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Disease Classification by Human Fingernail Colour Image Processing

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Abstract: This project focuses on image recognition using four different fingernail colour analysis which is yellow, white, pale and pink as to identify the type of disease where changes in nail colour is a symptom of a variety of disorders that primarily affect the nails. Image processing techniques are applied by converting the image into a digital form to extract features of a fingernail for disease classification as to classify disease such as liver disease from a white nail, lung disease from a yellow nail, anaemia disease from the pale nail and compare them with a healthy pink nail. Each fingernail image will be uploaded into the GUI first to go through the image pre-processing, binary image, and segmentation techniques. These techniques isolate the type of colour that is detected and give what the type of colour is. Once the colour has been identified, the type of disease detected will be displayed in the GUI system. The red green blue (RGB) value is used as a fingernail characteristic for fingernail colour analysis and disease detection. In this project, it is used the RGB value of the input image to classify the diseases, but it may include other features of the fingernail, such as the pattern of the fingernail to classify the diseases.

Keywords: Fingernail, Image Processing, Colour Analysis, Disease Classification

1. Introduction

Anything that impacts the growth and appearance of the fingernails or toenails could indicate a problem. The condition of a person's nails can indicate a great deal about their overall health [1]. A person's pink fingernails usually indicate that they are in good health. In pretty good health, the nails are smooth and consistent in colour. This project focuses on image recognition using fingernail colour analysis to identify the type of disease. Fingernail can be used to diagnose a variety of disorders. This system works by extracting the colour feature from the fingernail image and it will be analyzed in RGB

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form [2]. The input to the system is a fingernail image taken from the health website, Kaggle.com. The image will be going through a filtering process first. The filtered image is then turned into a binary image, which assigns a 1 or a 0 to each pixel of the image. Segmentation is the last part of image processing to break down a digital image into separate segments, each with its own set of homogeneous pixels for identifying the object or other data in the image. The system then will compare the nail colour with the defined colour range and lastly, it will classify the nail image with the diagnosed diseases. Graphical User Interface (GUI) is then developed for a visual representation of the system, allowing users to easily access the system. This project will focus only on four different nail colour which are yellow, white, pale and pink indicating the healthy nails showing good health condition. The role of a healthy fingernail is to protect the fingertip and surrounding soft tissues from injury.

1.1 Problem Statement

Medical research has progressed significantly, and there are now numerous methods for detecting disease in the human body [1]. Pathological testing, MRI's, X-rays, and other methods are already in use around the world. Although the approaches described above generate reliable results, their implementation is both costly and time-consuming [2]. Nowadays, many people often take lightly doing health checkups. As a result, they are uninformed of diseases that may threaten their health. Society may be unaware that disease in a person's body can be detected simply by examining their fingernail. Time restrictions, a lack of finances, and a fear of health screenings are all common reasons given by society. Nail analysis can be used to diagnose a variety of disorders. Human eyes, on the other hand, have a hard time recognizing slight colour changes [3]. As a result, it is less precise and time-intensive. Changes in nail colour, texture, or shape are symptoms of a variety of disorders that primarily affect the nails. The tips of our fingers and toes are protected by fingernails and toenails, which are crucial organs of our body. As a result, disease reveals itself first in the human body's nails [4]. To address these issues, this project will apply methods for detecting disease in the human body by examining and analyzing the colour of fingernails via image processing techniques and a graphical user interface. Image processing is a method of improving or extracting usable information from an image by applying operations to it. It's a kind of signal processing in which an image serves as the input and the output is either that image or its characteristics/features [5].

1.2 Hypothesis

Fingernails can detect the type of disease. The brighter the colour change of the nail that appears in an image, the higher the accuracy of the type of disease that can be detected by a computer. Thus, a computer system is much better to use compared to the human eye for detecting color changes in nails as the human eye is fraught with limitations to small colour changes.

