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A GUI BASED APPROACH FOR NOISE REMOVAL AND FILTERING IN FINGERPRINTS

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ABSTRACT

Biometric authentication is a process of establishing an individual's identity through measurable characteristics of their behavior, anatomy or physiology. Fingerprint recognition is a biometric technology that has been extensively used in various range of contexts from immigration control on airports, transactions in banks, applying for driving license, passport to Aadhar card in India and personal computing. In recent emerging technologies, the usability aspects of system design have received less attention rather than technical aspects. The researches on fingerprint have shown many challenges for users like placing of fingers to capture fingerprints, system feedback and instructions to use fingerprint systems. This paper proposes a Graphical User Interface (GUI) system for studying various operations in recognizing fingerprints for biometric identification of individuals using an iterative, participative design approach. During this process, several different layouts have been identified. The fingerprint GUI provides facility to users to use by clicking on the buttons on the front-end interface of the system. The coding for the back-end interface functions are written in MATLAB. This study has been tested over a data set of 72 fingerprint images divided into 9 classes and is seen to provide accurate recognition results. The minutiae and texture features of fingerprints have been studied and the results show 100% matching of an individual from the collected database. Fingerprint recognition using GUI is reliable and easy to understand the operations and results more efficiently.

Keywords: *Graphical User Interface (GUI), fingerprint recognition, biometrics, enhancement, noises, filters.*

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I. INTRODUCTION

In modern life information and communication technologies (ICT) are spreading widely throughout the globe in daily routine activities of people [1]. Therefore to make these systems secure are most important challenge. Identifying genuine users of using systems is a necessary process with many unique issues. User identification can be done into three different ways- Token-based identification, knowledge-based identifications and biometrics. Token-based identification requires a presence of a physical objects like ID cards, passes, etc. to authenticate users where as in knowledge-based identification, it relies on non-obvious information like passwords, personal identification numbers (PINs) to confirm the authenticity of an individual. In contrast, biometric identification considers physical, behavioral or anatomical characteristics of the user to authenticate the identity. The appeal of using biometrics for identification is increasing day by day because characteristics used to authenticate an individual cannot be stolen, lost or forgotten and are therefore seems more secure than other categories of identification.

Today biometric authentication technology is used in both commercial and public sectors. According to the prediction of International Biometrics Group (IBG), the usage of biometrics will be double in size over the next five years in comparison of today [2]. There are numerous trends that support this prediction of IBG. Firstly, secure user identification is an international trend these days. There are many large scale projects going on world-wide that uses public facing implementations of biometric systems including the immigration control in US, Dubai, Malaysia, etc., identity card scheme in the United Kingdom, Aadhar card in India and many more. Secondly, to secure the information in IT world is also contributing an increased usage of biometric technology [3, 4].

According to many researchers the benefits of biometrics are so huge that will eventually lead to the technology which is used in almost every application that needs identification of users [5]. But there are many challenges associated with the use of biometrics. The process of biometric identification involves two stages; an enrollment or registration stage and an authentication stage. During enrollment, a biometric sample is associated with an individual's identity. Identification or authentication is the process of matching other sample with the enrolled samples in the database to verify an individual's identity. The process of automated identity verification through biometrics is often not transparent to users though and most people have little or no familiarity with the technology. This is the motivation behind this study to develop Graphical User Interface (GUI) for fingerprint recognition. The interface will help the users to understand all the operations by looking on the results only after clicking on the buttons available on the panels of the interface.

Most of the user-centric research on biometrics to date has centered on fingerprint systems, so these systems are the most commonly used biometric. A number of operations have been performed on the image to enhance the quality of image so that features can be extracted from it and can be used for authentication purposes. Therefore there is a need of a system that explains the complete process of fingerprint recognition with the help of clicking the buttons only to those people who are not from the technology background and the functionalities of the buttons are also explained for the researchers who can further improve the results for better understanding of the processes involved in the recognition.

Usability problems with biometric systems have significant outcomes, as people are unlikely to tolerate being mistakenly denied access to their devices, work place, etc. The front end plays an integral role in the usability of any interactive system and biometric system. During last few years design of the interface for fingerprint systems has received an increases amount of attention from the researchers. The GUI presented in this study for fingerprint recognition have included all the enhancement operations, histograms, feature extractions, noises and filters, similarity measures and performance parameters. The organization of rest of the paper is as follows: Section II describes the overview of presented GUI, Section III presents the preprocessing and post processing steps alongwith noise removal and filtering for better matching of fingerprints, and Section IV brings up the overall conclusions and future scope.

II. SYSTEM DEVELOPMENT

A GUI is developed to support the understanding of various operations that are used in fingerprint recognition. An image of the GUI of fingerprint recognition that has been developed using MATLAB has shown in Fig. 1.

