer representing the **morph_rect** type and an object of the type **Size**.

```
Imgproc.getStructuringElement(int shape, Size ksize);
```


The following program demonstrates how to perform the dilation operation on a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class DilateTest {

    public static void main( String[] args ) {

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="C:/EXAMPLES/OpenCV/sample.jpg";
        Mat src = Imgcodecs.imread(file);

        // Creating an empty matrix to store the result
        Mat dst = new Mat();

        // Preparing the kernel matrix object
        Mat kernel = Imgproc.getStructuringElement(Imgproc.MORPH_RECT, new
        Size((2*2) + 1, (2*2)+1));

        // Applying dilate on the Image
        Imgproc.dilate(src, dst, kernel);

        // Writing the image
        Imgcodecs.imwrite("E:/OpenCV/chap10/Dilation.jpg", dst);

        System.out.println("Image Processed");
    }
}
```

Input

Assume that following is the input image **sample.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



29. OpenCV – Erosion

Erosion is quite a similar process as dilation. But the pixel value computed here is minimum rather than maximum in dilation. The image is replaced under the anchor point with that minimum pixel value.

With this procedure, the areas of dark regions grow in size and bright regions reduce. For example, the size of an object in dark shade or black shade increases, while it decreases in white shade or bright shade.

Example

You can perform this operation on an image using the **erode()** method of the **imgproc** class. Following is the syntax of this method:

```
erode(src, dst, kernel)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **kernel:** A **Mat** object representing the kernel.

You can prepare the kernel matrix using the **getStructuringElement()** method. This method accepts an integer representing the **morph_rect** type and an object of the type **Size**.

```
Imgproc.getStructuringElement(int shape, Size ksize);
```

The following program demonstrates how to perform the erosion operation on a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class ErodeTest {
    public static void main( String[] args ) {

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );
```

```
// Reading the Image from the file and storing it in to a Matrix object
String file ="C:/EXAMPLES/OpenCV/sample.jpg";
Mat src = Imgcodecs.imread(file);

// Creating an empty matrix to store the result
Mat dst = new Mat();

// Preparing the kernel matrix object
Mat kernel = Imgproc.getStructuringElement(Imgproc.MORPH_RECT, new
Size((2*2) + 1, (2*2)+1));

// Applying erode on the Image
Imgproc.erode(src, dst, kernel);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap10/Erosion.jpg", dst);

System.out.println("Image processed");
}
}
```

Assume that following is the input image **sample.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Loaded

If you open the specified path, you can observe the output image as follows—



30. OpenCV – Morphological Operations

In the earlier chapters, we discussed the process of **erosion** and **dilation**. In addition to these two, OpenCV has more morphological transformations. The **morphologyEx()** of the method of the class **Imgproc** is used to perform these operations on a given image.

Following is the syntax of this method:

```
morphologyEx(src, dst, op, kernel)
```

This method accepts the following parameters –

- **src:** An object of the class **Mat** representing the source (input) image.
- **dst:** object of the class **Mat** representing the destination (output) image.
- **op:** An integer representing the type of the Morphological operation.
- **kernel:** A kernel matrix.

Example

The following program demonstrates how to apply the morphological operation "**top-hat**" on an image using OpenCV library.

```
import org.opencv.core.Core;
import org.opencv.core.CvType;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class MorphologyExTest {

    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap12/morph_input.jpg";
        Mat src = Imgcodecs.imread(file);

        // Creating an empty matrix to store the result
```

```
Mat dst = new Mat();

// Creating kernel matrix
Mat kernel = Mat.ones(5,5, CvType.CV_32F);

// Applying Blur effect on the Image
Imgproc.morphologyEx(src, dst, Imgproc.MORPH_TOPHAT, kernel);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap12/morph_tophat.jpg", dst);

System.out.println("Image Processed");
    }
}
```

Assume that following is the input image **morph_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—






More Operations




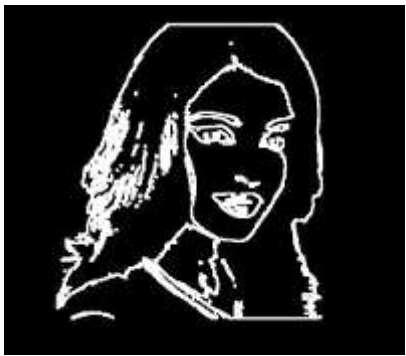
In addition to the morphological operation **TOPHAT**, demonstrated in the previous **example**, OpenCV caters various other types of morphologies. All these types are represented by predefined static fields (fixed values) of **Imgproc** class.




You can choose the type of the morphology you need by passing their respective predefined value to the parameter **op** of the **morphologyEx()** method.

```
// Applying Blur effect on the Image  
Imgproc.morphologyEx(src, dst, Imgproc.MORPH_TOPHAT, kernel);
```


Following are the values representing the type of morphological operations and their respective outputs.

Operation and Description	Output
MORPH_BLACKHAT	
MORPH_CLOSE	
MORPH_CROSS	

MORPH_DILATE	
MORPH_ELLIPSE	
MORPH_ERODE	
MORPH_GRADIENT	

MORPH_OPEN	 A binary image showing the result of a morphological opening operation. The background is black, and the subject's features (hair, face, neck) are represented by white pixels.
MORPH_RECT	 A binary image showing the result of a morphological rectangle operation. The background is black, and the subject's features are represented by white pixels.
MORPH_TOPHAT	 A binary image showing the result of a morphological top-hat operation. The background is black, and the subject's features are represented by white pixels.

31. OpenCV – Image Pyramids

Pyramid is an operation on an image where,

- An input image is initially smoothed using a particular smoothing filter (ex: Gaussian, Laplacian) and then the smoothed image is subsampled.
- This process is repeated multiple times.

During the pyramid operation, the smoothness of the image is increased and the resolution (size) is decreased.

Pyramid Up

In Pyramid Up, the image is initially up-sampled and then blurred. You can perform Pyramid Up operation on an image using the **pyrUP()** method of the **imgproc** class. Following is the syntax of this method:

```
pyrUp(src, dst, dstsize, borderType)
```

This method accepts the following parameters –

- **src:** An object of the class **Mat** representing the source (input) image.
- **mat:** An object of the class **Mat** representing the destination (output) image.
- **size:** An object of the class **Size** representing the size to which the image is to be increased or decreased.
- **borderType:** A variable of integer type representing the type of border to be used.

Example

The following program demonstrates how to perform the Pyramid Up operation on an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class PyramidUp {

    public static void main( String[] args ) {
```

```
// Loading the OpenCV core library
System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

// Reading the Image from the file and storing it in to a Matrix object
String file ="E:/OpenCV/chap13/pyramid_input.jpg";
Mat src = Imgcodecs.imread(file);

// Creating an empty matrix to store the result
Mat dst = new Mat();

// Applying pyrUp on the Image
Imgproc.pyrUp(src, dst, new Size(src.cols()*2, src.rows()*2),
Core.BORDER_DEFAULT);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap13/pyrUp_output.jpg", dst);

System.out.println("Image Processed");
}
}
```

Assume that following is the input image **pyramid_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



Pyramid Down

In Pyramid Down, the image is initially blurred and then down-sampled. You can perform Pyramid Down operation on an image using the **pyrDown()** method of the **imgproc** class. Following is the syntax of this method:

<code>pyrDown(src, dst, dstsize, borderType)</code>

This method accepts the following parameters –

- **src:** An object of the class **Mat** representing the source (input) image.
- **mat:** An object of the class **Mat** representing the destination (output) image.
- **size:** An object of the class **Size** representing the size to which the image is to be increased or decreased.
- **borderType:** A variable of integer type representing the type of border to be used.

Example

The following program demonstrates how to perform the Pyramid Down operation on an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class PyramidDown {

    public static void main( String[] args ) {

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap13/pyramid_input.jpg";
        Mat src = Imgcodecs.imread(file);

        // Creating an empty matrix to store the result
        Mat dst = new Mat();

        // Applying pyrDown on the Image
        Imgproc.pyrDown(src, dst, new Size(src.cols()/2, src.rows()/2),
Core.BORDER_DEFAULT);

        // Writing the image
        Imgcodecs.imwrite("E:/OpenCV/chap13/pyrDown_output.jpg", dst);

        System.out.println("Image Processed");
    }
}
```

Assume that following is the input image **pyramid_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



Mean Shift Filtering

In Mean Shifting pyramid operation, an initial step of mean shift segmentation of an image is carried out.

You can perform pyramid Mean Shift Filtering operation on an image using the **pyrDown()** method of the **imgproc** class. Following is the syntax of this method.

```
pyrMeanShiftFiltering(src, dst, sp, sr)
```

This method accepts the following parameters –

- **src:** An object of the class **Mat** representing the source (input) image.
- **mat:** An object of the class **Mat** representing the destination (output) image.
- **sp:** A variable of the type double representing the spatial window radius.
- **sr:** A variable of the type double representing the color window radius.

Example

The following program demonstrates how to perform a Mean Shift Filtering operation on a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class PyramidMeanShift {

    public static void main( String[] args ) {

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file = "E:/OpenCV/chap13/pyramid_input.jpg";
        Mat src = Imgcodecs.imread(file);

        // Creating an empty matrix to store the result
        Mat dst = new Mat();
```

```
// Applying meanShifting on the Image
Imgproc.pyrMeanShiftFiltering(src, dst, 200, 300);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap13/meanShift_output.jpg", dst);

System.out.println("Image Processed");
    }
}
```

Assume that following is the input image **pyramid_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



Thresholding

32. OpenCV – Simple Threshold

Thresholding is a method of image segmentation, in general it is used to create binary images. Thresholding is of two types namely, simple thresholding and adaptive thresholding.

