Vein Detection System Using Infrared Light

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Abstract- *The process of finding intravenous (IV) access, Vein detection, is an everyday function in medical field and there are more than one million vein detection related procedures such as blood draws, peripheral catheter insertions, intravenous therapies, etc. performed per year. Excessive vein detection are both time and resource consuming events causing anxiety, pain and distress in patients, or can lead to severe harmful injuries. The major problem faced by the doctors today is critically in accessing veins for intra-venous drug delivery & other medical conditions. There is a need to develop vein detection equipments which can clearly show veins. This project deals with the design development of non-invasive subcutaneous vein detection system and is implemented based on near infrared imaging and interfaced to a laptop to make it portable. A customized CCD camera is used for capturing the vein images and Computer Software modules (MATLAB) is used for the processing.*

Keywords- Near-Infrared imaging, vein detection system, MATLAB, Webcam and Vein Detection.

I. INTRODUCTION

Locating veins in situations of elderly or obese and dark toned & adult patients becomes very critical. Although significant work has been done in this field and many equipments have come up, but the serious problem lies in their portability and cost. A low cost, portable & efficient infrared imaging detection system is the need of the hour. Burns and other physical injuries make it critical to locate veins and administer lifesaving drugs. In such conditions it becomes very important to have a equipments that detects the exact location of required vein. Also in case of blood transfusion or withdrawal, etc. it is important to know the position of the veins. Even experienced nurses and doctors many times find it critical to exactly locate the blood veins on the first attempt itself. In some medical conditions, the location of vein needs to be identified. Each second counts when the doctors are treating trauma patients. The other conditions where vein imaging is required are:

(A) Bruises and Bums: In case of vein diseases bruises present on the skin such as Deep Vein Thrombosis and Varicose Veins, hence for the treatment detection of veins is highly essential. The appearance of the skin becomes deterred making the skin to present either darker or whiter. The determinations of veins become tough in such situations.

(B) Intravenous injections: For injecting medicines and drugs to the patients, intra venous injections are given by doctors and nurses.

(C) Amongst children: Having to puncture them several times with a needle is very frightful and agonizing for the child & so locating veins in young children and infants may be critical.

(D) Blood transfusions: It is a process in which blood is given to the person intravenously. Blood donation, kidney dialysis also need perfect vein detection.

(E) (E) Geriatrics: Old people often require numerous blood tests or medicinal injections and an efficient means of puncture would minimize excessive bruise and enhance the patients overall comfort level.

Human eyes can only detect visible light that occupies a very narrow band (400 - 700nm) of the spectrum. However, in other bands of the electro-magnetic spectrum there is much more information contained rejected by the objects of interest.

The visibility under normal visible light conditions is very low for human vein patterns on the periphery. This can be resolved by Near-Infrared (NIR) imaging techniques. The special properties of Near-Infrared imaging are:

Depth penetration of up to 3mm into biological tissue using NIR. More absorption of radiation by venous as compared to surrounding tissues. The vein image maybe captured by an IR sensitive camera, hence, by shooting the infrared radiation of specific wavelength at the desired body part results the veins to present darker than the surrounding tissue in the image.

A spectral window exists from 700 to 900 nm where light can penetrate deep into the tissues. The wavelength of the Infrared (IR) light beam coming out from a light source is selected to be around 850nm. It also avoids undesirable interference from the radiation (3um – 14um) of human body.

(A) The basic phenomenon is radiation of the wave-length region 740 nm-760nm is to detect veins but not arteries because of selective absorption of infrared radiation in blood vessels. The reason is the deoxidized haemoglobin [deoxy-Hb or Hb] in the veins almost completely absorb the radiation while the oxidized haemoglobin [HbO] become almost transparent.

