Vein Detection System using Infrared Camera

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***Abstract*— A lot of complaint in healthy area about difficulty to stick syringe for medicine given or other liquid. This difficulty because can't see vein in medical patient clearly, especially children, and baby. Determined vein location is important problem and if vein location shown in short time, it can help medical patient faster than before. Instrument system can help to see vein location in short system. Camera will get image from vein with infrared light help and then compare contrast from vein will be shown again to medical patient skin in real time using projector after get process from computer sets of equipment. Every shown vein on skin will show different contrast, and it will easier to see it.**

Keywords—location vein, infrared, contrast, real-time.

I. INTRODUCTION

In the medical field, installation needle infusion has done by medical officer to patient's hospitalization. The Officer Not only done that, but also require vessels vein for blood donations, blood transfusion, and enter medications or fluids in the body.

The Process to find location vein vessels are very important for the doctor or the nurse to help patient. Many of them difficult to locate vein vessels so they difficult to insert needle in patients arm in the first experiment. It will make the patient feel uncomfortable and will slow down the action for wasting time to do a second time. Therefore, determine the location of venous vessels in humans is extremely important in the field of health [4].

Specify the location of the right venous vessels in patients of small children is also important. Because from the small children, venous vessels difficult to find and if done wrong on the action of inserting a needle in children will suffer greatly. The errors that occur when inserting the needle will make the patient can trauma, hematoma and swell in the skin, cuts on the bone, allergic reactions, appear black spots on the veins, the veins going black on the scratch wound vessels veins, and other [4].

In these problems, then a single tool for showing the veins clearly commonly called vein viewer. This tool will work by emitting infrared in the body with a specific wavelength and then the camera will take pictures in body parts that are infrared, veins will look darker than the other networks, with the wavelength of the spectral display will range from 700 to 900 nm, the light on the spectral display to penetrate tissue [4]. Image obtained from the camera will be processed on the computer, which the results are displayed again in the skin with a projector in the same position with the camera taking pictures.

II. INFRARED THEORY

A. Skin Anatomy

The largest organ of the body is the skin, have been multilayered with its three main layers being epidermis, dermis and hypodermis. Fig. 2.1 shows the part of skin. The epidermis is the outermost layer and does not comprise any blood vessels. It allows light to pass through it owing to its presence in the surface section of skin. The middle layer known as the dermis comprise capillaries, glands and hair follicles. Diffusion occur place between the dermis and epidermis to give nutrient supply. The hypodermis lying up the muscle and bone is the lowermost layer in the skin consists of fat cells, veins, arteries and nerves. The number of subcutaneous fat in this layer specify the penetration of light into tissue underneath it. Children have skin of lesser thickness as compared to adults. The depth of epidermis ranges from 0.027 – 0.15mm and that of dermis between from 0.6 – 3mm. The hypodermal thickness can be between 0 – 3mm with the maximum in the abdomen.

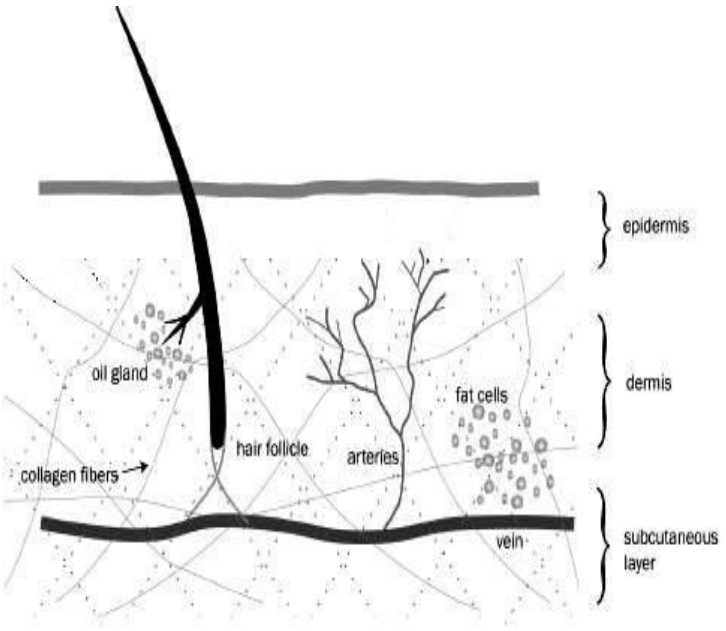


Fig 2. 1. Section of human skin [5]