1.3 Objectives

This research work embarks on the following objectives which are to apply image processing techniques in MATLAB by converting the image into a digital form to extract features of fingernails for disease classification. Next, to identify the fingernail colour in RGB form to classify the type of disease. Lastly, to design a GUI as a visual representation to the users.

2. Materials and Methods

There are many steps that need to be pursued to guarantee that this project progresses. In addition, this chapter explains the description of the project in order to accomplish the project's key objectives. This chapter will address the methods utilized in this project. There are different image processing techniques that need to be pursued to guarantee that this project progresses. The techniques such as image pre-processing, binary image and image segmentation are the main techniques of the project in order to accomplish the project's key objectives.

2.1 Materials

The concept of disease detection in the human body using a human fingernail image and processing the data from the image based on fingernail colour are referred to Table 1 which is the knowledge base about various types of diseases through fingernail colour [1]. In this project, it is used the RGB value of the input image to classify diseases.

Table 1: Knowledge base of various disease through fingernail colour

Colour	Type of disease problem
Blue Nails	Not enough oxygen in the bloodstream
White Nails	Liver disease, Diabetes
Pale Nails	Anaemia
Half Pink, Half White Nails	Kidney disease
Yellow Nails	Lung disease, Nail infection
Dusky Red Half Moons	Heart disease
Blue Half Moons	Sign of poisoning

- Image pre-processing

For image pre-processing, this technique executed the type of image processing technique which is image filtering. First, the image must be read in the workspace using the function ‘imread’. This function will make the selected image can be read by the system. For image filtering, this project used the contrast adjustment technique to remaps the image intensity values to the data type's full display range. Highlights appear brighter and shadows appear darker in the high contrast image. The function 'imadjustn' used in this project is to adjust the intensity values in the N-D volumetric image for the fingernail image. It is more to brighten up the contrast as to detect any colour changes on the nail image [2].

- Binary image

For a binary image, the filtered image is then turned to a binary image, allowing it to focus solely on the area of interest (1 for yes and 0 for no) [6]. The filtered image is used to create this binary image. This method assigns a 1 or a 0 to each pixel of the image. The coding function for binary image is ‘im2bw’ [7]. Binary image will create a new mask layer where pixel 0 will be used as the main layer to help users see the type of colour extracted when going through the segmentation process. Because pixel 0 is black, the type of colour extracted through the segmentation technique can be seen clearly and easily. This causes the type of colour that is extracted to be viewed separately from the layer that has been created.

- Image segmentation

For image segmentation, this project used thresholding based methods or known as colour thresholding to segment the detected color on nail image [8]. As the fingernail image are all in RGB colour, colour thresholding technique used to segment the image. This technique identified the specific range of values for the colour attributes. Also, this technique identified the pixel value colour of the region part on the fingernail by using the function ‘impixel’. This will give the pixel value in the range of RGB [8]. This project used the RGB value of the input image to classify the diseases. The RGB values for each colour type separated by the segmentation technique are shown in Table 2. In segmentation, after an RGB value has been identified, a new mask of the identified colour will be created to indicate the colour region detected on the fingernail by the system. After the binary image creates a new mask, segmentation will extract the type of colour that has been detected through a known RGB value into the mask. This causes the type of colour that is extracted will be incorporated into the

new mask and will cause the type of colour can be seen easily because the background for this new mask only has a value of 0 which can help users see the type of colour that is detected. Image segmentation is a well-known technique in image processing, as well as a hot spot and focuses for image processing approaches [9]. When segmentation is processed, the image is segmented using a sequence of decisions where there is no one-size-fits-all segmentation approach for all types of images, and one image can be segmented using multiple methods [10].

Table 2: Colour pixel range for a different colour

Colour	Range value in RGB form
Yellow	R>185 G>112 B<65
Pale	R>209 G>180 B<220
White	R>230 G>197 B<220
Pink	R>200 G>120 B<160

2.2 Methods

Procedures in completing this project can be described using the flowcharts that are shown in Figure 1, which is the system design in examining and analyze the fingernail image.