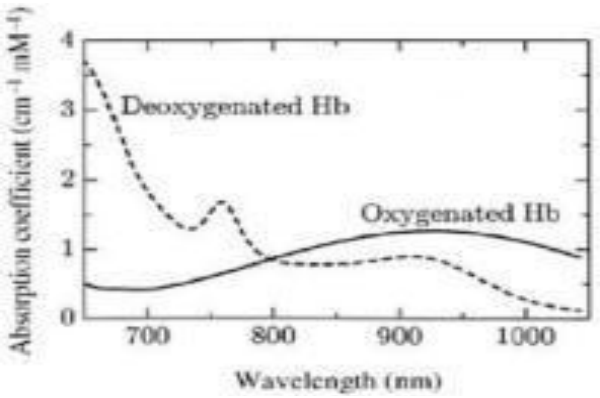

Figure 1. Absorption of light by blood

There are two types: Far-Infrared (FIR) & Near Infrared (NIR). Because of its certain attributes as compared to FIR, NIR gives better results for vein detection. Far infrared imaging means red hot im-age, that recognition rate often greatly influenced by humidity and temperature, NIR penetrates most human tissue easily, so it can acquire clearer and reliable image quality than FIR.

The designed vein detection takes images of the particular veins under a source of infrared radiation. Almost any part of the body could analyze in this technique. In many medical practices, X-ray and ultrasonic scanning can also be used to form vein images. They are all invasive techniques as they require injection of agents in blood stream. This is not feasible for general purpose imaging applications. The key challenge in a vein pattern biometric system obtaining the vein pattern images in a fast and non-invasive manner.

II. LITERATURE REVIEW

Vein detection is one of the latest biomedical techniques researched today. While the concept behind the method is simple, there are various challenges to be found throughout the design and implementation of a device concerning the lighting system and the image processing algorithms at a very low price. While a very few devices based on the infrared technique have been implemented, there still exists a strong need to develop such medical devices.

1) Naoya Tobisawa, Takeshi Namita, Yuji Kato and Koichi Shimizu[1] gives system consists of a high-intensity and low-leak light source, near-infrared CMOS camera and a small and light one-eye head mounted display.
2) Manam Mansoor1, Sravani.S.N2 , Sumbul Zahra Naqvi, Imran Badshah,[2] Mohammed Saleem gives system is composed of a modified wed camera with a long-pass, a NIR ring of LEDs is used for illuminating the desired body part with infrared light. The LED ring has a circuit driver and the power is provided from the laptop itself through a USB cable. The software used for processing is Computer Vision(OpenCV) on Ubuntu. It is an open source computer vision library which is originally developed. The library is written in C and C++ and runs under Linux, Windows and MacOS X.
3) Deepak Prasanna.R a*, Neelamegam.P a, Sriram.S b, Nagarajan Raju[3] they explains various enhancement techniques such as image negative, gray level slicing, histogram equalization, contrast stretching, laplacian sharpening, unsharp masking, high boost filtering, and Histogram equalization of high boost filter. These techniques are applied on the hand image using (OpenCV) open source computer vision library developed by Intel. A comparative study of all these enhancement techniques is carried out to find the best technique to enhance hand vein pattern. The result shows the histogram equalization of high boost filtering technique provides better enhancement of vein pattern.
4) Septimiu Crisan,Ioan Gavril Tarnovan, Titus Eduard Crisan gives[5] Vein pattern recognition system. We take the advice of doctors and locate the dorsal veins in hand which is used to insert the drugs into body.

III. PROPOSED SYSTEM

NIR ring of eight LEDs were used for illuminating the desired body part with infrared light. The design of the light source should provide perfect illumination so that the vein images can be captured and there should be a contrast between the veins and the surrounding tissue. So a ring of LED is chosen as the camera lens is circular, making the centre as webcam lens. The experiments conducted had shown that near infrared LED array provided illumination but it had a ringing effect light had alternate light and dark bands. So, to correct this, each LED was diffused by using sandpaper, and rinsed by water. The result was an almost uniform intensity of illumination. Also, NIR vein imaging technique does not depend upon the skin color and pigmentation of the person and it does not interfere with the imaging process. In case of people with several tattoos due to which the radiation were not able to pass through the skin.