B. Skin Optics

Studying the phenomena of light shift in tissue will provide a better comprehension of the working of the vein viewer system. Fig 2.2 describe the spreading of light in human tissue. The light beam that is incident on the skin undergoes absorption, spreading and reflection by the various layers of tissue at different depths. The characteristics of light propagation distinct with respect to each layer in the skin. The reflection of light from the skin surface is called specular reflection. Light that is secularly reflected does not allow light to propagate through internal tissue and can thus add brightness to a vein image.

A three part type of skin is considered which consists of epidermis, dermis and subcutaneous layer. The epidermal layer permeates some light and send light into the tissue layers beneath it after spreading. A lot of spreading occurs in the dermis before it worm to the hypodermal layer while a part of the light is absorbed. Fat scatters a major deploy of light and permeate very little. Several of the light reaching blood in the vessels is absorbed by the hemoglobin present in it, while some is spread mostly in the forward direction due to the large size of the red blood cells. It has been notified that the blood in the veins is dominated by deoxy-hemoglobin with the oxy-hemoglobin content concentration around 47% while that in the arteries comprise more oxy- hemoglobin (90%-95%). Both types of hemoglobin possess different light absorption properties as shown in Fig2.2 both types exhibit almost the same absorption characteristics till the wavelength of 600nm. It can be realized that the permeation of light by veins is higher than that by arteries between the wavelengths of 600nm-800nm. The chart falls fast for the deoxy-hemoglobin while it rises a little and then falls for the oxyhaemoglobin.

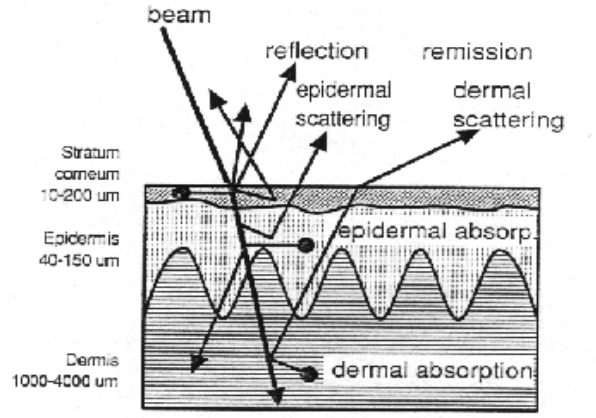


Fig 2. 2. Propagation of light in various tissues [5]

Light have distinct wavelengths reaches distinct depths when it travels through tissue as seen in Fig 2.2. The bars in Fig 2.3 indicate the extent of transmission of light in all layers of the skin at various wavelengths. Visible light wavelengths between 400nm-700nm while infrared wavelengths range from 700nm – 10^6 nm. Light at wavelengths between 300nm and 400nm achieve only the epidermal and dermal sections of the skin which do not comprise any veins. Light at near infrared wavelengths (700 – 1000nm) is less absorbable by other tissue and reaches the blood vessels in the subcutaneous tissue. The VV utilizes this phenomenon to view veins which cannot be visualized in visible light. The principle of working of the vein viewer system is found on tissue light interaction in the body that has already been discussed up. Details of the device instrument and show are given in the next chapter. The clinical utility of the vein viewer system decided from prior studies on pediatric subjects is also discussed.

