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Vein Detection using a Pulse Oximeter

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Abstract: Two out of every five patients need to be injected during a medication process, and it becomes a very crucial task to inject the needle accurately which demands the detection of the vein. Incorrectly inserting the needle can lead to various issues for the patient, such as swelling in the injected area and other circulation problems. The idea of a vein detection device is that it would help nurses and medical practitioners to detect the vein in a more accurate form at a low cost. The vein detection proposed in the paper uses the NIR sensors and a pulse oximeter, the NIR sensors will differentiate between oxygenated and deoxygenated blood whereas the pulse oximeter will help find oxygen levels of the vein, thus we get the best vein to puncture. This would be very lucrative in the field of medical industry.

I. INTRODUCTION

Physicians and people serving in the healthcare sector have been timely using advanced technologies in different medical exigencies. These technologies are adapted to ease and minimize the pain and inconvenience faced by the patient. Injection of the syringe in an inappropriate way is one such generic problem that is discussed in the proposed research paper.

According to a blog from Harvard Medical School written by Robert H. Shmerling, MD, Senior Faculty Editor, Harvard Health Publishing; 2 in every 3 children and 1 out of every 4 adults have a fear of injecting vaccines or any other type of syringe in their body, and this fear of the syringe is termed trypanophobia. Trypanophobia arises due to the long history of nurses and medical practitioners inappropriately injecting the syringe.

Many reasons make it difficult for the practitioner to detect the veins, some of which are dark skin tone, lard, obese or elderly body. Minuscule medical negligence can cause problems like swelling, bleeding, scarring, blood vessel injury, blood clots, lymphatic damage, muscle or nerve damage, paralysis, and other neuropathic diseases.

In September 2014, the Times of India(TOI) reported about a 14-year-old girl from Chennai named Ezhilarasi who suffered acute neurological damage in her left leg, leaving her paralyzed below the knee, just because of a small problem of vein detection.

The vein detection Methods used previously are:

1) Visual Inspection: This technique involves visually identifying veins on the patient's skin. It is a simple and cost-effective method, but it heavily relies on the clinician's expertise and may lead to errors due to variations in vein visibility, skin tone, and lighting conditions.
2) Tactile Palpation: This technique involves manually feeling veins by applying gentle pressure on the skin. While it can provide some information about vein location and size, it may not be accurate enough for precise venipuncture. Additionally, it is subjective and relies on the clinician's skill and experience.
3) Transillumination: This technique uses a light source to illuminate the patient's skin and detect veins based on light transmission and reflection. However, transillumination can be affected by factors such as obesity, skin pigmentation, and depth of veins, making it less reliable in some cases.
4) Ultrasound Imaging: Ultrasound employs high-frequency sound waves to generate real-time images of veins. It is accurate and can provide information about vein depth and diameter. However, ultrasound equipment is costly, requires skilled operators, and may not be suitable for routine venipuncture procedures.
5) Vein Contrast Enhancers: These are dyes or substances injected into the patient's veins to enhance their visibility. While they can improve vein detection, there is a risk of adverse reactions or allergies to the contrast agents.

It's worth noting that the effectiveness and drawbacks of these techniques can vary depending on factors such as patient characteristics, clinician skill, and technological advancements. Ongoing research and development aim to overcome these limitations and improve vein detection techniques in medical industries.

The given research paper proposes an idea to detect the vein using a device that would make syringe injection feasible and save many lives.

II. LITERATURE REVIEW

The oxygen saturation level in a single blood vessel is simulated.

Different oximetry is used to access SpO2 using 2 near-infrared wavelengths, the backscattered light is collected by two photodetectors located at different distances from a light source. The calculation of photon migration in the model is done via Mont Carlo (MC) simulation.[1].

Vein Pattern Locating Technology for Cannulation: A Low-Cost Vein Finder Prototypes using Near Infrared (NIR) Light to Improve Peripheral Subcutaneous Vein Selection for Phlebotomy.

This discusses the significance of medical laboratory testing for diagnosis and the use of venous blood samples, which require invasive cannulation and proper vein selection. It highlights the importance of vein finders, which utilize camera-assisted near-infrared (NIR) light technology, in locating veins easily and accurately. The paragraph outlines the methodology used for this review, including searching electronic databases and screening publications related to vein finder prototypes, NIR technology, vein detection, and infrared imaging. The results reveal that the utilization of a vein finder can address challenges faced by medical practitioners during cannulation, but there is a limited number of publications assessing the personnel performing cannulation. Additionally, there are variations in methodology, patient demographics, and materials used in the assessment of developed prototypes. The paragraph concludes by emphasizing the need for further improvement and testing of low-cost effective vein finders, considering human factors and increasing the parameters and participants for commercialization. Furthermore, it highlights the scarcity of publications assessing the performance of phlebotomists using vein finders.[2]

1) *A Real-Time Vein Detection System*

The paper introduces the proposed system for designing a real-time vein detection system. The process starts with capturing the frame with the help of a NIR light sensor. Then median filters(Digital filtering tech) are applied to enhance each frame. Next is the enhancement step. CLASHE algorithm is used to enhance the vein pattern [3].