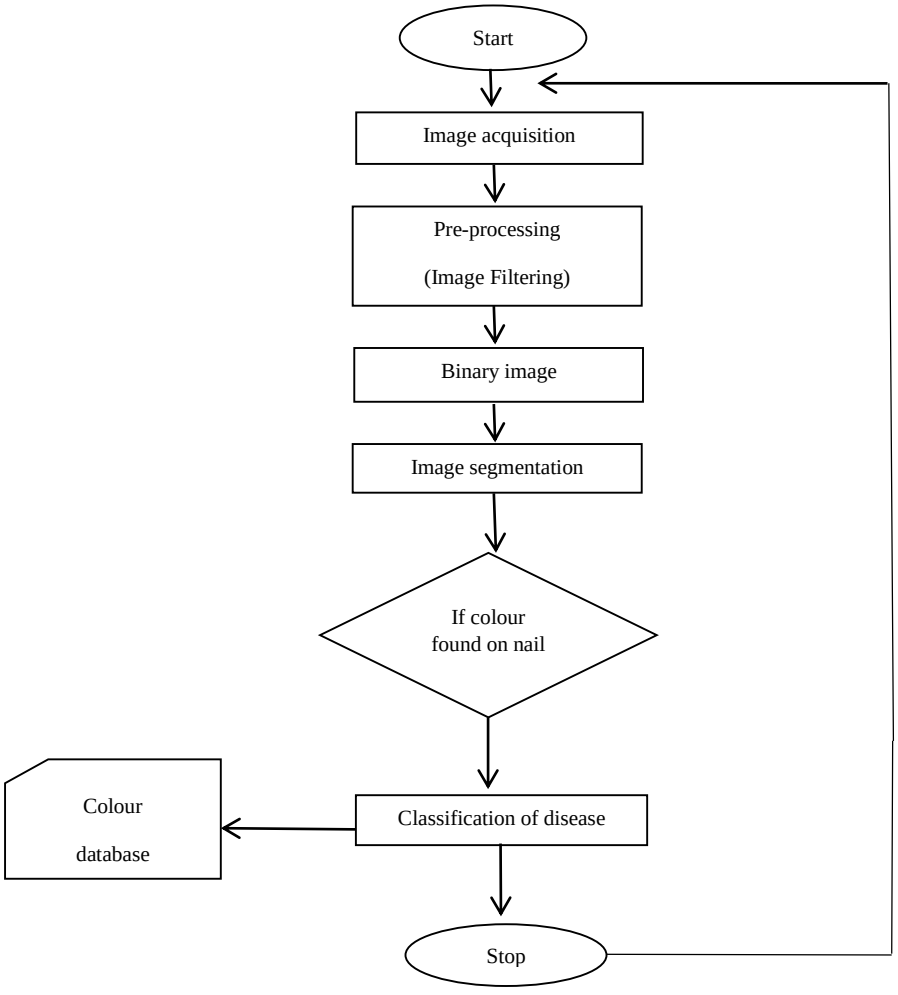


Figure 1: System design

2.3 GUI Development

GUI is the output of this project. GUI has been designed to have 4 button groups, 10 push buttons and 4 axes. There are four types of pushbuttons in determining the type of colour detected where the yellow push button will detect the type of yellow colour found in the fingernail, the pale push button will detect the type of pale colour found in the fingernail, the white push button will detect the type of white colour found in the fingernail and the pink push button will detect the type of pink colour found in the fingernail. The purpose of these four push-buttons are separated is because it wants to inform the user that the system only detects the four types of colors only. As an example, if analyzing the fingernail image type is yellow but the white push button is pressed, then the system will not work and will not provide output. This is because, the yellow push button is only designed for yellow fingernail image only, as well as white push button is designed for white fingernail images, pale push button is designed for pale fingernail images and pink push button is designed for pink fingernails only. Each function for a push button is totally different. The use of axes is to display the output. Also, real live camera will also be used in this GUI. Real live camera will use the webcam camera and snap the user's finger nail and analyze it.