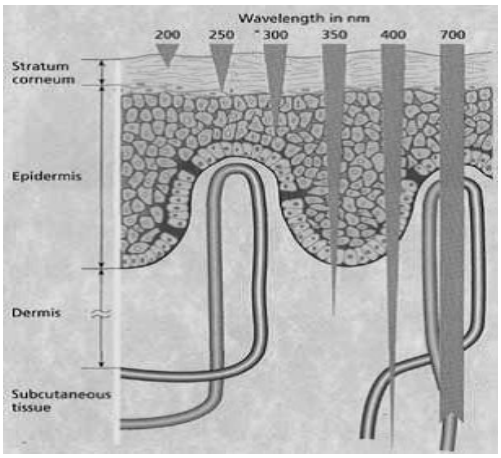


Fig 2. 3. Light propagation at different wavelengths in tissue [5]

III. SYSTEM ARCHITECTURE

Before the theory test is performed, then need the design of the system firstly. How the system will be tested later in a way, what exactly was done, so the system can run and works well. The infrared cameras and the image processing programming must be prepared. The following is a chart of the image processing programming that will be applied.

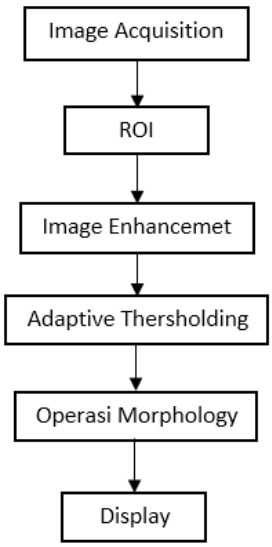


Fig 3. 1 Diagram program pengolahan citra

Image acquisition is the first step in any image processing applications from set distance with proper illumination.

ROI select the region of interest that is selected which is obtained from masking processing. The image obtained from global thersholding is mask on gray image which is obtained from color to gray transformation.

Image enhancement is one of the simplest and most appealing areas of digital image processing. The idea behind enhancement techniques is to bring out detail that is embezzled or simply to highlight certain features of interest in an image. This is very subjective area of image processing. The choice of algorithm be used depends on the nature of the image acquired.

Thresholding is used for converting gray scale image into binary image

Adaptive Thresholding:- In this particular case adaptive Thresholding will be used to generate binary image of each segmented digits so as to obtain dark (0's) regions for veins and bright (1's) background. This obtained binary image is display on computer.

Morphological operation is used to remove unwanted noise from an image that is doted part is removed from image.

Also we design for vein detection system GUI window which include capture batten which capture the image of palm and veins show button which show the vein after applying image processing algorithm

IV. ANALYSIS AND IMPLEMENTATION

The test of System will begin with getting vein picture in the hand as an input, then conducted initial image processing to separate vein vessels with the other networks. Here is an implementation from the theory.

A. Implementation of the image processing programing

Using image processing, image of the veins that have been captured with an infrared camera is processed to be better image and then separete the vein with another network. Figure 3.4 shows the block diagram of image processing that has been done.

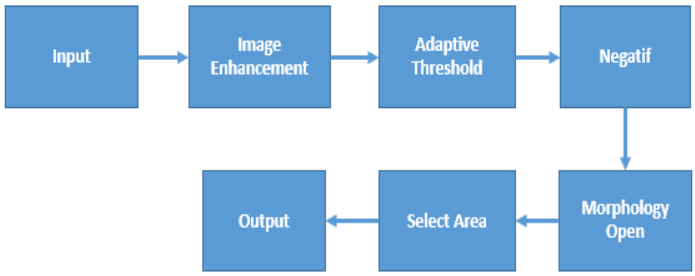


Fig 3. 2. Block diagram of image processing

Based on the block diagram shown in figure 3.4, when Image input vein has been obtained then the next process is median filter. This process aims to eliminate noise from the input image as well as to make the difference intensity of one region to another color more evenly. Figure 3.5 shows the result of the median filter.