The camera should have sufficient spatial resolution so as to identify the vein details. The camera is perfectly capable of detecting NIR up to a wave length of approximately 1mm but all modern cameras have an infrared cut-off filter in front of the sensor since the main reason of the camera is to view the maximum amount of visible radiation. This filter was eliminated in order to achieve access to the infrared part of the radiation spectrum for the detection system.

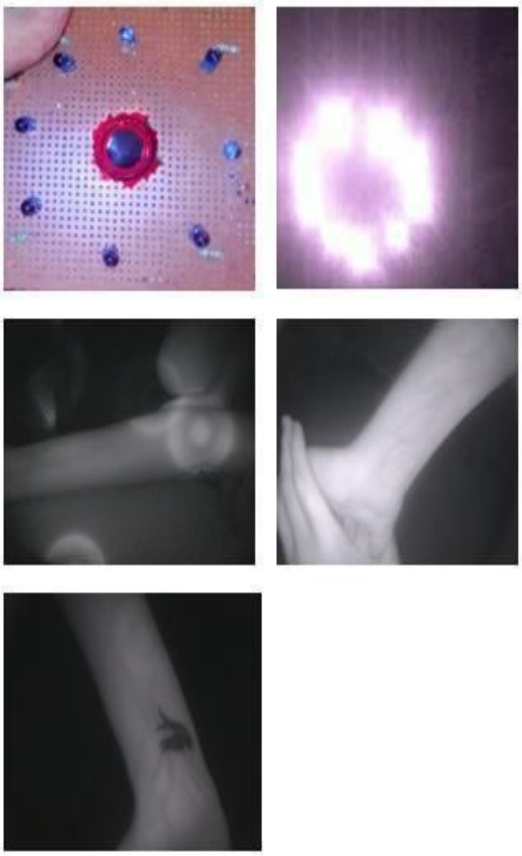

Figure from L-R, Assembly, LED output. Ring Efficiency. Diffused LEDs images

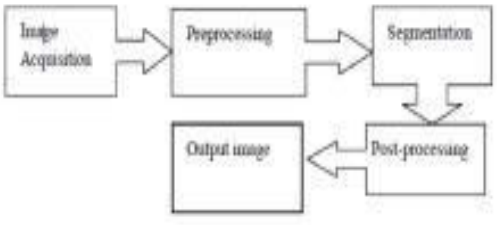

Figure. Software Algorithm

The main aim of the project was to make a cost effective and portable device. Visible LEDs inbuilt in the webcam were replaced with Infrared LEDs. The added benefit was that batteries were redundant, as the LEDs were driving power from the IC board of the webcam itself. The LEDs were soldered in the same position as the previously connected.

2.1 Image Acquisition and Preprocessing:

The image of the arm was captured using an ordinary webcam that has been altered to only allow infrared light to reach the image detectors. After taking the image, preprocessing was applied to the image. The purpose of this step was to enhance the imaging quality so that vein patterns can be more easily detected during the segmentation. This was done by first cropping the image to separate the ROI, applying filters to minimize noise and enhance the contrast.

2.2 Segmentation and Post-processing:

Since the noise had been minimized and the contrast enhanced, segmentation permitted to separate the vein pattern from the background. The vein pattern was located and isolated from the rest of the image. This was the most crucial step in the entire recognition. If the veins are not properly detected, the error increases. The resulted segmented grayscale images were with some unwanted information such as noise, shadows and faint veins. Therefore it was false representation of the actual vein pattern.

IV. CONCLUSION

This paper investigates near infrared techniques for vein imaging. The stand-alone, portable NIR vein detection system was able to envisage and detect vessels from anterior forearm. Various image algorithms were tried on still images the histogram equalization worked best on MATLAB. Since we have made portable IR imaging due to that we have encountered motion artifacts issues. Therefore, our main aim of obtaining a portable efficient vein imaging system at a very low cost is accomplished.

V. ACKNOWLEDGMENT

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