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Implementation of Vein Visualization Using Vein Viewer forMedical Diagnosis

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Abstract: Non-invasive vein detection for intravenous(IV) procedures can be carried out using infrared(IR) rays for the purpose of illuminating a region, and then using an infrared camera for observing it. The image is processed using different techniques on the Open-CV software platform. We further propose the model for patient health parameter reading like BPM, SPO2, Temperature on google Firebase cloud. A This project works on the principle of absorbance of infrared (IR) lightby veins and its diffusion to surrounding tissues which makes the vein appear darker when viewed through an IR sensitive camera.One of the challenges faced while implementing this system is to make an efficient system for image acquisition and image processing at low cost. Thus, a customized sensitive camera is used to cut down the cost.

Keywords: Intravenous, infrared rays, open-CV, image acquisition.

I INTRODUCTION

The designed vein detection system in this project comprises of an easy-to-implement device that usesa modified IR sensitive camera to take a snapshot of the subject's vein under a source of infrared radiation at a specific wavelength. Such a system is able to detect veins but not arteries due to specific absorption of infrared radiation in blood vessels. NIR and FIR are two imaging techniques used for this purpose. Multitudinous challenges are faced on a day-to-day basis by phlebotomy, nurses and pathologists while detecting a patient's vein for vene puncture.

Improper puncturing may lead to problems such as swelling, bleeding or permanent damage to the veins, especially in cases with elderly subjects. To overcome these problems various devices have been developed but the challenge that remains is cost and portability factor. Also, very few devices have been implemented using infrared radiation, which is highly instrumental in detection of superficial veins in the human body. Therefore, the crux of the project is based upon implementation of near infrared light to detect veins and consequently carry out smooth vein puncturing.

NIR imaging works within the range of 700-1000nm and provide good quality images as NIR falls under a specific range of wavelength that can penetrate human tissues (up to 3mm of depth) resulting into a significantly better quality of images. The vein pattern is captured, stored, and softwareprocessed for better visibility. Thus, vein detection for vene puncture provides a non-invasive way to detect veins thereby preventing complications arising from invasive techniques. There is a medical spectral window of light which extends approximately from about 700 to 900nm, where light penetrates into the tissues, thereby allowing non-invasive investigation. Therefore, typically, the wavelength of the infrared light beam coming out from a light source is chosen to be within 850nm.

Vein visualization through the application of Vein Viewer technology has emerged as a groundbreaking tool in the realm of medical diagnosis, particularly in procedures involving vascular access. This innovative system employs near-infrared light to illuminate the patient's veins, creating a real-time, high-definition map that healthcare professionals can use for various medical interventions.

The real-time visualization allows healthcare providers to choose the optimal insertion site, avoiding potential complications and ensuring safer interventions.Beyond vein-puncture, Vein-viewer finds utility in various medical scenarios, including the administration of intravenous medications, contrast- enhanced imaging studies, and vascular access in challenging cases such as pediatric or elderly patients. Its non-invasive nature contributes to patient satisfaction and improves the overall patient experience during medical interventions.

In conclusion, the implementation of Vein-viewer technology stands as a testament to the continuous advancement of medical tools, enhancing precision and efficiency in diagnostics and therapeutic procedures. This vein visualization innovation holds immense promise for revolutionizing vascular access procedures, ultimately improving patient

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outcomes and the quality of healthcare delivery.

II OBJECTIVES

1. To improve accuracy which facilitates accurate identification of veins, reducing the likelihood ofmultiple needle insertion attempts and minimizing patient discomfort.
2. Efficiency as it streamlines the vein-puncture process by quickly identifying suitable veins,saving time for healthcare professionals and patients.
3. Reduced complications to minimize the risk of complications such as hematoma, nerve damage,and infiltration by aiding in precise needle placement.