Simple Thresholding

In simple thresholding operation the pixels whose values are greater than the specified threshold value, are assigned with a standard value.

You can perform simple threshold operation on an image using the method **threshold()** of the **Imgproc class**, Following is the syntax of this method.

```
threshold(src, dst, thresh, maxval, type)
```

This method accepts the following parameters –

- **src:** An object of the class **Mat** representing the source (input) image.
- **dst:** An object of the class **Mat** representing the destination (output) image.
- **thresh:** A variable of double type representing the threshold value.
- **maxval:** A variable of double type representing the value that is to be given if pixel value is more than the threshold value.
- **type:** A variable of integer type representing the type of threshold to be used.

Example

The following program demonstrates how to perform simple thresholding operation on an image in OpenCV.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class Thresh {

    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );
```

```
// Reading the Image from the file and storing it in to a Matrix object
String file ="E:/OpenCV/chap14/thresh_input.jpg";
Mat src = Imgcodecs.imread(file);

// Creating an empty matrix to store the result
Mat dst = new Mat();

Imgproc.threshold(src, dst, 50, 255, Imgproc.THRESH_BINARY);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap14/thresh_trunc.jpg", dst);

System.out.println("Image Processed");
}
}
```

Assume that following is the input image **thresh_input.jpg** specified in the above program.

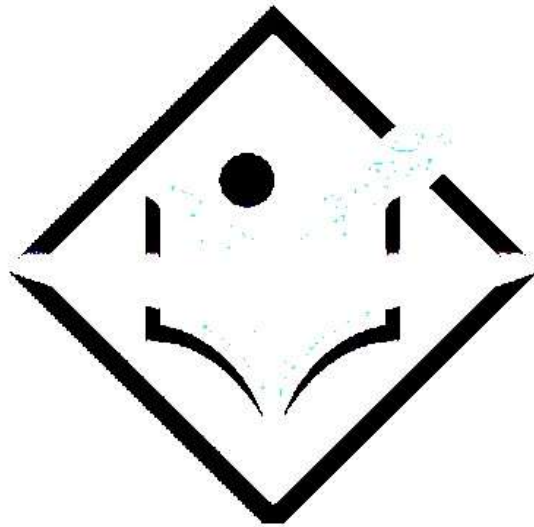


Output

On executing the program, you will get the following output.

```
Image Processed
```

If you open the specified path, you can observe the output image as follows—



Other types of simple thresholding





In addition to the **THRESH_BINARY** operation demonstrated in the previous example, OpenCV caters various other types of threshold operations. All these types are represented by predefined static fields (fixed values) of **Imgproc** class.

You can choose the type of the threshold operation you need, by passing its respective predefined value to the parameter named **type** of the **threshold()** method.

```
Imgproc.threshold(src, dst, 50, 255, Imgproc.THRESH_BINARY);
```

Following are the values representing various types of threshold operations and their respective outputs.

Operation and Description	Output
THRESH_BINARY	

THRESH_BINARY_INV	 A binary image where the original logo is white on a black background. The logo consists of a diamond shape containing a stylized 'e' and a book.
THRESH_TRUNC	 A grayscale image where the original logo is dark gray on a dark gray background. The logo is faint and barely visible.
THRESH_TOZERO	 A grayscale image where the original logo is white on a light gray background. The logo is clearly visible and has a drop shadow.
THRESH_TOZERO_INV	 A grayscale image where the original logo is dark gray on a black background. The logo is faint and barely visible.

33. OpenCV – Adaptive Threshold

In **simple thresholding**, the threshold value is global, i.e., it is same for all the pixels in the image. **Adaptive thresholding** is the method where the threshold value is calculated for smaller regions and therefore, there will be different threshold values for different regions.

In OpenCV, you can perform Adaptive threshold operation on an image using the method **adaptiveThreshold()** of the **Imgproc** class. Following is the syntax of this method.

```
adaptiveThreshold(src, dst, maxValue, adaptiveMethod, thresholdType, blockSize, C)
```

This method accepts the following parameters –

- **src:** An object of the class **Mat** representing the source (input) image.
- **dst:** An object of the class **Mat** representing the destination (output) image.
- **maxValue:** A variable of double type representing the value that is to be given if pixel value is more than the threshold value.
- **adaptiveMethod:** A variable of integer type representing the adaptive method to be used. This will be either of the following two values
 - **ADAPTIVE_THRESH_MEAN_C:** threshold value is the mean of neighborhood area.
 - **ADAPTIVE_THRESH_GAUSSIAN_C:** threshold value is the weighted sum of neighborhood values where weights are a Gaussian window.
- **thresholdType:** A variable of integer type representing the type of threshold to be used.
- **blockSize:** A variable of the integer type representing size of the pixel-neighborhood used to calculate the threshold value.
- **C:** A variable of double type representing the constant used in the both methods (subtracted from the mean or weighted mean).

Example

The following program demonstrates how to perform Adaptive threshold operation on an image in OpenCV. Here we are choosing adaptive threshold of type **binary** and **ADAPTIVE_THRESH_MEAN_C** for threshold method.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;
```

```
public class AdaptiveThresh {

    public static void main(String args[]) throws Exception{

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap14/thresh_input.jpg";

        // Reading the image
        Mat src = Imgcodecs.imread(file,0);

        // Creating an empty matrix to store the result
        Mat dst = new Mat();

        Imgproc.adaptiveThreshold(src, dst, 125, Imgproc.ADAPTIVE_THRESH_MEAN_C,
        Imgproc.THRESH_BINARY, 11, 12);

        // Writing the image
        Imgcodecs.imwrite("E:/OpenCV/chap14/Adaptivemean_thresh_binary.jpg", dst);

        System.out.println("Image Processed");
    }
}
```

Assume that following is the input image **thresh_input.jpg** specified in the above program.

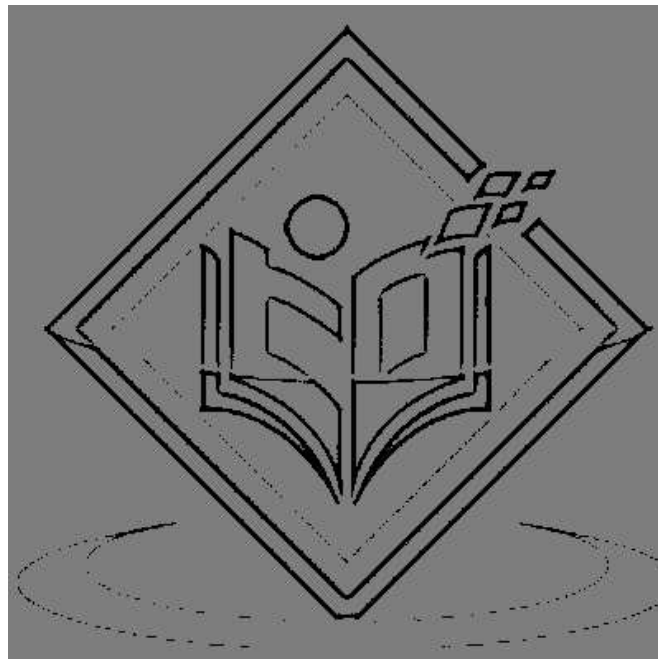


Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—







Other Types of Adaptive Thresholding

In addition to the **ADAPTIVE_THRESH_MEAN_C** as the adaptive method and **THRESH_BINARY** as the threshold type as demonstrated in the previous example, we can choose more combinations of these two values.

```
Imgproc.adaptiveThreshold(src, dst, 125, Imgproc.ADAPTIVE_THRESH_MEAN_C,
    Imgproc.THRESH_BINARY, 11, 12);
```

Following are the values representing various combinations of values for the parameters **adaptiveMethod** and **thresholdType** and their respective outputs.

adaptiveMethod / thresholdType	ADAPTIVE_THRESH_MEAN_C	ADAPTIVE_THRESH_GAUSSIAN_C:
THRESH_BINARY		
THRESH_BINARY_INV		

34. OpenCV – Adding Borders

This chapter teaches you how to add borders to an image.

The `copyMakeBorder()` Method

You can add various borders to an image in using the method **`copyMakeBorder()`** of the class named **`Core`**, which belongs to the package **`org.opencv.core`**. following is the syntax of this method.

```
copyMakeBorder(src, dst, top, bottom, left, right, borderType)
```

This method accepts the following parameters –

- **src:** An object of the class **`Mat`** representing the source (input) image.
- **dst:** An object of the class **`Mat`** representing the destination (output) image.
- **top:** A variable of integer the type integer representing the length of the border at the top of the image
- **bottom:** A variable of integer the type integer representing the length of the border at the bottom of the image
- **left:** A variable of integer the type integer representing the length of the border at the left of the image
- **right:** A variable of integer the type integer representing the length of the border at the right of the image
- **borderType:** A variable of the type integer representing the type of the border that is to be used.