3. Results and Discussion

The final results for four types of finger nails colour image obtained from the simulations will be shown according to the sequence of image processing techniques. The focus of this project is on the image processing techniques so the results will be displayed by each of image processing techniques used. The image processing is the way of how can it reveal the fingernail colour using the system. The use of the GUI is to display the results obtain from the image processing techniques which make the output result become easier to understand and analyze.

3.1 GUI design

Based on Figure 2, the GUI has been designed with 4 button groups, 10 push buttons and 4 axes. Button group will put the push button in the same function. Push button will execute the function. While the axes will show the result after the push button is pressed. For push button load image, the image will be uploaded into the system in png format. For the input group button, it has 2 push buttons, namely, load image and analyze. For push button analyze, the system will analyze the image that has been uploaded earlier through image filtering techniques, image binary and segmentation. For button group colour detection, when the push button is pressed either yellow, white, pale or pink, the system will detect the type of colour that has been separated after going through the segmentation technique. Thus, when the colour type has been detected by the system, the colour type found in the disease will be displayed in the output group button. The same applies to the live image group button. It has 3 push buttons, namely snap image, analyze and colour detection. To push the snap image button, when it is pressed, the user's fingernail should be placed in front of the webcam and the image will be snapped automatically. For push button analyze, the system will analyze the image that has been snapped earlier through image filtering techniques, image binary and segmentation. While for push button colour detection, the system will detect the type of colour that has been separated after going through the segmentation technique. Thus, when the colour type has been detected by the system, the colour type found in the disease will be displayed in the output button group. For push button reset, system memory will be cleared.

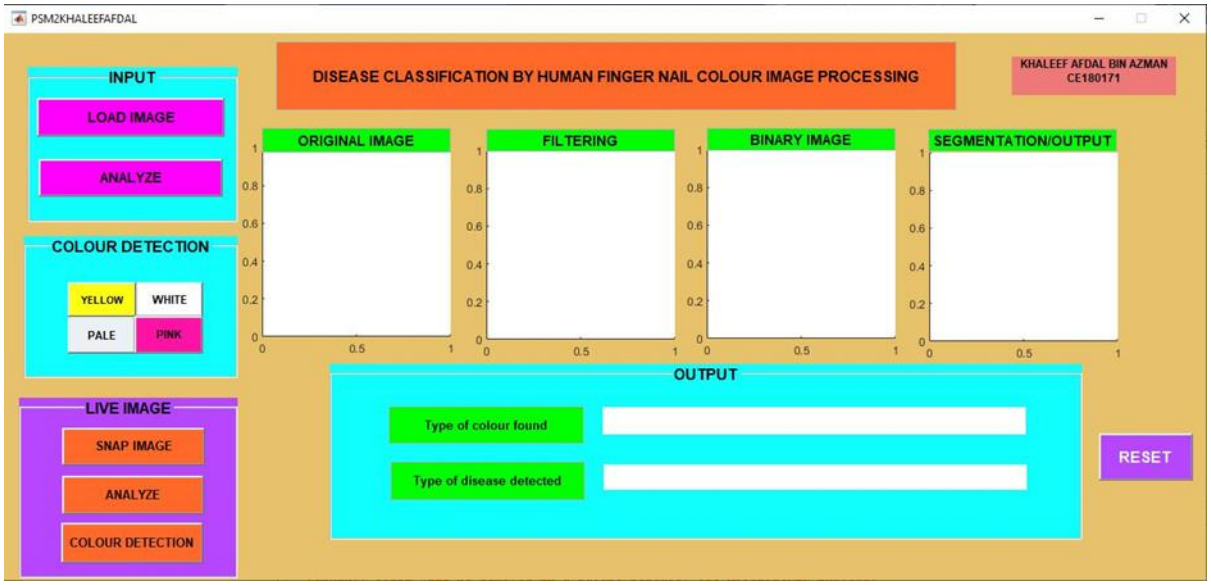
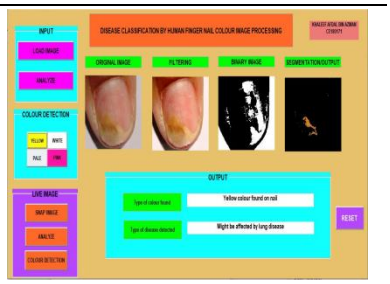
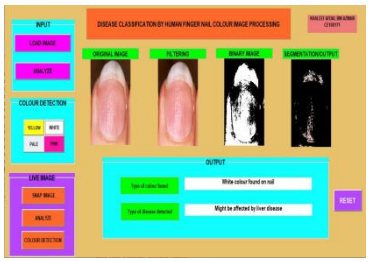
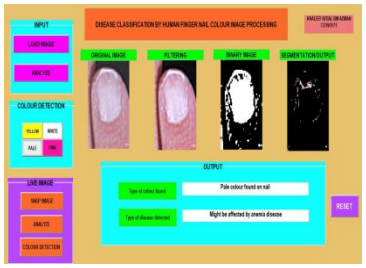
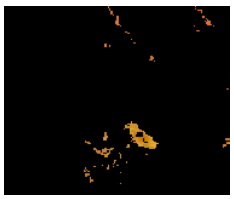
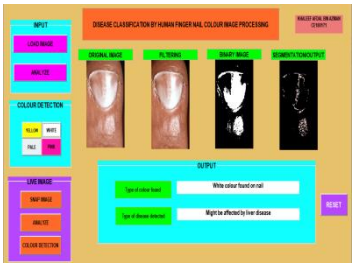