III METHODOLOGY

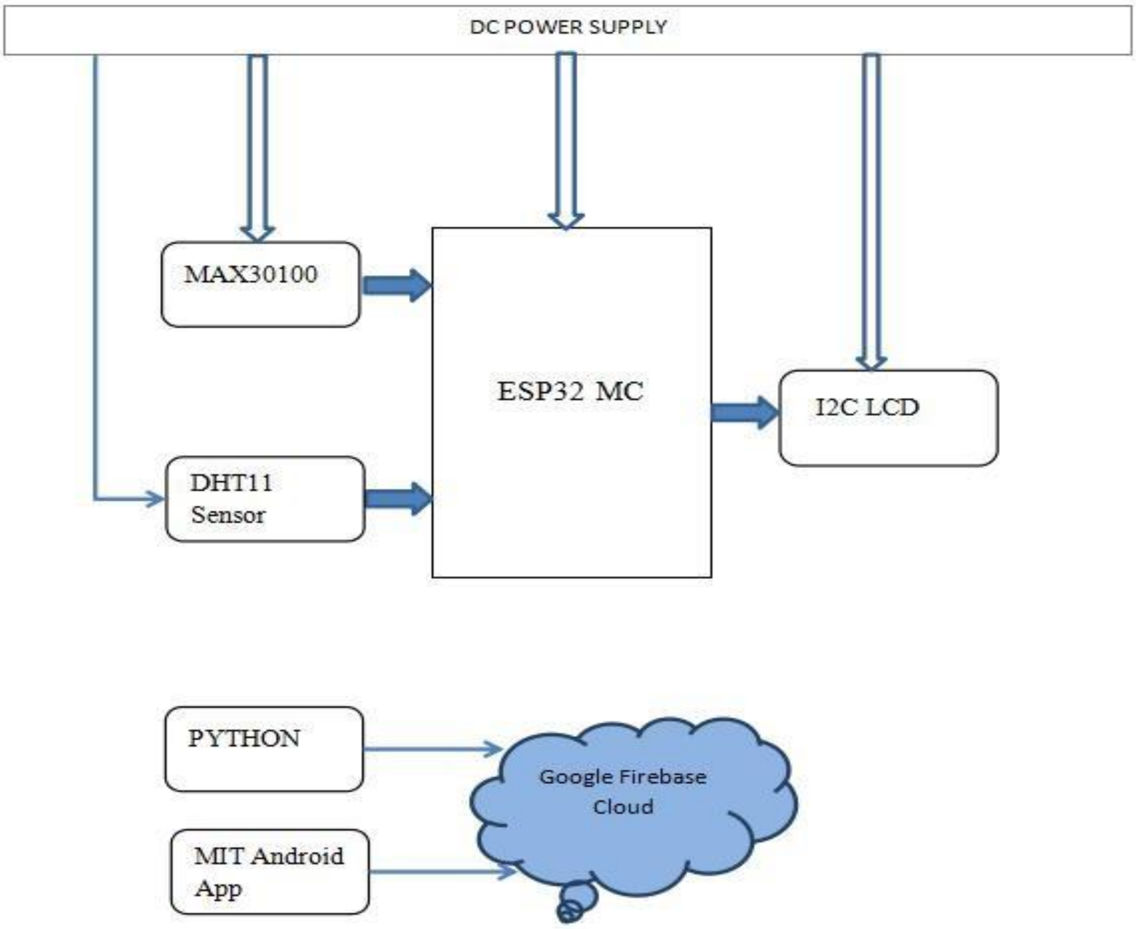

Fig .1 Block Diagram of Vein Viewer

The primary task is to identify the hardware components which are suitable for this work. Block diagram consist of hardware components which are interconnected with each other to perform specific task like ESP32 microcontroller as main component.

The block diagram illustrates the flow of information and control among these components, with the ESP32 acting as the central hub. The MAX30100 captures vein patterns, the LCD displays the results, the relay manages certain components, and the cloud facilitates remote access and data storage. The IR transmitter and other components contribute to the overall functionality of the system.