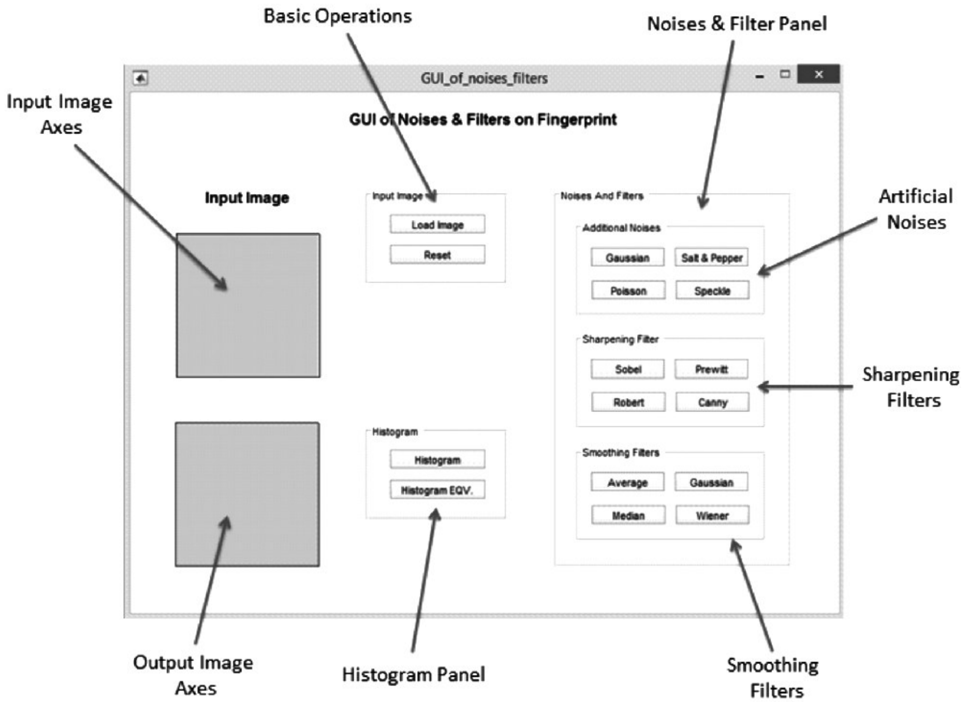

Fig. 1 GUI of noises and filters on fingerprint

A complete GUI has 2 axes and 3 panels. First axes is to show the input image and second one is to display the output image after performing the operations on input image. Panel-1 is basic operations panel that contain 2 buttons: Load Image button is to import the image for processing and Reset button is used to restarts the system. Histogram is the Panel-2 of GUI containing 2 buttons namely Histogram and Histogram EQV. This process is used for adjusting intensity values of an image. Addition of artificial noises and there removal using various filters have been shown in Panel-3. This contains noises buttons of Gaussian, Salt and Pepper, Poison, and Speckle.

Buttons for sharpening filters are Sobel, Prewitt, Robert, and Canny and for smoothing filters it have Average, Gaussian, Median and Weiner.

III. PROPOSED SYSTEM FUNCTIONS

In this study, a prototype GUI of fingerprint recognition has been developed and has tested on a database of 72 fingerprint images of 9 individuals. Functionality of proposed system is logically divided into 2 axes 3 panels. Algorithms developed in this study are to improve the performance for recognition of an individual using various features. The functionalities of all components of GUI are as follows:

Panel-1: Basic Operations Panel

This panel contains 2 buttons Load Image and Reset. When a user clicks on Load Image button, it displays the locations of fingerprint images database from where we can select the image and after selecting the image, it will be displayed in Input Image Axes on GUI, as shown in Fig. 2. The function of Reset button is to restart the process of the system. To load an image imread() function is used.

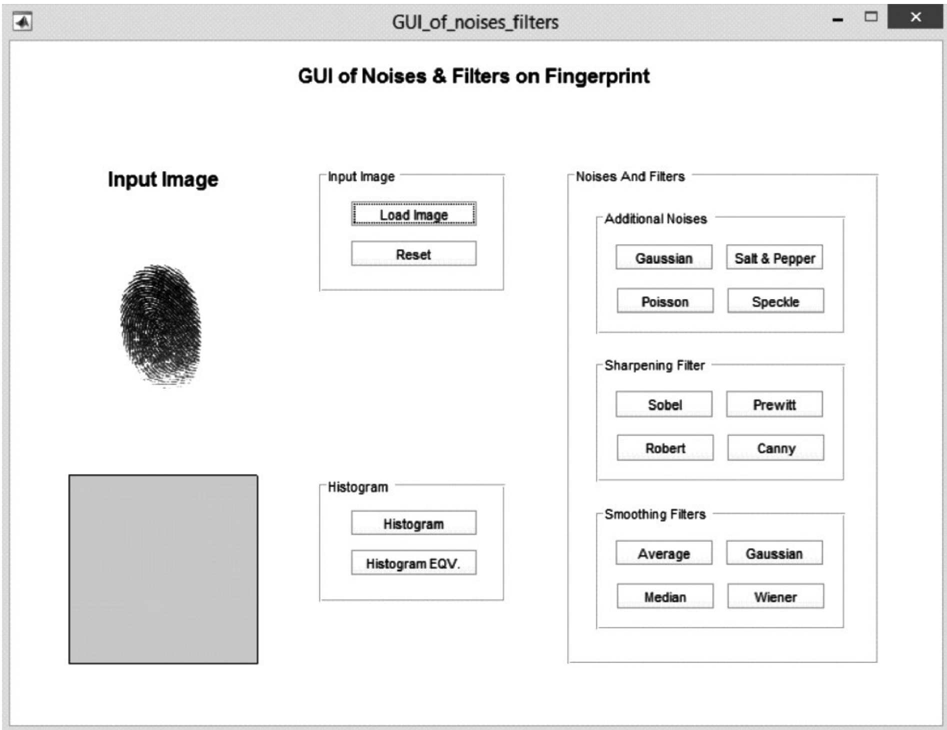

Fig. 2 Load fingerprint image

Panel-2: Histogram

Histogram techniques provide a sophisticated method for modifying the dynamic range and contrast of an image by altering that image such that its intensity has a desired shape. Histogram technique may employ non-linear and non-monotonic transfer functions to map between pixel intensity values in the input and output images. Histogram of an image represents relative frequency of occurrence of various grey levels. In 2-dimensional plot x-axis has a grey levels and y-axis has number of pixels in each grey level. Histogram equalization employs a monotonic, non-linear mapping which reassigns the intensity values of the pixel in the input image such that the output image contains a uniform distribution of intensities. Thus histogram equalization generally is used to enhance contrast of an image. Fig. 3 shows histogram and Fig. 4 shows histogram equalized image of a fingerprint. Function imhist() is used to generate the histogram for the fingerprint image and histeq() is used to equalize the histogram [6].