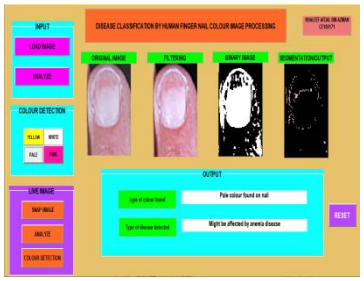
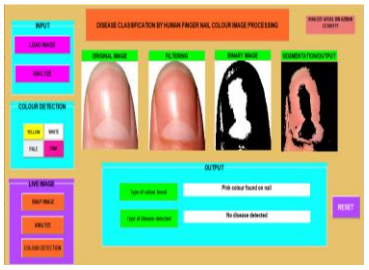
Figure 2: Final result of GUI development

3.2 Result for image processing technique

Based on Table 3, the GUI system will analyze each uploaded image and provide a decision on the disease encountered through the color database. The result shows the original image and their result after be analyzed. Segmentation will separate the colors according to the RGB value that has been set by the system where each colour has a different RGB value. Image no 1 and 4 in the Table 3 show the results of yellow nails that have been fully analyzed. It can be seen that the yellow colour in the nail can be separated successfully through segmentation. This can make the system detect the yellow color and classify the type of disease through supervised classification. The possible disease from the yellow nail colour is a lung disease. The same process is used to analyze white nails. Image no 2 and 5 in the Figure 3.2 show the results of white nails that have been fully analyzed. It can be seen that the white colour in the nail can be separated successfully through segmentation. This can make the system detect the white colour and classify the type of disease through supervised classification also. The possible disease from the white nail colour is liver disease. For pale nails, Image no 3 and 6 in Table 3show the results of pale nails that have been fully analyzed. It can be seen that the pale colour in the nail can be separated successfully through segmentation. This can make the system detect the pale colour and classify the type of disease through supervised classification also. The possible disease from the pale nail colour is an anemia disease. For image no 7 from Table 3, it is a pink nail colour. These nails are a healthy type and the results of this nail analysis show that the segmentation technique can isolate most of the pink colour from the nails. Also using supervised classification, this type of nail disease is classified as no disease detected or healthy nails.