Example

Following program is an example demonstrating, how to add border to a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;

public class AddingBorder {

    public static void main( String[] args ) {

        // Loading the OpenCV core library
```

```
System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

// Reading the Image from the file and storing it in to a Matrix object
String file ="E:/OpenCV/chap15/input.jpg";
Mat src = Imgcodecs.imread(file);

// Creating an empty matrix to store the result
Mat dst = new Mat();

Core.copyMakeBorder(src, dst, 20, 20, 20, 20, Core.BORDER_CONSTANT);
Imgcodecs.imwrite("E:/OpenCV/chap15/border_constant.jpg", dst);

System.out.println("Image Processed");
}
}
```

Assume that following is the input image **thresh_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

```
Image Processed
```

If you open the specified path, you can observe the output image as follows—



Other Types of Borders





In addition to the border type, **BORDER_CONSTANT** demonstrated in the previous example, OpenCV caters various other types of borders. All these types are represented by predefined static fields (fixed values) of Core class.




You can choose the type of the threshold operation you need, by passing its respective predefined value to the parameter named **borderType** of the **copyMakeBorder()** method.

```
Core.copyMakeBorder(src, dst, 20, 20, 20, 20, Core.BORDER_CONSTANT);
```

Following are the values representing various types of borders operations and their respective outputs.

Operation and Description	Output
BORDER_CONSTANT	

BORDER_ISOLATED	
BORDER_DEFAULT	
BORDER_REFLECT	
BORDER_REFLECT_101	

BORDER_REFLECT101	 The image shows a central logo of an open book with a person reading, enclosed in a diamond shape. The logo is surrounded by a thick black border. The border is composed of two parallel lines, with the space between them filled with a repeating pattern of small, light gray squares. The entire image is set against a white background.
BORDER_REPLICATE	 The image shows a central logo of an open book with a person reading, enclosed in a diamond shape. The logo is surrounded by a thick black border. The border is composed of two parallel lines, with the space between them filled with a repeating pattern of small, light gray squares. The entire image is set against a white background.
BORDER_WRAP	 The image shows a central logo of an open book with a person reading, enclosed in a diamond shape. The logo is surrounded by a thick black border. The border is composed of two parallel lines, with the space between them filled with a repeating pattern of small, light gray squares. The entire image is set against a white background.

Sobel Derivatives

35. OpenCV – Sobel Operator

Using the **sobel operation**, you can detect the edges of an image in both horizontal and vertical directions. You can apply sobel operation on an image using the method **sobel()**. Following is the syntax of this method:

```
Sobel(src, dst, ddepth, dx, dy)
```

This method accepts the following parameters –

- **src**: An object of the class **Mat** representing the source (input) image.
- **dst**: An object of the class **Mat** representing the destination (output) image.
- **ddepth**: An integer variable representing the depth of the image (-1)
- **dx**: An integer variable representing the x-derivative. (0 or 1)
- **dy**: An integer variable representing the y-derivative. (0 or 1)

Example

The following program demonstrates how to perform Sobel operation on a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;

import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class SobelTest {
    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary(Core.NATIVE_LIBRARY_NAME);

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap16/sobel_input.jpg";
        Mat src = Imgcodecs.imread(file);

        // Creating an empty matrix to store the result
        Mat dst = new Mat();

        // Applying sobel on the Image
```

```
Imgproc.Sobel(src, dst, -1, 1, 1);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap16/sobel_output.jpg", dst);

System.out.println("Image processed");
}
}
```

Assume that following is the input image **sobel_input.jpg** specified in the above program.

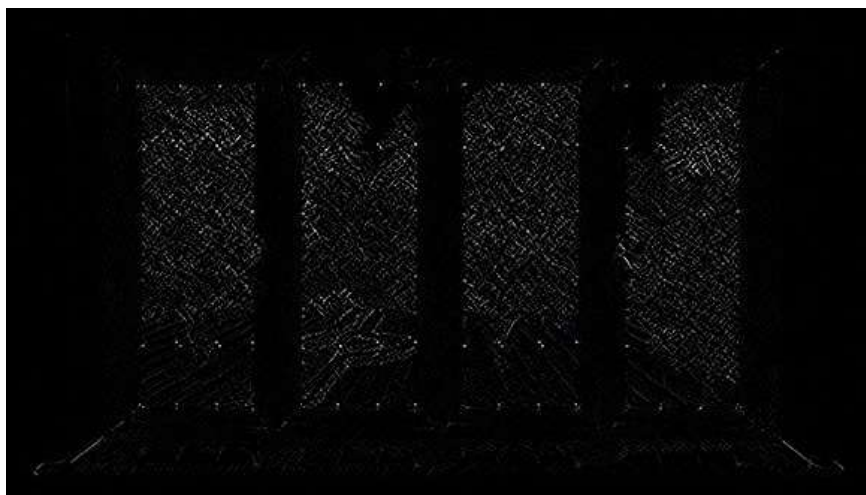


Output

On executing the program, you will get the following output.

```
Image Processed
```

If you open the specified path, you can observe the output image as follows—






sobel Variants

On passing different values to the last two parameters (dx and dy) (among 0 and 1), you will get different outputs:

```
// Applying sobel on the Image
Imgproc.Sobel(src, dst, -1, 1, 1);
```

The following table lists various values for the variables **dx** and **dy** of the method **Sobel()** and their respective outputs.

X-derivative	Y-derivative	Output
0	1	
1	0	
1	1	

36. OpenCV – Scharr Operator

Scharr is also used to detect the second derivatives of an image in horizontal and vertical directions. You can perform scharr operation on an image using the method **`scharr()`**. Following is the syntax of this method:

```
Scharr(src, dst, ddepth, dx, dy)
```

This method accepts the following parameters –

- **src:** An object of the class **Mat** representing the source (input) image.
- **dst:** An object of the class **Mat** representing the destination (output) image.
- **ddepth:** An integer variable representing the depth of the image (-1)
- **dx:** An integer variable representing the x-derivative. (0 or 1)
- **dy:** An integer variable representing the y-derivative. (0 or 1)

Example

The following program demonstrates how to apply scharr to a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class ScharrTest {

    public static void main( String[] args ) {

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file = "E:/OpenCV/chap16/scharr_input.jpg";
        Mat src = Imgcodecs.imread(file);

        // Creating an empty matrix to store the result
        Mat dst = new Mat();
```

```
// Applying Box Filter effect on the Image
Imgproc.Scharr(src, dst, Imgproc.CV_SCHARR, 0, 1);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap16/scharr_output.jpg", dst);

System.out.println("Image processed");
}
}
```

Assume that following is the input image **scharr_input.jpg** specified in the above program.

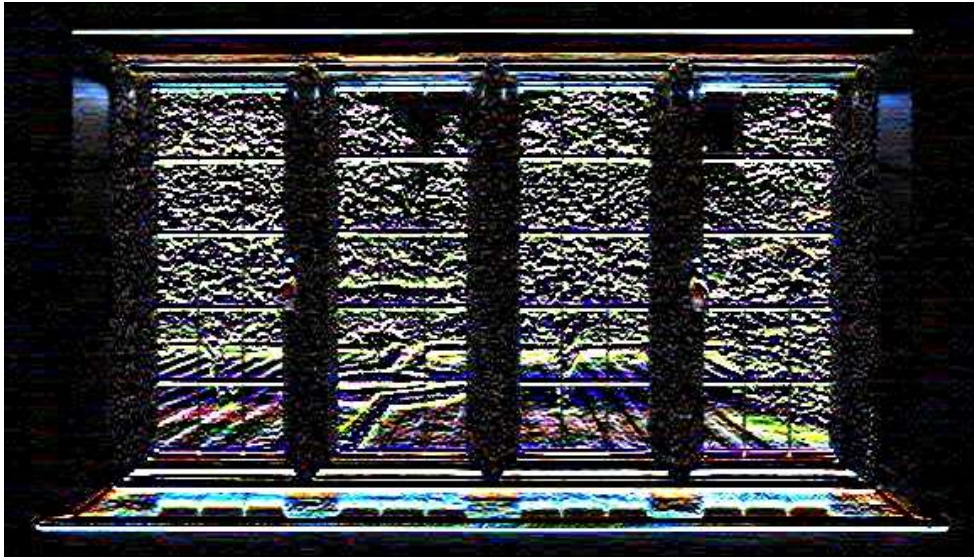


Output

On executing it, you will get the following output.

```
Image Processed
```


If you open the specified path you can observe the output image as follows—

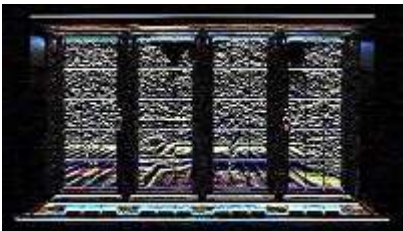



More Scharr Derivatives

On passing different values to the last two parameters (dx and dy) (among 0 and 1) you will get different outputs

```
// Applying scharr on the Image
Imgproc.Scharr(src, dst, -1, 1, 1);
```

Following is a table listing various values for the variables **dx** and **dy** of the method **scharr()** and their respective outputs.

X-derivative	Y-derivative	Output
0	1	
1	0	

Transformation Operations

37. OpenCV – Laplacian Transformation

Laplacian Operator is also a derivative operator which is used to find edges in an image. It is a second order derivative mask. In this mask we have two further classifications one is Positive Laplacian Operator and other is Negative Laplacian Operator.

Unlike other operators Laplacian didn't take out edges in any particular direction but it takes out edges in following classification.

- Inward Edges
- Outward Edges

You can perform **Laplacian Transform** operation on an image using the **Laplacian()** method of the **imgproc** class, following is the syntax of this method.

```
Laplacian(src, dst, ddepth)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **ddepth:** A variable of the type integer representing depth of the destination image.