In this integrated system, the ESP32 micro-controller orchestrates the seamless interaction among diverse components. The MAX30100 sensor plays a pivotal role by leveraging infrared and red light to meticulously capture vein patterns, contributing to the precise vein visualization process. The LCDdisplay serves as the user-friendly interface, conveying

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real-time feedback and displaying the intricacies of the captured vein images.

The relay component, under the ESP32's control, assumes a critical role in managing the system's dynamics. It functions as a switch, facilitating the activation or deactivation of specific components asdictated by the program logic. This capability is essential for optimizing power consumption or selectively controlling the operation of the MAX30100 sensor, ensuring efficiency in resource utilization.

Cloud Storage is applicable for security protocols could be any security protocols required for secure data transmission and storage in the cloud. Storage capacity indicate the estimated amount of storage space needed for captured vein patterns.

IV IMPLEMENTATION

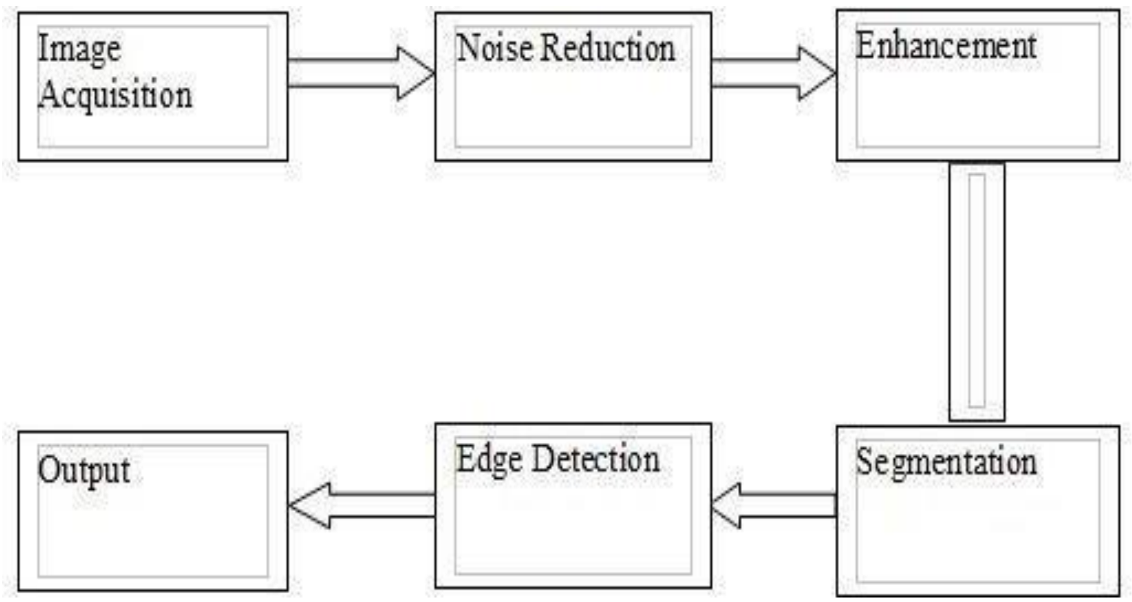

Fig.2 FLOW DIAGRAM OF THE IMPLEMENTATION

The Fig.2 describes Block Diagram of a vein viewer system. It outlines the process of imageacquisition, noise reduction, edge detection, segmentation and enhancement .

- **Image Acquisition**: This is the first step, where the image of the vein is captured.

- **Noise Reduction:** This step attempts to remove any noise from the image that may have been introduced during the acquisition process. Noise can come from a variety of sources, such as thesensor itself, the lighting conditions, or electrical interference.

- **Edge Detection:** This step identifies the edges of the veins in the image. Edges are importantbecause they can help to distinguish the veins from the surrounding tissue.

- **Segmentation:** This step groups pixels in the image that belong together. In the case of a veinviewer, segmentation would be used to group the pixels that belong to the veins together.

- **Enhancement:** This step is used to improve the quality of the image. This can be done in anumber of ways, such as increasing the contrast or brightness of the image.