Table 3: Type of disease based on fingernail colour

No	Nail type	Input image	Result from developed system	Output from GUI
1	Yellow Nail			
2	White Nail			
3	Pale Nail			
4	Yellow Nail			
5	White Nail			

6	Pale Nail			
7	Pink Nail			

3.3 Result for live camera image

Table 4 shows the result from the live camera image that has been fully analyzed. At first, users must place the fingernail in front of the webcam camera and it will snap automatically. After analyze the image, It can be seen that the pale colour in the nail can be separated successfully through segmentation. This can make the system detect the pale colour and classify the type of disease through supervised classification. The quality of an image also influences detecting the type of colour found in the image. If using a good camera, the image quality will be better and the pixel value can give the whole RGB value accurately. If the image quality is bad, the pixel value will give an RGB value that is not accurate. Using a webcam camera like in Table 4, it gives results that are not entirely accurate due to the relatively poor image quality.

Table 4: Result from the live camera fingernail image

Input image taken from webcam	Result from developed system	Output from GUI
		

3.4 Implication of Research

This research has contributed to the application of philosophy and engineering skills to the medical field that incorporates design and problem-solving. Specifically, this research has focused on providing

convenience to people who want to do a health check. Therefore, this research will be to some extent beneficial in solving the problem. Moreover, this research can also help in the world of medicine nowadays because the world now is the modern world where all problems will be solved by the system. This research uses Matlab software to apply the image processing techniques and create GUI in order to solve the problem statement that has been identified. To detect the disease at an early stage and the type of disease, the help of computer systems is needed because they are more sophisticated and save time consumption.

4. Conclusion

All image processing techniques used in this project have been successfully used to detect the type of colour found in the image of the fingernail as well as being able to determine the type of disease suffered. Based on the results analysis shows each four types of fingernail colour gives a different type of disease which are the type of lung disease for yellow fingernail colour, the type of liver disease for white fingernail colour, the type of anemia disease for pale fingernail colour and no disease detected for pink fingernail colour. The RGB value is used as a fingernail characteristic for fingernail colour disease detection. As it overcomes human eyes' limitations such as subjectivity and resolution power, this approach produces more accurate results from human vision. Furthermore, the designed system able to analyze the human fingernails colour and gives the accurate prediction of the disease foe all the sample of images used. In this project, it is used the RGB value of the input image to classify the diseases, but in the future, it may include other features of the fingernail, such as the pattern of the fingernail to classify the diseases.