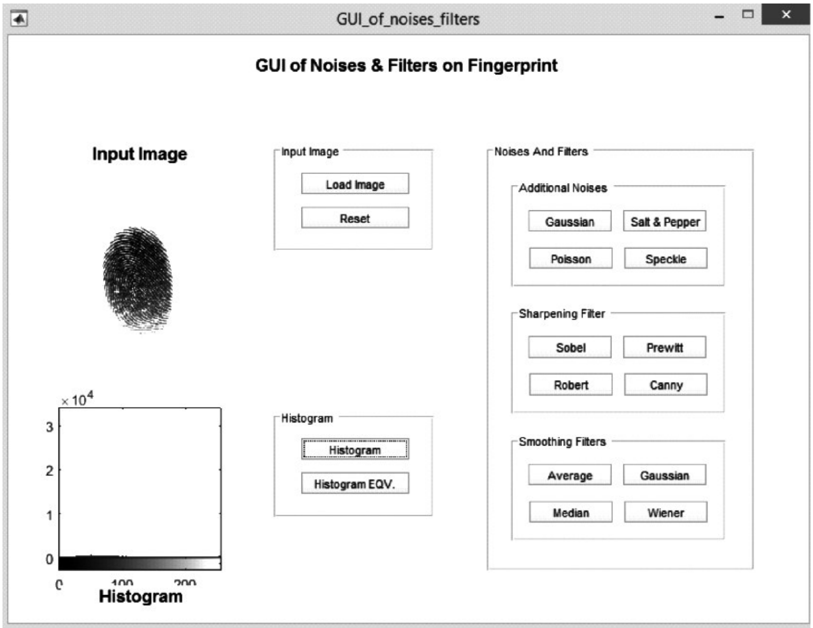

Fig. 3 Histogram of a fingerprint image

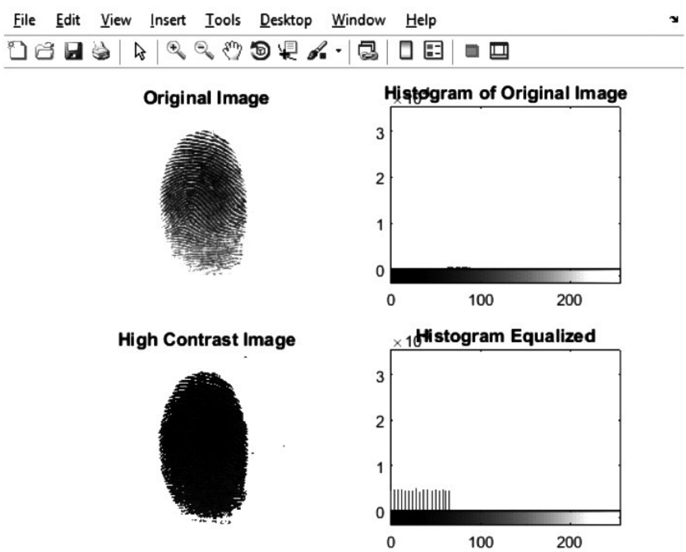

Fig. 4 Histogram equalization of a fingerprint image

Panel-3: Noises and Filters

This panel shows the effects of various noises and functionality of various filters which are used to remove these noises which occur during image acquisition or transmission.

Noises

Noise is an evitable problem in image processing. The noise which comes in the image are either come during at the time of image acquisition i.e. using camera, scanner, and photographic film to capture an image or at the time of image transmission. Different types of noise having certain characteristics like their intensity, wavelength, etc. Different noises which have been studied in this work are as follows:

Gaussian Noise

The feature of Gaussian noise is that it evenly distributed over the signal. It means noisy image pixel is the sum of the actual pixel value and a random Gaussian distributed noise value. The distribution function of Gaussian noise is given by, where z= grey-level, µ is average or mean of a function, ó = standard deviation of noise, p(z)= Probability density function [7]. Default value into image, Gaussian noise have zero mean and variance is 0.05.

The computed Gaussian noise can be seen by clicking on Gaussian button in the noise panel on the interface which is shown in Fig. 5.

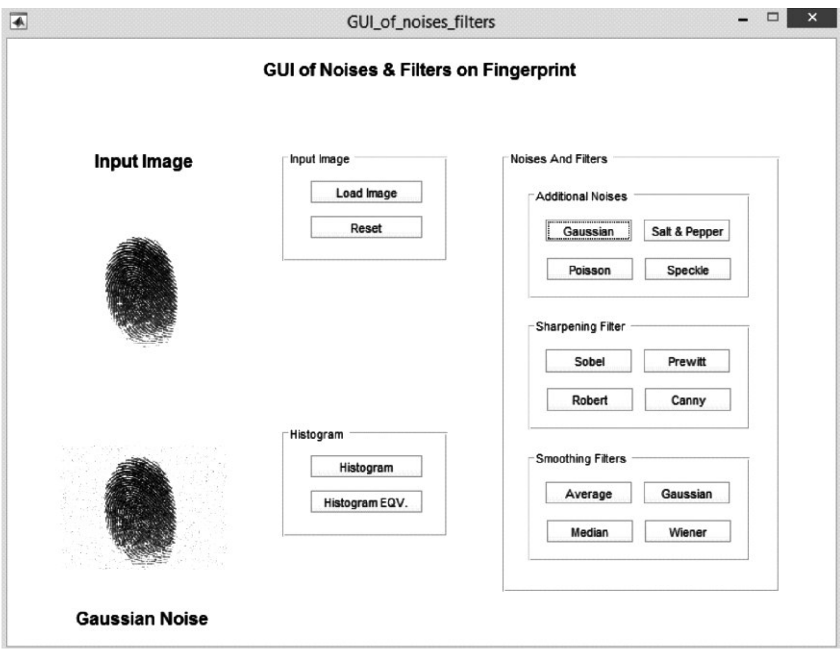

Fig. 5 Gaussian noise added to the fingerprint image

Salt and Pepper Noise

Salt and pepper noise is a form of noise sometimes seen on images. It presence itself as sparsely occurring white and black pixels. Given the probability r (with 0 ? r ? 1) that a pixel is corrupted, we can introduce salt and pepper noise in an image by setting a fraction of r/2 randomly selected pixel to black, and another fraction of r/2 randomly selected pixel to white. The salt and pepper noise added to the image is shown in Fig. 6.