2) *Real-Time Vein Detection and Mapping using Near Infra-Red Lights*

The NIR grid emits the light on the hand and then an illuminated image is captured by the camera. Wiener Filter is used to remove the additive noise and invert the blurring in the image simultaneously. An Adaptive Median filter was also used. CLAHE is for contrast enhancement so the hand can differentiate from the background. Feature extraction is the procedure of isolating and extracting the features of the processed image [4].

3) *A Novel Method of Vein Detection with the Use of Digital Image Correlation*

In the given research paper the methodology used by the author is Digital Image Correlation (DIC) for detecting the vein. This method is based on the fact that hemoglobin absorbs the light emitted by diodes, the image is taken as a reference, and further patterns are developed concerning the reference image [5].

This study delves into thermal imaging's application for secure biometric authentication, focusing on vein pattern recognition. Emphasizing the reliability and security advantages of biometrics, particularly in comparison to traditional methods, the paper underscores the stability and resistance to external influences of vein patterns. Infrared radiation, specifically the far-infrared (FIR) method, is highlighted for capturing unique vascular patterns beneath the skin's surface. The proposed PV320T2 thermal camera is introduced, and the paper outlines the vein pattern authentication system model, emphasizing Image Acquisition, pseudo-coloring, Noise Reduction, and Vein Segmentation. Pseudo-coloring is suggested for enhanced visibility, while noise reduction techniques, such as Median and Average Linear Filtering, are applied. The study provides a concise yet comprehensive overview of the methodology and rationale for utilizing thermal imaging in vein pattern recognition, contributing to advancements in secure biometric authentication. [6] This study delves into the integration of micro-electro-mechanical systems (MEMS) in healthcare, focusing on the revolutionary impact of Application Specific Integrated Circuits (ASIC)-MEMS. It highlights the role of MEMS in Micro LED for precise blood vessel detection and optimization of blood flow, addressing the evolving demands of personal-use medical devices. Emphasizing miniaturization, cost-effectiveness, and reliability, the research anticipates BioMEMS biomedical sensors' integration, paving the way for advancements in remote and home care applications. In essence, the study underscores MEMS as a transformative force in reshaping healthcare, particularly in blood flow monitoring and telemedicine.[7]

The proposed image enhancement algorithm focuses on underwater images, employing contrast-limited Adaptive Histogram Equalization (CLAHE) separately in YIQ and HSI color spaces. RGB to YIQ involves linear transformation, while RGB to HSI is nonlinear. CLAHE is applied to enhance the luminance (Y) in YIQ and intensity (I) in HSI.

Tuning CLAHE parameters like Block Size and Clip Limit influences the quality of enhancement. Afterward, YIQ and HSI enhancement images are converted back to RGB. Harmonization is applied in RGB space to address component coherence issues. A self-adaptive weight selection algorithm, combining 4-direction Sobel edge detection, fuses YIQ-RGB and HSI-RGB images for a final enhanced output. Evaluation metrics demonstrate superior detail enhancement and colorfulness restoration, effectively improving the quality of underwater images while mitigating noise interference.[16]

The detection of blood veins during medical procedures, particularly in overweight patients, is crucial but can be challenging. This paper proposes a real-time vein detection system using Near Infrared (NIR) illumination and a Night Vision camera. The Hemoglobin in the blood absorbs NIR light, and Contrast Limited Adaptive Histogram Equalization (CLAHE) enhances vein patterns. This method, implemented with MATLAB, aids in locating veins during needle infusion, reducing potential calamities. The system proves effective in real-time video processing, providing clear vein visualization. The CLAHE algorithm significantly contributes to image enhancement, ensuring accurate vein detection and potentially assisting in identifying bleeding spots and clots. This system, if integrated with smartphones, could revolutionize vein detection in medical settings.[19]

Image enhancement plays a pivotal role in refining the quality of color retinal images. While histogram equalization is a commonly employed technique, our research focuses on contrast-limited Adaptive Histogram Equalization (CLAHE) for its simplicity and low computational load. Notably, color retinal images exhibit a unique characteristic with significance in the green (G) channel. To mitigate noise effects from the acquisition process, we propose a novel enhancement method utilizing CLAHE specifically in the G channel. This approach is tailored to address the distinct features of color retinal images, showcasing its potential to significantly improve image quality, particularly in the field of ophthalmology.[21]