Example

The following program demonstrates how to perform Laplace transform operation on a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class LaplacianTest {
    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary(Core.NATIVE_LIBRARY_NAME);

        //Reading the Image from the file and storing it in to a Matrix object
        String file = "E:/OpenCV/chap18/laplacian_input.jpg";
        Mat src = Imgcodecs.imread(file);
```

```
// Creating an empty matrix to store the result
Mat dst = new Mat();

// Applying GaussianBlur on the Image
Imgproc.Laplacian(src, dst, 10);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap18/laplacian.jpg", dst);

System.out.println("Image Processed");
    }
}
```

Assume that following is the input image **laplacian_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

```
Image Processed
```

If you open the specified path, you can observe the output image as follows—



38. OpenCV – Distance Transformation

The **distance transform** operator generally takes binary images as inputs. In this operation, the gray level intensities of the points inside the foreground regions are changed to distance their respective distances from the closest 0 value (boundary).

You can apply distance transform in OpenCV using the method **distanceTransform()**. Following is the syntax of this method.

```
distanceTransform(src, dst, distanceType, maskSize)
```

This method accepts the following parameters –

- **src:** An object of the class **Mat** representing the source (input) image.
- **dst:** An object of the class **Mat** representing the destination (output) image.
- **distanceType:** A variable of the type integer representing the type of the distance transformation to be applied.
- **maskSize:** A variable of integer type representing the mask size to be used.

Example

The following program demonstrates how to perform distance transformation operation on a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class DistanceTransform {

    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap19/input.jpg";
        Mat src = Imgcodecs.imread(file,0);
```

```
// Creating an empty matrix to store the results
Mat dst = new Mat();
Mat binary = new Mat();

// Converting the grayscale image to binary image
Imgproc.threshold(src, binary, 100, 255, Imgproc.THRESH_BINARY);

// Applying distance transform
Imgproc.distanceTransform(mat, dst, Imgproc.DIST_C, 3);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap19/distnctTransform.jpg", dst);

System.out.println("Image Processed");
}
}
```

Assume that following is the input image **input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—






Types of Distance Transform Operations



In addition to the distance operation type **DIST_C** demonstrated in the previous example, OpenCV caters various other types of distance transform operations. All these types are represented by predefined static fields (fixed values) of `Imgproc` class.

You can choose the type of the distance transform operation you need, by passing its respective predefined value to the parameter named **distanceType** of the **distanceTransform()** method.

```
// Applying distance transform  
Imgproc.distanceTransform(mat, dst, Imgproc.DIST_C, 3);
```

Following are the values representing various types of **distanceTransform** operations and their respective outputs.

Operation and Description	Output
DIST_C	
DIST_L1	
DIST_L2	

DIST_LABEL_PIXEL	
DIST_MASK_3	

Camera & Face Detection

39. OpenCV – Using Camera

In this chapter, we will learn how to use OpenCV to capture frames using the system camera. The **VideoCapture** class of the **org.opencv.videoio** package contains classes and methods to capture video using the camera. Let's go step by step and learn how to capture frames:

Step 1: Load the OpenCV native library

While writing Java code using OpenCV library, the first step you need to do is to load the native library of OpenCV using the **loadLibrary()**. Load the OpenCV native library as shown below.

```
// Loading the core library
System.loadLibrary(Core.NATIVE_LIBRARY_NAME);
```

Step 2: Instantiate the video capture class

Instantiate the Mat class using any of the functions mentioned in this tutorial earlier.

```
// Instantiating the VideoCapture class (camera:: 0)
VideoCapture capture = new VideoCapture(0);
```

Step 3: Read the frames

You can read the frames from the camera using the **read()** method of the **VideoCapture** class. This method accepts an object of the class **Mat** to store the frame read.

```
// Reading the next video frame from the camera
Mat matrix = new Mat();
capture.read(matrix);
```

Example

The following program demonstrates how to capture a frame using camera and display it using JavaFX window. It also saves the captured frame.

```
import java.awt.image.BufferedImage;
import java.awt.image.DataBufferByte;
import java.awt.image.WritableRaster;
import java.io.FileNotFoundException;
import java.io.IOException;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
```

```
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.videoio.VideoCapture;

public class CameraSnapshotJavaFX extends Application {

    Mat matrix = null;

    @Override
    public void start(Stage stage) throws FileNotFoundException, IOException {

        // Capturing the snapshot from the camera
        CameraSnapshotJavaFX obj = new CameraSnapshotJavaFX();
        WritableImage writableImage = obj.captureSnapShot();

        // Saving the image
        obj.saveImage();

        // Setting the image view
        ImageView imageView = new ImageView(writableImage);

        // setting the fit height and width of the image view
        imageView.setFitHeight(400);
        imageView.setFitWidth(600);

        // Setting the preserve ratio of the image view
        imageView.setPreserveRatio(true);

        // Creating a Group object
        Group root = new Group(imageView);
```

```

// Creating a scene object
Scene scene = new Scene(root, 600, 400);

// Setting title to the Stage
stage.setTitle("Capturing an image");

// Adding scene to the stage
stage.setScene(scene);

// Displaying the contents of the stage
stage.show();
}

public WritableImage captureSnapshot(){
    WritableImage WritableImage = null;

    // Loading the OpenCV core library
    System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

    // Instantiating the VideoCapture class (camera:: 0)
    VideoCapture capture = new VideoCapture(0);

    // Reading the next video frame from the camera
    Mat matrix = new Mat();
    capture.read(matrix);

    // If camera is opened
    if( capture.isOpened()){

        // If there is next video frame
        if (capture.read(matrix)){

            // Creating BuffredImage from the matrix
            BufferedImage image = new BufferedImage(matrix.width(),
matrix.height(), BufferedImage.TYPE_3BYTE_BGR);
            WritableRaster raster = image.getRaster();
            DataBufferByte dataBuffer = (DataBufferByte) raster.getDataBuffer();

```

```
        byte[] data = dataBuffer.getData();
        matrix.get(0, 0, data);
        this.matrix = matrix;

        // Creating the Writable Image
        WritableImage = SwingFXUtils.toFXImage(image, null);
    }
}
return WritableImage;
}

public void saveImage(){

    // Saving the Image
    String file = "E:/OpenCV/chap22/sanpshot.jpg";

    // Instantiating the imgcodecs class
    Imgcodecs imageCodecs = new Imgcodecs();

    // Saving it again
    imageCodecs.imwrite(file, matrix);
}

public static void main(String args[]) {
    launch(args);
}
}
```

Output

On executing the program, you will get the following output.



If you open the specified path, you can observe the same frame which is saved as a jpg file.

40. OpenCV – Face Detection in a Picture

The **VideoCapture** class of the **org.opencv.videoio** package contains classes and methods to capture video using the system camera. Let's go step by step and learn how to do it.

Step 1: Load the OpenCV native library

While writing Java code using OpenCV library, the first step you need to do is to load the native library of OpenCV using the **loadLibrary()**. Load the OpenCV native library as shown below.

```
// Loading the core library
System.loadLibrary(Core.NATIVE_LIBRARY_NAME);
```

Step 2: Instantiate the CascadeClassifier class

The **CascadeClassifier** class of the package **org.opencv.objdetect** is used to load the classifier file. Instantiate this class by passing the **xml** file **lbpcascade_frontalface.xml** as shown below.

```
// Instantiating the CascadeClassifier
String xmlFile = "E:/OpenCV/facedetect/lbpcascade_frontalface.xml";
CascadeClassifier classifier = new CascadeClassifier(xmlFile);
```

Step 3: Detect the faces

You can detect the faces in the image using method **detectMultiScale()** of the class named **CascadeClassifier**. This method accepts an object of the class **Mat** holding the input image and an object of the class **MatOfRect** to store the detected faces.

```
// Detecting the face in the snap
MatOfRect faceDetections = new MatOfRect();
classifier.detectMultiScale(src, faceDetections);
```


Example

The following program demonstrates how to detect faces in an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfRect;
import org.opencv.core.Point;
import org.opencv.core.Rect;
import org.opencv.core.Scalar;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;
import org.opencv.objdetect.CascadeClassifier;

public class FaceDetectionImage {

    public static void main (String[] args) {

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file = "E:/OpenCV/chap23/facedetection_input.jpg";
        Mat src = Imgcodecs.imread(file);

        // Instantiating the CascadeClassifier
        String xmlFile = "E:/OpenCV/facedetect/lbpcascade_frontalface.xml";
        CascadeClassifier classifier = new CascadeClassifier(xmlFile);

        // Detecting the face in the snap
        MatOfRect faceDetections = new MatOfRect();
        classifier.detectMultiScale(src, faceDetections);

        System.out.println(String.format("Detected %s faces",
        faceDetections.toArray().length));

        // Drawing boxes
        for (Rect rect : faceDetections.toArray()) {
```

```
        Imgproc.rectangle(src,          // where to draw the box
                           new Point(rect.x, rect.y),    // bottom left
                           new Point(rect.x + rect.width, rect.y + rect.height), // top right
                           new Scalar(0, 0, 255),
                           3);                // RGB colour
    }

    // Writing the image
    Imgcodecs.imwrite("E:/OpenCV/chap23/facedetect_output1.jpg", src);