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V RESULTS

Vein viewers have shown promise in aiding diagnoses like venous insufficiency by allowing visualization of vein size, depth, and blood flow patterns while vein viewers are effective, some studies report a success rate below 100%, indicating they may not always be definitive. This section is a glimpse of the hardware module developed along with a pilot set of results obtained for veins imaged with the aid of the developed vein viewer hardware module.

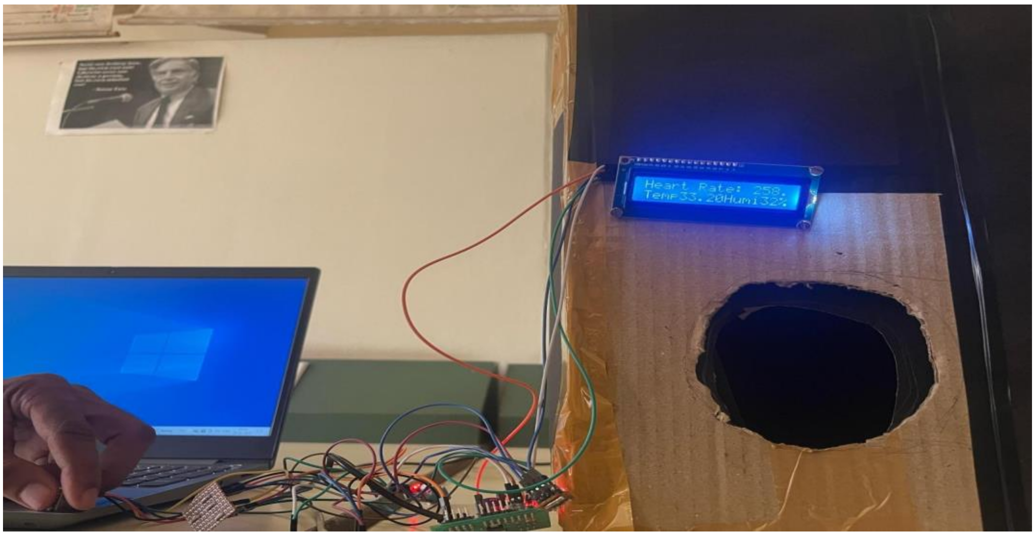

Fig.3 Hardware Model of Vein Visualization using Vein Viewer for medical diagnosis.