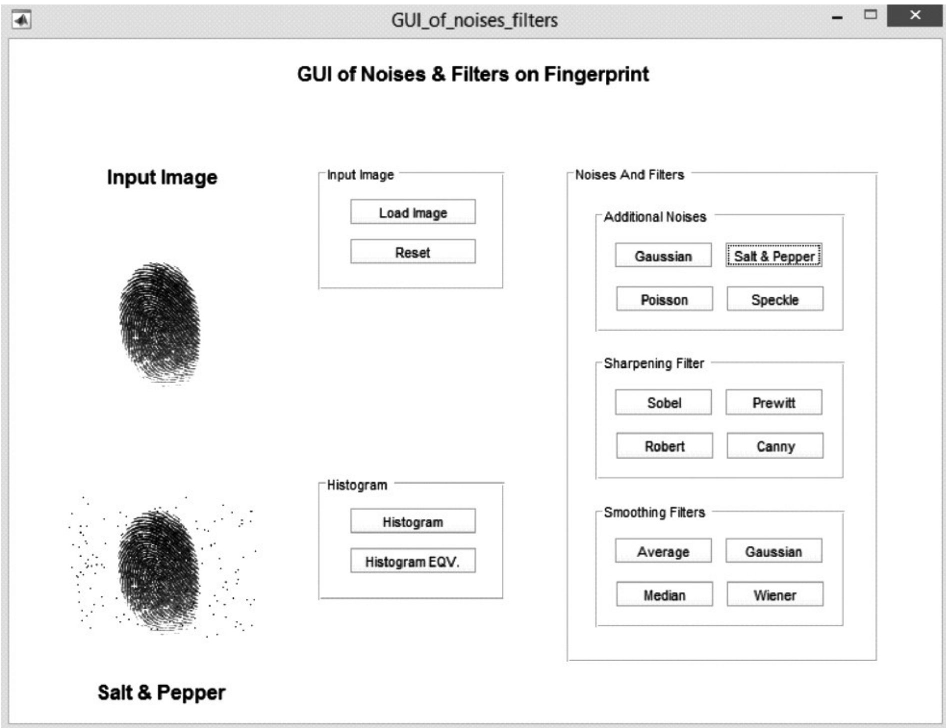

Fig. 6 Salt & pepper noise added to the fingerprint image

Poisson Noise

Poisson noise is a discrete probability distribution that expresses the probability of a given number of events occurring in a fixed interval of time or space, if these events occur with a non-constant rate and independently of the time since the last event.
The Fig. 7 shows the poisson noise added to the fingerprint image.

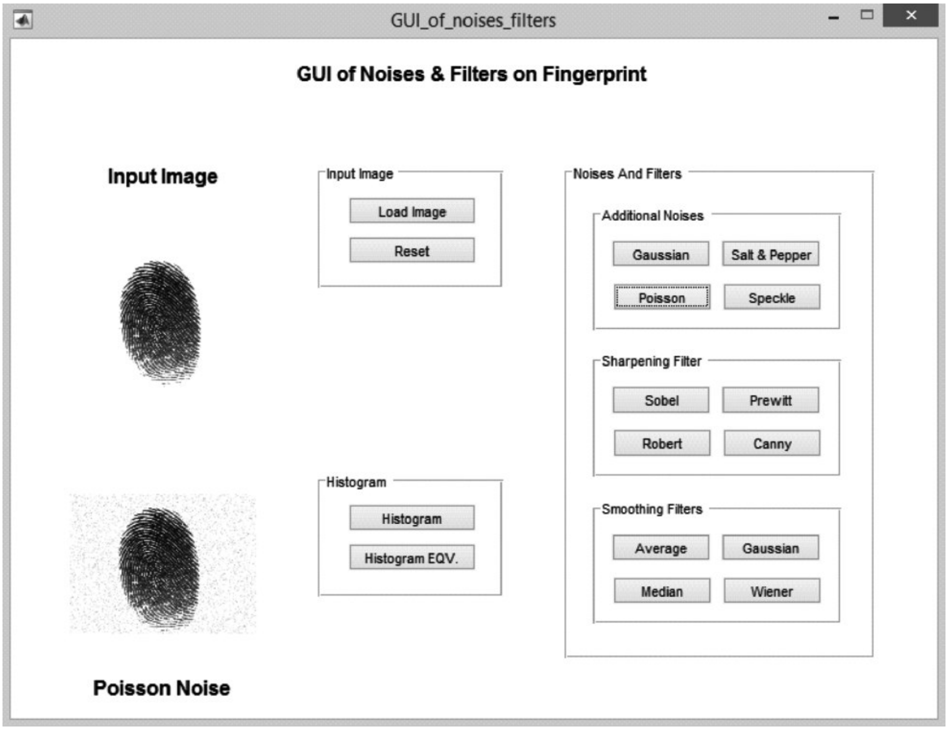

Fig. 7 Poisson noise added to the fingerprint image

Speckle Noise

Speckle is a granular noise that inherently exists in and degrades the quality of the image. The vast majority of surfaces, synthetic or natural are extremely rough on the scale of wavelength. Images obtained from these surfaces generally suffer from a common noise called speckle. Speckle noise has shown in Fig. 8.

The function which is used to introduce these noises is imnoise(im, type, parameters) where im is fingerprint image, type defines the noise that is being used e.g. to calculate Gaussian noise the value will be 'gaussian' and parameters is an optional parameter to the function which defines the intensity ranging from 0 to 1. The other values for 'type' can be 'salt & pepper', 'poisson', 'speckle' and all these noises can be seen by clicking on these buttons on the noise panel.