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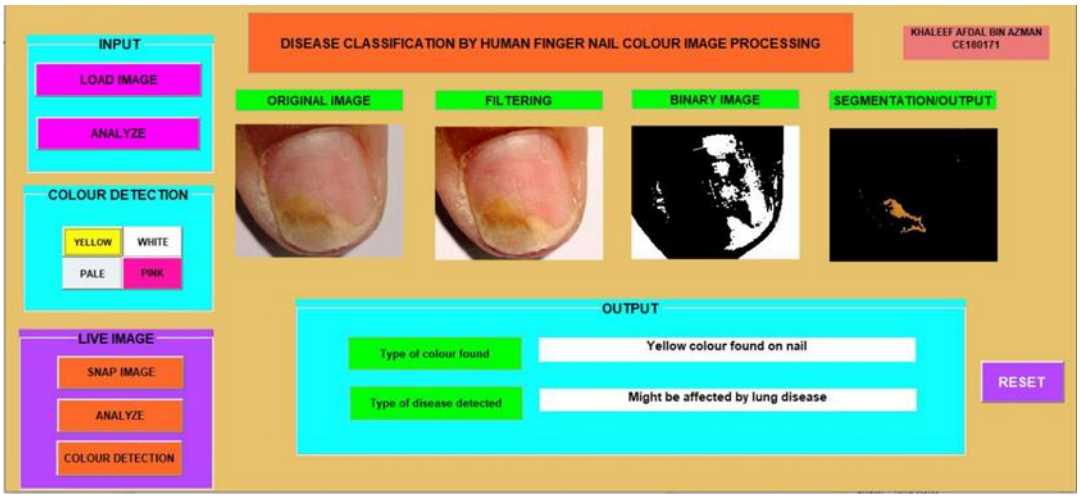
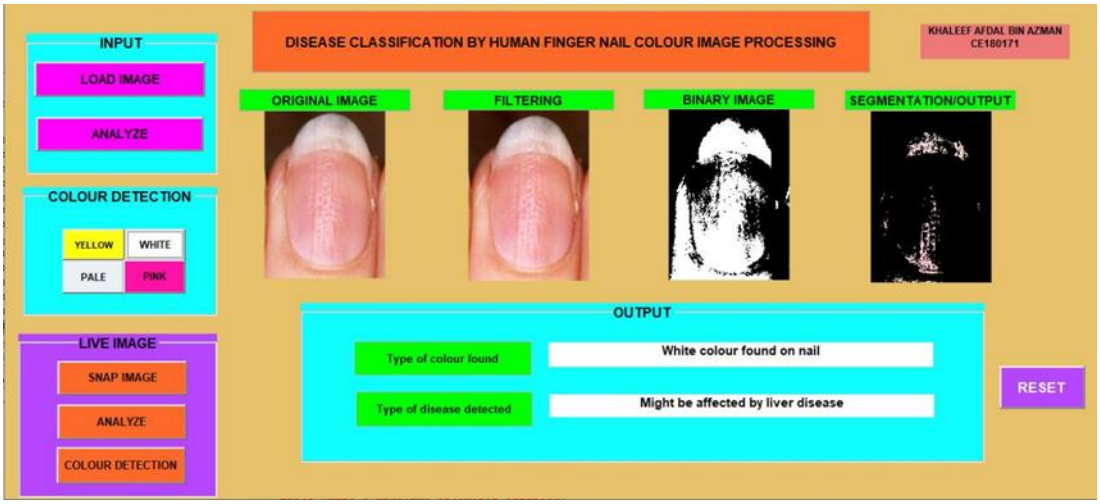
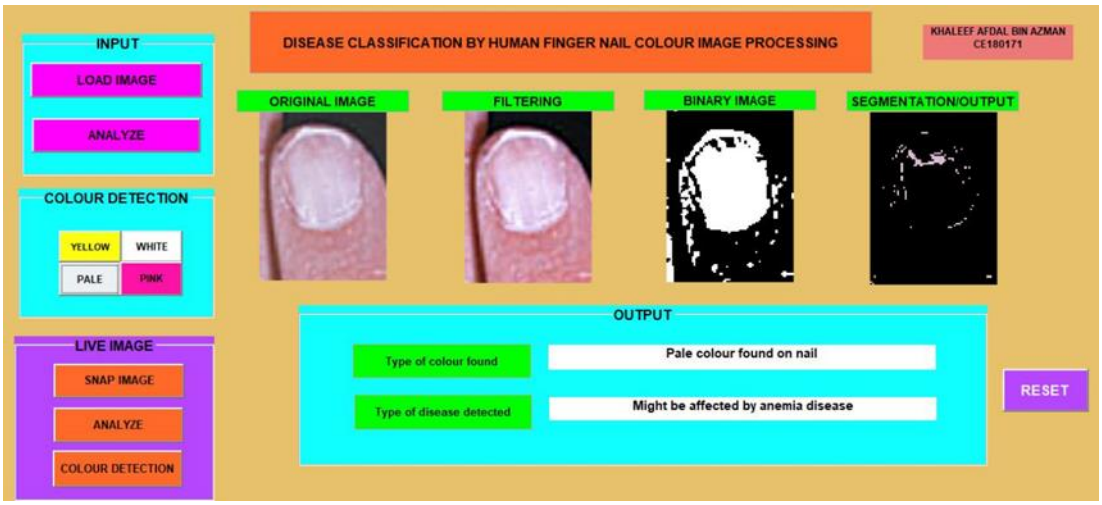
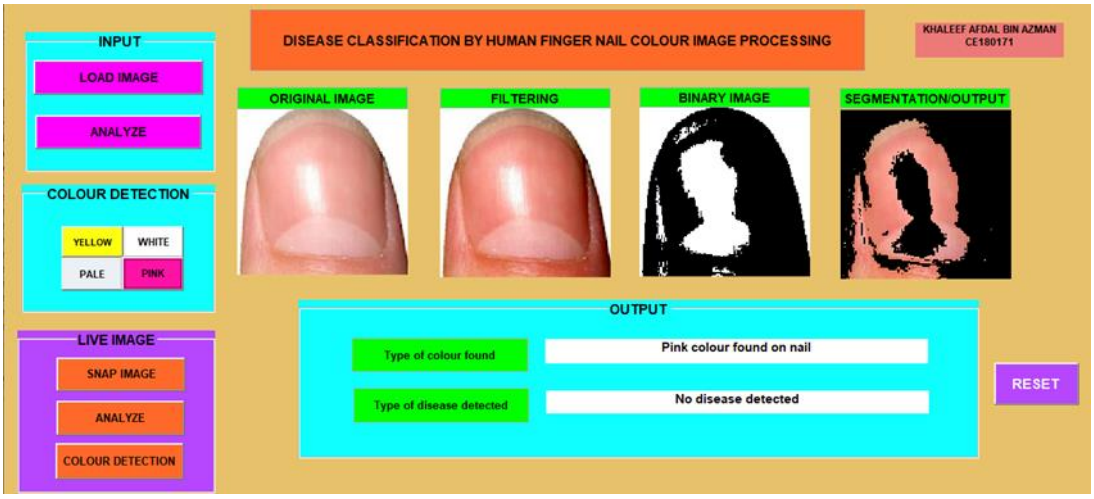
Appendix A