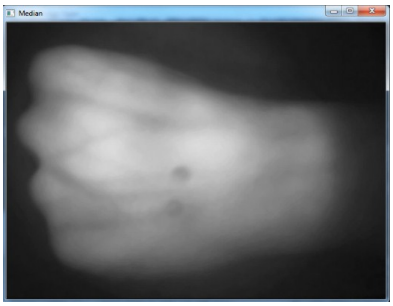


Fig 3. 3. Filter Median

The nest process is adaptive threshold process, that is the process of converting grayscale values 0-255 to be threshold of 0 and 1. Threshold selected is adaptive threshold because this tool expected to be used anywhere, while in the image processing, light is very important for the outcome to be good. By using adaptive threshold can be of little help in the process because of the adaptive threshold will still get good results even though the intensity of light in the image uneven. Figures 3.6 shows the result of the adaptive threshold

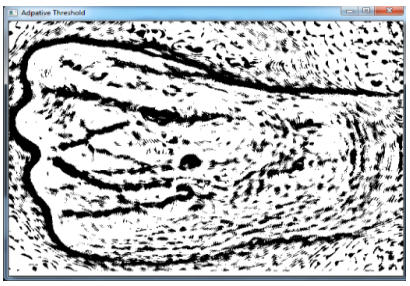


Fig 3. 4. Adaptive Threshold

The next process is negative, the meaning of the negative here is to make the 0 to 1, 1 to 0 or make the color black to white and white to black. Figures 3.7 shows the result of the negative process

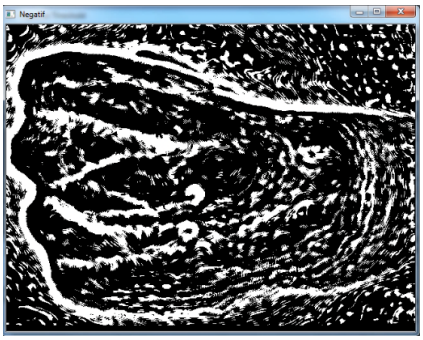


Fig 3. 5. Negative

In order to get better results, the next process is open morphology. This process will help the image that have value to be made into certain areas that will help the next process which is select area. Figure 3.8 shows the result of this process.

Fig 3. 6. Morphology Open

The last process is to choose an area that needed, in this case is the vein. The way is by passing the area to a certain magnitude and eliminate an area that is less than that value. Figure 3.9 shows the result of this process.

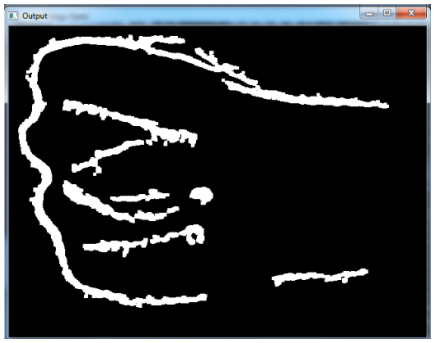
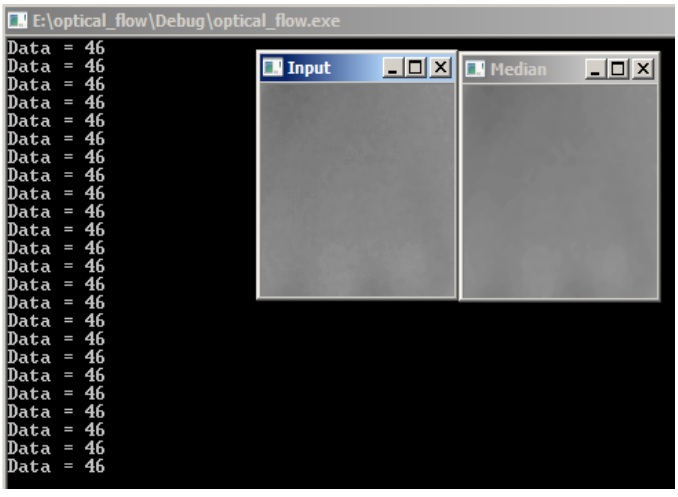