III. METHODOLOGY/ EXPERIMENTAL

A. Technology used:

1) Arduino ide
2) Near-infrared
3) MX30102

B. Working

Firstly, there's a need to find the blood vessel in a human hand, which is not possible through the naked eye, for the detection of blood vessels in the hand near-infrared light is used in this project because blood absorbs a very specific part of the light spectrum which is named as near-infrared light as it is not completely infrared and not completely visible, to solve this issue NIR sensor is used. These NIR sensors emit light of a certain wavelength and that wavelength of light is absorbed by the blood in the human body, a result of this absorption is a blue line which indicates the presence of blood vessels, once there are multiple blood vessels under that light or in the region of that light 3 spo2 sensors are placed over them.

There are 3 MAX30102 sensors (slave) connected to Arduino (master) communicating using I2C protocol, and all three sensors have a variable assigned to them, in the first part Arduino will send read instructions to the pulse oximeter sensor to calculate oxygen levels of the body part beneath the sensor, once level for one sensor is calculated sensor will send that value to the Arduino and will be stored in a variable, once the data from one sensor is received Arduino sends read instructions to another pulse oximeter sensor and collects the oxygen level and stores it in another variable, now Arduino will read instructions to the third sensor which also sends the measured pulse oxygen levels to the Arduino and is stored in the third variable.

Reading of one MAX30102 sensor is given after recording 100 sample readings taken by the sensor, after those 100 samples one reading is calculated from the stack of all 100 sample data i.e the difference in absorption of red and IR light by different blood vessels that are oxygen-carrying blood vessel and deoxygenated blood carrying blood vessel.

Once all 3 variables have some values in them after their first readings they are sorted in ascending order, and the smallest value is stored in the fourth variable, now the value of a fourth variable is compared to the other three variables, whichever variable has the same value as of the fourth variable that variables corresponding sensor's light will glow up indicating the vein below that sensor is deoxygenated and is a required blood vessel, that is how the deoxygenated blood vessel is detected under the NIR light.

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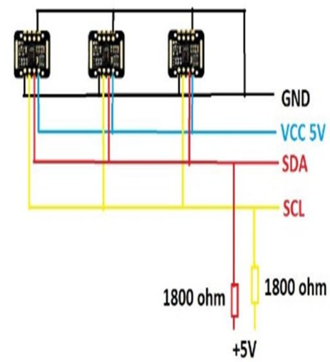
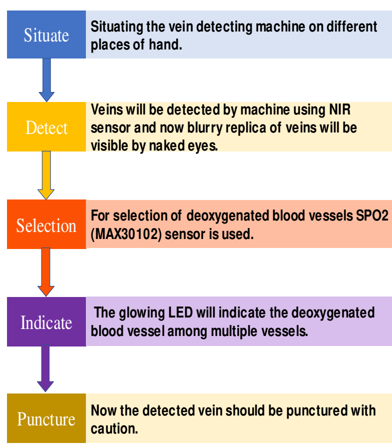


Flowchart:



IV. RESULTS AND DISCUSSIONS

The overall result of this project is a product that is capable of helping a selective segment of doctors, nurses, and students in the early stage of their careers, from the conclusion of some trials and experiments conducted this machine can detect the deoxygenated blood vessel every 7 out of 10 times, with an accuracy of 70%, these trials were conducted under the supervision of authorized doctors and staff members, the accuracy of this device can be increased using pulse oximeter sensors with high accuracy and NIR light with variable wavelength and intensity control unit integrated into the device itself, and also the machine can be made more user friendly and more portable by using a variety of different components and a good durable design for users that are doctors, nurses, and medical students.

V. FUTURE SCOPE

We are trying to spark the camera lens manufacturer's discernments to bring IR non-blocking cameras into a smartphone.

VI. CONCLUSION

We have tested our device successfully. The best result appeared when we visited a govt hospital and asked for assistance from a senior doctor(unknown) to verify the results of the device. With the permission of the doctor, we tested our device on a patient, the NIR sensor differentiated deoxygenated blood vessels from the oxygenated ones, The readings of the 3 sensors were 94,95,91 respectively thus the third bulb glowed indicating it to be the best vein to puncture. The senior doctor who assisted us also verified.

In conclusion, vein detection systems are used for a variety of medical and non-medical purposes.

The system provides real-time feedback to help medical professionals adjust their technique as needed during the procedure.

Overall, vein detection systems are valuable tools that help healthcare professionals improve patient care and comfort, while also providing a range of other applications in various fields.