    System.out.println("Image Processed");
}
}
```

Assume that following is the input image **facedetection_input.jpg** specified in the above program.

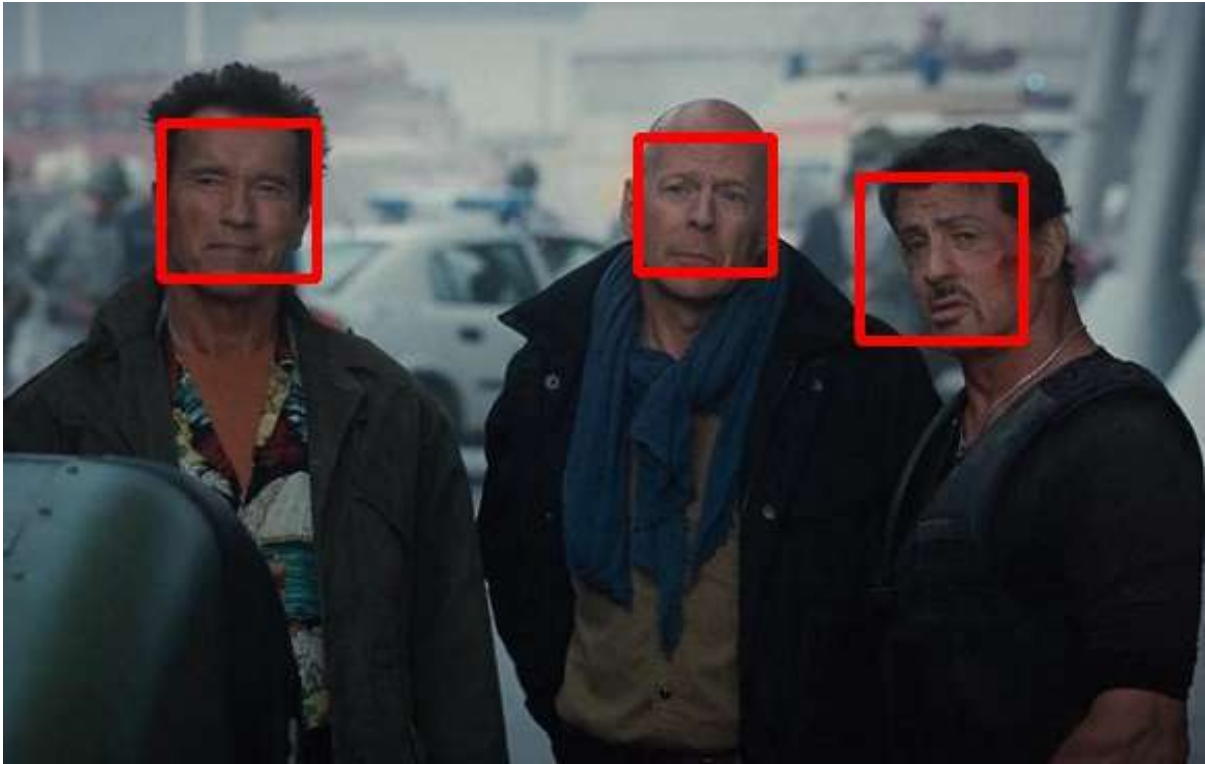


Output

On executing the program, you will get the following output.

```
Detected 3 faces
Image Processed
```

If you open the specified path, you can observe the output image as follows—



41. OpenCV – Face Detection using Camera

The following program demonstrates how to detect faces using system camera and display it using JavaFX window.

```
import java.awt.image.BufferedImage;

import java.awt.image.DataBufferByte;
import java.awt.image.WritableRaster;
import java.io.FileNotFoundException;
import java.io.IOException;
import javafx.application.Application;
import javafx.embed.swing.SwingFXUtils;
import javafx.scene.Group;
import javafx.scene.Scene;
import javafx.scene.image.ImageView;
import javafx.scene.image.WritableImage;
import javafx.stage.Stage;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfRect;
import org.opencv.core.Point;
import org.opencv.core.Rect;
import org.opencv.core.Scalar;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;
import org.opencv.objdetect.CascadeClassifier;
import org.opencv.videoio.VideoCapture;

public class faceDetectionJavaFX extends Application {

    Mat matrix = null;

    @Override
    public void start(Stage stage) throws FileNotFoundException, IOException {
```

```
// Capturing the snapshot from the camera
faceDetectionJavaFXX obj = new faceDetectionJavaFXX();
WritableImage writableImage = obj.captureFrame();

// Saving the image
obj.saveImage();

// Setting the image view
ImageView imageView = new ImageView(writableImage);

// setting the fit height and width of the image view
imageView.setFitHeight(400);
imageView.setFitWidth(600);

// Setting the preserve ratio of the image view
imageView.setPreserveRatio(true);

// Creating a Group object
Group root = new Group(imageView);

// Creating a scene object
Scene scene = new Scene(root, 600, 400);

// Setting title to the Stage
stage.setTitle("Capturing an image");

// Adding scene to the stage
stage.setScene(scene);

// Displaying the contents of the stage
stage.show();
}

public WritableImage captureFrame(){
    WritableImage writableImage = null;
```

```

// Loading the OpenCV core library

System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

// Instantiating the VideoCapture class (camera:: 0)
VideoCapture capture = new VideoCapture(0);

// Reading the next video frame from the camera
Mat matrix = new Mat();
capture.read(matrix);

// If camera is opened
if(!capture.isOpened()){
    System.out.println("camera not detected");
}else
    System.out.println("Camera detected ");

// If there is next video frame
if (capture.read(matrix)){

    ////////// Detecting the face in the snap //////////
    String file = "E:/OpenCV/facedetect/lbpcascade_frontalface.xml";
    CascadeClassifier classifier = new CascadeClassifier(file);

    MatOfRect faceDetections = new MatOfRect();
    classifier.detectMultiScale(matrix, faceDetections);
    System.out.println(String.format("Detected %s faces",
faceDetections.toArray().length));

    // Drawing boxes
    for (Rect rect : faceDetections.toArray()) {
        Imgproc.rectangle(matrix, //where to draw the box
            new Point(rect.x, rect.y), //bottom left
            new Point(rect.x + rect.width, rect.y + rect.height), //top right
            new Scalar(0, 0, 255)); //RGB colour
    }
}

```

```

        // Creating BuffredImage from the matrix
        BufferedImage image = new BufferedImage(matrix.width(),
matrix.height(), BufferedImage.TYPE_3BYTE_BGR);

        WritableRaster raster = image.getRaster();

        DataBufferByte dataBuffer = (DataBufferByte) raster.getDataBuffer();
        byte[] data = dataBuffer.getData();
        matrix.get(0, 0, data);

        this.matrix = matrix;

        // Creating the Writable Image
        writableImage = SwingFXUtils.toFXImage(image, null);
    }
    return writableImage;
}

public void saveImage(){

    // Saving the Image
    String file = "E:/OpenCV/chap23/facedetected.jpg";

    // Instantiating the imagecodecs class
    Imgcodecs imageCodecs = new Imgcodecs();

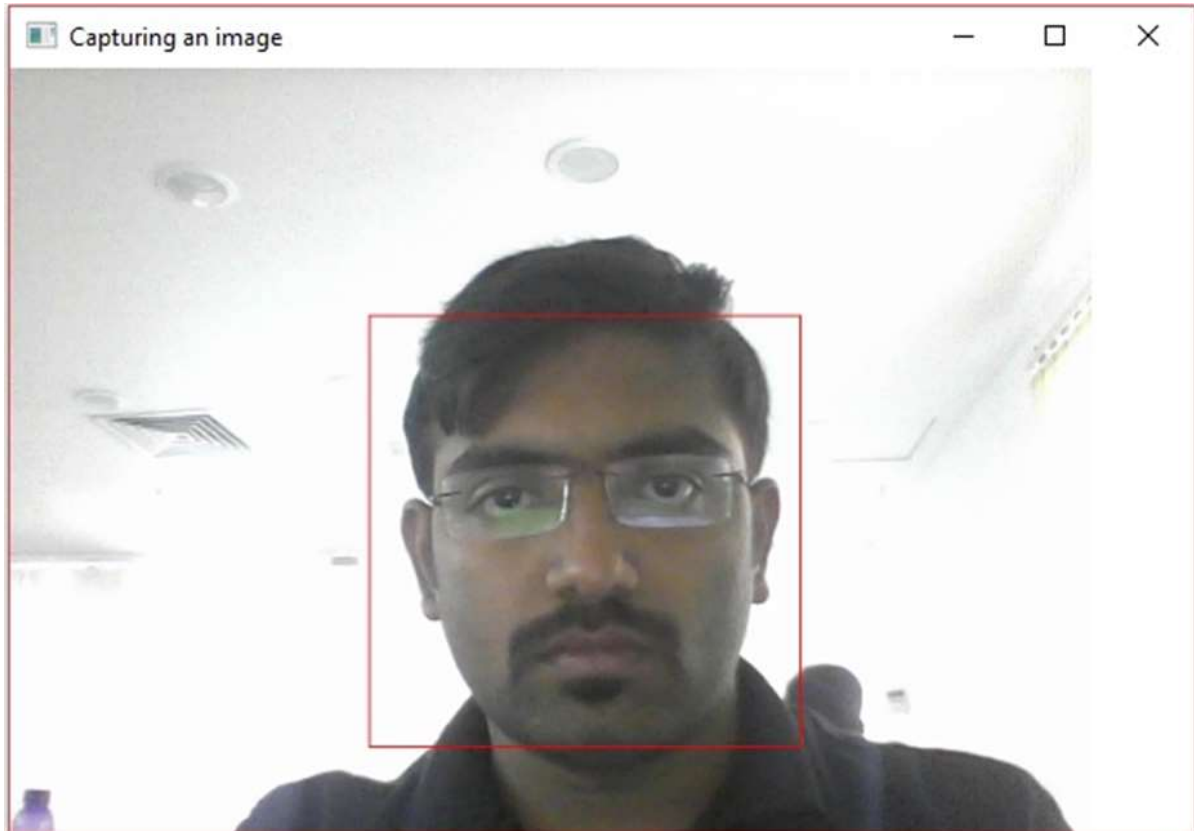
    // Saving it again
    imageCodecs.imwrite(file, matrix);
}

public static void main(String args[]) {
    launch(args);
}
}

```

Output

On executing the program, you will get the following output.



If you open the specified path, you can see the same snapshot saved as a **jpg** image.

Geometric Transformations

42. OpenCV – Affine Translation

You can perform **affine translation** on an image using the **warpAffine()** method of the **imgproc** class. Following is the syntax of this method:

```
Imgproc.warpAffine(src, dst, transformMatrix, size);
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **transformMatrix:** A **Mat** object representing the transformation matrix.
- **size:** A variable of the type integer representing the size of the output image.