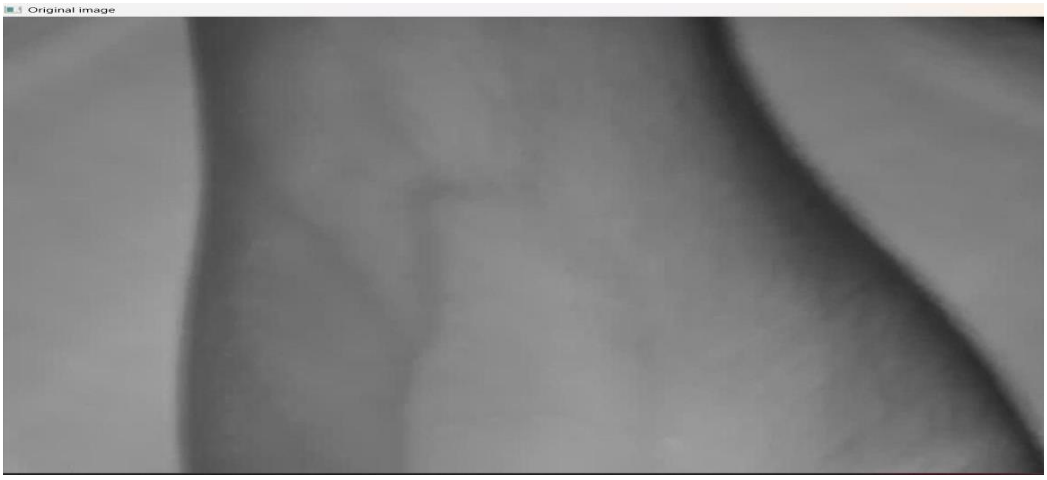

Fig.4 Original Image

Image captured using CP Plus E-24A camera using night vision mode

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Fig.5 Equalized Image

Equalized image formed by adjusting clip limit according to ambient light

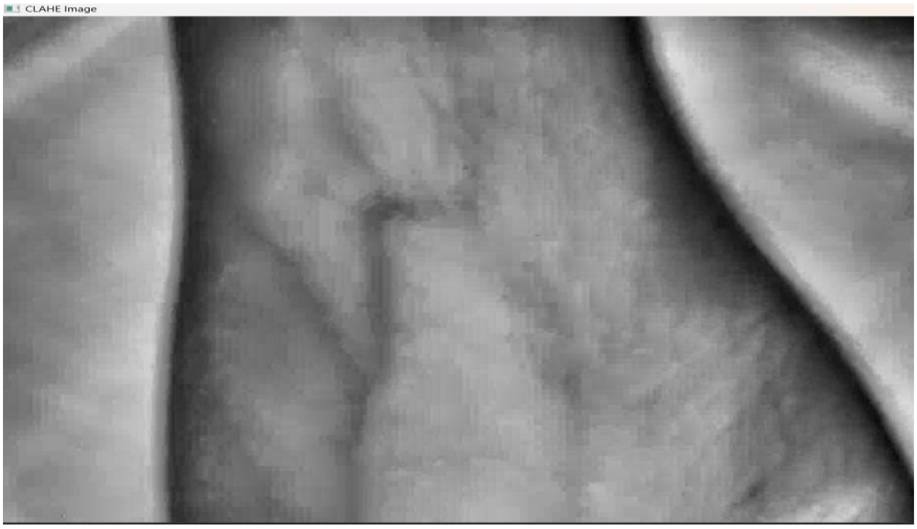

Fig.6 CLAHE Image

Image formed by adjusting adaptive brightness of histogram equalized image

Fig.7 Temperature,Humidity and Heart Rate output.

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Vein viewer technology brings a trifecta of advantages to medical procedures. Firstly, it significantly improves accuracy. By providing a clear view of underlying veins, healthcare professionals can locate them precisely, reducing the need for multiple needle attempts. This translates to a more comfortable experience for patients as the frustration and pain of repeated jabs are minimized. Secondly, vein viewers enhance efficiency. They streamline the vein puncture process by quickly identifying suitable veins. This saves valuable time for both healthcare professionals, who can move on to other tasks quicker, and patients, who spend less time waiting and experiencing discomfort. Finally, vein viewers play a crucial role in reducing complications. By aiding in precise needle placement, they minimize the risk of issues like hematoma (blood collecting outside the vein), nerve damage, and infiltration (leakage of medication outside the vein). Overall, vein viewer technology offers a win-win situation for both patients and healthcare professionals, leading to a more accurate, efficient, and safer medical experience.

CONCLUSION AND FUTURE SCOPE

Vein viewer technology, using near-infrared light to see veins, offers a significant boost to medical practices. Studies show improved success rates in tasks like IV insertion, leading to faster and more comfortable procedures for patients. Beyond routine use, vein viewers hold promise in diagnosing conditions like venous insufficiency. While not perfect, they are a valuable tool for healthcare professionals, improving efficiency and patient care. Additionally, the reduced time and resources needed per patient due to fewer missed attempts can lead to cost savings in healthcare settings.

Looking ahead, the future of vein viewer technology is bright. Imagine healthcare professionals wearing AR glasses that display real-time vein maps directly on patients, allowing for unparalleled precision during procedures. Vein viewers could even evolve to analyze vein patterns and blood flow, potentially aiding in diagnosing various venous conditions. Furthermore, miniaturized and portable vein viewers could revolutionize medical care by allowing paramedics to locate veins quickly in emergencies or nurses to streamline blood draws. Integration with telemedicine platforms could also enable remote healthcare providers to guide patients or technicians through procedures at home, increasing accessibility for everyone.

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