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REFERENCES

[1] H. K. Al Ghozali, et al., "Vein detection system using infrared camera," 2016 Int. Electron. Symp., pp. 122–127, 2016.
[2] M. Kavya, "Vein Pattern Extraction : A Review," Int. J. Eng. Res. Technol., vol/issue: 6(5), pp. 869–870, 2017.
[3] M. Marathe, et al., "A novel wireless vein finder," Proc. Int. Conf. Circuits, Commun. Control Comput. I4C 2014, pp. 277–280, 2014.
[4] S. I. Shchukin, "Peripheral vein detection using electrical impedance method," J Electr Bioimp, vol. 8, pp. 79–83, 2017.
[5] B. Besra, "Extraction of Segmented Vein Patterns using Repeated Line Tracking Algorithm," in 2017 IEEE 3rd International Conference on Sensing, Signal Processing and Security (ICSSS) Extraction, pp. 89–92, 2017.
[6] N. S. Gnee, "A study of hand vein, neck vein, and arm vein extraction for authentication," ICICS 2009 - Conf. Proc. 7th Int. Conf. Information, Commun. Signal Process., pp. 5–8, 2009.
[7] G. C. Meng, et al., "Prototype design for wearable veins localization system using near-infrared imaging technique," 2015 IEEE 11th Int. Colloq. Signal Process. Its Appl., pp. 112–115, 2015.
[8] S. Yusoff, et al., "Review on Vein Enhancement Methods for Biometric System," Int. J. Res. Eng. Technol., vol/issue: 4(4), pp. 833–841, 2015.
[9] S. Crisan and B. Tebrean, "Low cost, high-quality vein pattern recognition device with liveness Detection. Workflow and implementations," Meas. J. Int. Meas. Confed., vol. 108, pp. 207–216, 2017.
[10] R. R. Fletcher, et al., "Development of mobile-based hand vein biometrics for global health patient identification," Proc. 4th IEEE Glob. Humanit. Technol. Conf. GHTC 2014, pp. 541–547, 2014.
[11] M. Wadhwani, et al., "Vein Detection System using Infrared Light," Int. J. Sci. Eng. Res., vol/issue: 6(12), pp. 780–786, 2015.
[12] Y. Kanzawa, et al., "Human Skin Detection by Visible and Near-Infrared Imaging," IAPR Conf. Mach. Vis., pp. 503–507, 2011.
[13] S. Kacmaz, et al., "The Use of Infrared Thermal Imaging in the Diagnosis of Deep Vein Thrombosis," Infrared Phys. Technol., 2017.
[14] B. W. Ficke, et al., "Near-Infrared Vein Visualization in Index Finger Pollicization," J. Hand Surg. Am., vol/issue:42(6), pp. 481.e1-481.e2, 2016.
[15] X. Dai, et al., "A fast vein display device based on the camera-projector system," IST 2013 - 2013 IEEE Int. Conf. Imaging Syst. Tech. Proc., pp. 146–149, 2013.
[16] J. Ma, et al., "Contrast Limited Adaptive Histogram Equalization Based Fusion for Underwater Image Enhancement," Preprints, pp. 1–27, 2017.
[17] R. Khan, "Comparison and Analysis of Various Histogram Equalization Techniques," Int. J. Eng. Sci. Technol., vol/issue: 4(4), pp. 1787–1792, 2012.
[18] M. Aarthy and P. Sumathy, "A Comparison of Histogram Equalization Method and Histogram Expansion," Int. J. Comput. Sci. Mob. Appl., vol/issue: 2(3), pp. 25–34, 2014.
[19] K. I. Ahmed, et al., "Enhanced Vein Detection from Video Sequences," Indones. J. Electr. Eng. Comput. Sci., vol/issue: 8(2), pp. 420–427, 2017.
[20] D. DV, "Satellite Imagery," 2016. [Online]. Available:
[21] T. Jintasuttisak and S. Intajag, "Color retinal image enhancement by Rayleigh contrast-limited adaptive histogram equalization," in International Conference on Control, Automation, and Systems, pp. 692–697, 2014.
[22] K. Zuiderveld, "Contrast Limited Adaptive Histogram Equalization," Academic Press, Inc., 1994.
[23] J. Dash and N. Bhoi, "Detection of Retinal Blood Vessels from Ophthalmoscope Images Using Morphological Approach," ELCVIA, vol/issue: 16(1), pp. 1–14, 2017.
[24] K. I. Ahmed, et al., "Enhanced Vision Based Vein Detection System," in 4th IEEE International Conference on Smart Instrumentation, Measurement, and Applications (ICSIMA), Putrajaya, Malaysia, 2017