Example

The following program demonstrates how to apply affine operation on a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.MatOfPoint2f;
import org.opencv.core.Point;
import org.opencv.core.Size;

import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class AffineTranslation {

    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap24/transform_input.jpg";
        Mat src = Imgcodecs.imread(file);

        //Creating an empty matrix to store the result
```

```
Mat dst = new Mat();

Point p1 = new Point( 0,0 );
Point p2 = new Point( src.cols() - 1, 0 );
Point p3 = new Point( 0, src.rows() - 1 );

Point p4 = new Point( src.cols()*0.0, src.rows()*0.33 );
Point p5 = new Point( src.cols()*0.85, src.rows()*0.25 );
Point p6 = new Point( src.cols()*0.15, src.rows()*0.7 );

MatOfPoint2f ma1 = new MatOfPoint2f(p1,p2,p3);
MatOfPoint2f ma2 = new MatOfPoint2f(p4,p5,p6);

// Creating the transformation matrix
Mat tranformMatrix = Imgproc.getAffineTransform(ma1,ma2);

// Creating object of the class Size
Size size = new Size(src.cols(), src.cols());

// Applying Wrap Affine
Imgproc.warpAffine(src, dst, tranformMatrix, size);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap24/Affinetranslate.jpg", dst);

System.out.println("Image Processed");
}
}
```

Assume that following is the input image **transform_input.jpg** specified in the above program.



Output

On executing it, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



43. OpenCV – Rotation

You can perform **rotation operation** on an image using the **warpAffine()** method of the **imgproc** class. Following is the syntax of this method:

```
Imgproc.warpAffine(src, dst, rotationMatrix, size);
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **rotationMatrix:** A **Mat** object representing the rotation matrix.
- **size:** A variable of the type integer representing the size of the output image.

Example

The following program demonstrates how to rotate an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.Point;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class Rotation {

    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file = "E:/OpenCV/chap24/transform_input.jpg";
        Mat src = Imgcodecs.imread(file);

        // Creating an empty matrix to store the result
        Mat dst = new Mat();
```

```
// Creating a Point object
Point point = new Point(300, 200)

// Creating the transformation matrix M
Mat rotationMatrix = Imgproc.getRotationMatrix2D(point, 30, 1);

// Creating the object of the class Size
Size size = new Size(src.cols(), src.cols());

// Rotating the given image
Imgproc.warpAffine(src, dst, rotationMatrix, size);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap24/rotate_output.jpg", dst);

System.out.println("Image Processed");
}
}
```

Assume that following is the input image **transform_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



44. OpenCV – Scaling

You can perform **scaling** on an image using the **resize()** method of the **imgproc** class. Following is the syntax of this method.

```
resize(Mat src, Mat dst, Size dsize, double fx, double fy, int interpolation)
```

This method accepts the following parameters –

- **src:** A **Mat** object representing the source (input image) for this operation.
- **dst:** A **Mat** object representing the destination (output image) for this operation.
- **dsize:** A **Size** object representing the size of the output image.
- **fx:** A variable of the type double representing the scale factor along the horizontal axis.
- **fy:** A variable of the type double representing the scale factor along the vertical axis.
- **Interpolation:** An integer variable representing interpolation method.

Example

The following program demonstrates how to apply **scale transformation** to an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class Scaling {

    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap24/transform_input.jpg";
        Mat src = Imgcodecs.imread(file);
```



```
// Creating an empty matrix to store the result  
  
Mat dst = new Mat();  
  
// Creating the Size object  
Size size = new Size(src.rows()*2, src.rows()*2);  
  
// Scaling the Image  
Imgproc.resize(src, dst, size, 0, 0, Imgproc.INTER_AREA);  
  
// Writing the image  
Imgcodecs.imwrite("E:/OpenCV/chap24/scale_output.jpg", dst);  
  
System.out.println("Image Processed");  
}  
}
```

Assume that following is the input image **transform_input.jpg** specified in the above program.

Output

On executing the program, you will get the following output.

```
Image Processed
```

If you open the specified path, you can observe the output image as follows—



45. OpenCV – Color Maps

In OpenCV, you can apply different color maps to an image using the method **applyColorMap()** of the class **Imgproc**. Following is the syntax of this method:

```
applyColorMap(Mat src, Mat dst, int colormap)
```

It accepts three parameters –

- **src**: An object of the class **Mat** representing the source (input) image.
- **dst**: An object of the class **Mat** representing the destination (output) image.
- **colormap**: A variable of integer type representing the type of the color map to be applied.

Example

The following program demonstrates how to apply **color map** to an image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class ColorMapTest {

    public static void main(String args[]){

        // Loading the OpenCV core library
        System.loadLibrary(Core.NATIVE_LIBRARY_NAME);

        // Reading the Image from the file and storing it in to a Matrix object
        String file = "E:/OpenCV/chap25/color_input.jpg";
        Mat src = Imgcodecs.imread(file);

        // Creating an empty matrix to store the result
        Mat dst = new Mat();

        // Applying color map to an image
        Imgproc.applyColorMap(src, dst, Imgproc.COLORMAP_HOT);
```

```
// Writing the image  
Imgcodecs.imwrite("E:/OpenCV/chap25/colormap_hot.jpg", dst);  
System.out.println("Image processed");  
}  
}
```

Assume that following is the input image **color_input.jpg** specified in the above program.



Output

On executing the above program, you will get the following output.

```
Image Processed
```

If you open the specified path, you can observe the output image as follows—




More Operations




In addition to **COLORMAP_HOT** demonstrated in the previous example, OpenCV caters various other types of color maps. All these types are represented by predefined static fields (fixed values) of `Imgproc` class.




You can choose the type of the colormap you need, by passing its respective predefined value to the parameter named **colormap** of the **applyColorMap()** method.

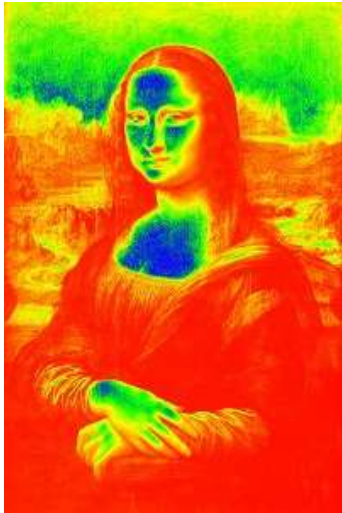


```
Imgproc.applyColorMap(src, dst, Imgproc.COLORMAP_HOT);
```

Following are the values representing various types of color maps and their respective outputs.

Operation and Description	Output
COLORMAP_AUTUMN	 The Mona Lisa painting is displayed using the COLORMAP_AUTUMN color map. The image is predominantly red and orange, with the subject's face and hands appearing in lighter shades of yellow and orange, contrasting with the darker reds of the background and clothing.
COLORMAP_BONE	 The Mona Lisa painting is displayed using the COLORMAP_BONE color map. The image is rendered in grayscale, with the subject's face and hands appearing in lighter shades of gray, contrasting with the darker grays of the background and clothing.
COLORMAP_COOL	 The Mona Lisa painting is displayed using the COLORMAP_COOL color map. The image is predominantly cyan and blue, with the subject's face and hands appearing in lighter shades of cyan, contrasting with the darker blues of the background and clothing.

COLORMAP_HOT	 The Mona Lisa painting is displayed using the COLORMAP_HOT color map. The image is predominantly dark, with the subject's face and hands highlighted in bright yellow and orange, contrasting sharply with the dark background.
COLORMAP_HSV	 The Mona Lisa painting is displayed using the COLORMAP_HSV color map. The image is predominantly dark, with the subject's face and hands highlighted in bright yellow and orange, contrasting sharply with the dark background.
COLORMAP_JET	 The Mona Lisa painting is displayed using the COLORMAP_JET color map. The image is predominantly dark, with the subject's face and hands highlighted in bright yellow and orange, contrasting sharply with the dark background.

COLORMAP_OCEAN	 The Mona Lisa painting is displayed using the COLORMAP_OCEAN color map. The image is predominantly dark blue and black, with the subject's face and hands appearing as lighter, cyan-colored features against the dark background.
COLORMAP_PARULA	 The Mona Lisa painting is displayed using the COLORMAP_PARULA color map. The image features a vibrant blue and green color scheme, with the subject's face and hands appearing as lighter, yellow-green features against the blue background.
COLORMAP_PINK	 The Mona Lisa painting is displayed using the COLORMAP_PINK color map. The image is rendered in a monochromatic pink and red color scheme, with the subject's face and hands appearing as lighter, yellowish-pink features against the darker pink background.

COLORMAP_RAINBOW	 The Mona Lisa painting is displayed using the COLORMAP_RAINBOW color map. The image is predominantly red and orange, with some green and blue highlights, particularly around the face and hands.
COLORMAP_SPRING	 The Mona Lisa painting is displayed using the COLORMAP_SPRING color map. The image is predominantly magenta and purple, with some yellow and green highlights, particularly around the face and hands.
COLORMAP_SUMMER	 The Mona Lisa painting is displayed using the COLORMAP_SUMMER color map. The image is predominantly green and yellow, with some blue and red highlights, particularly around the face and hands.

COLORMAP_WINTER



Miscellaneous Concepts

46. OpenCV – Canny Edge Detection

Canny Edge Detection is used to detect the edges in an image. It accepts a gray scale image as input and it uses a multistage algorithm.

You can perform this operation on an image using the **Canny()** method of the **imgproc** class, following is the syntax of this method.