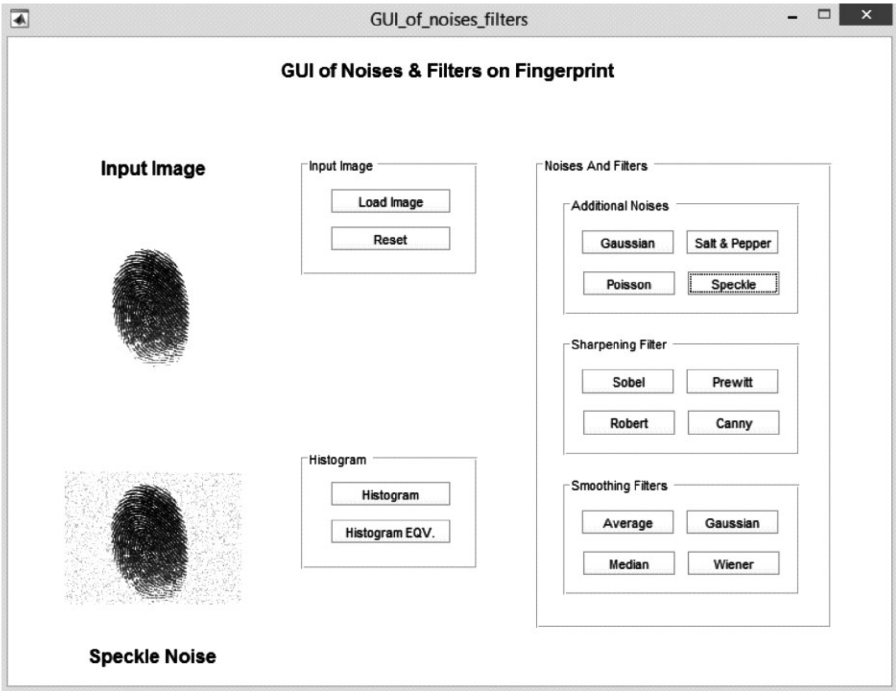

Fig. 8 Speckle noise added to the fingerprint image

SHARPENING FILTERS

Sharpening is the technique for increasing the apparent sharpness of the image. Sharpness is a combination of two factors: resolution and acutance. Resolution is the size in the pixels of the image and higher the resolution of the image the more pixels it has and the sharper it can be.

Acutance is the measure of the contrast at an edge of the image. Edges that have more contrast appear to have a more defined edge to the human visual system. Image sharpening refers to enhancement technique that highlights the edges, line structures and fine details in an image. Image sharpening consists of adding to the original image a signal that is proportional to a high pass filtered version of the original image. The high pass filter which have been studied in this study are as follows: Sobel filter [8, 9] is used to detect the edges of an image. The Sobel filtering reduces the visibility of those regions in which the intensity changes slowly, allowing to highlight the edges. 2-D gradient is computed by Sobel operator to find out the edge strength at each point.

Normally a 3×3 Sobel mask is used as a gradient along x-axis and along y-axis. Prewitt filter [10] is another operator which is used for edge detection in the image. It calculates the gradients of the image intensity at each point, giving the direction of the largest possible increase from light to dark and the rate of change in that direction. Therefore the resulted image shows how smoothly or abruptly the image changes at that point and able to detect the edge as well as how that edge is likely to be oriented. This filter is used for detecting edges horizontally and vertically and is therefore relatively inexpensive in terms of computations like Sobel. Robert [11] and Canny [12] filters have also been used to detect the edges in this study. Function which is used to compute the gradients for these filters is edge (im, type, thresh) where im is fingerprint image, type defines the filter i.e. being used e.g. for Sobel filter the value will be 'Sobel' and thresh is an optional parameter to the function, if provided then function will return all the values stronger than thresh else the function will automatically decide its value and will return all the values stronger than that and the same can be seen by clicking on the filter buttons on the GUI which have been shown in Fig. 9-12.