Image processing in GUI




INPUT
LOAD IMAGE
ANALYZE
COLOUR DETECTION
YELLOW
WHITE
PALE
PINK
LIVE IMAGE
SNAP IMAGE
ANALYZE
COLOUR DETECTION
DISEASE CLASSIFICATION BY HUMAN FINGER NAIL COLOUR IMAGE PROCESSING
KHALEEF AFDAL BIN AZMAN
CE180171
ORIGINAL IMAGE
FILTERING
BINARY IMAGE
SEGMENTATION/OUTPUT
OUTPUT
Type of colour found
White colour found on nail
Type of disease detected
Might be affected by liver disease
RESET


INPUT
LOAD IMAGE
ANALYZE
COLOUR DETECTION
YELLOW
WHITE
PALE
PINK
LIVE IMAGE
SNAP IMAGE
ANALYZE
COLOUR DETECTION
DISEASE CLASSIFICATION BY HUMAN FINGER NAIL COLOUR IMAGE PROCESSING
KHALEEF AFDAL BIN AZMAN
CE180171
ORIGINAL IMAGE
FILTERING
BINARY IMAGE
SEGMENTATION/OUTPUT
OUTPUT
Type of colour found
Pale colour found on nail
Type of disease detected
Might be affected by anemia disease
RESET


INPUT
LOAD IMAGE
ANALYZE
COLOUR DETECTION
YELLOW
WHITE
PALE
PINK
LIVE IMAGE
SNAP IMAGE
ANALYZE
COLOUR DETECTION
DISEASE CLASSIFICATION BY HUMAN FINGER NAIL COLOUR IMAGE PROCESSING
KHALEEF AFDAL BIN AZMAN
CE180171
ORIGINAL IMAGE
FILTERING
BINARY IMAGE
SEGMENTATION/OUTPUT
OUTPUT
Type of colour found
Pink colour found on nail
Type of disease detected
No disease detected
RESET

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