```
Canny(image, edges, threshold1, threshold2)
```

This method accepts the following parameters –

- **image:** A **Mat** object representing the source (input image) for this operation.
- **edges:** A **Mat** object representing the destination (edges) for this operation.
- **threshold1:** A variable of the type double representing the first threshold for the hysteresis procedure.
- **threshold2:** A variable of the type double representing the second threshold for the hysteresis procedure.

Example

Following program is an example demonstrating, how to perform Canny Edge Detection operation on a given image.

```
import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class CannyEdgeDetection {

    public static void main(String args[]) throws Exception{

        // Loading the OpenCV core library
        System.loadLibrary(Core.NATIVE_LIBRARY_NAME);

        // Reading the Image from the file and storing it in to a Matrix object
        String file = "E:/OpenCV/chap17/canny_input.jpg";

        // Reading the image
        Mat src = Imgcodecs.imread(file);
```

```
// Creating an empty matrix to store the result
Mat gray = new Mat();

// Converting the image from color to Gray
Imgproc.cvtColor(src, gray, Imgproc.COLOR_BGR2GRAY);

Mat edges = new Mat();

// Detecting the edges
Imgproc.Canny(gray, edges, 60, 60*3);

// Writing the image
Imgcodecs.imwrite("E:/OpenCV/chap17/canny_output.jpg", edges);

System.out.println("Image Loaded");
}
}
```

Assume that following is the input image **canny_input.jpg** specified in the above program.

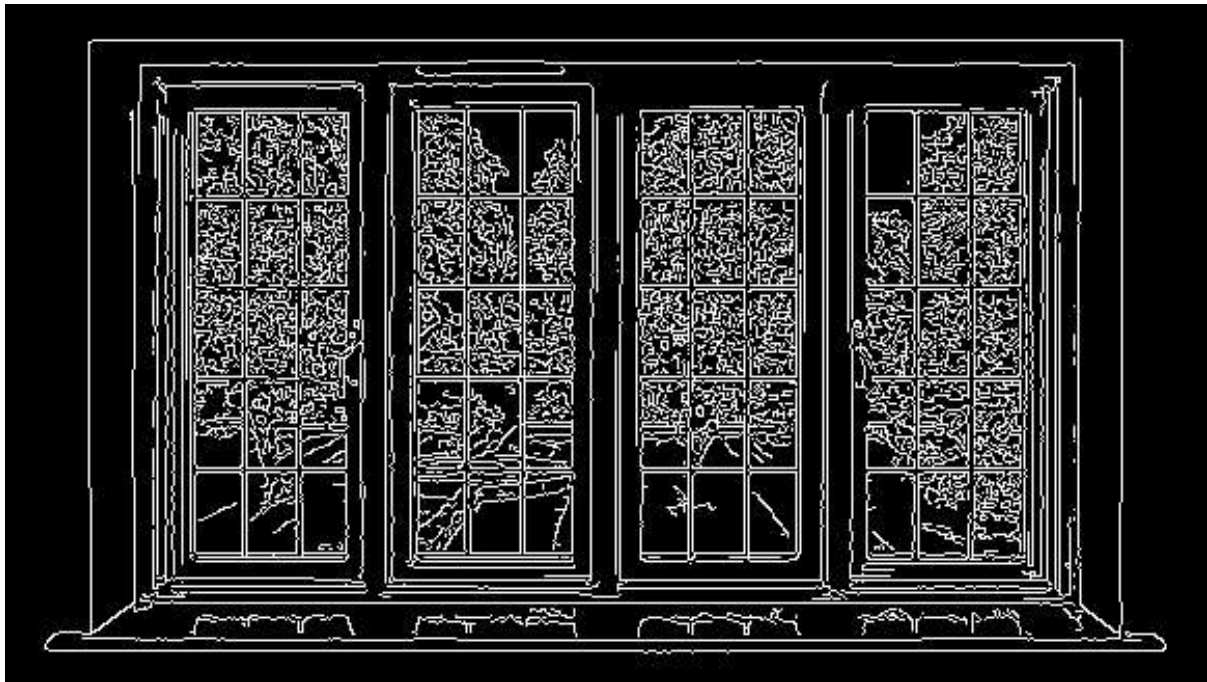


Output

On executing the above program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—



47. OpenCV – Hough Line Transform

You can detect the shape of a given image by applying the **Hough Transform technique** using the method **HoughLines()** of the **Imgproc** class. Following is the syntax of this method.

```
HoughLines(image, lines, rho, theta, threshold)
```

This method accepts the following parameters –

- **image:** An object of the class **Mat** representing the source (input) image.
- **lines:** An object of the class **Mat** that stores the vector that stores the parameters (r, θ) of the lines.
- **rho:** A variable of the type double representing the resolution of the parameter r in pixels
- **theta:** A variable of the type double representing the resolution of the parameter θ in radians.
- **threshold:** A variable of the type integer representing the minimum number of intersections to “detect” a line.

Example

The following program demonstrates how to detect Hough lines in a given image.

```
import org.opencv.core.Core;

import org.opencv.core.Mat;
import org.opencv.core.Point;
import org.opencv.core.Scalar;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class HoughlinesTest {
    public static void main(String args[]) throws Exception{

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
```

```
String file = "E:/OpenCV/chap21/hough_input.jpg";

// Reading the image
Mat src = Imgcodecs.imread(file,0);

// Detecting edges of it
Mat canny = new Mat();
Imgproc.Canny(src, canny, 50, 200, 3, false);

// Changing the color of the canny
Mat cannyColor = new Mat();
Imgproc.cvtColor(canny, cannyColor, Imgproc.COLOR_GRAY2BGR);

// Detecting the hough lines from (canny)
Mat lines = new Mat();
Imgproc.HoughLines(canny, lines, 1, Math.PI/180, 100);

System.out.println(lines.rows());

System.out.println(lines.cols());

// Drawing lines on the image
double[] data;
double rho, theta;
Point pt1 = new Point();
Point pt2 = new Point();
double a, b;
double x0, y0;
for (int i = 0; i < lines.cols(); i++){
    data = lines.get(0, i);
    rho = data[0];
    theta = data[1];
    a = Math.cos(theta);
    b = Math.sin(theta);
    x0 = a*rho;
    y0 = b*rho;
    pt1.x = Math.round(x0 + 1000*(-b));
```



```

        pt1.y = Math.round(y0 + 1000*(a));
        pt2.x = Math.round(x0 - 1000*(-b));
        pt2.y = Math.round(y0 - 1000 *(a));
        Imgproc.line(cannyColor, pt1, pt2, new Scalar(0, 0, 255), 6);
    }

    // Writing the image
    Imgcodecs.imwrite("E:/OpenCV/chap21/hough_output.jpg", cannyColor);

    System.out.println("Image Processed");
}
}

```

Assume that following is the input image **hough_input.jpg** specified in the above program.

2016 JUNE						
SUN	MON	TUE	WED	THU	FRI	SAT
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Output

On executing the program, you will get the following output.

```
143
1
Image Processed
```

If you open the specified path, you can observe the output image as follows—

2016 JUNE						
SUN	MON	TUE	WED	THU	FRI	SAT
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

48. OpenCV – Histogram Equalization

The **histogram** of an image shows the frequency of pixels' intensity values. In an image histogram, the X-axis shows the gray level intensities and the Y-axis shows the frequency of these intensities.

Histogram equalization improves the contrast of an image, in order to stretch out the intensity range. You can equalize the histogram of a given image using the method **equalizeHist()** of the **Imgproc** class. Following is the syntax of this method.

```
equalizeHist(src, dst)
```

This method accepts the following parameters –

- **src:** An object of the class **Mat** representing the source (input) image.
- **dst:** An object of the class **Mat** representing the output. (Image obtained after equalizing the histogram)

Example

The following program demonstrates how to equalize the histogram of a given image.