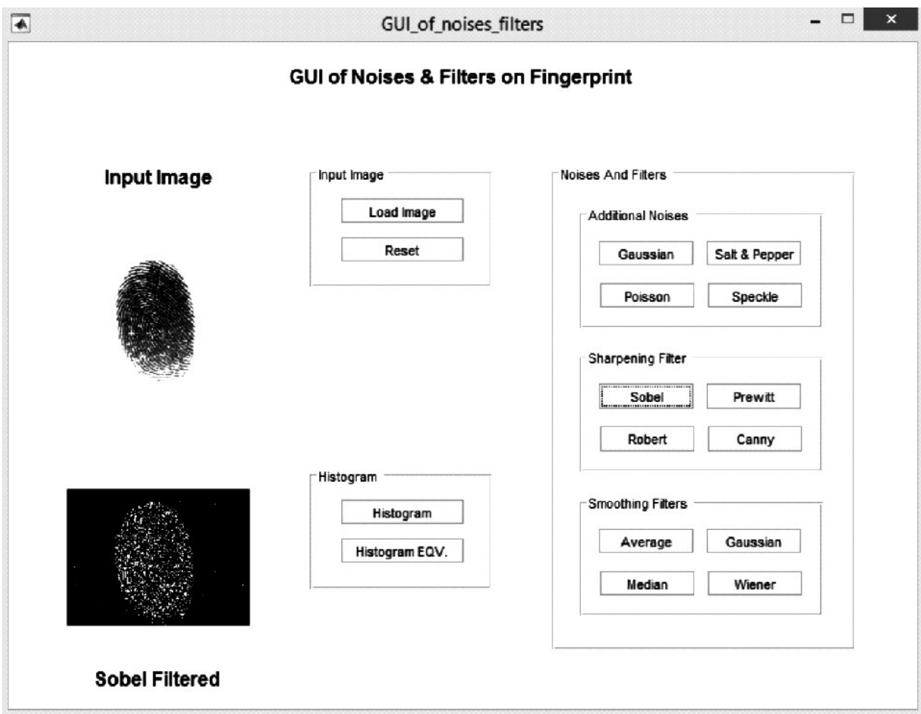

Fig. 9 Sobel filtered fingerprint image

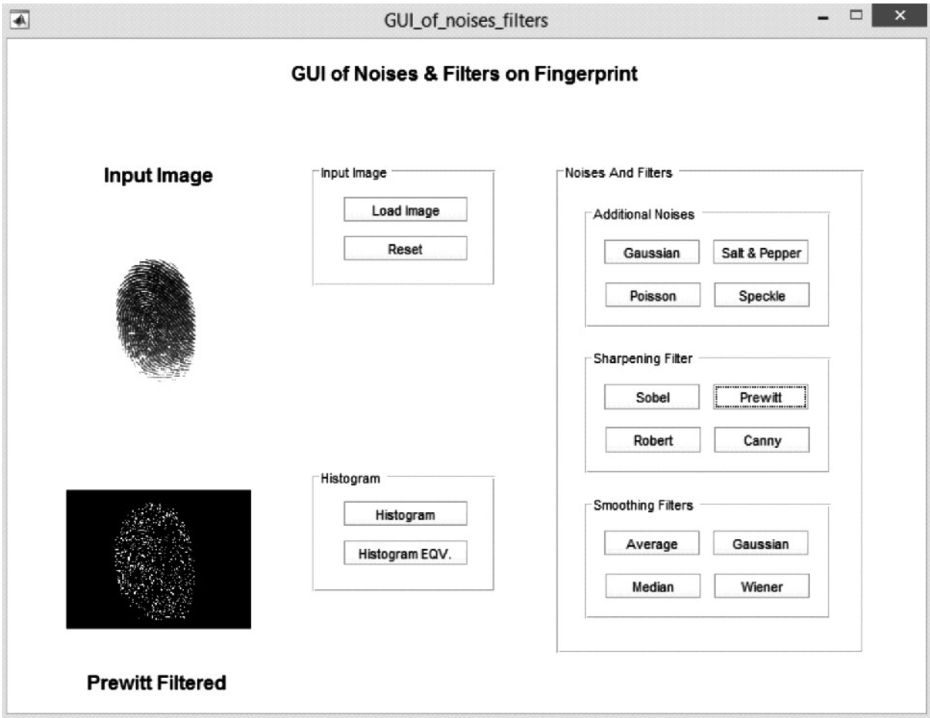

Fig. 10 Prewitt filtered fingerprint image

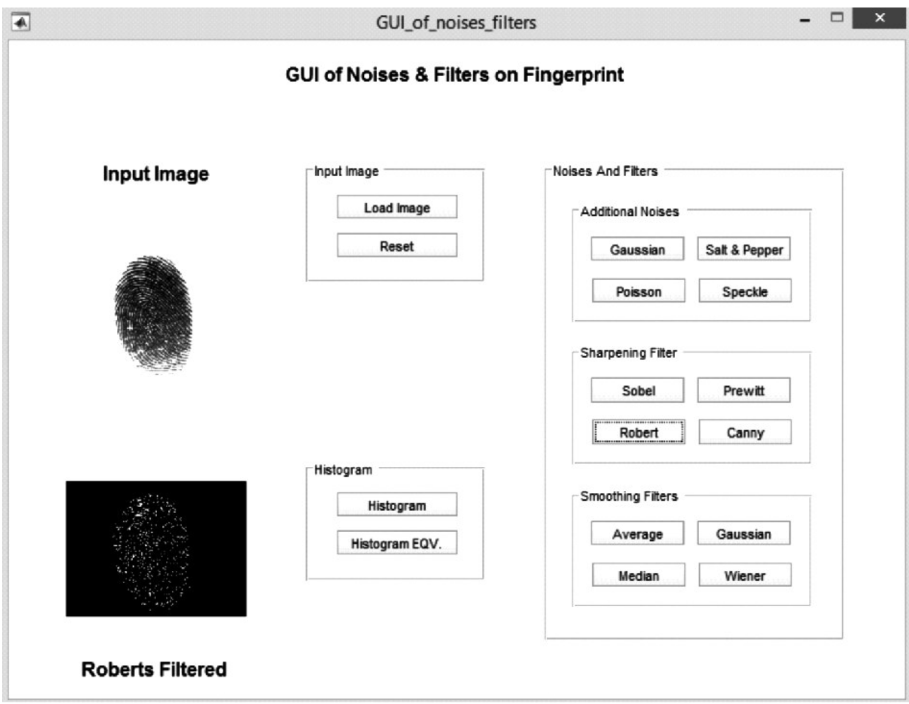

Fig. 11 Roberts filtered fingerprint image

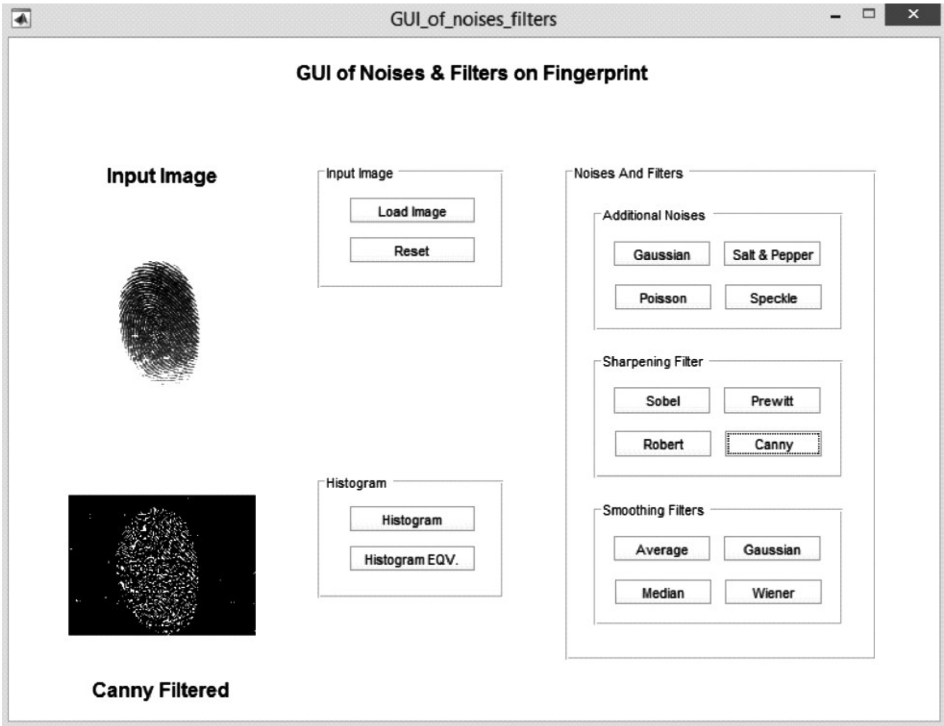

Fig. 12 Canny filtered fingerprint image

Smoothing Filters

Smoothing is often used to reduce noise within an image or to produce a less pixelated image. Most smoothing methods are based on low pass filters. The premise of data smoothing is that one is measuring a variable that is both slowly varying and also corrupted by random noise. Then it can sometimes be useful to replace each data point by some kind of local average of surrounding data points. Since nearby points measure vary nearly the same underline value, averaging can reduce the level of noise without biasing the value obtained. The filters which have been studied in GUI fingerprint recognition are as follows: Average filter is used for reducing the noise in the image by masking the entries of the filer with positive entries that sum to 1. It replaces each pixel with an average of its neighborhood. Therefore variance of noise in the average is smaller than the variance of the pixel noise. Function filter2(fspecial(type, hsize), im) where fspecial() function defines the type of filter being used by taking type as the fitler type and hsize is size of filter and im is the fingerprint image, is used for average filtering of an image.

Gaussian filter [13] is a case of weighted averaging having 2-D coefficients. Here, weight at the central pixel are more than the weights to the neighbors. Function imgaussfilt(im) is used to remove the noise and for smoothing of image im. The next filter which is studied and used for smoothing is Median filter [14]. medfilt2(im, [m n]) function performs median filtering, where each output pixel contains the median value in [m n] neighborhood around the corresponding pixels in the input image. The last filter in this study used for smoothing operation is Wiener. Function wiener2(im, [m n]) performs wiener filtering, where im is fingerprint image and [m n] specifies the size m-by-n of the neighborhood to estimate the local image mean and standard deviation. The output of all these filters have shown below in Fig. 13-16 can be seen by clicking their buttons on the interface.

