**Question 2) Sorting: Noise Removing Application** (20%)

Problem: **Salt-and-pepper noise**, also known as impulse noise, is a form of noise sometimes seen on digital images. This noise can be caused by sharp and sudden disturbances in the image signal. It presents itself as sparsely occurring white and black pixels. (See more information: https://en.wikipedia.org/wiki/Salt-and-pepper\_noise#:~:text=Salt%2Dand%2Dpepper%20noise%2C,occurring%20white%20and%20black%20pixels.)

Example (image with Salt-and-pepper noise)



An effective noise reduction method for this type of noise is a median filter.

Median Filter:

A program reads a pixel and its 8 surrounding pixels (This 3x3 block of pixels is called sliding window in digital image processing) from an image then find the median of these 9 pixels. Finally, the median replaces the central pixel. Sliding window moves onto the next pixel and repeats this process until all pixels has been changed (To make the assignment simple, it excludes the bound pixels).

Diagram

Description automatically generated

Median: the middle score when all the scores are arranged **in order** of size from the smallest to the highest. If there are an even number of scores, then it is the average of the two middle scores (It will not be the case in this assignment).

The code of reading image, getting pixels, saving pixels to an image has been done for you. Your task is to find median for given pixels. In order to find the median, You need to sort an array of 9 pixels.

Example (output image after removing noise)



Your task:

Please download NoiseRemoving.zip file and extract it to a folder. The project contains two .java files. “**ImageProcess.java**” and “**NoiseRemoving.java**”. If you run the project, it loads an image and generates a .jpg file, named “noise\_removed.jpg”, but the generated image still contains noise for now. You need to complete the method of “cleanNoise” to clean the noise in the ImageProcess class.

“**ImageProcess.java**” deals with an image. It has a method named “**cleanNoise**”. There is a gap in the method. You need to add your SortableArray Class to the project and fill the gap to complete the ImageProcess Class (3%).

You need to write a “**SortableArray**” Class. It takes a generic Comparable type of array and sorts array in order.

SortableArray Class has an “**array**” field. It stores a reference of an array. (1%)

SortableArray Class has “**setArray**” method. It takes a reference of an array and passes the reference to the “array” field. (1%)

SortableArray Class has “**quickSort**” method. It runs quick sort algorithm and sorts array in order. (3%)

**DO NOT COPY THE CODE FROM THE CHAPTER 3 EXAMPLES**

|  |
| --- |
| SortableArray <E extends Comparable> |
| + array : E[ ] |
| + setArray(E[ ] array)  + quickSort() : void |

**PLEASE FULLY COMMENT YOUR CODE** (3%)

**Answer following questions in your Comments at the beginning of your code.**

1. Is quick sort the best way of finding median? Why? (3%)
2. What is another good way of finding median? Please provide your explanation. (3%)

Finally, you need to design a GUI of noise removing application (2%). So, the application can load an image, clean the noise, and save to a new image. And produce a .jar file of this project. (1%)

**\***If you are interested in image process, you may try some open-source library. OpenCV for C/C++ or JavaCV for Java.