```
import java.util.ArrayList;
import java.util.List;

import org.opencv.core.Core;
import org.opencv.core.Mat;
import org.opencv.core.Size;
import org.opencv.imgcodecs.Imgcodecs;
import org.opencv.imgproc.Imgproc;

public class HistoTest {
    public static void main (String[] args) {

        // Loading the OpenCV core library
        System.loadLibrary( Core.NATIVE_LIBRARY_NAME );

        // Reading the Image from the file and storing it in to a Matrix object
        String file ="E:/OpenCV/chap20/histo_input.jpg";

        // Load the image
        Mat img = Imgcodecs.imread(file);
```

```
// Creating an empty matrix
Mat equ = new Mat();
img.copyTo(equ);

// Applying blur
Imgproc.blur(equ, equ, new Size(3, 3));

// Applying color
Imgproc.cvtColor(equ, equ, Imgproc.COLOR_BGR2YCrCb);
List<Mat> channels = new ArrayList<Mat>();

// Splitting the channels
Core.split(equ, channels);

// Equalizing the histogram of the image
Imgproc.equalizeHist(channels.get(0), channels.get(0));
Core.merge(channels, equ);
Imgproc.cvtColor(equ, equ, Imgproc.COLOR_YCrCb2BGR);

Mat gray = new Mat();
Imgproc.cvtColor(equ, gray, Imgproc.COLOR_BGR2GRAY);
Mat grayOrig = new Mat();
Imgproc.cvtColor(img, grayOrig, Imgproc.COLOR_BGR2GRAY);

Imgcodecs.imwrite("E:/OpenCV/chap20/histo_output.jpg", equ);
System.out.println("Image Processed");
}
}
```

Assume that following is the input image **histo_input.jpg** specified in the above program.



Output

On executing the program, you will get the following output.

Image Processed

If you open the specified path, you can observe the output image as follows—





No	Description	Annotation
code_001	Load Image	✓
code_002	Gray Image	✓
code_003	Image Create	✓
code_004	Pixel Read and Write	✓
code_005	Image Pixel Arithmetic Operations	✓
code_006	Image Pseudo-Color Enhancement	✓
code_007	Image Pixel Operation (Logical Operation)	✓
code_008	Image Channel Separation and Merging	✓
code_009	Color Space Conversion	✎
code_010	Image Pixel Value Statistics	✓
code_011	Image Pixel Normalization	✓
code_012	Video Read and Write	✓
code_013	Image Flip	✓
code_014	Image Interpolation	✓
code_015	Draw Geometry	✓
code_016	ROI of Image	✓
code_017	Image Histogram	✓
code_018	Histogram Dqualization	✎
code_019	Histogram Comparison	✓
code_020	Histogram Backprojection	✓
code_021	Image Convolution	✓
code_022	Averaging and Gaussian Blur	♥
code_023	Median Blur	✓

No	Description	Annotation
code_024	Image Noise	✓
code_025	Smoothing Images	✓
code_026	Gaussian Bilateral Blur	✓
code_027	Mean-shift Blur)	✓
code_028	Image Integral Algorithm	✓
code_029	Fast Image Edge Filtering Algorithm	✓
code_030	Custom Filter	✓
code_031	Sobel Operator	✓
code_032	More Gradient Operators	✓
code_033	Laplace Operator	✓
code_034	Image Sharpening	✓
code_035	USM Sharpen Algorithm	✓
code_036	Canny Edge Detection	♥
code_037	Image Pyramid	✓
code_038	Laplace Pyramid	✓
code_039	Image Template Matching	✓
code_040	Binary introduction	✓
code_041	Basic Thresholding	✓
code_042	OTSU Thresholding	✎
code_043	TRIANGLE Thresholding	✓
code_044	Adaptive Thresholding	✎
code_045	Binary and Smoothing	✎
code_046	Image Connectivity component	✓

No	Description	Annotation
code_047	Image Connected component state statistics	✓
code_048	Image Contours	♥
code_049	Bounding Rectangle	♥
code_050	Contour Area and Perimeter	✎
code_051	Contour Approximation	✓
code_052	Contour Centroid Calculate	✓
code_053	HuMoment for Contour Matching	✓
code_054	Contour Circle and Ellipse fitting	✓
code_055	Convex Hull	✎
code_056	Fitting a Line	✓
code_057	Point Polygon Test	✓
code_058	The Largest Inner Circle	✓
code_059	Hoffman Line Detection	✓
code_060	Probability Hoffman Line Detection	♥
code_061	Hoffman Circle Detection	♥
code_062	Dilation and Erosion	♥
code_063	Structuring Element	✓
code_064	Opening Transformation	✎
code_065	Closing Transformation	✎
code_066	Application of Opening and Closing Operations	✎
code_067	Top Hat	✓
code_068	Black Hat	✓
code_069	Morph Gradient	✓

No	Description	Annotation
code_070	Contour based on Morph Gradient	
code_071	Hit and Miss	
code_072	Defect Detecting-1	
code_073	Defect Detecting-2	
code_074	Extract the Maximum Contour and Coding Key Points	
code_075	Image Inpainting	
code_076	Perspective Transformation	
code_077	Video Read, Write and Process	
code_078	Identify and Track Specific Color Objects in Video	
code_079	Video Analysis-Background/Foreground Extraction	
code_080	Video Analysis-Background Subtraction and ROI Extraction of the Foreground	
code_081	Corner Detection-Harris	
code_082	Corner Detection-Shi-Tomas	
code_083	Corner Detection-Sub-Pixel	
code_084	Video Analysis-KLT Optical Flow-1	
code_085	Video Analysis-KLT Optical Flow-2	
code_086	Video Analysis-Dense Optical Flow	
code_087	Video Analysis-Frame Difference Moving Object Analysis	
code_088	Video Analysis-Meanshift	
code_089	Video Analysis-CamShift	
code_090	Video Analysis-Object Movement Trajectory Drawing	
code_091	Object Detection-HAAR Cascade Classification	

No	Description	Annotation
code_092	Object Detection-HAAR Feature Analysis	✓
code_093	Object Detection-LBP Feature Analysis	✓
code_094	ORB Feature Critical Point Detection	✎
code_095	ORB Feature Descriptor Matching	✓
code_096	Multiple Descriptor Matching Methods	✎
code_097	Location of Known Objects Based on Descriptor Matches	✎
code_098	SIFT Feature Critical Point Detection	✓
code_099	SIFT Feature Descriptor Matching	✓
code_100	HOG Pedestrian Detection	✓
code_101	HOG Multiscale Detection	✎
code_102	HOG Extract Descriptor	✓
code_103	HOG Use Descriptors to Generate Sample Data	✓
code_104	(Detection Case)-HOG+SVM Train	✓
code_105	(Detection Case)-HOG+SVM Predict	✓
code_106	AKAZE Features and Descriptors	✓
code_107	Brisk Features and Descriptors	✓
code_108	GFTT Detector	✓
code_109	BLOB Feature Analysis	✓
code_110	KMeans Data Classification	✓
code_111	KMeans Image Segmentation	✓
code_112	KMeans Background Change	✓
code_113	KMeans Extract Image Color Card	✓
code_114	KNN Classification	✓

No	Description	Annotation
code_115	KNN-Train Data Save and Load	✓
code_116	Decision Tree Algorithm	✓
code_117	Image Mean-shift Segmentation	✓
code_118	Grabcut-Image Segmentation	✓
code_119	Grabcut-Background Change	
code_120	Qrcode detect and decode	
code_121	DNN- Read the information of each layer of the model	✓
code_122	DNN- Realize image classification	✓
code_123	DNN- Model runs to set the target device and compute the background	✓
code_124	DNN- SSD Single Image Detection	✓
code_125	DNN- SSD Real-time Video Detection	✓
code_126	DNN- Face Detection based on Residual Network	✓
code_127	DNN- Video Face Detection based on Residual Network	✓
code_128	DNN- Call the Detection Model of Tensorflow	✓
code_129	DNN- Call the Openpose Implementation Attitude Assessment	✓
code_130	DNN- Call YOLO Object Detection Network	✓
code_131	DNN- YOLOv3-tiny Real-time Object Detection	✓
code_132	DNN- Single and Multiple Image Detection	✓
code_133	DNN- Colorful Image Colorization	✓
code_134	DNN- ENet Image Segmentation	✓
code_135	DNN- Real-time Fast Image Style Transfer	✓

<<사전작업>>

1. python install -python.org down & install
2. open terminal – pip install opencv-python
3. pip install opencv-contrib-python

code_001

```
import cv2

src = cv2.imread("test.jpg")

cv2.namedWindow("input", cv2.WINDOW_AUTOSIZE)

cv2.imshow("input", src)

cv2.waitKey(0)

cv2.destroyAllWindows()
```

code_002

```
import cv2

src = cv2.imread("./test.png")

cv2.namedWindow("input", cv2.WINDOW_AUTOSIZE)

cv2.imshow("input", src)

gray = cv2.cvtColor(src, cv2.COLOR_BGR2GRAY)

cv2.imwrite('gray.png', gray)

cv2.imshow("gray", gray)

cv2.waitKey(0)
```

```
cv2.destroyAllWindows()
```

code_003

```
>> pip install numpy
```

```
import cv2 as cv
```

```
import numpy as np
```

```
src = cv.imread("./test.png")
```

```
cv.namedWindow("input", cv.WINDOW_AUTOSIZE)
```

```
cv.imshow("input", src)
```

```
m1 = np.copy(src)
```

```
m2 = src
```

```
src[100:200,200:300,:] = 255
```

```
cv.imshow("m2",m2)
```

```
m3 = np.zeros(src.shape, src.dtype)
```

```
cv.imshow("m3", m3)
```

```
m4 = np.zeros([512,512], np.uint8)
```

```
# m4[:,:] = 127 try to give gray value 127
```

```
cv.imshow("m4", m4)
```

```
m5 = np.ones(shape=[512,512,3], dtype=np.uint8)
```

```
m5[:, :,0] = 255
```

```
cv.imshow("m5", m5)
```

```
cv.waitKey(0)
```

```
cv.destroyAllWindows()
```

code_004

```
import cv2 as cv

src = cv.imread("./test.png")

cv.namedWindow("input", cv.WINDOW_AUTOSIZE)

cv.imshow("input", src)

h, w, ch = src.shape

print("h , w, ch", h, w, ch)

for row in range(h):

    for col in range(w):

        b, g, r = src[row, col]

        b = 255 - b

        g = 255 - g

        r = 255 - r

        src[row, col] = [b, g, r]

cv.imshow("output", src)

cv.waitKey(0)

cv.destroyAllWindows()
```