Fig 3. 7. Select Area

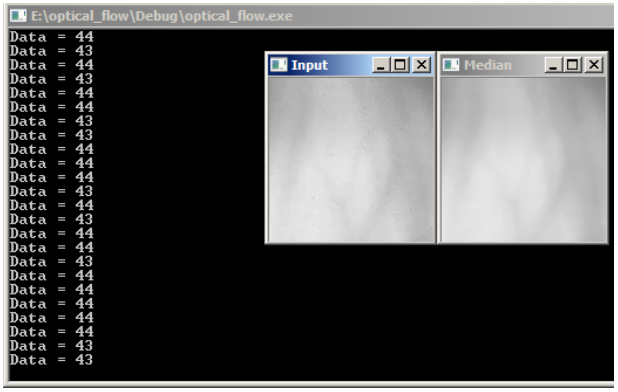
B. Compare the RGB camera with infrared cameras

Now we will make experiment with compare the image processing on common RGB camera and infrared camera to proof the same result or theory in the previous chapter. This is the experiment result have been conducted.

Median on RGB camera



Median on infrared camera



From the picture on the upside we will know that the data will be get from PSNR result (Peak Signal to Noise Ratio). PSNR is the comparison between maximum value (from the measured signal) with noise value. But before do that process, we must determine first the MSE value (Mean Square Error). MSE is average error square value between origin image with image after have been processed. This is the equation of MSE and PSNR.

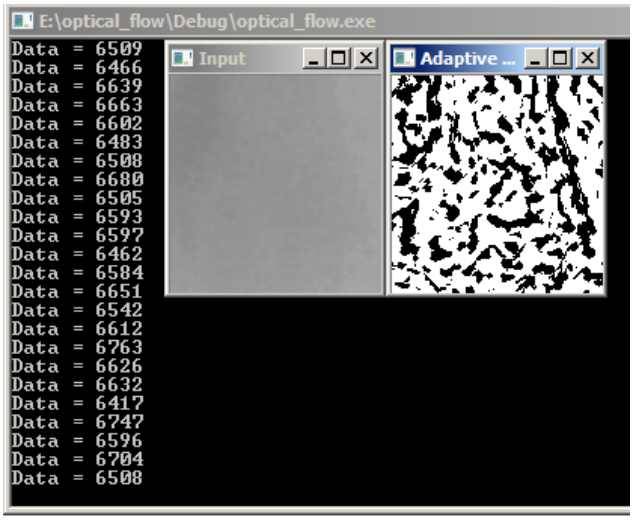
$$MSE = \frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}\left(S_{xy} - C_{xy}\right)^2$$

$$PSNR = 10\log_{10}\left(\frac{C_{max}^2}{MSE}\right)$$

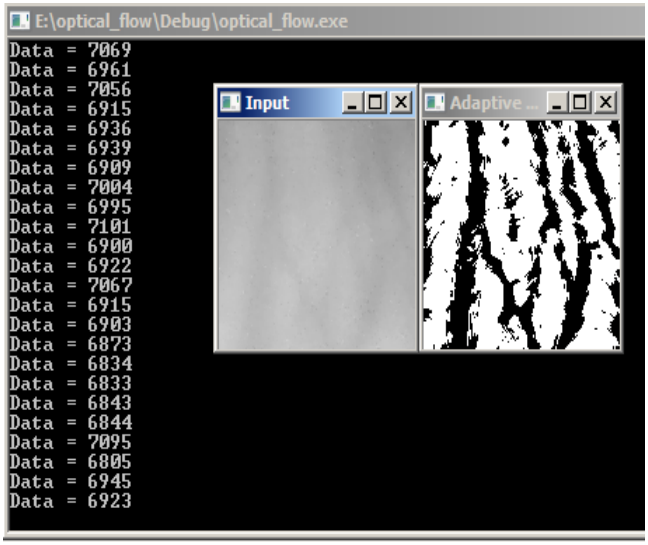
$$C_{max}^2 \leq \begin{cases} 1, & double - precision \\ 255, & uint8\ bit \end{cases}$$

The highest of PSNR data value will be the best result of the image processing. We can look the data on median process with RGB camera are getting average on 46 score. The data on infrared camera getting smaller than RGB camera is 44. The difference from both camera is not much far. If the value of PSNR is getting higher than 40 , it can be included in good image processing result