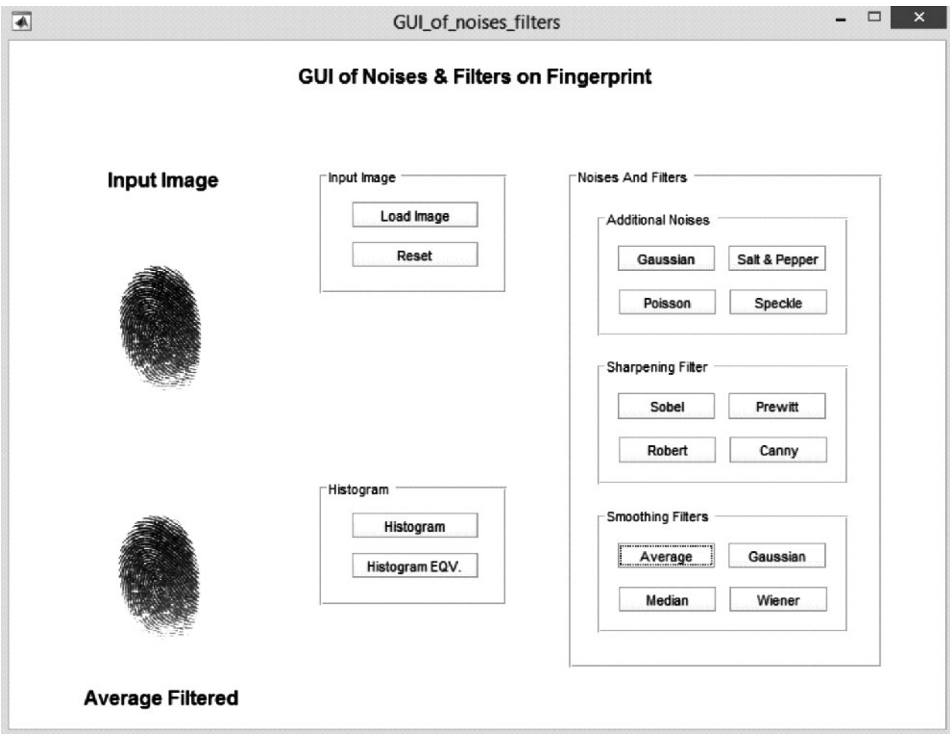

Fig. 13 Average filtered fingerprint image

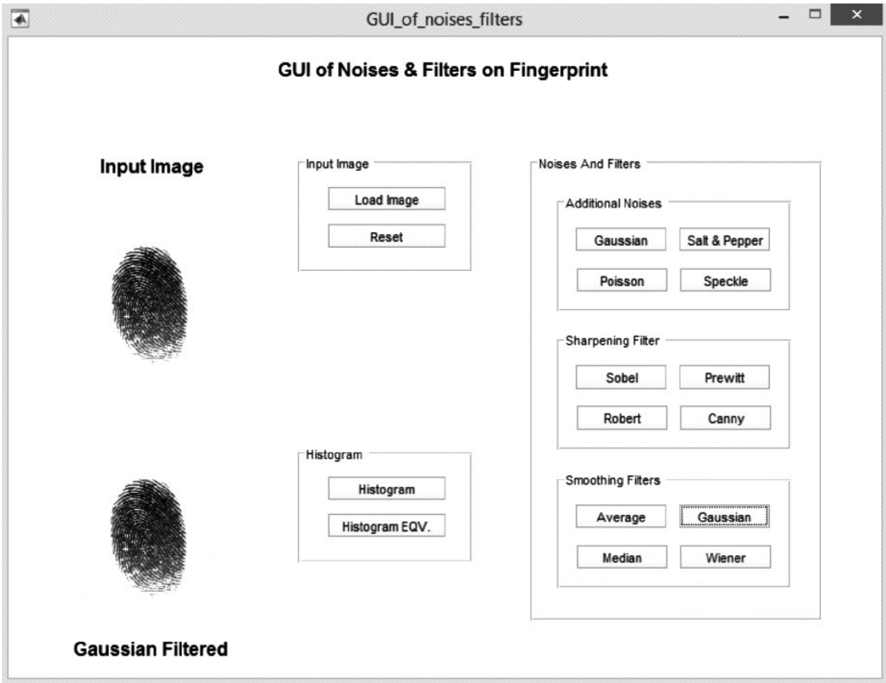

Fig. 14 Gaussian filtered fingerprint image

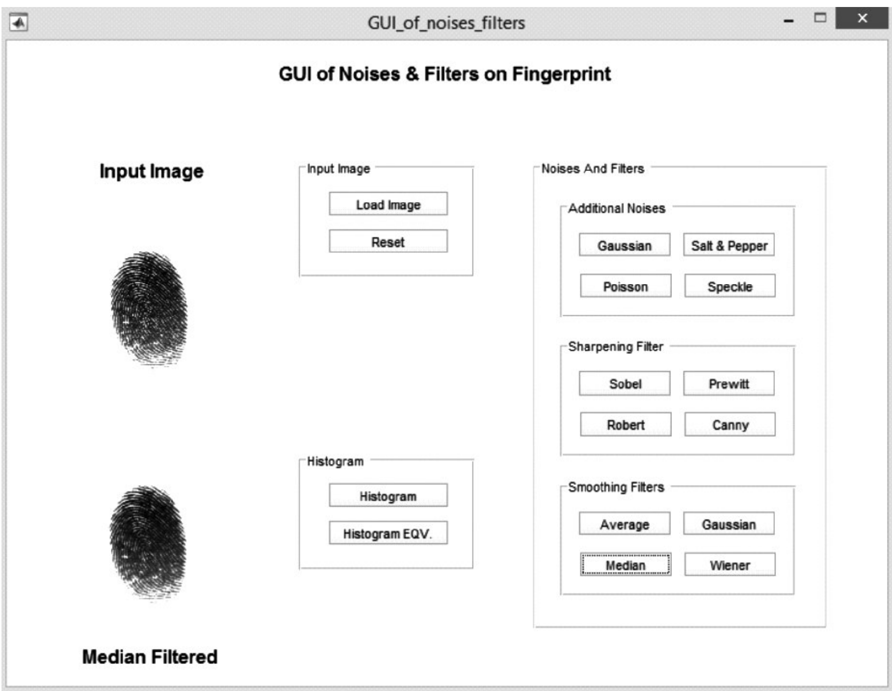

Fig. 15 Median filtered fingerprint image

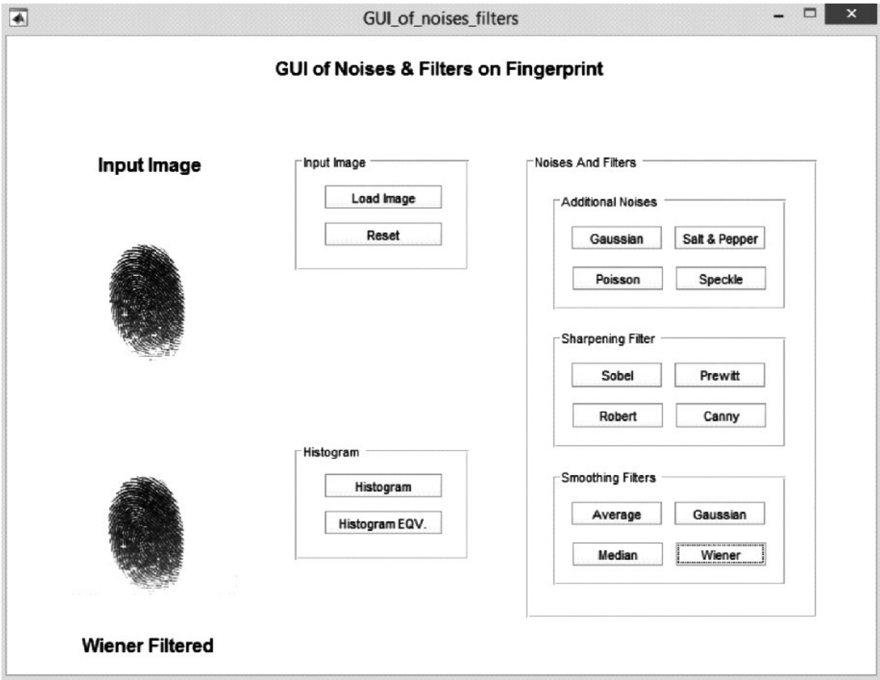

Fig. 16 Wiener filtered fingerprint image

IV. CONCLUSION

This research work was carried on adding and removing different noises on a fingerprint image with the help of GUI. Different approaches have been implemented in this paper like histogram equalization has been done on input image to enhance the image, different additional noises have been introduced in the input image e.g. Gaussian noise, Salt & pepper noise etc., different sharpening and smoothing filter techniques have been used to remove the noise from the image e.g. Robert filter, Canny filter, Median filter, Wiener filter etc. This GUI helps to understand the concepts of histogram, histogram equalization, noises and filters with the help of clicking on buttons. Further, in future, this GUI can be extended by adding buttons for image enhancement techniques, feature extractions and performance parameters to understand these concepts for image enhancement.

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