Adaptive threshold on RGB camera



Adaptive threshold on infrared camera

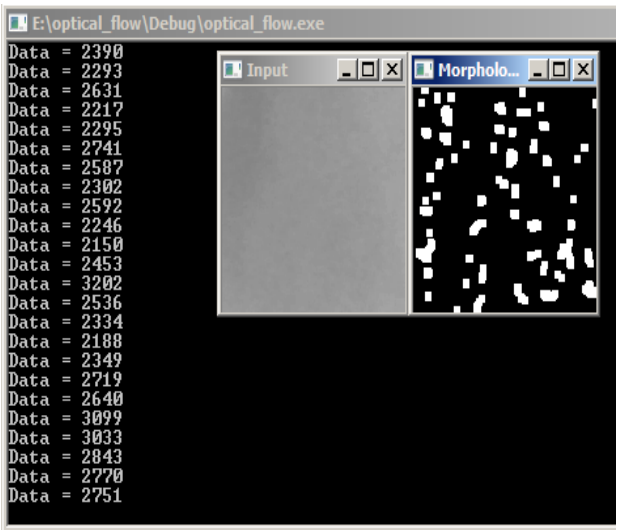


Data value on both picture in upside is zero value data in each image pixel. If the 24 data wanto to know the average value, then

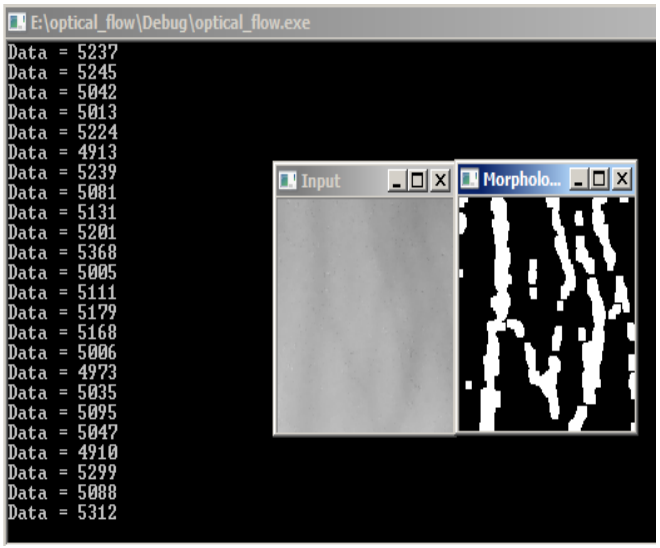
$$RGB = \frac{\sum_i^n data}{n} = \frac{156216}{24} = 6509$$
$$infrared = \frac{\sum_i^n data}{n} = \frac{166587}{24} = 6941.125$$
$$selisih = infrared - RGB = 7242{,}91 - 6792 = 432.125$$

The difference result is getting too much far in 432.125. The zero value on infrared camera is higher than the RGB camera. From the result can be explained that there are much the dark color(it means getting much vein). The line that making vein shape on infrared camera is show clearer than RGB camera. We can see the difference much more if we do the next step.

Morphology open on RGB camera



Morphology open on infrared camera

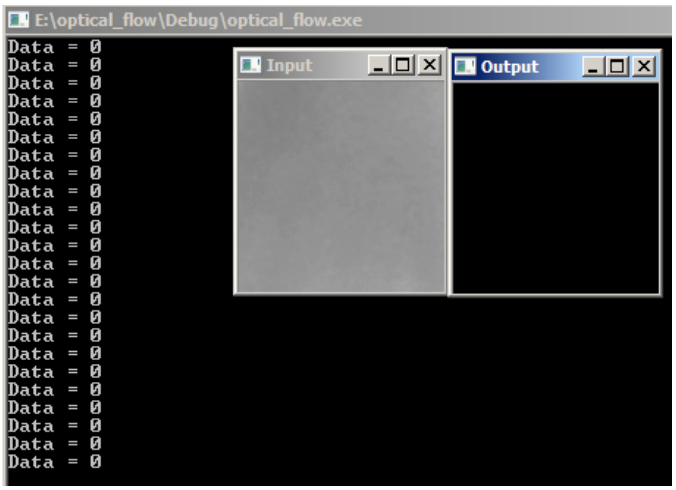


On the morphology process, data will be show as one value because there are some inverse process at previous step. If the 24 data wanto to know the average value, then

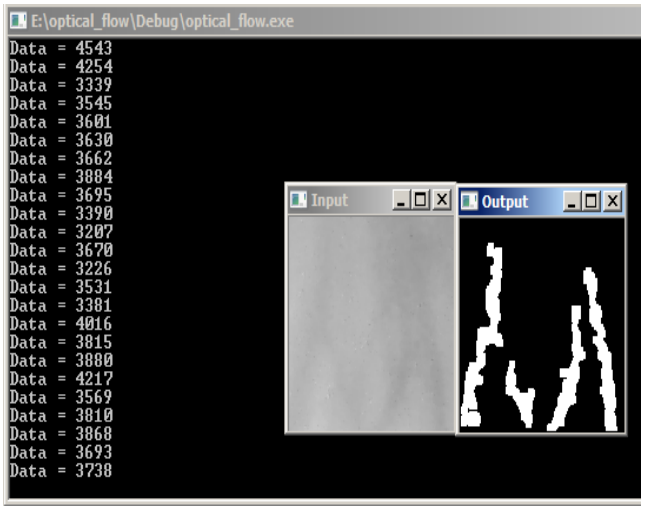
$$RGB = \frac{\sum_i^n data}{n} = \frac{61361}{24} = 2556.708$$
$$infrared = \frac{\sum_i^n data}{n} = \frac{122922}{24} = 5121.75$$
$$selisih = infrared - RGB = 5121.75 - 2556.708 = 2565.042$$

We can look that the difference result is 2565.042 which one value on infrared camera is higher than RGB camera. But if we look again on average one value in RGB camera is not bad because itstill show the noise on this process. The vein on infrared camera show clearer and the noise became decrease on this process.

Select area on RGB camera



Select area on infrared camera



Select area is the process that getting picture from some area. The data will be show is one value. This is the average value from both camera.

$$RGB = \frac{\sum_i^n data}{n} = \frac{0}{24} = 0$$

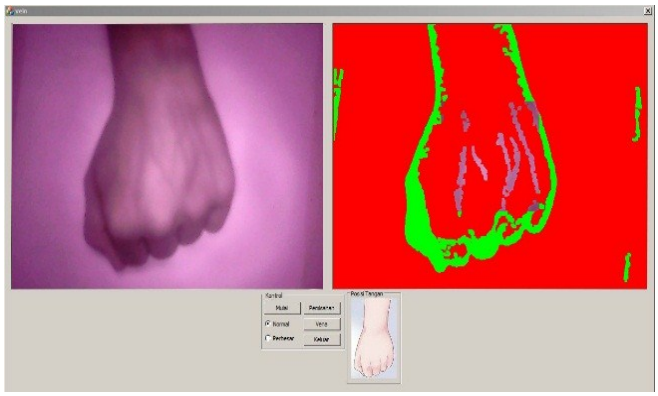
$$infrared = \frac{\sum_i^n data}{n} = \frac{89164}{24} = 5121.75$$

$$selisih = infrared - RGB = 5121.75 - 2556.708 = 3715.166$$

The difference result is getting too much far in 3715.166 because the average data on RGB camera is zero(means that there are no one value anymore or vein is not detected). The image from infrared camera is showing vein clearly and the noise is nothing. So we can say on binary image that one value is vein and zero value is other tissue not vein.

C. Device vein detection

(a)



(b)

Fig 3. 8. (a) camera infrared (b) desain aplikasi

Fig (a) is a result from infrared camera that have been modified webcam camera. Camera modified using infrared LED around lens and change the filter. Fig (b) is a result from display application.

CONCLUSION

Image processing method can already be used to separate the vein with other networks on the body. RGB camera with comparable data on the median of the system proves 13:04% better, on the threshold adaptive 6:22% better, the morphology open 50 081% better, and in the process of select area 100% better than the RGB camera. But the image processing method is determined by the input of good vein image.

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